Servitization: A Pathway Towards A Resilient, Productive And Sustainable Future

Proceedings of the Spring Servitization Conference 2021

10 - 12 May, 2021

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Research and Programmes

The Advanced Services Group

The Advanced Services Group
The Advanced Services Group (ASG) is a centre of excellence within Aston Business School specialising in servitization and, in particular, advanced services. It delivers education, training and research to help global manufacturers and technology innovators to develop services-led strategies. The Centre have worked with over 200 businesses, including Baxi, Domino Printing Sciences, Ishida, Legrand, Thales and Waters, as well as a multitude of SMES, who have both informed and benefited from its research.

The Advanced Services Partnership
This is an international research network, which was formed in 2015, and comprises larger manufacturing organisations that are traditionally production-focused, and now in the earlier stages of exploring, developing and deploying advanced services. It sustains a nurturing environment comprised of one-to-one support and roundtables that are structured so that experiences can be shared openly and constructively. Partners are drawn from across Europe and the USA.

Digitally Enhanced Advanced Services (DEAS+) NetworkPlus. A community of researchers and practitioners funded by the EPSRC. The DEAS NetworkPlus works collectively across disciplines (e.g., computer science, engineering and business) and industry sectors (manufacturing, transport and financial services), to accelerate the innovation of Digitally Enhanced Advanced Services.

Pathways Towards Servitization: A Transnational Study of Organisational Transformation. An ESRC project with the primary aim of developing organisational transformation pathways that manufacturers can follow to efficiently and effectively innovate their organisations through servitization and compete through advanced services.

Advanced Services Growth 1. This project will provide new knowledge, accessed through a digital learning platform, for SMEs in the Greater Birmingham and Solihull region of the UK – it will underpin changes that SMEs will need to make in order to benefit from the changing digital landscape.

European Union
European Structural
and Investment Funds

Advanced Services Growth 3. This project will underpin new growth in manufacturing SMEs in the Black Country of the UK – it will be achieved through a series of business support interventions to help these SMEs to develop business models for advanced services that 'co-create' value for themselves and their customers.

Introduction

The Spring Servitization Conference (SSC) is dedicated to understanding how organisations can develop and adapt their business models around servitization and advanced services. Since its inception, the mission of SSC has been to play a key role in the development of a better understanding of servitization and to demonstrate the potential impacts upon businesses and society. SSC continues to fulfil this mission and provides the major forum for researchers from across disciplines including operations management, strategic management, service innovation, service marketing, information system, etc. to constructively share and debate their findings, generates new ideas, network and forge research partnerships.

We were planning to host the Spring Servitization Conference 2021 in Florence, Italy. However, similar to SSC2020, due to the COVID-19 pandemic, we were forced to move this year's conference to a fully virtual event too. The theme will be *Servitization: A Pathway towards a Resilient, Productive and Sustainable Future* and once again we will follow the now established format of a single stream where all contributors have an opportunity to present to the whole conference audience and engage in both structured and semi-structured panel sessions to discuss their work. The programme is designed to encourage strong participation, extensive debate, and bridge research theory and industrial practice. The conference will also feature keynotes from senior executives at leading manufacturing businesses.

We would like to thank all contributors, both new and returning colleagues, reviewers, delegates, sponsors, and staff for the continued support and commitments to the Spring Servitization Conference despite the uncertainties and challenges generated by the COVID-19 pandemic. We are truly hoping to return to our normal face-to-face conference from 2022.

Dr Ali Z. Bigdeli and Professor Tim Baines
The Advanced Services Group, Aston University, UK
May 2021

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EXECUTIVE SUMMARIES

A PRICING MODEL FOR DATA DRIVEN INDUSTRIAL SERVICES. AN EMPIRICAL CASE STUDY

Gorka Mendizabal-Arrieta, Eduardo Castellano-Fernández

ABSTRACT: As the manufacturing industry implements and develops digital servitization strategies, three characteristics of data are becoming more important; (1) its quality, (2) its production cost, and (3) the value given to it by suppliers and customers. Thus, within the framework of data-based industrial services, a case study has been carried out with a manufacturer from the Basque Country. In this way, a method that serves to assign a price to the data has been developed, integrating the previously mentioned features.

Purpose: To develop a pricing model for data driven industrial services.

Design/Methodology/Approach: A literature research has been conducted to identify scientific industrial data pricing frameworks. Concretely Shen et al. (2016) has served as the basis of the model presented, applied through a case study in an industrial manufacturer developing data-driven industrial services.

Findings: Integrating both the customer's and the manufacturer's assessment of data tuples into the proposed model facilitates the exploration of value co-creation, which benefits both parties. It provides the industrial manufacturer with a more effective data pricing policy and a strategy for building buyer loyalty. The customer obtains a way of making their needs known and a way of obtaining a more tailored product.

Originality/Value: Based on the model of Shen et al. (2016), which is focused on the case of personal data, the proposed model has been extended to the industrial environment, adding aspects related to data quality.

KEYWORDS: digital servitization, data pricing models, value co-creation, data quality

1.INTRODUCTION

In the context of digital servitization (Paschou et al., 2020), data-based business models are becoming more significant (Kühne; Böhmann, 2019), as is the need to use economic logic (Luong et al., 2016) to understand the sources of income (Opresnik et al., 2013). In this sense, it is important to consider the value generated through the interaction between customers and manufacturers (Martin et al., 2019), because this helps to improve the long-term experience of servitization (Jang. et al., 2020) and innovation in services (Johansson et al., 2019).

This paper thus sets out to propose a quantitative pricing model for data and reports a research study intended to fill the current gaps in the literature (Carrière-Swallow and Haksar, 2019). A second, parallel objective is to analyze the notion of value co-creation in a real case. Thus, an investigation has been carried out at an industrial manufacturer, where the data from a sensorized industrial machine was analyzed. Due to the characteristics of the model to be presented, the quality of data is considered numerically, along with the value assigned by the manufacturer and the customer to it. To respect confidentiality matters, some of the information used in the model is aggregated or exemplified.

The paper is organized as follows: Section 2 outlines the theoretical and empirical background; Section 3 describes the objectives and the methodologies applied; Section 4 shows the model proposed and its application to the case study, and; Section 5 summarizes the conclusions, limitations of the research and future research lines.

2. THEORETICAL BACKGROUND

2.1 Data pricing methodology and data quality

According to servitization literature (Castellano and Lopez, 2020), in order to quantify data-driven business models (Engelbrecht et al. 2016), methods for calculating; data quality costs (Haug et al., 2011) and pricing digital goods and services (Laatikainen and Ojala, 2018), should be highly considered.

In terms of data pricing methods, Zhang and Beltrán (2020) presents a comprehensive state of the art of different logics that could be applied. In such analysis, the study by Tang et al. (2013) related to "pricing tuples" is identified. This method is also used by Balazinska et al. (2011) and by Shen et al. (2019). In the case of Shen et al. (2016), a reversed pricing method is used, defined by Bernhardt (2004) as a "dynamic pricing mechanism, where the buyer and the seller influence the final price of a transaction". This same logic is used by Stahl and Vossen (2017), who state in regard to the relationship between these two actors that "[their] model enables data providers to tap the willingness to pay of customers, who would otherwise not buy their relational data product; in turn customers receive a highly custom-tailored data product".

2.2 Value Co-creation, perceived value, and consumer value

The concept of value co-creation (Grönroos, 2011; Galvagno and Dalli, 2014) is based on the relationship between manufacturers and customers, which is why it should be analyzed in the context of services (Vargo, et al., (2008) and Jaakkola et al. (2015).

Another significant notion is that of "perceived value", which is analyzed by Sánchez-Fernández and Iniesta-Bonillo (2007) and Suryadi et al. (2018) and in the context of the service industry by Boksberger and Melsen (2011). Graf and Maas (2008), Rajala et al. (2015), and Leroi-Werelds (2019) focus their research exclusively on analyzing consumer value, while Song et al. (2016) study the different levels of customer participation in the value proposition. Zeithaml et al. (2020) consider the value of the consumer from three different perspectives; (1) positivist, (2) interpretive, (3) social constructionist.

In the measurement of consumer value, the research by Sánchez-Ferández et al. (2009) details the use of unidimensional and multidimensional models. In this regard Klaus and Maklan (2012) present the application of multivariate analysis for measuring customers' service experience although, as advocated by Drolet and Morrison (2001), this type of study is costly at the very least. Hinterhuber (2008) as well as Liozu et al. (2012) and Töytäri et al. (2015) analyze the reasons why the method of value-based pricing encounters obstacles among companies, e.g. value assessment and communication, market segmentation, sales force management, and top management support.

3. RESEARCH OBJECTIVES AND RESEARCH METHODOLOGY

3.1 Objectives

The objective is twofold; firstly, to assign a price to the data generated by the sensors on an industrial machine, and secondly, to make a practical proposal that enables value to be co-created by the manufacturer and the buyer.

3.2 Methodology

A systematic literature research is applied, defined by Okoli and Schabram, (2010) as a "systematic methodology that is explicit and reproducible, to identify, assess, and synthesize the work produced by researchers and academics". Based on it, the work carried out by Shen et al. (2016), which proposes an equation for the pricing of personal data based on tuple granularity, has inspired the model proposed in this paper. This model has been developed based on a case study of an industrial manufacturer developing a data-driven industrial services.

Shen et al. (2016) equation and constraints are as follows:

$$p_i = P_s \times \left(\frac{w_i}{w} \times \alpha + \frac{q_i}{q} \times \beta + \frac{r_j}{r} \times \gamma\right) \qquad [1]$$

Where:

P_s Supply Price of data: This is obtained by subtracting the demand price of a data packet from the cost of collecting, analyzing, and sharing trading platform data.

$\frac{w_i}{w}$ Value weight: This is set according to experience and the greater the value weight is, the more important the data is.

$\frac{q_i}{q}$ Information entropy: As per Shannon, this refers to the probability distribution function that represents uncertainty; the greater the entropy the smaller the possibility of correctly estimating its value.

$$H(x_i) = -\sum_{j=1}^{k} p(x_{ij}) \log_2 p(x_{ij}) \qquad [2]$$

$$H(X) = \sum_{i=1}^{n} H(x_i) = -\sum_{i=1}^{n} \sum_{j=1}^{k} p(x_{ij}) \log_2 p(x_{ij}) \qquad [3]$$

$\frac{r_j}{r}$ Data reference index: This measures the authority of the user from the purchase amount and purchase times of data tuples at the same time.

The aforementioned study (Shen et al. 2016) focuses on the allocation of prices for personal data. Thus it has been adapted to the industrial data through the case study. The industrial machine analyzed is considered as a data packages, while the data tuples are the tabs displayed on the industrial manufacturers' dashboard (Sarikaya et al. 2018). The items represented are those considered as the attributes mentioned by Shen et al. (2016). In this way, six data tuples, namely "consumption", "temperature process", "feeding system process", "alarms", "OEE" and "maintenance" have been selected. For confidentiality matters, the items presented are referred as IT1, IT2, IT3, IT4, IT5, IT6.

In addition, eight workers were surveyed to secure information on the Data Scores variable. The questionnaire was completed by four employees of the industrial manufacturer and four employees of the customer itself, who were asked to give a score from one to seven to the six items mentioned above, with one as the lowest value and seven as the highest.

4. A PRICING MODEL FOR DATA DRIVEN INDUSTRIAL SERVICES

The model proposed is the following.

$$p_i = P_s \times \left[\left(1 - \frac{DQ_i}{DQ}\right) \times \alpha + \frac{w_i}{w} \times \beta + \frac{q_i}{q} \times \gamma + \frac{CRI_j}{CRI} \times \delta\right] \quad [4]$$

The characteristics of each variable are detailed below:

$\left(1 - \frac{DQ_i}{DQ}\right)$ **Data Quality.** It sets the logic proposed to confirm the validity of data. The sensor system emits one line of data per second, so a range of lines recorded is established: If between 3550 and 3600 lines are recorded in one hour the quality of the data is considered as valid. If the figure is under 3550 it is considered as invalid. Once this "quality filter" has been applied, the new data samples for each of the six items are defined as DQi, with the sum of all of them being DQ. The intention is for the items that have lost few lines to be "rewarded" with a higher final value. An example is shown in the table below.

Table 1: Example of the variable Data Quality

Item	Pre-data quality lines (A)	Post-data filtered lines (B)	DQ_i	DQ_i/DQ	$1 - (DQ_i/DQ)$
IT1	100	94	6	0,176470588	0,823529412
IT2	95	92	3	0,088235294	0,911764706
IT3	80	70	10	0,294117647	0,705882353
IT4	87	80	7	0,205882353	0,794117647
IT5	93	90	3	0,088235294	0,911764706
IT6	65	60	5	0,147058824	0,852941176
TOTAL	520	486	34	1	0

$\frac{q_i}{q}$ **Data Entropy.** To calculate the probability, the readings for each of the six items are divided into five ranges depending on their characteristics, and formulae [3] and [4] are then applied to estimate the ratio of the entropy.

Table 2: Example of the variable Data Entropy

Item	**RANGE**				
IT1	[0 - 5]	[5 - 10]	[10 - 30]	[30 - 80]	[80 - 110]
	30	15	20	25	4
IT2	[13 – 14.5]	[14.5 -16]	[16 – 17.5]	[17.5 - 19]	[>= 19]
	7	30	30	20	5
IT3	[<= 240000]	[240000 - 480000]	[480000 - 720000]	[720000 - 960000]	[>= 960000]
	13	22	5	20	10
IT4	[<=10]	[10 - 20]	[20 - 30]	[30 - 40]	[>=40]
	10	20	25	15	10
IT5	[Good]	[Pore rejections]	[Jet rejection]	[trap door rejection]	[Rejects lying down]
	50	7	13	5	15
IT6	[<=40]	[40 - 80]	[80 - 120]	[120 - 160]	[>=160]
	15	25	17	1	2

$\frac{w_i}{w}$ **Data Scores.** The results obtained in the survey are shown below. The columns TOTAL MANUFACTURER and TOTAL CUSTOMER are obtained by adding the score given to each of the items by the manufacturer and the buyer, while MANUFACTURER RATIO and CUSTOMER RATIO are obtained by normalizing that score to the number of participants, i.e. 4.

Table 3: Results of the variable Data Scores

Item	Manufacturer's scores (PS)	Customer's score (CS)	ADJUSTED score (AS)
IT1	0,134751773	0,225	0,18120805
IT2	0,163120567	0,10833333	0,15436242
IT3	0,184397163	0,15833333	0,17449664
IT4	0,191489362	0,2	0,18120805
IT5	0,14893617	0,15	0,1409396
IT6	0,177304965	0,15833333	0,16778523
TOTAL	1	1	1

As can be seen, there are differences in how the data is assessed. In cases where the customer gives a higher score, the industrial manufacturer can adopt the strategy of increasing its own score to match that of the buyer. When the customer's opinion is lower, the manufacturer can impose its own criteria and set a minimum aligned with its own interests. This results in the third column, namely ADJUSTED SCORE.

$\frac{CRI_j}{CRI}$ **Customer Relevance Index (CRI).** To measure the weight of each customer, the Customer Relevance Index indicator is proposed. This consists of three elements: (1) Whether or not the digital services offered by the manufacturer to the customer are contracted; (2) The weight of the customer in the operating account; (3) The number of machines for which the digital service is contracted. Thus, one point is awarded if the customer contracts the services and one more for each machine for which the product is contracted. Finally, one tenth of a point is awarded for each percentage point that the customer accounts for in the manufacturer's operating account. In this way, the CRI ratio obtained is 0.16666667, the same for all six items under consideration.

After describing the variables and the way in which they are obtained, the next step is to present the set of ratios needed to obtain the final price.

Table 4: Set of ratios obtained

Item	RATIO of DQ	Score RATIO			RATIO of Entropy	RATIO of CRI
		MANUFACTURER	CUSTOMER	ADJUSTED		
IT1	0,82352941	0,134751773	0,225	0,18120805	0,17436773	0,16666667
IT2	0,91176471	0,163120567	0,10833333	0,15436242	0,16769663	0,16666667
IT3	0,70588235	0,184397163	0,15833333	0,17449664	0,17764007	0,16666667
IT4	0,79411765	0,191489362	0,2	0,18120805	0,18272198	0,16666667
IT5	0,91176471	0,14893617	0,15	0,1409396	0,1495906	0,16666667
IT6	0,85294118	0,177304965	0,15833333	0,16778523	0,147983	0,16666667
TOTAL	5	1	1	1	1	1,00000002

P_S **Supply price.** Five elements that influence the different phases of the data life cycle are identified from the production of the data through an intermediate stage to the production of the information (Mendizabal, Castellano, Galfarsoro, 2021); (1) the total cost of the sensors, (2) the cost of the energy consumed by the machine, (3)the price to be paid to the company contacted, (4) the software used for data analysis and (5) the salary of the data analyst. For exemplification matters the supply price has been set to 3000€.

In addition, an estimate has been drawn up of the possible combinations of the four factors (i.e. α, β, γ, δ) used in the formula. A range between [0 - 0.50] has been established for each of them, with an interval of 0.05. Of the 14641 combinations, the requirement α + β + γ + δ = 1 is met in 891 cases, only 66 of which meet the requirement of IT1 + IT2 + IT3 + IT4 + IT5 + IT6 = 3000.

Table 5: Statistical results

	STATISTICS	**IT1**	**IT2**	**IT3**	**IT4**	**IT5**	**IT6**
MANUFACTURER	AVERAGE	475,786175	497,483866	528,703899	540,878007	465,193437	491,954636
	ESTAND.DEVI	14,7784141	1,68894027	6,29576397	8,85671996	7,07299593	10,4435387
	VARIANCE	218,401522	2,85251923	39,636644	78,4414884	50,0272714	109,067501
CUSTOMER	AVERAGE	566,034402	442,696632	502,64007	549,388646	466,257267	472,983005
	ESTAND.DEVI	22,2962127	23,9070446	6,8128785	11,7286676	6,85469665	6,58531708
	VARIANCE	497,121102	571,54678	46,4153134	137,561643	46,9868661	43,3664011
ADJUSTED	AVERAGE	522,242455	488,725714	518,803381	530,596699	457,196864	482,434906
	ESTAND.DEVI	5,11837144	5,21978706	3,97585393	6,23699627	9,21064236	7,82642173
	VARIANCE	26,1977262	27,246177	15,8074145	38,9001225	84,8359326	61,252877

5. CONCLUSIONS

5.1 Academic and practical implications

Academically, the research contributes to the state of the art by adapting Shen et al. (2016) model to the industrial data domain, as well as extending it through new variables, such as the quality of data and the cost of data production.

From a practical point of view, the data-driven industrial services pricing model proposed in this paper allows to integrate both the customer's and the manufacturer's valuation of data tuples, facilitating the exploration of value co-creation. It provides industrial manufacturers with a more effective data pricing policy and a strategy for building buyer loyalty. Besides, the customer obtains a way of making their needs known and a way of obtaining a more tailored product.

5.2 Limitations and future research

The study has been carried out at a single industrial manufacturer developing data-driven industrial services. It’s extension to new cases is desirable for generalization purposes.

Besides, the model presented is based on lineal relationships between the constituent variables. Non-lineal relationships could be explored for validating the robustness of the results.

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THE MULTI-DIMENSIONAL HIERARCHICAL STRUCTURE OF THE SERVITIZATION TRANSFORMATION

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ABSTRACT

Purpose: This paper is studying the hierarchical structure of the six servitization dimensions, in order to help the reader understand the potential relational maturity effects emerged among these.

Design/Methodology/Approach: This study is framed upon a theoretical reasoning of nine hypothetical relations among servitization dimensions. These postulated relations are investigated by a statistical partial least square analysis, based on 101 observations of Danish SME manufacturers.

Findings: Seven significant relations were identified which emphasise the coexistence of a multi-dimensional transformation. None of these relations were found to add a negative effect.

Originality/Value: As one of the first quantitative studies to investigate the coexistence of multiple servitization dimensions, this study leads to valuable insight and a set of new research avenues.

KEYWORDS: servitization, maturity, multi-dimensional, consequential effects, partial Least Square

1. INTRODUCTION

Servitization is an organisational transformation embracing the entire organisation (Baines et al., 2009). Previous literature has assumed that this transformation is following a redefined and structured path (Oliva et al., 2003), and while the structured progression models are mainly based on large manufacturing firms (Brax et al., 2017), it seems that the versatility of SMEs, facilitate them to succeed through various value constellation in a multifarious progression (Kowalkowski et al., 2013). This indicates that the servitization transformation, in reality, is unstructured and following a continuum. Hence, the maturity of servitization should be understood in a similar manner. Additionally, it is believed that the servitization transformation should be viewed in a multi-dimensional perspective (Baines et al., 2017). While servitization is following a continuum, such multiple dimensions follow a simultaneous progression, which potentially entail a relational influence among each other. Thus, a superior understanding of such relations is crucial to understand the full effects toward a successfully progression of servitization. Furthermore, such understanding includes the relational consequential effects among the dimensions (Kindstrom et al., 2014). For this reason, it is the researcher' vision to identify the pathway towards a successful servitization transformation, through unique maturing combinations of the servitization dimensions and underlying components. Firm maturity is defined as the increased capability to manage specific domains (Rapaccini et al., 2013, p. 302). By adopting the view of positive and negative consequential effects, it is believed that a successful transformation consists of the right proportion of several dimension' maturity level. To consider the maturing proportion a profound understanding of the dimensional relations is necessary. Yet, although recent servitization research have successfully presented a comprehensive, or even holistic, framework for understanding the servitization maturity in a multi-dimensional perspective (Adrodegari et al., 2020). It have been emphasised that a profound maturity model embracing the transformation as a whole are still missing, as important components like management and strategic dimensions are absent in current models (Andersen et al., 2020). Extending the thoughts of Adrodegari et al. (2020), Andersen et al. (2020) identified six generic dimensions (organisational governance; strategic management; value function activities; market reach; digital integration; and service integration) consolidated by existing literature of servitization and conceptualised upon prior servitization maturity models (e.g. Jin et al. (2014)). For this reason, these extended dimensions are employed in the further investigation. However, prior research overlooked the importance of understanding the relation among co-existing dimensions, hence failing in taking the fluctuating progression into account. As It is reasonable to believe that such relations are not equivalent among each dimension, a certain hierarchical order may occur. For this reason, the research is studying the hierarchical structure of the six servitization dimensions, in order to help the reader understand the relational effects emerged among these.

2. THEORY AND HYPOTHESIS

2.1 The Relation of Servitization Maturity Components

As stated by Adrodegari et al. (2020), only few studies have constructed a servitization maturity model (MM) of the transition toward service businesses. The degree of maturity has been assessed upon multifaceted levels, and consist in the literature of pre-defined levels of maturity (Rapaccini et al., 2013), theoretical defined prescriptions (Wikström et al., 2009), and evaluating own performance scores (Coreynen et al., 2018). A similarity for the prior MM is it, that each of the presented MM' evaluate the maturity level of each component individually, and not in relation to each other. Neither do they consider the outcome of other components. An exception is the study by Coreynen et al. (2018), who evaluate the maturity level of each component on multiple observable variables, but who did not consider the relations among the components. For this reason, it leaves a potential to further develop our understanding of MM' by incorporating such balanced view of the relational connections among each dimension, which to our best knowledge has not been achieved within servitization.

2.2 The Hypothetical Relations of Servitization Maturity Dimensions

2.2.1 Organisational Governance

The organisational governance (OG) refers to a firms' ability to build, integrate and align the organisation with the transformational properties from embarking on the servitization journey (Andersen et al., 2020), from which new experiences and realities emerges for the manufacturer (Oliva et al., 2003). These new realities comprise of the need for re-engineer new organisational structures to facilitate service design and delivery (Jin et al., 2014; Rapaccini et al., 2013), and the awareness on managing strategic choices by developing clear, implementable service management policies, process and resources (Tukker et al., 2006). The degree of formalised procedures and processes have been seen as a progression of servitization, as these ensures consistency and quality (Jin et al., 2014). While such formalisation of the organisation follows the organisational concept (Wikström et al., 2009), it is reasonable to believe that such elements have a positive influence on service infrastructure, thus relating to integration of services. Service integration comprise among other things of the firm's ability to seize service opportunities (Coreynen et al., 2018), whereas elements as processes, capabilities and available resources influences the outcome of this dimension. For this reason, are the following hypotheses stated: **H**^{1}: *A manufacturing firms' degree of organisational governance have an impact on the degree of service integration.* In similar constellations, are the value function activities positively influenced by the allocation of resources, and the organisational structure to facilitate co-created value (Huikkola et al., 2016), this in term of procedure and processes (Coreynen et al., 2018), organisational concept, and personnel approach (Wikström et al., 2009). This in particular by establishing dedicated teams and roles for new service development, and developing specific sales tools, methods and procedures for cost of ownership models (Adrodegari et al., 2020): **H**^{2}: *A manufacturing firms' degree of organisational governance have an impact on the degree of value function.* Further, the availability of resources, formalisation of procedures and processes, and the organisational concept all are seen as instruments for the management to implement new strategic directions. Hence: **H**^{3}: *A manufacturing firms' degree of organisational governance have an impact on the degree of strategic management.*

2.2.2 Strategic Management

Strategic management (SM) refers to firms' ability to build and maintain strategies in order to successfully implement servitization (Andersen et al., 2020; Baines et al., 2017). Prior research investigating the consequences of servitization have emphasised that servitization is a beneficial strategy if managed properly and with strategic focus (Baines et al., 2009; Neff et al., 2014). The managerial commitment poses a fundamental role in maintaining and building strategies of the transition (Lexutt, 2020; Neff et al., 2014), and is seen as an important element for the value function activities. As the managerial mindset changes toward customer-centric logic, it will facilitate better value propositions through customer integration, hence leading to new value creation and optimised cost structures (Huikkola et al., 2016; Liu et al., 2019). As well as the fundamental change of the organisational culture as accommodative to service provision (Baines et al., 2009). Hence, **H^{4}**: *A manufacturing firms' degree of strategic management have an impact on the degree of value function.*

2.2.3 Value Function Activities

The value function activities (VF) refer to firms' ability to embrace servitization by developing new business models that can create and capture value that servitization promises (Andersen et al., 2020; Baines et al., 2014). Particular emphasis are placed on the value chain activities, regarding the responsibility to support service-products throughout the product life-cycle, along with finding an innovative way to make service more tradable, with a functional cost structure (Spring et al., 2013). Managing the value chain activities within servitization can be challenging, and required skills have to be acquired through organisational governance (H^{2})(Adrodegari et al., 2020), as well as new up- and downstream partnerships. The latter, need to be managed effectively in order to leverage the needed capabilities in a strategic management perspective (H^{4})(Adrodegari et al., 2020; Cui et al., 2019). For this reason, market reach is an important component for the VF as the co-creation and solution development are enabled through the integration of customer needs (Lenka et al., 2017) and utilising network capabilities (Coreynen et al., 2017). Hence, **H^{5}**: A manufacturing firms' degree of market reach have an impact on the degree of value function activities.

2.2.4 Market Reach

The market reach (MR) refers to firms' ability to scan the business environment to identify and apply external capabilities and resources in supporting the servitization journey through new and optimised service solutions (Andersen et al., 2020). Prior literature agrees on the importance of value co-creation of whom a particular emphasis is put on the role of customers and network partners (H5) (Rapaccini et al., 2013). Accordingly, digitalisation enables a deeper integration into customers processes, to reach new levels of servitization through increased network involvement and value creation (Coreynen et al., 2017), which potentially influences both the MR and VF of the firm. Hence, **H^{6}***: A manufacturing firms' degree of digital integration have an impact on the degree of market reach.*

2.2.5 Digital Integration

Digital integration (DI) refers to firms' ability to integrate new technologies, increase external accessibility and apply data as a resource for new service offerings (Andersen et al., 2020). Digitalisation is breaking barriers between industry segments and changing traditional value chains into the provision of services (Kuula et al., 2018). As such, incorporating digital services aims to develop the capturing and processing of data and information, allowing manufacturers to develop new business models by exploiting the potential of their products (Neff et al., 2014; Vendrell-Herrero et al., 2017). Hence, **H^{7}***: A manufacturing firms' degree of digital integration have an impact on the degree of value function.* Digitalisation enables better allocation of resources and more accurate information sharing within and outside the boundaries of the firm (Kindstrom et al., 2014). Both of which positively influences the market reach (H^{6}) and management governance. Hence, **H^{8}**: *A manufacturing firms' degree of digital integration have an impact on the degree of management governance.* Further, digital technologies and appliance create new opportunities and is understood as a core enabler and driver for servitization (Sjödin et al., 2020). Digitalisation is seen as essential for effective delivery by optimising the service infrastructure and processes (Reim et al., 2019), which potentially influence the service integration positively as the maturity of service integration increases: **H^{9}**: *A manufacturing firms' degree of digital integration have an impact on the degree of service integration.*

2.2.6 Service Integration

The service integration refers to firms' ability to integrate data appliance from service and product data, service infrastructure, and process and policy formalization into the development of new optimised service solutions (Andersen et al., 2020).

2.3 The multi-dimensional servitization maturity framework

The dimensions compose an essential role in the progression of servitization toward the achievement of it. Success is seen as a progression or development of the focal firm' performance toward a preferred situation (Bustinza et al., 2019), and should be assessed upon financial and non-financial measures. As such, the model is estimated to predict the servitization success (SS), and hence each dimension' prediction toward the endogenous variable (SS). The improvement of each dimension is believed to contribute to a successful achievement of servitization. Figure 1 illuminate the hypothetical relation among each dimension, and illustrates the complexity within the servitization field in a simplified manner. Further assessment of the dimensional impact of servitization success, are outside the scope of this study.

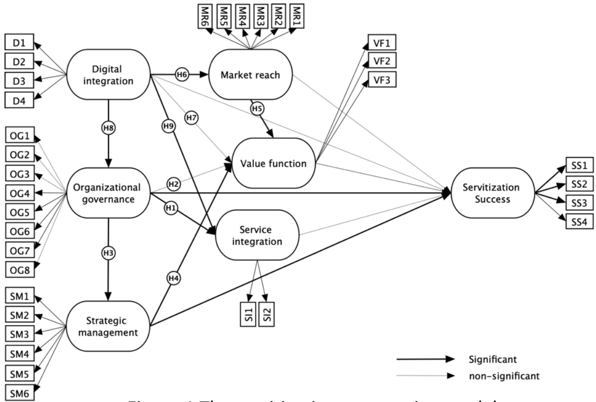

Figure 1 The servitization progression model

3. METHODOLOGY

Inspired by the study of Kohtamäki et al. (2013), the postulated relations are tested upon a partial least square (PLS), by computing the significance of the relations' path-coefficients. PLS is a suitable statistical tool for predicting the relationships rather than explaining them, in the latter covariance-based methods are preferred (Jöreskog et al., 1982). Generally, PLS is seen as more robust than other SEM techniques in violation of statistical assumptions, and are referred to as a distribution-free method (Vilares et al., 2010). The statistical tool SmartPLS 3.0 are used for this study.

3.1 Data Collection, Response Pattern and Respondents

The data collection was distributed through a web-based questionnaire sent to manufacturing firms registered under the Danish industry code ´C28. producers of machinery and tools´ within the Danish firm register (CVR.dk). This provided the study with 1.597 potential SMEs of which 1.194 had approved sharing contact information. Additional mails were sent to 358 SMEs enrolled in the Servitize.dk project, to ensure participants with varying degree of service implementation. The first notification comes with a brief description of the research purpose and the potential managerial contribution to encourage the respondents. A second notification were sent to all non-responders six days later. Following the ten times rule, a minimum of observations is estimated by the highest denominator of eighter the largest number of observable variables for a single latent variable (in this case 8), or the largest number of loadings toward a single latent variable (6) in the model (Hair et al., 2011). Thus, a required number of observations are set to 80 respondents. In total, 163 observations were gathered resulting in a response rate of 22,9% (82) for servitize.dk and 6,7% (81) for the industry. Three control variables were included to ensure the relevance of the observations. The degree of servitization established whether firms are involved in a servitization process assessed upon their service advancement (none, initial, repeatable, defined, managed or optimised) inspired by Rapaccini et al. (2013). The number of employees states whether they are considered a SME (5 removed).

3.2 Measurement of Constructs

The measures and items used in this investigation are adopted from prior research in servitization maturity modelling. By adopting the item formulations by Coreynen et al. (2018), each item are rephrased to statement-related whereas respondents evaluate recent performance upon each item. This evaluation was scaled on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). As such, being positively related to the progression of servitization with respect for the adopted item' measures. Each item adopted this framing to ease the reading and interpretation by the respondent. As the study have rephrased and structured new items, a particular focus were made on testing the validity and reliability prior to distribution. To assess the internal validity of measures, items and the survey structure, three academic colleagues were invited to evaluate these aspects leading to smaller phrasing adjustments. Further, by inviting one respondent to conduct the survey while observed, additional linguistic adjustments were made. The survey was distributed in Danish, which potentially creates a misinterpretation due to linguistics. To protect the content validity of the translated items, a back-translation were made by letting an unbiased person translate the Danish version into English and compare the English versions. Finally, a pilot test was conducted for test of the measure' reliability and internal consistency. 200 respondents were invited to participate, providing 11 responses. From here, a Cronbach' Alpha (α = .976) proved the reliability and consistency of the measures (Hertzog, 2008, p. 185). The final distribution gathered 104 completed observations and 59 partially completed. All observations exceeding an 85% completion rate were merged into the dataset (n=125), and a further missing value analysis proved the values as Missing Completely at Random (P = .483). To avoid biased results from imputations, a pair-wise deletion was chosen during the investigation. This, however results in an uncertain effective sample size.

3.3 Common Variance

A preliminary analysis of the model and the dataset were made by evaluating the significance of both outer loadings and weights, controlling for variance inflation factors (VIF) and for outliers. This led to a sequential extraction of two items both insignificant in loadings and weights (SS4 and OG3), while no VIF' were identified at this stage. Additionally, an assessment of the factor scores led to a list-wise removal of 24 outliers, with an absolute value above 1.96 (α=.05) (Weston et al., 2006). To evaluate the reliability and validity of the estimated model, a further emphasis is put on the internal reliability, convergent validity and discriminant validity in the following. To test for internal consistency a composite reliability of the models' constructs were applied, which fulfilled the criterion for a confirmatory model (>= .70) with adequate reliability as the scores ranged from .781 to .883 (Hair et al., 2011). Further, all outer loadings obtain significant, although several items attained a weak outer loading beneath the criterion of .70 for good indicators. Following Hair et al. (2011), OG8 were removed as it did not surpass the critical .40 cut-off (.384). The remaining weak outer loadings were obtained as the removal of these might harm the content validity. This indicate that the combination of items is insufficient as they do converge poorly. To ensure the convergent validity on the construct level an assessment of the Average Variance Extracted (AVE) were performed. From here, it was evident that the constructs are capable of explaining more than half of the variance of its indicators by exceeding the .50 limit, hence establishing the convergent validity of the constructs (Hair et al., 2011). Further, the discriminant validity was established, as no cross-loadings exceeded the indented loadings of the associated constructs. Additionally, while the disattenuated correlation establishes the discriminant validity for the majority of the constructs, this is not true for OG (Heterotrait-Monotrait ratio = .962), which emphasises the necessity for remodelling the construct. While OG2 (.512) and OG1 (.557) showed weak loadings, these were previously kept for the sake of content validity. However, as the analysis illuminate how each discriminates the validity, these are removed sequentially. Finally, a bootstrapping procedure were performed with 2000 re-samples with the same number of cases as the original sample (n = 101), to establish the significance of the postulated relations.

Table 1 - Adopted and rephrased Items and constructs

Constructs and Items (all measured in 7-point Likert scale)	**Loading**
Organizational Governance (1 strongly disagree – 7 strongly agree)	
OG1: We have incorporated a focus on natural work flows within the entire organization – Wikström et al., 2009	-
OG2: We have prioritized business development – Wikström et al., 2009	-
OG3: We encourage employees to manage decision on their own - Coreynen et al., 2018	-
OG4: We have ensured a formal, optimized process for the service delivery - Coreynen et al., 2018	.744***
OG5: We are able to turn service activities into a profitable business - Coreynen et al., 2018	.914***
OG6: We are able to turn service activities into a professional business - Coreynen et al., 2018	.886***
OG7: We have procedures and routines to minimize costs related to new service activities - Coreynen et al., 2018	.848***
OG8: We can overcome internal resistance and conflicts - Coreynen et al., 2018	-
Strategic management (1 strongly disagree – 7 strongly agree)	
SM1: [Our management] consider services as a lasting differentiation strategy – Coreynen et al., 2018	.686***
SM2: … consider the combination of products and services as a potential way to improve profitability –Coreynen et al., 2018	.782***
SM3: … aims to exploit the financial potential of services – Coreynen et al., 2018	.836***
SM4: … considers services to compensate fluctuating product sales – Coreynen et al., 2018	.715***
SM5: … considers services as highly profitable – Coreynen et al., 2018	.771***
SM6: We are able to formulate clear service-related strategies and objectives – Coreynen et al., 2018	.676***
Value function activities (1 strongly disagree – 7 strongly agree)	
VF1: Are able to provide a performance-based solution that guarantees product's operational performance – Cui et al., 2013	.741***
VF2: We are able to provide customized cost structures for our customers – Cui et al., 2013	.672***
VF3: We evaluate the operating and financial risks and manage uncertainty continuously – Lexutt, 2020	.777***
Market reach (1 strongly disagree – 7 strongly agree)	
MR1: We analyse what we would like to achieve with each customer – Coreynen et al., 2018; Jin et al., 2014	.680***
MR2: We regularly discuss with our customers how we can support one another in our success – Cui et al., 2014	.789***
MR3: We remain informed about the goals, potential and strategies of our customers – Coreynen et al., 2018	.764***
MR4: We analyse what we would like to achieve with each supplier – Coreynen et al., 2018	.787***
MR5: We determine in advance possible suppliers with whom to discuss the building of relationships – Coreynen et al., 2018	.703***
MR6: We remain informed about the goals, potential and strategies of our suppliers – Coreynen et al., 2018	.752***
Digital Integration (1 strongly disagree – 7 strongly agree)	
D1: Our technology allows fully automated and optimized real-time data – Neff et al., 2014	.717***
D2: Our IT systems allows us integrated access to customer-related data – Coreynen et al., 2018	.857***
D3: Our IT systems allows us integrated access to value chain-related data – Coreynen et al., 2018	.830***
D4: Our IT systems allows us integrated access to market-related data – Coreynen et al., 2018	.801***
Service integration (1 strongly disagree – 7 strongly agree)	
SI1: We can easily add significant product-service variety without increasing costs – Coreynen et al., 2018	.915***
SI2: We can add product-service variety without sacrificing quality – Coreynen et al., 2018	.770***
Servitization Success (1 strongly disagree – 7 strongly agree)	
SS1: We were able to increase the service-specific revenue in the previous 24 months (only services)	.851***
SS2: We were able to increase the company-specific profit margin in the previous 24 months (entire firm)	.673***
SS3: Degree of service implementation (service advancement) – Jovanovic et al., 2016	.675***
SS4: Our sales are primarily to established customers with recurring buying patterns (Customer's loyalty) -	-

*** $p \leq 0.001$ **$p \leq 0.01$ *$p \leq 0.05$

4. RESULTS

The reconfigured model obtains a SRMR of .098 (<.10) indicating an acceptable fit (Weston et al., 2006). The inner model obtained no critical collinearities with a max VIF of 2,23. Overall, the validity and reliability of the items and constructs are assessed as acceptable for a preliminary study with reasoning in statistical and theoretical emphasis. Further, the model were capable of explaining 44,2% of servitization success, with an adjusted R^2 of .442, which emphasis weak strength of the model (Hair et al., 2011). The relations emerged from OG, counts the connections toward SI (H1), VF (H2) and SM (H3), of which the relation between OG to SI (β=.40; p≤.05) and OG to SM (β=.68; p≤.05) were significant. In the meantime, the relation from OG to VF (β=-.03; n.s.) were statistically insignificant. Hypothesis 4 identified a significant relation from SM to VF (β=.31; p≤.05), similar to the relation from MR to VF (β=.47; p≤.05). Further, the DI obtained the most postulated relations, and hence the potential strongest emphasis for increasing the servitization effort. The relations emerged from DI included DI to MR (H6; β=.41; p≤.05), DI to OG (H8; β=.40; p≤.05) and DI to SI (H9; β=.37; p≤.05) which all returned significant, while DI to VF (H7) were insignificant. The majority of relations toward servitization success were found to be insignificant except SM to SS (β=.21; p≤.05) and OG to SS (β=.44; p≤.05). This, however, can be explained by a poorly estimation of SS, which the outer loadings did imply and due to the removal of SS4. The evaluation of these relations is illustrated in figure 1.

5. DISCUSSION

The study identified seven statistically significant relations among the servitization dimensions, hence retaining the majority of the postulated hypothesis. The findings demonstrate several relations, impacting several dimensions simultaneously, which strengthen the idea of servitization as a continuous transformation of multiple coexisting dimensions. As interestingly, none of the significant relations articulated a negative consequential effect, although OG to VF possessed a small insignificant negative effect (β=-.033). This indicates that the dimensions are positively influenced by each other, and it is reasonable to conclude, that an increase in one dimension, leads to an increase in another related dimension. Such findings, allows practitioners to evaluate future plans accordingly to the potential impact of each dimension. This, by acknowledging the relational effect among each other, but in particular by estimating an accurate influence. The composite value calculated through linear weighting process based on the models outer loadings and the respective response of each item (Song et al., 2013), potentially provides the practitioners with such preliminary evaluation tool of own servitization maturity score of each dimension. The standardised outer loadings interpret the impact of each predictors toward the intended construct, while the path coefficients reveal the impact of each relation. As such, these findings potentially can be used to assess the importance of each theoretical element, hence ease the decision-making process, by allocating resources to the elements with the highest impact toward a given goal. For instance, an increase of the manufacturer’s organisational governance eventually led to an increase of .683 in the performance of strategic management, which e.g stems from the allocated resources. Furthermore, this weighted importance of each dimension’ role in servitization, emphasising important streams for future research. However, as the PLS are most suitable for predicting relations, additional investigations are needed to obtain the explanation of these predictions. Despite the delimitation of the model, due to the remodelling in section 3.3, it is reasonable to believe that these relations provide important insights in the search of fully understanding the field of servitization as a whole.

6. CONCLUSION

This research illuminated new insight into the hierarchical structure of the six servitization dimensions, by theorising and statistically identifying seven significant (DI>OG, DI>MR, DI>Si, OG>SI, OG>SM, SM>VF, MR>VF) and two insignificant (DI>VF, OG>VF) relations. These findings add to the stream of a multi-dimensional perspective of servitization maturity, by establishing the coexistence of the six dimensions. Further, these findings provide practitioners with a preliminary foundation for decision-making through weighted importance of each dimension, their relations and underlying parameters. Importantly, none of the relations had a significant negative consequential effect. Due to the limitations of the model, additional studies into statistical predictors of the dimensions are needed. In particular, this study calls for further investigation into predictors of organisational governance and servitization success to enable a better prediction of the dimensions impact. Finally, additional research into usability of the weights, and the identified relations are welcome. Overall, it is believed that these findings are an important first step toward a unique maturing combination approach.

7. LIMITATIONS

The study is lacking under the need for a clear definition of servitization success, which hindered the ability to construct or adopt predictors of this dimension.

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BUSINESS MODEL ELEMENTS AND PATTERNS OF IOT PLATFORMS IN THE ENERGY INDUSTRY

Lino Markfort

ABSTRACT

Purpose: To unlock new, more data-driven business opportunities, product companies are seeking to incorporate IoT platform logic into their business models. In this paper a phase model illustrates different paths companies can take shaping business model innovations in the context of IoT platforms.

Design/Methodology/Approach: The study applies a mixed method with two research studies: Study I – a qualitative interview study to explore dominant business model elements, and Study II – an explorative desk research combined with a systematic evaluation of IoT platform development stages.

Findings: Study I confirmed the platform types known from the literature and characterized associated business model elements in more detail. Study II provides an overview of the development of IoT platforms in the energy industry and enables a structuring of individual development stages.

Originality/Value: The paper makes two original contributions: (1) it extends the previous paths to digital servitization with development stages to business model innovations for the path to an IoT platform logic, (2) it relies on a mixed method approach identifying these stages.

KEYWORDS: IoT platforms, business model innovation, energy industry

1. INTRODUCTION

In recent years the importance of platforms has steadily increased both in theory and in practice. In particular the large digital platforms of Amazon, Facebook or Google have aroused the interest of scientists due to their enormous value creation potential. In the literature on digital servitization data is described as a crucial production factor that enables companies to gain insights into how systems work, customer behavior and the use of value networks. Companies in the B2C context, such as Amazon, Facebook, Google, AirBnB or Uber, have already proved that value creation using data transmitted via digital platforms can be a lucrative business. This trend has also spread to companies in the B2B sector, such as Siemens (Mindsphere), General Electric (Predix) or even Hitachi (Lumada), which see not only growth opportunities, but also the possibility of building more sustainable and resilient business models through digital offerings and applications. In the literature initial insights have been gained around business models and patterns of companies using IoT platforms. Nevertheless, the exploration of an industry along the entire value chain has been neglected so far. For this thesis, therefore, the energy sector was considered, which is also currently undergoing strong change and requires a dynamic view of the business models. Looking at the energy sector, it is striking that this industry has changed significantly in recent years and continues to change. One main driver, climate change, requires a change in value creation in favor of energy production using renewable processes (e.g. solar energy, wind energy, tidal power plants or hydrogen production) instead of using fossil fuels (e.g. coal, oil or natural gas). This transformation at the level of physical products and services offered also opens up new opportunities for value creation in relation to digital products and services. So far, the literature has mainly considered business models from a static perspective. This paper addresses this gap by looking at a dynamic perspective of business model development using the energy industry as an example and presents a phase model based on the product-service continuum of Oliva & Kallenberg (2003).

2. THEORETICAL BACKGROUND

Two main platform concepts are known in the literature - transactional (Wheelwright & Clark, 1992) and technological (Frattini et al., 2014; Gawer & Cusumano, 2014). These concepts have been mainly used in B2C contexts and it has been assumed that essential elements can also be adopted for platforms in B2B contexts (de Reuver et al., 2018; Saarikko et al., 2016). However, recent literature speaks of three types of platforms: Transactional platforms, Innovation platforms, and Hybrid or Integrated platforms (Parker et al., 2016). Transaction platforms act as intermediaries and enable transactions between different actors on the different sides of the platform (e.g. Ebay as a marketplace to mediate between buyers and sellers, Uber as an intermediary between passengers and drivers). The actors connected via the transaction platform form an ecosystem. Innovation platforms create a technological foundation for other companies in the ecosystem to develop complementary technologies, products or services (e.g. Google Android and Apple iOS as a technical foundation for app developers, Microsoft Xbox as a technical foundation for game developers). Integrated platforms combine elements of transactional and innovation platforms (e.g. Apple's App Store is a marketplace for transactions between app providers and users while providing technical tools for content creation to partners in the ecosystem).

In order to create digital offerings on these platforms, the literature identifies important elements such as the technologies for connectivity (e.g. sensors), networking and data analytics, and cloud infrastructure (Porter & Heppelmann, 2015; Iansiti & Lakhani, 2014). Another characteristic of business models (BMs) around IoT platforms is the existence and use of an ecosystem consisting of various interconnected actors (e.g., provider, owner, producer, and customer) (Parker et al., 2016). Within the platform ecosystem, companies can play multiple roles and generate different revenue streams simultaneously, implying a value network (Gawer & Cusumano, 2014; McIntyre & Srinivasan, 2017).

Beyond the existence of platforms in the B2B context, however, the question of the economic viability of such platforms arises repeatedly. Here, the BM behind the platform concept is the decisive factor. The business logic of equipment manufacturers is characterized by the fact that they want to offer customer solutions through a combination of products and services, which make the customer more successful by increasing efficiency and effectiveness (Tuli, Kohli, & Bharadwaj, 2007). Here, the products are machinery and spare parts. In particular, financial and external services (e.g. machine financing, repair, maintenance) and more advanced services (e.g. equipment modernization, integration, and optimization) are seen as services (Baines et al., 2017). In addition, services to guarantee and charge for product use and performance (e.g. pay-per-use services) should also be mentioned (Cusumano, Kahl, & Suarez, 2015). Consequently, value-added activities can be the development, manufacturing, and distribution of products, for the provision of services and their integration into customized solutions. Looking at the share of sales, services already account for 20 to 50% of total sales (Fischer, Gebauer, & Fleisch, 2012). Oliva & Kallenberg (2003) presented a model with their product-service continuum, which depicts the development of companies from a product-centric to a service-oriented offering. Thereby, the transformation towards a service-centric company follows different stages. In the first stage, companies invest in the intelligence of their existing product and service offering by connecting devices to the Internet, enable data collection and transfer to make these products “smart” (Raff et al., 2020). This involves embedding software, sensors, actuators and microprocessors into products. In addition, components to create connectivity are used to enable communication between the product and a data cloud (Fleisch, Weinberger, & Wortmann, 2015; Ng & Wakenshaw, 2017; Yoo, Boland Jr, Lyytinen, & Majchrzak, 2012). The next step is to use a data cloud (also referred to as a "cloud") and an extended technology stack to analyze and evaluate data. Here, the evaluation can range from more descriptive, diagnostic analyses to prescriptive and autonomous processes (Gouriveau et al., 2016), which are enabled by Big Data, machine learning, and artificial intelligence (Opresnik & Taisch, 2015). This results in a phase model, according to which increasing autonomy of digital services becomes possible with increasing complexity of data analysis [as shown in Figure 1]. Taken as a whole, these phases all belong to the process of using digital technologies to enable the development of new products and services and the improvement of existing ones, which is also referred to in the literature as digital servitization (Gebauer et al., 2020 b). In this context, it is also worth mentioning the notion of (co-)value creation, which enables companies to generate valuable knowledge from data in collaboration with other participants in an ecosystem (Paschou, Rapaccini, Adrodegari, & Saccani, 2020).

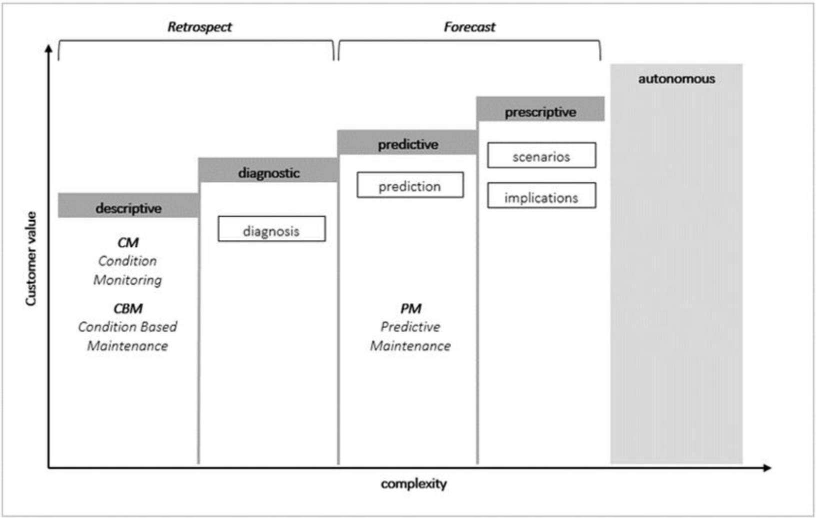

Figure 1: Phase model of the evolution of customer value as a function of the complexity of digital offerings (Own representation 2021, based on: Gouriveau et al., 2016)

As explained at the beginning, researchers in the servitization literature assume that the share of services in companies' portfolio of offerings will continue to increase. An initial matrix illustrating the individual growth paths, that companies can follow, has been described by Gebauer et al. (2020 a). This matrix [as shown in Figure 2]., where there are two main movements in this matrix.

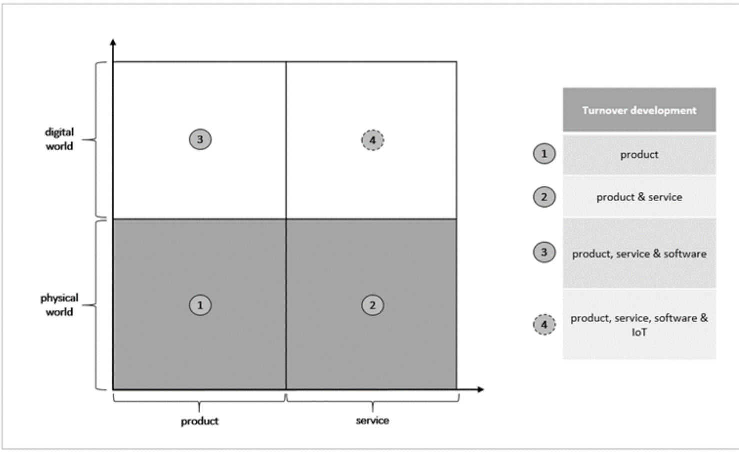

Figure 2: Growth matrix for product-service combinations (Own representation 2021, based on: Gebauer et al., 2020 a)

Movement along the horizontal axis indicates that companies are increasingly generating revenue with traditional services, while movement along the vertical axis implies revenue growth through digital offerings (Gebauer et al., 2020 a). However, although these considerations are already being made and implemented in companies, there are signs that companies are struggling to achieve the expected revenue growth. This phenomenon is also described as the digital paradox (Gebauer et al., 2020 a; Wortmann et al., 2019), because although high investments are made in the expansion of digital value creation and offerings for customers, economic success often fails to materialize. Gebauer et al. (2020 a) present possible reasons here in their work, which they refer to as barriers within a BM. In this context, the dynamics resulting from the transformation of the BM is one of the decisive factors. In particular, the phases of such a transformation result in changes to the BM components of value proposition, value creation, and profit equation (Gebauer et al., 2020 a).

Based on the discussion around the adaptation and expansion of companies' portfolio of offerings, the BM concept in particular is crucial as a basis for the economic success of a company. A BM is described as a complex system that hypothetically enables the central value proposition to be transferred to the customer as a benefit (Seelos & Mair, 2007). In this context, two interwoven perspectives are described in the literature: a holistic one, based on the logic underlying the business, and a multi-component perspective, through which the entire business logic is implemented (Zott & Amit, 2013). The holistic perspective describes BMs as "templates" that reflect the way companies do business (Zott & Amit, 2013). In this context, BMs can also be viewed as overarching theories of doing business and/or as typical models that can change (Baden-Fuller & Morgan, 2010; Chesbrough & Rosenbloom, 2002; McKendrick & Carroll, 2001). The second perspective is known as the multicomponent perspective, linking a firm's internal operations to the customer value proposition in the external market environment and how value is monetized (Baden-Fuller & Mangematin, 2013; DaSilva & Trkman, 2014). Although there are several conceptualizations of BM components (Osterwalder & Pigneur, 2010; Wirtz, Pistoia, Ullrich, & Göttel, 2016), the most concise identifies three key components: value proposition, value creation (delivery), and profit equation (Ghezzi, Cortimiglia, & Frank, 2015; Teece, 2010).

The concept of value proposition captures all facets of the company's offering that provide value to customers (Chesbrough & Rosenbloom, 2002) and address specific customer needs or problems. Companies must consider relevant customer segments and determine which communication and delivery channels can reach those segments (Osterwalder & Pigneur, 2010). To realize their value propositions, they need certain resources, capabilities, and processes (Johnson, Christensen, & Kagermann, 2008), known as value creation activities (Amit & Zott, 2001). The profit equation is the financial manifestation of the value proposition and the value creation mechanism; companies are concerned with how value is captured for customers and how the costs of value creation are structured (Bowman & Ambrosini, 2000).

3. RESEARCH METHODOLOGY

For this work the author has chosen a mixed methods research approach. Due to the mixture of qualitative and quantitative methods, the research process is divided into 2 studies.

For Study I, in-depth interviews were conducted with 25 experts from 10 companies in the energy industry. Companies were selected using a purposive sampling method (Yin, 1994). In addition to the interviews, industry reports were studied to identify the business model elements that are relevant in the creation of digital offerings. Within these semi-structured expert interviews, questions were asked on the following areas: Technological infrastructure of the IoT platform; participants of the platform; involvement of external partners; organizational location and platform activities; degree of openness of the platform. Furthermore, previous changes in business models, and management decisions and practices were addressed and the interviewees were asked to position their company in the product-service continuum by Oliva & Kallenberg (2003) as well as to outline the complexity of their digital offerings. The author took care of asking unbiased and unobtrusive questions to achieve objective results (McCracken 1988). Participants were also asked to back up their statements with concrete examples (Mishler 1986). To enable an objective evaluation of the interviews, they were coded and analyzed by at least 3 independent researchers. In addition, the individual topics were, if possible, summarized in a superordinate level. This categorization was reviewed and consolidated again in an exchange with the companies.

In Study II, a catalog of 146 companies from the energy industry was created based on the business model elements identified in Study I. The catalog was then used as a basis for the explorative desk research. With the help of annual reports, company publications, websites and other reports, the digital products and services offered on IoT platforms were examined. In 2 teams of 3 researchers each, this catalog was then systematically evaluated according to the components of value proposition, value creation, profit equation, network effects and scaling. In doing so, 3 main platforms types, which are also known from the literature (Parker et al., 2016), and their associated business model components could be identified. As to investigate the identified patterns of business models and business model elements of IoT platforms systematically, the research followed a sequence of iterations, sequentially switching between theoretical inputs and empirical results. The nature of the research process was therefore abductive, i.e. a combination of deduction and induction (Dubois & Gadde, 2002).

4. FINDINGS

Study I revealed 3 platform types with associated business model components [as shown in Table 1]:

	Transaction Platform	Innovation Platform	Integrated Platform
Value proposition	Matching according to demand	Increase energy efficiency & Availability and performance increase	Matching according to demand, Increase energy efficiency & Availability and performance increase
Value creation	Exchanging products, services & data	Innovate existing or inaugurate novel products, services & data	Exchange & Innovate products, services & data
Profit equation	Product price & transaction fees	Service contracts & transaction fees	Product price, service contract & transaction fees
Scaling	Using both sides of the market	Using one side of the market	Using multiple sides of the market
Network effects	Increasing platform attractiveness	Upgrading products	Upgrading products & Optimization of service activities
Examples	enviaM Mein Community Strom; RWE ECT; Innogy WebMarket; enmacc; Verivox	Siemens Gamesa Mindsphere; Nordex Service Platform; General Electric Predix; Vestas Utopus Insights /Scipher	Alpiq Energie easy4you; Innogy Share & Charge; Dajie PROSUME;

Table 1: Platform types and elements in the energy industry (Own representation, 2021).

Our results revealed, that transaction platforms in the energy industry offer matchmaking of energy supply and demand, which is one of the main enablers for a stable energy grid. As known from the literature this platform type uses both sides of the market to grow in size. Hence, this platform type is very similar to what has been already described in the literature.

Innovation platforms in the energy industry focus on upgrading existing physical products by offering digital products and offerings, that will increase the availability and efficiency of e.g. wind turbines or tidal power plants. Those offerings can range from descriptive / diagnostic to predictive and prescriptive character, which makes it possible for equipment manufacturers to strengthen and extend their market position. This can also be objected by the companies that use this kind of platform as they are mainly equipment manufacturers. In contrast to the literature, however, companies in the energy sector limit themselves to using only one side of the innovation platform for scaling purposes.

Integrated platforms take on a very exciting function in the energy industry, as they usually occur in the interstices of the value chain, where value is often not otherwise created. A good example of this is the Innogy Share & Charge platform, which is mainly intended to improve the charging infrastructure around e-cars, but is also a useful partner for energy producers by providing insights into the amount of energy needed by e-cars.

Study II revealed a phase model, which depictures different complexity levels according to the increasing customer value [as shown in Table 2]:

	Type of perspective	Type of digital service offering	Product service continuum (According to Oliva & Kallenberg, 2003)	Process model for developing Installed Base service capabilities (According to Oliva & Kallenberg, 2003)		Customer value	Examples
Phase 1	*Retrospect*	Descriptive & diagnostic	Services as „add-on“	Consolidating product-related services Entering the Installed Base service market		Overview and assessment of the current machine condition	Sonnen & TenneT; Nordex
Phase 2	*Forecast*	Predictive		Expanding to relationship-based services	Expanding to process-centered services	Forecast of possible shutdowns, pending repairs or downtime	Vestas Utopus Insights / Schipher; Uniper SE Enerlytics
Phase 3		Prescriptive				Predetermination of processes and events	SENEC Solar.Cloud; Innogy Share & Charge
Phase 4		Autonomous	Tangible goods as „add-on“	Taking over the end-user´s operation		Self maintenance of the system; Proactive interactions are not needed anymore	General Electric Predix; Siemens Gamesa Mindsphere

Table 2: Phase model for digital offerings with increasing complexity (Own representation, 2021).

The phase model provides an initial overview of the structure and character of digital offerings in the energy industry. The individual steps proposed by Oliva & Kallenberg (2003) could be combined with the complexity model. In stage 1, companies are still before entering the market of installed base services and offer largely diagnostic and descriptive services. In Phase 2 and 3, companies then develop relationship-oriented and process-oriented services, respectively. Here the complexity and the value proposition for the customer increases strongly through the development of a predictive service into a prescriptive service, since the customer can then predetermine how the product-service combination should function. In phase 4, a stage is reached where the product can be managed by the services themselves. Consequently, the value of the services also exceeds the value of the product for the customer. The product has thus become an "add-on" and the focus is on service management.

5. THEORETICAL AND PRACTICAL CONTRIBUTION

On a theoretical level, this work has shown that the business model components known from the literature can also be found in the area of digital offerings in the energy industry. Furthermore, this work has shown that IoT platforms are a tool for companies from the energy sector to optimize customer processes with the help of data in the course of the transformation to sustainable energy generation. Furthermore, using the concept of the product-service continuum (Oliva & Kallenberg, 2003), it could be shown that companies develop individualized digital offerings with IoT platforms that evolve continuously to state where products become an “add-on” and services are the main driver for customer value.

For practitioners this work provides a phase model, that enables them to use different business models and associated elements to determine their own position. In addition, with the help of the elements presented here, a strategy can be defined to revise the business model strategy and thus initiate a transformation from a mere product provider to a solution provider.

Nevertheless, many questions remain unanswered and further research should be done in this area. There is still little scientific consideration of how BM develops in the long term, whether corresponding elements change in the process, which success factors and drivers, but also obstacles and barriers are crucial for economically successful BM. Another topic that has not yet been addressed scientifically is the comprehensive study of how platform ecosystems function and what influence the size of the network has on the cost and revenue structure of digital platforms in particular.

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SERVITIZATION IN FAMILY FIRMS:
A CASE FROM AN ITALIAN MANUFACTURING INDUSTRY

Elena Casprini, Mario Rapaccini & Alessandro Marelli

ABSTRACT

Purpose: We study how family firms can overcome their innovation-related barriers thanks to a strategic alliance. In particular, we focus on the interorganizational factors that facilitate the development of servitization strategies. These are of paramount importance for the competitiveness of SMEs operating in the lift industry.

Design/Methodology/Approach: we conducted a longitudinal case study, exploring some firms in a consortium of 21 small- and medium-sized Italian family firms operating in the lift industry.

Findings: Although preliminary, our findings confirm that small and medium-sized family firms can innovate their service-orientation thanks to strategic alliances; we found that it is relevant the role played by the 'boundary spanners' and the pressure to protect their business and family from rivalries.

Originality/Value: This is a first attempt to shed lights on how networks can help innovation and servitization of small- and medium-sized family firms, thus helping them in overcoming their ability-willingness paradox.

KEYWORDS: ability-willingness paradox; family firms, servitization, SMEs.

1. INTRODUCTION

The research exploring the pros and cons of servitization strategies in small- and medium-sized enterprises (SMEs) is growing rapidly (Confente et al. 2015). As well known, these firms are highly vulnerable to competitive pressures (Man et al. 2002), and have little resources to sustain radical transformations, such as business model innovation (Madrid-Guijarro et al. 2009). In addition, SMEs are in most cases constituted by family firms.

Family firms face a unique paradox, known as *ability-willingness* (Chrisman et al. 2015). It has been in fact shown that family firms have a peculiar interplay of opposite forces. On one side, family business could have a good predisposition (*ability*) to innovate since their discretion to act. This originates directly from the fact that top managers are the main shareholders. On the other side, innovation and business decisions in family firms could not always stem from grasping profit opportunities and pursuing economic goals, but also the preservation of the socioemotional wealth of the family members.

While analysing these dynamics, we encountered a particular case of an Italian consortium (as a peculiar form of strategic alliance) among family firms in the lift industry (Rapaccini et al. 2019), that irrespective of their size has successfully carried out several innovation initiatives, in order to pursue servitization. This pushed us to address how this form of strategic alliance facilitates overcoming the ability-willingness paradox of each affiliates. Using the lens of servitization as the innovation strategy that the firms in an alliance have tried to elaborate and pursue, this paper aims at answering the following research question*: how does a consortium help family firms in pursuing servitization?*

In an argumentative form, this paper presents some of the preliminary findings coming from this research, and is therefore structured as follows: the next section revises the literature on the ability-willingness paradox. Then, Section 3 describes the research methodology. Section 4 presents the findings and Section 5 draws some conclusions and implications from this research.

2. SERVITIZATION IN FAMILY FIRMS: AN OVERVIEW

2.1 Innovation in family firms

Family firms have governance models and decisional processes that are more effective than larger organizations. This should lead to greater innovativeness (Bennedsen and Foss 2015). At the same time, it is said that in these contexts, innovation can be hindered by the company's strong regulative network, which is informed by heritages and family values that are often reluctant to changes (Bennedsen and Foss, 2015: 78). To explain this interplay, the literature has introduced the *ability-willingness paradox* (Chrisman et al. 2015). In short, this tells that family firms are more able (*ability*) to arrange their resources according to what they want, and simultaneously their willingness to innovate is greatly influenced by non-economic goals, such as the family socioemotional wealth preservation and intergenerational succession.

Another factor that since so far has been considered by the literature addressing innovation of SMEs, is the importance of establishing strong relationships with strategic partners (Casprini et al. 2017, Feranita et al., 2017) and of social capital (Pearson et al. 2008, Zahra 2010). However, little is known on how the imprinting/DNA of the firm can evolve/mutate across generations as a consequence of the innovation experiences developed through the network (Dieleman, 2019). In other terms, the literature addressing the role of external partners in overcoming the ability-willingness paradox of family firms, is scant.

2.2 Family firms' networks

Frequently family firms participate to networks and communities to develop new forms of organizational knowledge that can reduce industry-specific (inter-organizational) uncertainties (Miller et al. 2008). To handle these relationships, it is key the role of specific figures that assume inter-firm responsibilities in order to facilitate innovation dynamics. Relationships with external partners are clearly built upon trust (Casprini et al., 2017, Lester and Cannella 2006). In fact, while in general it has been acknowledged the importance of formal relationships - such as joint ventures and cooperation contracts – it is claimed that trust is of paramount importance in the case of family firms (Bouncken et al. 2020). Niemelä (2004) shows also that the reasons why family firms embrace interfirm cooperation can be explained by the concept of power. This is dictated by the extent of control each firm has over those resources that are perceived to be beneficial to the network. Power then originates by formal agreements (commitment), trust (network structure), and learning opportunities. These latter explain the way each family firms owners can learn from the others allies of a collaborative network. While the mentioned constructs are relevance to explain why and how family firms establish network collaboration, they do not show in depth how participating to the alliance and relying on partners allows the family firm to overcome its ability-willingness paradox.

2.3 Servitization of small and medium-sized family firms

Servitization can be beneficial not only to larger firms, but also to SMEs (Kowalkowski et al. 2013, Kowalkowski et al. 2017, Coreynen et al. 2017), in numerous industries (Ambroise et al. 2018). These moves are pushed by the lowering of product margins, higher competition and searching for new business opportunities (Michalik et al. 2019). Smaller firms could also benefit from their ability to better cope with the factors that hinder servitization in larger companies (Tauqeer and Bang 2018). About the controversy over whether family firms are better or worse places to innovate than are nonfamily firms we follow the idea that the socioemotional wealth theory highlights: family owners strive to protect and enhance their socioemotional endowments by fostering stronger perceptions of organizational caring among their employees compared to those working for non-family firms and this can help the rapid implementation of an innovation in the servitization if strongly decided by the family owners (Christensen-Salem et al 2021).

Among these challenges, the service paradox indicates the risk of missing the return on the service investment (Gebauer et al. 2005). For this reason, Malleret (2006) claims that some critical threshold could be required before reaching a satisfactory profitability from services. Another issue to be tackled pertains to the lack of time and commitment to develop a service culture (Dubruc et al. 2014, de Jesus Pacheco et al., 2019). Servitization in fact requires new culture, mindset and greater customer orientation (Dahmani et al. 2016). To compete with services, SMEs had to change their structure. This latter is frequently ossified around the product business (Hsieh and Chou 2018, Michalik et al. 2019). In addition, they have to face higher complexity that typically originates from delivering service operations (Baines et al. 2009, Coreynen et al. 2017).

3. RESEARCH METHOD

This paper adopts a longitudinal case study approach (Yin, 1994), in which we have multiple units of analysis. These are small and medium sized Italian family firms, operating in the lift industry.

The term “family” has been variously defined in previous studies. Senftlechner and Hiebl (2015) suggested three main approaches that can define family firms: “ownership” (firm when a person or family holds at least 20-50% of its shares), “management” (if it is managed by or if the decision process is controlled by a single person or family) and “self-perception” whether the firm is perceived as a family or not by the informant (Dello Sbarba and Marelli, 2018). This research mirrors a combination of the three approaches: in our cases the family represents the dominant shareholder the family is the main decision maker and the people feel to work in a family firm.

Now the consortium has 18 firms plus 3 subsidiaries. So if we want to count those too they are 21, and they have a strong need to grow, to increase the number of companies that are part of the consortium. The peculiarity of this research is the focus on micro level about individual family firms’ intention/willingness as well as abilities/limitations of all those family firms that, having a long term relationship since 1980s, in the last decade have established a new horizontal alliance in the form of a *consortium*. At the same time, it is possible to investigate the initiatives and arrangements developed at a consortium level (meso), to unveil the interfirm dynamics and address the research question of this paper. Data have been collected through primary and secondary data sources in different times. In particular, we have conducted numerous interviews with different informants in a long time interval (late 2018- early 2021); in three cases, we did multiple interviews over the three years. Each interviews lasted between 60 and 120 minutes, were recorded and then transcribed. Table 1 presents a summary of the informants, their position and representativeness and other elements that qualified the sources (type, length and year of interviews) .

Table 1: Summary of interviews

Interviewee’s Role in the Consortium and (eventually) as a Consortium “partner”	*Type of contact*	*Length of interview*	*year*
i) Former President of the Board of Director of the Consortium of the Consortium, ii) CEO of one ally	Face-to-face	90 minutes	2018
i) New President of the Board of Director of the Consortium of the Consortium, ii)CEO of one ally	Face-to-face	120 minutes	2018
i) Member of the Board of Director of the Consortium ii) CEO of one ally	Call and face to face	90 minutes	2021
i) Actual CEO of the Consortium, ii) consultant	Call	80 minutes	2018
	Call	120 minutes	2021
i) Former CEO of the Consortium, ii) consultant	Face-to-face	120 minutes	2018
	Face-to-face	120 minutes	2021
i) Responsible of technical assistance and training of the Consortium, ii) consultant	Call	60 minutes	2018

i) Project Manager, ii) consultant	Call	60 minutes	2018

Additionally, we tap into archival data such as internal surveys and financial reports. This manuscript, in particular, focuses on the findings coming from these interviews, and shed lights on the key facts and motivation that, time by time, convinced these family businesses to enter and remain in the alliance.

4. FINDINGS

About 10 years ago, some entrepreneurs and managers of less than twenty Italian family firms, operating in the lift industry, decided to establish a consortium. The network relationships and initiatives were of paramount importance in the transition to the service business of these firms, that was collectively undertaken in the last years. Originally, the consortium was constituted with the aim of sharing technical knowledge and industry-specific practices, in order to protect their small business from the threats of global leaders such as Otis, Schindler, Thyssen Krups and Kone, that were dominated that industry worldwide and had invested heavily to develop their service business. Conversely, these SMEs had very narrow markets, at metropolitan or at least regional level. Although the good reputation with their local clients (building managers), contrary to larger firms they could rely on neither financial resources nor skilled managers (e.g. operations, sales or service directors). Therefore, these entrepreneurs faced a relentless competition that in most cases overwhelmed their own strengths.

At the same time the local completion is characterized by sufficient margin of profit generated by a rigid demand. This positive earnings reduce the willingness to change and innovate their business model, in particular when the decision should be taken by second or third generations. Actual CEO of the Consortium underline that the next generation is more conservative than the previous one, thus having difficulties in pursuing innovation. This is because of the fear of doing mistakes. The current situation, with the pandemic that has impeded, for example, condominium assemblies, has not helped in that respect.

In particular, the consortium was key in setting up the capabilities required for increasing the sales of contractual maintenance services, and this led to a generalized increase of revenues, and helped the affiliates to face the economic downturn of the construction industry in the years following the crisis of 2008. Our analysis shows that long-standing relationships among the entrepreneurs of the involved family firms, even before the consortium constitution, have been important for building trust. However, prior to joining the consortium, any affiliate had a product-centric business models. Business priorities were the sale of new units (lifts), and only minor revenues came from selling renovation services, repairs, spares and maintenance services. Consequently, key competencies consisted in the design, production and installation of lifts/escalators for commercial and residential buildings. Basically, no one of the smaller firms could believe to be able to establish a service business and to develop all those new capabilities. Actually, in some cases these firms had a very limited range of innovation possibilities, and most of their efforts were devoted to keeping the pace of technological innovation in products, imposed by the market leaders.

The consortium had a crucial role in overcoming the ability-willingness paradox of the affiliates. In fact, with the help of common projects and initiatives, all the firms have been able to shift towards servitization. This has been possible because the “ability” sphere of each family firm has been influenced by the belongingness to a wider alliance of other family firms. Some “innovators” belonging to the consortium have been able to show how a more service-oriented business model could benefit the firm: this has allowed the other firms to overcome their ability towards innovation since they acted as “followers” of what the consortium has decided to pursue.

Actual CEO of the Consortium underlines the importance of long lasting relationships among the affiliates. Family firms belonging to the consortium have reciprocal esteem and are mutually available.

The consortium has never imposed decisions. However, from the analysis, it two main dimensions have been identified as important in helping firms to innovate and overcoming the ability-willingness paradox.

The first dimension is the role of the consortium CEO as a “boundary spanner”, that acted on the ability side. The CEO of the consortium is external to the family firms since he is an “anomalous” professional consultant. He was deeply involved in supporting the development of the consortium's activities and in determining the hardware, procedural, contractual and software/license components on which to feed the system for collecting, processing and determining performance indicators. The approach followed by the consultant was a "learning by doing". He fuelled a debate to help questioning the traditional approaches and business models. This debate was facilitated by the predisposition to discussing common issues such as market threats and organizational difficulties, as well as sharing also revenues and cost data of financial reports. This is achieved because the companies of the consortium needed to evaluate the convenience of developing the provision of new services that could thus integrate the turnover generated by their original business model. The work of the consultant has allowed the firms of the consortium to focus on the development of contractual services - such as emergency and standard and / or scheduled maintenance - to be provided on plants both installed directly and on those produced by competitors but acquired for maintenance. The consultant provided information and reports relating to the management of quality, management control, and human resources of the companies of the consortium. The consultant has created a fiduciary relationship with consortium’s firms and he has acted as a “boundary spanner” in the sense that he was able to collected, analysed and shared data among the several affiliates.

The second dimension has been the family firms’ willingness to protect their companies from fierce competition, that acted on the willingness side. The companies joined the consortium since they recognized their difficulty in competing against larger businesses. To a certain extent, we can say that the affiliates are coopetitors since they are both competing and cooperating. The actual CEO of the consortium describing the innovation coming from the servitization processes underlines that:

> *“… it is a model that has been effectively adopted in all these evolutions: i) the chief technical managers, ii) the new commercial managers, iii) the Internet of things (IoT), iv) the automation of processes…. these are all virtuous examples where we have not imposed anything on the consortium members but we have left each consortium member the possibility of maturing this innovation within his organization and therefore bringing his organization to be able to accept it in the least painless way possible!*”.

5. CONCLUSIONS

This paper presents a preliminary work aimed at explaining how networks can help innovation and servitization of small- and medium-sized family firms and overcome their ability-willingness paradox. The study aims at contributing to three streams of research. First, the paper focuses on the ability-willingness paradox (Chrisman et al., 2015) showing how a new type of governance mechanism (i.e. strategic alliance) could influence the ability sphere. Second, due to a paucity of research showing how family firms ally, (Feranita et al. 2017), the paper aims at contributing to strategic alliances of family firms. The case is a particular example of horizontal strategic alliance, thus contributing to previous research that has usually investigated other types of alliances (e.g. López-Cózar-Navarro et al. 2017). Finally, the paper contributes to the servitization literature since it represents a case of family firms that have changed their business model towards a service-oriented one. As noticed by some recent contributions (e.g. Casprini 2019), there is a paucity of studies about servitization in family firms.

The consortium has facilitated the servitization process of the several firms affiliated. From producing lifts, they move towards a service first, service only business model. The case analysed presents preliminary interesting insights such as the role played by professional consultant and the willingness to compete (Devece et al., 2017) to face external, bigger competitors.

However, this study has several limitations since it is an ongoing project. The first limitation is linked to data analysis. The data presented here are mainly descriptive, not supported by quotations and codes. This is due to the fact that the researchers are collecting additional data over multiple levels of analyses. The researchers are codifying quotations on the basis of the ability and willingness dimensions and, in particular, they are distinguishing for each company analysed which have been their "ability" (in terms of discretion to act) and their "willingness" (in terms of disposition to act) (Chrisman et al., 2015). Finally, the researchers are re-reading the data collected and advancing their understanding through additional interviews moving from a social capital perspective. In particular, considering the framework proposed by Pearson, Carr, and Shaw (2008), the researchers are trying to investigate how belonging to a consortium helps the development of social capital that influences the family firms' resources and capabilities and, consequently, their competitive advantage and family wealth creation over time.

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SERVITIZATION AND INNOVATION STRATEGY: THE TRADE-OFF BETWEEN SERVICE-BASED DIFFERENTIATION AND PRODUCT R&D STRENGTH

Ornella Benedettini, Christian Kowalkowski

ABSTRACT

Purpose: This paper brings to the fore the notion of R&D strength to examine the relationship and trade-off between servitization and a company's product innovation activity.

Design/Methodology/Approach: Conceptual paper.

Findings: Drawing on organisational learning theory and the RBV of the firm, our analysis reveals that heavy investment in service-based differentiation at the cost of inadequate funding of product R&D erodes the R&D strength accumulated by the company over time. We submit that this introduces a, so far neglected, long-term risk since servitized companies still need to be able to develop effective product innovations; that is, to compete through their R&D strength. The experience-based nature of R&D strength and its exposure to time-compression diseconomies add further complexity to the problem.

Originality/Value: The view that servitized companies can substitute product innovation with value innovation and business model innovation is too simplistic. We show that the opportunity cost associated with a service-based innovation strategy needs to be addressed from a long-term perspective and considering its effects on the company's R&D strength.

KEYWORDS: Servitization, Service-based value, Product innovation, Service innovation, R&D strength

1. INTRODUCTION

The transition from manufacturing to services, conventionally known as "servitization", is a departure from the company's core identity (Neu and Brown 2005; Josephson et al. 2016) often resulting in significant changes to the company's innovation strategy. Under servitization, value innovations achieved by combining product offerings with complementary service elements are regarded as a flagship for competition (Raddats et al. 2019) and are adopted as viable substitutes for R&D-based product innovation (Eggert et al. 2011). The resulting innovation strategy implies that less resources are devoted to product innovation through R&D to the benefit of value innovation via services (e.g., Ambroise et al. 2018). While there are positives to this type of strategy, it is not without costs. These include the relative perils of decreasing the accumulation of expertise through product R&D which, in turn, affects the company's competence at R&D activity in the long run. Despite this, discussions of servitization seem more focused on exploring the role of services as a new value catalyst or driver, rather than understanding how to sustain the strategic use of such value over time.

As an organisational change process, servitization adheres to a diversification logic of expanding into service activity as a way to exploit the stock of knowledge from prior investment in product R&D and existing customer relationships (Fang et al. 2008; Benedettini et al. 2017). Unfortunately, emphasising the strategic content of services to the detriment of R&D-based product innovation pulls resources away that otherwise would have been used to maintain and increase the company's stock of R&D know-how and so improve its ability to translate future R&D efforts into effective product innovations. Indeed, because of the cumulative nature of knowledge and as emphasised by organisational learning theory (Cyert and March 1963) and the resource-based view of the firm (Barney 1991), new product technology is generated using both accumulated knowledge capital and resources expended in the current period. Therefore, substituting R&D-based product innovation with service activity may erode the company's ability to leverage R&D outlays in future development of product innovations; that is, its R&D strength (Danneels 2008). This paper brings to the fore the notion of R&D strength to examine the relationship and trade-off between servitization and company's product innovation activity. This motivation emanates from evidence suggesting that diversifying into services does not always produce the returns that manufacturers expect (Spring and Araujo 2013) and from our awareness that product-based knowledge is too often treated as a stable, unproblematic element in servitization discussions. Therefore, we present a conceptual discussion that addresses two questions: (1) how does servitization affect a company's ability to bring innovative products to the market? (2) how may servitization be approached to enable valuable exploitation of services as a component of the company's long-term innovation strategy?

2. INNOVATION STRATEGY

From an innovation perspective, servitization deviates from traditional ways of value creation and often leads to significant changes in the innovation strategy of manufacturing companies (Table 1). Historically, manufacturers have centred most of their innovation efforts on technological innovation related to new and improved products (Eggert et al. 2015), attempting to gain competitive advantage through core competences in value-creating product technologies. Traditional manufacturers typically conduct market research, analyse customer satisfaction, examine how the products are used, identify conscious or unconscious customer needs, and then focus on developing technical product features that address those needs (Shelton 2009). The underlying strategy is to rely on R&D, technology and product development to target opportunities such as creating barriers for potential new competitors and controlling premium market segments, opening new markets, defining industry standards and dominant product designs, and building solid market reputations (Tongur and Engwall 2014).

Table 2: Innovation within traditional manufacturing and servitized companies

	Traditional approach	Servitization approach
Innovation strategy	Investing in technological R&D to gain competitive advantage through product innovation	Embedding products in a value proposition of product-service systems to enhance the ability to fulfil customer needs
Competitive drivers	Product excellence and technology leadership	Service-based value concepts connected to customer experience and functional needs
Sources of customer value	Technical product features that address customer needs	Utility provided to the customers through a total offer including combined products and services
Focus of innovation	Value-creating product technology	Specific modes of value proposition, value creation and value capture (i.e., business model)

In contrast, the servitization approach suggests that customer value can be created in other ways besides pure technological innovation. Under servitization, value innovations achieved by combining product offerings with complementary service elements are regarded as a flagship for competition and are adopted as viable substitutes for R&D-based product innovation (Eggert et al. 2011). A servitized company extends the conventional boundaries of product manufacturing activities (Spring and Araujo 2013) by integrating the value chain from product design to service provision, embedding the product in a value proposition of a seamless customer experience and integrated product-service solution. The role of product technical features is diminished since the focus is on the utility provided to the customers, in line with the purpose of creating a total offer. Consequently, by emphasising service-based value concepts connected to customer experiences and functional needs, servitized companies can move away from an innovation strategy with technological R&D and product development as main competitive drivers. Specifically, such companies adopt an innovation strategy of pursuing business model innovation instead of technological innovation (Shelton 2009; Forkmann et al. 2017).

Within the business and management fields, the business model concept refers to the underlying logic of the company's go-to-market approach, including how the company converts the value potential embedded in its knowledge and resources into market outcomes (Chesbrough and

Rosenbloom 2002). Thus, the notion of business model revolves around the company's value proposition to the market; that is, the value that the company promises to create for (or with) customers through its products and services. In addition, the business model outlines the mechanisms that the company employs to create such value, as well as how the company captures value (e.g., earns revenues) from delivering offers to customers (Teece 2010). In short, business model choices define the modes of value proposition, value creation and value capture adopted by the company. While the notion of value is clearly central in the business model concept, companies may or may not use technological innovation and product R&D as a basis for the value that they offer to customers. That is, the business model can be a source of competitive advantage that is distinct from the company's product market position (Christensen 2001). Along these lines, servitized companies adopt value attributes and value capture techniques that are based primarily on providing systems of combined products and services, rather than product development, to enhance their ability to match value propositions with customer demands (Tongur and Engwall 2014; Story et al. 2017).

3. PRODUCT STRATEGY

As already noted, the servitization perspective sees services as a strategic alternative to product innovation. Servitized companies seek to differentiate themselves through a value proposition of functional sales and product-service combinations, rather than just via their ability to address customers' product requirements (Story et al. 2017). The higher the level of servitization chosen by the company, the higher also the share of total value creation that stems from service elements. Thus, with their service-based business model, servitized companies have less incentive to invest in product development and technological R&D. Products may even represent only a small part of the solution or wider function provided to the customers.

In line with this notion, the mainstream servitization research tends to assume that a company's core products or product technology would remain unchanged when it integrates forward into service business (Tongur and Engwall 2014). Since the emphasis is placed on the opportunities for value creation stemming from service elements, R&D-based product innovation is ignored, or at least taken for granted. The product is treated as a stable platform against which the offer of various service elements can be configured.

In general terms, products appear to perform two main functions in servitized offerings. The first function is to provide a vehicle for the sale of services. Although manufacturers' service arrangements may include also product-independent services (e.g., business consulting, general financing, professional training; Raddats and Kowalkowski 2014), servitized offerings typically include services that support customer processes in the primary and complementary activity chains (Sawhney et al. 2004) associated with an installed base of products (e.g., product maintenance, operation, insurance, renewal and upgrade, take-back). The point is that installed products require a range of services during their life cycle and a manufacturer, especially if it has already provided the product, is well placed to provide such services since it has an established relationship with the customer and experience concerning the product (Raddats and Easingwood 2010). Moreover, if the manufacturer retains ownership of the product with the customer being charged for access or outcome, product-based transactions ordinarily include services to support the product in the operational environment.

The second function that servitization theory assigns to products is to carry competences and resources that can be leveraged for service provision. Certain service extensions (e.g., maintenance of capital equipment) draw on similar capabilities as the product business. To offer these services, manufacturers can take advantage of the capabilities conferred by product-based assets and intangible input such as knowledge of product technology (Benedettini et al. 2017). In this sense, products are implicit signifiers of potential spill-overs that may reduce the need for service-specific resources (Fang et al. 2008). Clearly, neither of these product functions point to R&D-based product innovation as the main source of customer value and competitive advantage. This further supports the argument that the servitization perspective is substantially based on the premise of a stable core product and product technology around which the services are created (Tongur and Engwall 2014).

4. KNOWLEDGE ACCUMULATION THROUGH R&D-BASED PRODUCT INNOVATION

Many servitized companies tend to underinvest in product innovation through R&D to the benefit of investments in value innovation via services (Ambroise et al. 2018). While there are positives to this type of strategy, it is not without costs. Drawing on organisational learning theory and the resource-based view of the firm, we suggest that reducing the investment in product R&D holds the prospect of important long-term effects on a company's knowledge assets and capabilities.

Organisational learning theory provides insights into how companies acquire, retain, update and act upon knowledge (Bell et al. 2002). This theory emphasises the emergence and development of know-how as the result of experience (Cyert and March 1963). The notion of know-how refers to procedural knowledge; that is, knowing how to do something. Therefore, know-how is a description of what defines current practices and routines within a company, including how to operate plants, manufacture products, structure processes, or conduct R&D activities (Kogut and Zander 1992). In the terminology of organisational learning theory, "know-how is the accumulated practical skill or expertise that allows someone to do something smoothly and effectively" (von Hippel 1988). The key word in this definition is "accumulated", which implies that know-how must be learned and acquired over time (Kogut and Zander 1992). In short, organisational learning theory holds that experience-based learning is essential in improving an organisation's competence at particular activities. This means that the productivity of R&D outlays is based on learning, which is itself the product of experience accumulated through past R&D activity.

Similarly, the resource-based view of the firm focuses on know-how as a strategic, company-specific asset which cannot be bought in factor markets but must necessarily be built or accumulated internally by following a consistent pattern of resource investments over some period of time (Barney 1991). In particular, R&D or technological know-how is viewed as a "stock" of knowledge which is accumulated over time through a history of R&D outlays or "flows" (Dierickx and Cool 1989). The "bathtub" metaphor (Dierickx and Cool 1989) illustrates the fundamental distinction between stocks and flows. At any moment in time, the stock of water in a bathtub is given by the level of water in the tub; it is the cumulative result of flows of water into the tub (through the tap) and out of it (through leaks). With respect to R&D, the level of water in the tub represents the stock of technological know-how at a particular moment in time. The flow of water into the tub represents current R&D spending, whereas the flow of water leaking out of the tub illustrates the fact that R&D know-how depreciates over time so that the contribution of older R&D investments becomes less valuable as time passes (Hall et al. 1986) . In essence, R&D know-how is a strategic asset that cannot be adjusted instantaneously. It takes a consistent pattern of R&D spending (resource flows) to build a required level of R&D know-how (asset stock) (DeCarolis and Deeds 1999). Clearly, the level of R&D know-how determines a company's potential for successful R&D; that is, its R&D strength defined as "the ability of the firm to build new technological competences" (Danneels 2008: 521).

As just outlined, R&D know-how (i.e., R&D strength) decays in the absence of adequate "maintenance" expenditures. Moreover, as an asset stock, R&D strength is commonly related to time compression diseconomies (Dierickx and Cool 1989), where maintaining a given rate of R&D spending over a particular time interval produces a larger increment to the stock of R&D know-how than maintaining a higher rate of R&D spending over a proportionally shorter time interval. This point in often backed up (e.g., Henderson 1999) with the example of "Crash" R&D programmes, which are typically less effective at building R&D know-how than programmes where annual R&D expenditures are lower but spread over longer periods of time. In short, R&D strength derives its value from development over a long period of time (Oliver 1997).

5. THE CASE OF SERVITIZED COMPANIES

As discussed, R&D strength is cumulative and depends on past R&D investments. New technological knowledge is generated using both accumulated knowledge capital and resources expended in the current period. Therefore, when servitized companies pull resources away from product R&D in order to expand into services, they turn down opportunities to increase their R&D strength and hence improve their ability to translate R&D outlays into effective product innovations. In addition, since the value of R&D know-how depreciates over time, inadequate funding of product R&D activity may further result in erosion of the stock of know-how (R&D strength) that was built incrementally across the company's R&D history. Finally, the challenges of path dependency and time compression diseconomies make it difficult and costly to offset periods of lower R&D spending and their effects on the company's R&D strength. In short, these issues imply that treating services as a substitute for product innovation results in a decline in R&D spending which should be followed by a decline in R&D strength.

Figure 1, which is based on Cummings and Knott (2018), can be used to illustrate this concept. It shows the R&D intensity (R&D spending/sales) and R&D strength history for General Electric under Jack Welch's tenure (1981-2001). In those years, General Electric adopted a strategy of divesting businesses in which it was neither number one nor number two in the market (television, semiconductors, aerospace) and expanding into businesses that did not rely on R&D (Cummings and Knott 2018). In this way, it pursued a comprehensive servitization business model, whose cornerstone was the growth of its financial arm, GE Capital. GE Capital grew from a small financing operation supporting the product business to an empowered source of sustained growth, which in 2002 accounted for 49% of the company's total revenues (Davies et al. 2004). General Electric was among the first companies to offer financial services as a part of integrated solutions packages combining products, maintenance, services and financing, as well as real estate and other loans unrelated to its manufacturing businesses. The company's R&D strength decayed dramatically because, in order to mine service opportunities, it depleted the stock of R&D know-how from previous R&D investments.

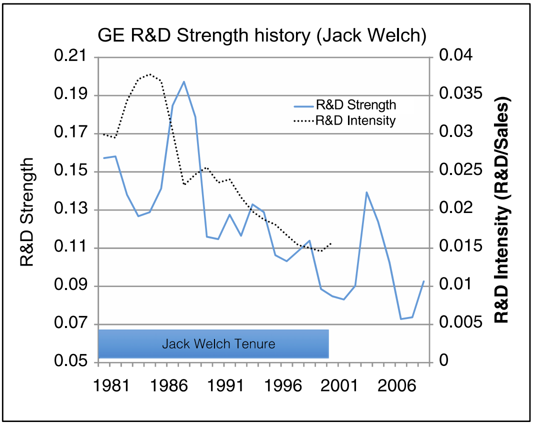

Figure 1: R&D intensity and R&D strength of General Electric under Jack Welch's tenure. R&D strength is measured using the "Research Quotient" metric defined in Cummings and Knott (2018)

Premised on the idea that services can be a leading source of customer value, the strategy followed by servitized companies is to substitute service elements and integrated product-service products for superior product design. As a result of this substitution process, the existing stock of R&D know-how becomes partly obsolete, since the value that technological excellence and product innovation create for the customers is sharply diminished (Eggert et al. 2015). Hence, declines in R&D strength (as shown in figure 1) would not weaken the company's competitive position because they are counterbalanced by rent-earning investments in service activities.

We submit – and this is our main point – that this traditional perspective of servitization neglects the strong connection between the products and the services typically offered by manufacturing companies. In particular, we maintain that the customer demand for the services offered by one such company importantly depends on the customer interest in the company's products. Indeed, although servitized companies may use their product-based experience to service also other vendors' products (Raddats and Easingwood 2010), in most cases the bulk of their service sales consists of services supporting use/functioning of their own products (e.g., maintenance, upgrade and refurbishing) or services supporting customer processes related to such products (e.g., management of spare parts, rental services, management of product operations, "vertical" financing) (Antioco et al. 2008). Nevertheless, some companies, like General Electric, IBM or Xerox, have engaged primarily with product-independent services such as "non-vertical" financing, technology consulting, and business process outsourcing.

In addition to providing technology products and solutions, IBM has become one of the world's largest providers of services in the areas of management consulting (especially financial and technology consulting) and of IT outsourcing (Spohrer 2017). After selling its personal computer group to China-based Lenovo, IBM changed its registration at the New York Stock Exchange (NYSE) from product to service company. Just like General Electric under Jack Welch, Xerox moved into product-independent services with the 2010 acquisition of ACS, the world's largest diversified business process outsourcing company (though, only six years later, the company decided to split into two – the more hardware-centric Xerox and the service-centric Conduent – due to lack of complementarities between the two types of business). Despite these exceptions, the majority manufacturers' service businesses are still very much anchored in products and product-complementary services. Further to contributing to the company's reputation and relationship to customers, the product offering generally provides the cornerstone of the market demand for its services. This is particularly the case to capital intensive products with long lifespans of several years or even decades (Kowalkowski and Ulaga 2017). And this regardless of the share of revenues that services account for.

Accordingly, we conclude that when a manufacturing company loses competitiveness in product design and technology, service-based differentiation becomes ineffective. If the customers are no longer interested in the company's products, there will be no market for pre-sale and at-sale services; the company may still be able to sell some after-sales services (e.g., maintenance and spare parts) but only until the existing product installed base remains in use. An example provided by Dierickx and Cool (1989) appears interesting in this respect. It refers to the strategy followed by Canon to overstep Xerox in the low to medium volume copier market. Capitalising on its stock of R&D know-how, Canon was able to separate the product from the services and substitute its superior product design for Xerox's extensive service network. As the customers found Xerox products to lag behind competition, also the value created by the company's services was sharply diminished. Hence, servitized companies still need to be able to bring innovative products to the market; that is, compete through their R&D strength. This in turn implies that the decline in R&D strength caused by heavy investment in service-based differentiation at the cost of inadequate funding of R&D efforts is a, so far neglected, long-term risk to which servitized manufacturing companies are exposed.

6. DISCUSSION AND CONCLUSIONS

Since most companies operate under resource constraints, exploration of novel competitive domains reduces the speed with which competences in existing ones can be enhanced (March 1991). Hence, it is clear that heavy investment in service opportunities comes at the cost of underinvestment in product R&D, which in turn affects the extent to which a manufacturing company will be capable of improving and sustaining its competence at new product development (R&D strength).

The research discourse on servitization has so far ignored this trade-off. The theoretical view held by most prior works has indeed focused on services as key source of customer value and competitive advantage, implicitly assuming that, while manufacturing companies integrate forward into services, their core products and product technology would remain unchanged. Following this line of thought, previous research has tended to neglect product innovation, or at least to take it for granted. One implication is that R&D strength has not been treated as a strategic asset for servitized companies.

We have defined R&D strength as the ability to come up with effective product innovations and relied upon organisational learning theory and the resource-based view of the firm to argue that R&D strength is experiential in nature and is developed incrementally through a history of R&D activity.

Therefore, at any moment in time, the R&D strength possessed by a company is the cumulative result of the choices made by the company about R&D outlays over an appropriate period of time. This implies that, when servitized companies underinvest in product R&D to allocate more of their strategic resources to differentiate themselves through service elements and product-service products, they forsake the opportunity to improve their R&D strength. Further still, as a knowledge asset, R&D strength decays over time since the contribution of older R&D investments becomes less valuable as time passes. Thus, inadequate funding of product R&D efforts is most likely to result in the erosion of the company's R&D strength.

Our analysis reveals that R&D strength is necessary to avoid that servitized companies may lose service revenues because their service-based value propositions are created around products that have become obsolete or adopt obsolete technology. Through its influence on product innovation capabilities, R&D strength sets the reference point for the development of functional offerings and product-service solutions that match the competitive context and technology landscape. The utility provided by product platforms remains essential for the soundness of servitized offerings, even though the competitive emphasis is on service attributes and service-based value concepts. Therefore, we submit that, although previous research into servitization seems to suggest otherwise, R&D strength remains a critical asset also for servitized companies.

The importance of investing in product R&D to ensure that the company can rely on an adequate R&D strength may not be evident at the time when servitization is embraced because the company can still mine the value of R&D strength from prior R&D investments. However, over time heavy investment in services at the cost of inadequate funding of product R&D will result in the progressive erosion of the initial R&D strength, which in the long-term will create the abovementioned risk that the company struggles to devise competitive value propositions. Additionally, the theories upon which our analysis is based bring about the issue of time compression diseconomies, which make it difficult and costly for servitized companies to sustain their R&D strength through discontinuous investment in product R&D. Building up R&D strength is a time-consuming process and making up for declines in R&D strength after shifting the focus of innovation investments from product R&D to service initiatives is likely to involve crash R&D investments.

In sum, we argue that the view that servitized companies can simply substitute product innovation with value innovation and business model innovation is too simplistic. The opportunity cost associated with a service-based innovation strategy needs to be addressed from a long-term perspective and concerning its effects on the company's competence at product R&D. Such competence, which we label as R&D strength, remains an important knowledge asset to ensure that product-service offerings do not become quickly obsolete and that servitized companies can retain a competitive edge. Hence, while manufacturing companies should leverage service-based value concepts to create innovative market offerings, they should also be careful to maintain an adequate level of investment in product innovation to protect the core R&D-based competences that remain the foundation of their competitive advantage.

The real managerial issue then becomes not the total benefits or experiences the customers obtain in the use of the company's services but the division of available resources and their allocation between product R&D and service endeavours. Such resource allocation decisions, we suggest, should importantly adopt a policy of integrating service market aspects into product innovation processes. Many manufacturing companies still pursue product R&D and launch new products without paying sufficient attention to service opportunities, which are often considered only later. Instead, servitized companies should design their products also with the service market in mind; for example, taking into account serviceability and durability. This is even more important today given that software has become an integral part of most products and servitization opportunities more and more lie in the digital domain with remote control, automation, and subscription-based models (Tronvoll et al. 2020). While servitized companies should be aware of the continued importance of investing in product R&D, they should at the same time work to make their product innovation processes (along with their business models) more service-oriented.

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SERVITIZATION PROGRAM MANAGEMENT PROCESS BASED ON SCALED AGILITY: A FACILITATING FRAMEWORK

Sarra Dahmani

ABSTRACT
Purpose: Identify how scaled agility process can contribute to facilitate managing servitization transition defined as a program of three interdependent projects.
Design/Methodology/Approach: Qualitative methodology based on grounded theory approach from four company cases, expert in scaled agility judgment and secondary data.
Findings: Definition a framework based on scaled agility to facilitate accomplishing servitization program and identifying facilitating principles according to Peopole, capability objectives and processes.
Originality/Value: Bring a new vision to define servitization according to a program of three interdependent projects – Identify how scalable agile environment can contribute to better achieve servitization program objectives.
KEYWORDS: Servitization; Scaled Agility ; Project Management Process; Program Management Process

1. INTRODUCTION

Servitization represents a development approach able to provide opportunities to achieve sustainability, improve enterprise competitiveness, and better satisfy customer needs (Bustinza, an al, 2015; Vandermer and Rada, 1998; Baines, 2017; Boucher an al, 2019; Dahmani and al; 2020). Since 1988, the definition of servitization first established by Vandermerwe and Rada has evolved significantly to cover the complete transition of the industrial firm towards a transition process.

Literature on servititaion over the last decade has prevailed empirical studies to prove the relevance of this transformation on the different dimensions of business value; its strategic virtues for the company as well as its social and environmental impacts. However, we note that practitioners in companies are still facing operational difficulties related to the successful achievement of the transition.

Servitization has been evolving in the same time as current tendencies of economy projectification (Midler, 1995). Servitization transition has been implemented and managed through changing projects in companies, relying sometimes on the help of consultant in the field, adapting previous experiences or benchmarks that do not necessarily align with the specific criteria and constraints of every business. We witness the difficulty of defining a standardized operational management approach to help the company achieve a successful completion to a servitized valuable model. These transformation projects are usually managed based on waterfall approaches, agile approaches are being introduced to digital servitization systems based mainly on IT functionalities. Our aim in this paper is to answer this gap to introduce scaled agility as a facilitating approach for implementing successful servitization strategies in companies.

Agility represents an important competitive advantage of contemporary organizations (Ciric and al, 2019). The agility of the organization can be defined as the ability to react quickly to changes in the dynamic business environment (Ciric and al, 2019). Although it emerged as a concept for software development and IT projects, agility today represents one of the basic competitive advantages of contemporary organizations.

This research represents a first step in a large explorative approach aiming to build a methodology approved by academia and Executive to introduce scaled agile principles and approaches to facilitate servitization program management. In this research we ask the question of “How scaled agile principles can play a facilitating role in achieving servitization program/projects ?”

This paper is structured in four main sections, the first section aims to cover the theoretical fundamentals about servitization schools of thoughts and new trends in research on one hand; and agility and scaled agility in the other hand; the second section introduces the methodological approach we adopt based on grounded theory among four different cases and with two experts in developing scaled agile frameworks. The fourth section exposes our results that we discuss in the last section.

2. THEOROTICAL BACKGROUND

2.1. EVOLUTION OF SERVITIZATION

Servitization, product service systems (PSS) concepts and experiments have spread during the last decades in academic and practitioner communities (Hou and al, 2013, Palo and al, 2019, Sjodin and al, 2020).

Recent tendencies in servitization management has called to study servitization as practice in practice (Kohtamäki and al, 2018, Sjodin and al, 2020). The current trends in servitization literature address the need for more operational tools to help controlling the servitization transition process for the industrial company; Baines and al (2020) have addressed a complete process to identify the stages marking a servitization transition process for a company. The impacts of servitization on the supply chain development addresses also an important question for the executive (Vendrell-Herrero and Wilson, 2017); new concepts related to servitization are evolving like open business model (Visnjic, 2018); the contribution of big data analysis (Ren and al, 2019) and big data to servitization transition are also part of the current trends in the field.

Valuable attempts were made in analyzing key strategical and organizational practices in implementing servitization (Rabetino and al., 2017; Dahmani and al, 2016; Baines and al, 2020); in business model evolution and co-existence (Kowalkowski and al 2015; Storbacka and al., 2013; Sjodin and al, 2020; Boucher and al, 2019; Peillon and al, 2015); in value co-creation through agile methods for digitalized servitization (Sjodin and al, 2020; Hernandez, 2019); risk management in servitization transition (Dahmani and al, 2020); servitization digitalization (Kohtamäki and al, 2019). We rely to all this important knowledge built to understand the concept and its various applications and impacts. At the same time, researches addressing the concern of operational implementation of the transition in the company still very limited. In the same time, we can witness the current trend of economy projectification leading to the spread of project management techniques and processes as a basic vector to manage strategic transformations in companies.

Projectification has been used since its first definition by Midler in 1995, the projectification of economy refers to the spread of project-based processes to cover all the principle organizational processes in the company (Geraldi and al., 2011). Projectification generalization brings academia and practitioner to pay attention to the new tendencies and practices developed for project management in order to disseminate them within the organization, which is the case of scalable agility.

Based on all this we propose in this research to complement the existing definitions of servitization with a vision based on the practical and operational aspect of the transition: the multiple interdependent projects of servitization transition, which can be considered as a program for the product-centric company.

As discussed in literature, PSS are not based only on technical aspects; organizational aspects are also involved at the level of the company’s processes and internal tools, which increases the complexity of implementing this concept in businesses (Cook and al, 2006; Rabetino and al, 2017, Dahmani and al, 2016). Many companies struggle with rapid digital innovation which is becoming part of the natural progress of companies and which has an important impact on deciding the transition to a service-centric business (Iansiti and Lakhani, 2014; Sjodin and al, 2020).

Based on all of the above we conclude that Servitization implementation in the company represents a program that questions three main aspects that can represent different specific scopes for three interrelated projects: the technical design of the PSS from a product based to a service based system (project A); the definition of the business model and business plan to clarify the value construction process for the users and for the company (project B); and the organizational changes covering all the aspects related to the internal changes in the company especially its information system development (project C). We introduce a specific approach to define servitization according to a program regrouping these different but related projects (figure 1).

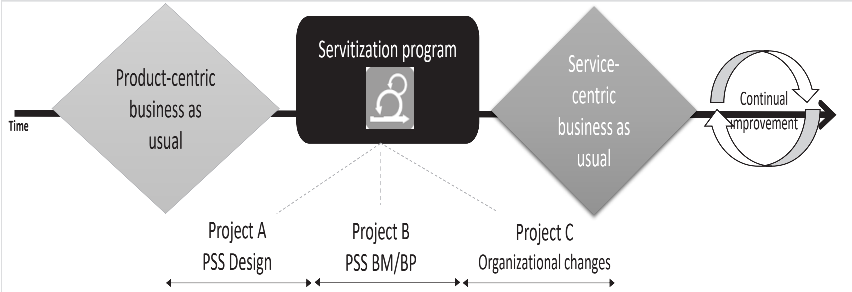

Figure 1: Servitization: a transition Program

We consider the important potential value new approaches in project management field, especially scaled agile practices, can bring to servitization. In the next section, we introduce agility with its multiple visions.

2.2. SCALED AGILITY

Scaled agility approaches are related to the spread of agile approaches at the level of the organization (SAFe; Venkatesh and Rakhra, 2020), impacting its structure, and its value creation process. The Organizational Agility competency describes how companies can transform business processes, optimize teams performance, evolve strategy with commitments, and quickly adapt the organization as needed to capitalize on new opportunities. Scaled agile framework are based on “classic” agile framework created firstly for IT project, and limited to small group of developers. These were used at the team level only to improve the process of information system development (Conboy,2009) providing no answer on how to coordinate larger groups of developers (Schuch and al, 2020). Thus, scaled-agile frameworks are codified descriptions of structure and process for organizations that strive to remain fast in delivery and responsive to market dynamics despite a growing number of participants and the detrimental effects that go along with increased communication efforts (Schuch and al, 2020). Applying agile on a large scale facilitates knowledge sharing and effective coordination in the company (Lagerberg and al, 2013). Increased use of agile methods in large-scale projects reduces failure risk (Kasauli and al, 2021).

In order to capture the promised value of agile diffusion in the company’s process, several companies all over the world are adopting large-scale agile frameworks (Ebert and Paasivaara, 2017) such as Scaled Agile Framework (SAFe) (Knaster and Leffingwell, 2017) and Large-Scale Scrum (LeSS) (Larman and Vodde, 2016, Kasauli and al, 2021).

Given the attention that these large-scale agile frameworks currently receive, we aim in this paper to discuss the facilitating aspect scaled agility can bring to succeed servitization program transition for a product centric to a service centric business. We are not giving a full summary of these complex frameworks for scaled agility in this research, but refer to and briefly describe various specific practices and principles.

Unlike classic agile framework defined at the level of the project, there is no explicit manifesto for Scaled agile framework. According to Bick and al (2018) scaled agile frameworks are based on similar principles: customer value, continual improvement, system approach, coordination (Bick and al., 2018); Dikert consider as a fundamental principle self-organization (Dikert and al., 2016); Knaster and Leffingwell (2017) give a more detailed model considering continuous improvement; transparency for building trust, which is essential for performance, innovation, risk-taking, and relentless improvement (Batra, 2020).

Based on this knowledge, and simultaneously being immersed with practitioners in managing servitization transition, we aim first to represent a framework to explain the positioning and mechanisms between the servitization transition program and the scaled agility environment. Our second objective consist in identifying a number of facilitating principles.

3. RESEARCH METHODOLOGY

This paper follows a grounded theory methodological approach (Charmaz and Belgrave, 2007; Glaser, 1999). Based on observing and accompanying four companies (table 1) in implementing servitization. We rely also on secondary data from previous feedbacks for companies, which have initiated their servitization journeys. In addition, we realized two focused groups with two experts in Agile methods and frameworks (table 2). Our aim consists in finding similarities and convergence points between servitization as a program regrouping three main interdependent projects, and practices from scaled agile environment to contribute to define a consistent approach for transition servitization program/project process.

The cases were selected following a system of criteria considering:1) the position of the company in the servitization journey; 2) the high level of maturity in using and developing project management processes in general; and 3) the diversity of the fields and sizes of the companies.

Data collecting was made through formal and informal interviews with leaders from the companies and with agile experts, and consulting official documentation of the companies from 2015 until 2021.

Data analysis were made through manual coding, and concept mapping with two main objectives: the first one is bout identifying in the criteria to define servitization projects/program. Our second objective is about mapping what we call in the research results the "facilitating principles" (FP) that represent the best practices that we have identified as making sense from scaled agility environment to implement in servitization program. In our vision these FP represent the basics for defining the scalable agile process for servitization program management.

Table 1: Details about the companies cases

	Company A	**Company B**	**Company C**	**Company D**
Size of the company	Small (3 employees) + a network of subcontractors	Medium (40 employees)	Big (100 employees) + international	Medium (20 employees)
Activity area	Manufacturing	Manufacturing	Industrial + Logistic	legal advice (based on AI)
When servitization journey has started ?	Since 2009	Since 2010	Since 2012	Not specifically called servitization – the initial BM is service-centric (since 2017)
Position of the interviewed people in the company	The leader	One of the leaders	The business development director	One of the leaders
Scaled agile environment	No specific practices or agile project management	No specific practices or agile project management	Agile project management practices	Start introducing agility at scale
Number of interview	3 of 60'	2 of 60'	2 (30' + 90')	1 of 90'

Table 2: Details about the Agile experts

	Expert Agility 1	**Expert Agility 2**
Profile	Coach and consultant	Consultant and academic
Years of experience	15	8
Expertise in scaled agile methods	Has contributed to 10 missions of implementing SAFe framework in companies – Expert and trainer for SAFe framework	Has completed a PhD thesis about scaled agility in big companies based on a seven comparative case studies of big French companies
Data collection	Focus group discussion + informal interviews	Focus group discussion + informal interviews

4. RESULTS: A FACILITATING FRAMEWORK AND PRINCIPLES

The first aim of this paper is to introduce a framework allowing facilitating servitization project management in companies based on scaled agility concepts.

In figure 2 we present the facilitating framework for servitization transition program we have deduced. The A, B, C projects, introduced before (cf. section 1), are presented in the servitization program; regular iterations are represented through the arrows among the projects in the program and with the scaled agile process in order to reach the overall performance represented through achieving servitization objectives to create value and agility performance among the general system of the company.
The scaled agile process we define is based on facilitating principles we detail in table 3 through three main groups: People, Capability objectives and Processes.

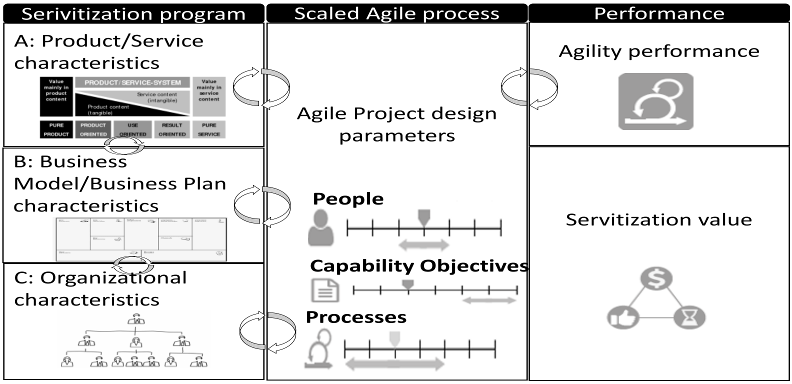

Figure 2: A facilitating framework for Servitization transition program in scaled agile environment

In table 3 we detail the different components FP of the Scaled Agile process for servitization program: our aim is to highlight the main principles facilitating the servitization program transition for the company.

Table 3: Facilitating principles for servitization program transition in scaled agility environment

FP1: People - Build and maintain shared understanding of the PSS value created for users/clients
a) Bridge gap to user
i. Make team understand customer value
ii. Unable to express value using user stories for example
iii. Regular feedbacks and clarification
b) Build long lasting client/user relationship
i. Build long-term lasting knowledge
ii. Build trust with clients and final user
c) Build and maintain shared understanding about servitization objectives for the company: vision and program Progress
d) Reinforce team communication
i. Reinforce intra-team collaboration (at the level of every project)
ii. Reinforce inter-team information distribution (at the level of the program)
iii. Reinforce inter-team information acquisition (at the level of the program)
e) Reinforce team multidisciplinarity
FP2: Capability objectives - Support change and evolution
a) Manage experimental requirements
b) Synchronize development
c) Update requirements
d) Build a user-based vision for the internal information system (for workers)

FP3: Processes

a) Iteration management
   i. Implement regular and efficient iterations within and between projects
   ii. Define and continuously update iteration duration for the PSS
   iii. Define and continuously update release duration for the PSS

f) Prioritize among different functionalities: steering by value (to manage PSS versioning)
g) Manage requirement process
h) Manage the balance Scope - quality – time – cost for the PSS features
i) Consider the impact of the transition on the infrastructure
j) Build long lasting watch process to anticipate the evolution of users' need

5. THEOROTICAL AND PRACTICAL IMPLICATIONS AND DISCUSSION

This study is part of a larger research vision aiming to build upon the potential value, practices in project management field, can bring to servitization field. We believe in the positive impact of adapting some practices in scaled agility to facilitate servitization transition for companies.

This research draws a specific distinction between the business as usual in service-centric business, and the servitization program that represents a transition multiple project and aims to reach a stable situation of run or business as usual for a service centric business, which is a first theoretical contribution at the level of the concepts. We focus on the operational aspect of servitization as a program including three main interdependent projects. The research highlights the facilitating role a scaled agility environment can play to achieve servitization objectives. It draws a global framework to explain the mechanisms a scaled agility environment can play in facilitating servitization accomplishment. This is the second intellectual contribution.

The facilitation principles (table 3) we established in this research are based on three dimensions People, Capability objectives and Processes, they represent the third intellectual contribution of this research.

- **People:** this principle considers the importance of people involvement in the different steps of servitization program. People represent all the contributors related to the servitization journey. We prefer using the vocabulary of "people" instead of "stakeholder" to emphasize the human aspect among all the possible interactions they might have. This principle treats the important aspects of sharing the same understanding of the deliverable of the projects/program between the company realizing the servitization transition or the developers and the customer/user. This dimension focuses also on building and maintaining a shared understanding of the PSS value created for users/clients. Further, it considers the importance of communication within the project teams and between the projects teams at the level of the program.
- **Capability objectives**: this principle has the objective of supporting change and evolution capabilities at the level of the company. It is about giving fundamental principles to orient the direction of knowledge and capability system evolvement in the company over and after servitization transition.
- **Processes**: are related to the scalable agile processes we found as important and consistent for servitization program success. They concern the management of iterations; the prioritization question; and the constraints of the servitization at the global level of the program and at the detailed level of the A B C projects.

The grounded theory approach adopted in the methodological approach of this research emphasizes the important practical perspective of this paper to contribute to facilitate the control of the servitization program leading to achieve successfully the transition. The definition of the framework and the facilitating principles represent an contribution for practitioners allowing understanding how scaled agility can facilitate achieving servitization. It helps decision makers also visualize clearly what are the criteria to take into consideration to reach a better control of the transition. This is the first research studying servitization from a perspective of a program, and including scaled agile practices in a program.

The limits of this research are related to the limits of the exploratory approach we adopt, the qualitative methodological process generate deeply immersed results in the different cases that need a more complete empirical approach to be confirmed and generalized. The second limit is about the necessity to go further in detailing the different facilitating principles and completing the framework with the important milestones a servitization program will pass through. We will build upon these limits for our future research works.

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

Mario Rapaccini, Federico Adrodegari, Nicola Saccani

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.

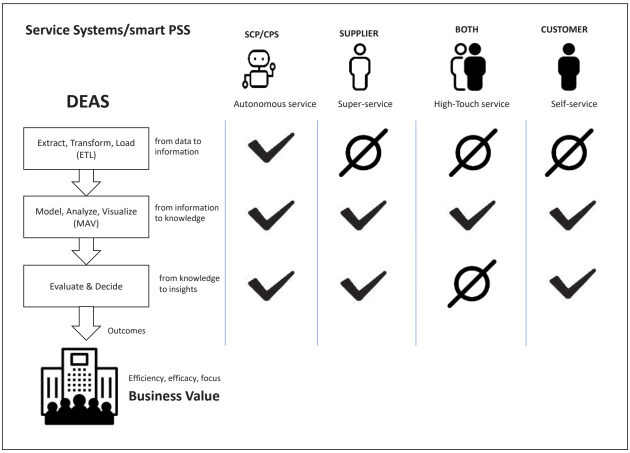

Figure 1: The data journey of DEAS based on SCP/smart PSS

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.

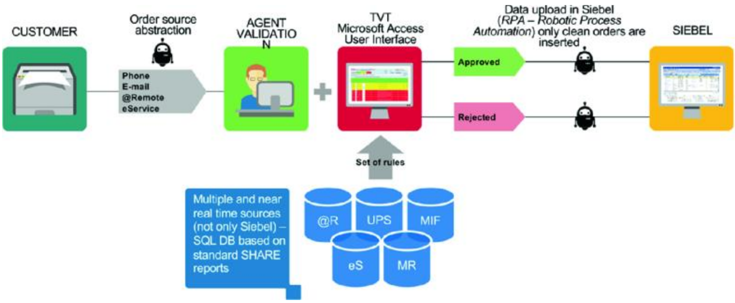

Figure 2: The data journey of the toner-request validation service [Stoll et al. 2020]

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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GLOBAL VALUE CHAIN BREADTH AND PRODUCTIVITY: EXPLORING THE EFFECT OF DIGITAL SERVITIZATION ON KNOWLEDGE ACCESS

Ferran Vendrell-Herrero, Oscar F. Bustinza & Marco Opazo Basáez

Purpose – Global value chains (GVC) incorporate internationally fragmented sources of knowledge so to increase global competitiveness and performance. This paper sheds light on the role of Digital servitization´s technological capabilities for facilitating knowledge access from international linkages and improving firm productivity.
Design/methodology/approach – Drawing on the organizational learning research, the present study argues that the relationship between GVC breadth, analysed in respect to the geographical fragmentation of supply chain facilities, and productivity follows an inverted U-shaped pattern that can be explained by the interplay between external knowledge access and the coordination costs associated with GVC breadth. We test our predictions on a unique sample of 426 Spanish manufacturing firms using Ordinary Least Squares (OLS).
Findings – Our results indicate that organizations following a traditional manufacturing system are able to benefitting from fewer transnational relationships (concretely 11 foreign facilities) in the search of productivity improvements. This can be largely attributed to the marginal value of the knowledge accessed and the costs of coordinating international counterparts´ knowledge transfer. However, our study discloses that the adoption of digital servitization have the potential to expand GVC breadth, in terms of the number of linkages to interrelate with (concretely 131 foreign facilities) so as to obtain productivity gains whilst mitigate the complexities associated with the transfer of knowledge.
Originality – The study unveils that digital servitization´s technological capabilities enable to manage wider GVC breadth, facilitating knowledge access and counteracting coordination costs from international counterparts.

KEYWORDS: Global value chain (GVC), Knowledge management, Digital servitization

1. INTRODUCTION

Previous studies have shown that participating in a GVC provides a gateway to international markets and renders an increase in business specialization (Gereffi 2019). Thus, in the present work we consider GVC participation as an opportunity to acquire new knowledge. In particular, by drawing on organizational learning theories (Woodman et al. 1993), we argue that knowledge acquisition arising from broader global value chains has a positive effect on the productivity of companies. However, as in any learning curve, these positive effects suffer from diminishing marginal returns (Asimakopoulos et al. 2020). On the other hand, we also argue that a wider GVC breadth can increase coordination costs, making possible the existence of decreasing returns. Altogether, the combination of both arguments indicate the existence of an optimal GVC breadth, which in empirical terms is reflected in an inverted U-shaped relationship between GVC breadth and firm productivity, and in practical terms is reflected in an optimal number of countries in which firms should operate their production facilities.

Additionally, there is a growing interest in how the adoption of digital servitization can improve knowledge acquisition and coordination management in global value chains (Vendrell-Herrero et al. 2017). We argue that digital technologies under the umbrella of digital servitization (e.g. the internet of things, big data and analytics, robotic systems, etc.) have the potential to influence both GVC configuration and geographical dispersion. In particular, we propose and empirically validate that the use of digital servitization´s technological capabilities enable to shift rightward the optimal level of GVC breadth in which the benefits of knowledge acquisition attenuate coordination costs.

We test the hypotheses on unique survey data on medium-sized (SMEs) Spanish manufacturing firms. The questionnaire administered to 426 firms was designed specifically to answer the questions pursued in this study. The questionnaire data were fused with accounting and financial data from the Bureau Van Dijk (BvD) to give the study more robustness in relation to monetary values (e.g. firm revenues).

The contributions of the study are threefold. First, we find that external sources of knowledge add value, but as opposed to other international business practices in which learning curves apply (i.e. diminishing marginal returns in exporting); we are the first to find that in the context of GVCs, coordination costs play an important role and may reverse the positive effects of external knowledge access producing decreasing returns. Second, the study demonstrates that in complex environments, digital servitization enhances knowledge acquisition in a form that boost firm productivity. This responds to recent calls enquiring for more research on the benefits of digital servitization within technology management (Sklyar et al. 2019) and international business (Alcacer et al. 2016). Third, this study contributes to the globalization vs de-globalization debate, by providing strong evidence that through increased technology it is practically impossible to put barriers into globalization.

2. THEORETICAL BACKGROUND AND HYPOTHESES

Knowledge transfer in GVCs is not static, but rather a dynamic process where the nature of the knowledge accessed serves as the base for building new knowledge or reconfiguring existing knowledge (Li and Hsieh 2009). Within this framework, different sources of external knowledge from geographically distant production activities intertwine, thus the effective coordination of activities among the geographically dispersed units becomes critical for GVC performance (Meyer et al. 2011). However, the coordination of knowledge sourcing is not free of complexity, and the lack or failure in the use of effective mechanisms can be detrimental to knowledge access among GVC inter-firm linkages (Wang et al. 2019). Accordingly, as GVC breadth widens, it demands for more effective coordination mechanisms to adequately manage knowledge transfer and harvest the benefits of the knowledge accessed from GVC linkages. However, the escalating complexity and coordination costs when dealing with a wider GVC breadth can increase to a point that might lead to decreasing returns, where the value of the knowledge accessed is likely to be outweighed by the emergence of coordination diseconomies (Meyer et al. 2011).

Taking into account these arguments, we propose that GVC breadth will have a positive impact on firm´s productivity because it enables them to access external knowledge sources that enrich existing knowledge and promote learning (Korzynski et al. 2019). Nonetheless, it needs to be acknowledged that beyond certain threshold, the benefits that firms achieve by accessing external knowledge can rapidly be offset by the existence of coordination diseconomies (Meyer et al. 2011). As such, we predict that the relationship between GVC breadth and productivity follows an inverted U-shaped pattern. Accordingly, we formulate the following hypothesis.

> **H1.** *The relationship between global value chain (GVC) breadth and firm productivity displays an inverted U-shaped pattern*

From a digital servitization perspective, the interconnection between systems, assets, and machines configure smart grids all along the value chain so to control and coordinate production processes seamlessly (Rymaszewska et al. 2017). To do so, traditional industrial machinery (e.g. manufacturing equipment) and products are endowed with sensors, RFID, and actuators to gather and transfer information (Porter and Heppelmann 2015). This allows monitoring all different steps of the manufacturing process in real time and, through data analytics and virtualization technologies, trace possible factors affecting manufacturing resources/processes (Paiola and Gebauer 2020). Hence, organizations are able to detect possible malfunctions (e.g. product quality defects or equipment faults), and make timely adjustments so as to ensure greater uniformity in the manufacturing process (Grandinetti et al. 2020). Additionally, within digital servitization settings, augmented-reality-based systems enable manufacturing processes (e.g. warehouse operations) to be performed remotely and in real time, facilitating thereby the normal execution of production processes, without time or geographical location constraints (Gebauer et al. 2020).

Based on the above arguments, we posit that firms' adoption of digital servitization broaden the inverted U-shaped relationship between GVC breadth and productivity. In particular, we suggest that the absorptive capacity embedded in digital servitization´s technological advances upgrade GVC capabilities to access timely and refined information/knowledge from external sources—as well as—increased coordination mechanisms for geographically disperse GVC linkages. In light of this, digital servitization has the potential to reduce the negative effect of diminishing marginal returns of knowledge acquisition (Li and Hsieh 2009) and coordination diseconomies (Meyer et al. 2011). Accordingly, we formulate the following hypothesis:

> **H2**. Digital servitization *will broaden the inverted U-shaped relationship between global value chain (GVC) and firm productivity*

Figure 1 exhibits the proposed framework in order to better visualize the predicted interrelationships captured in the study's hypotheses.

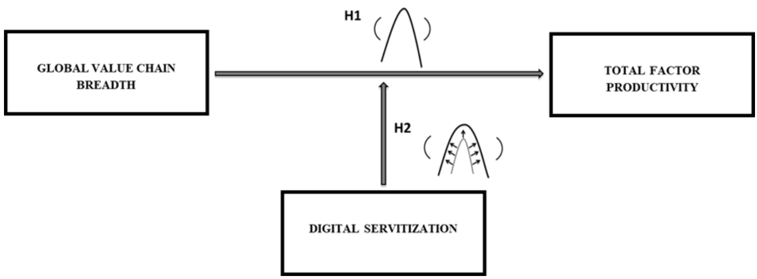


Figure 1: Proposed framework for GVC, digital servitization, and firm productivity

3. RESEARCH METHODOLOGY

3.1 Data and variables

To identify the population of firms we utilize the SABI database, a service of Bureau Van Dijk (BvD) (http://sabi.bvdep.com), which provides a good representation of all strata of the Spanish manufacturing population. The population of firms varies in size from 50 to more than 1000 employees that work in industries with manufacturing NAICS codes 31 to 33 (~7,000 firms). Firms were contacted via Computer-Aided Telephone Interviewing during November and December 2018, until we obtained 438 responses, being 426 of them fully complete answers. Once the survey was completed, it was merged with the SABI database to ensure that the monetary values of interest including revenues and profits for the current (2018) and subsequent (2019) periods were fully objective.

Our dependent variable is Total Factor Productivity (TFP). We estimated TFP using Levinsohn and Petrin's (2003) method. This method requires an output and three types of inputs (intermediate input, fixed capital and labour input). We used firm's accounting information from

SABI to account for those inputs. Sales proxied output. Operating expenses net of depreciation, amortisation, and labour were used as intermediate inputs, the book value of fixed assets measured fixed capital, and labour expenses measure labour input.

Our independent variable is Number of Countries with Production Facilities. This variable provides a good indication of the participation of firms in Global Value Chains. In the survey, respondents provide information about the number of countries in which they have a production facility. As can be observed in Table 1, almost three quarters of the firms (73.7%) do all the production in the home market. Among the rest of firms, a majority have production facilities in between 1 and 5 countries (22.3%). Only 17 firms (4%) have more than 6 production facilities abroad, 5 (1.2%) of them reaching 50 countries or more.

Table 1: Distribution of observations in terms of GVC participation and size

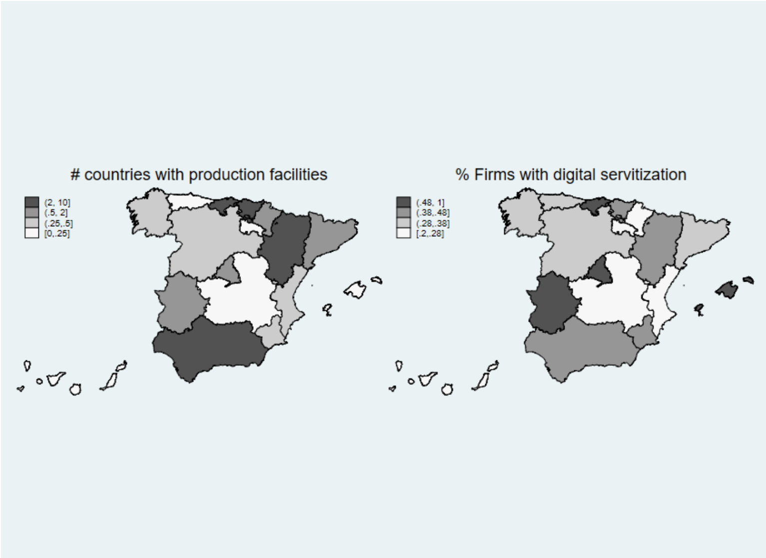
GVC class		**Size class**	
Number of countries		***Number of employees***	
0	314	1-49	0
	73.7%		*0.0%*
1-5	95	50-149	235
	22.3%		*55.2%*
6-10	7	150-249	102
	1.6%		*23.9%*
11-49	5	250-999	79
	1.2%		*18.5%*
50+	5	1000+	10
	1.2%		*2.3%*
Total	**426**		**426**

Our moderating variable is Digital servitization. This binary variable takes value '1' when the firm uses 'virtual or cloud data storage' and 'computational intelligence and / or computational (digital) analytical tools to support decision-making', items that were introduced in the survey as separate questions. In total 164 firms answered positively to those questions (38.5%) and can be classified as possessing digital servitization capabilities.

The study contains a number of control variables. Firm size is operationalized with the number of employees. According to Table 1, sample contains small, medium and large enterprises. The class size with more representation is the one between 50 and 149 employees (55.2%). Roughly, a fifth of firms are large as they employ more than 250 workers (20.8%). Other control variables are firm age that measures the difference between current year and foundation year, and B2B that measures the type of client. This binary variable takes the value '1' when the main client of the firm is another firm and '0' when the firm sells to end consumers.

Finally, the present study controls for industry and regional fixed effects. By construction, the study contains three manufacturing industries with NAICS codes 31, 32 and 33. These codes include industries such as food, beverage, and textile processing (NAICS 31); non-mineral manufacturing including wood, petroleum, plastics and chemical processes, and the pharmaceutical industry (NAICS 32); and mineral manufacturing, including the construction of hardware, vehicles, machines, turbines, and engines (NAICS 33). The study also controls for regional factors. In particular, we consider Spanish Autonomous Communities. Figure 2 maps the average value of the independent and moderation variables by region.

Figure 2: Regional distribution of participation in GVC and adoption of Digital servitization



3.2 Empirical approach

We estimate ordinary least squares (OLS) of the following form

$$TFP_i = \beta_0 + \beta_1\#countries_i + \beta_2\#countries_i^2 + \Omega_i + \gamma_s + \gamma_r + \varepsilon_i \quad (1)$$

Where the subscript *i* refer to the firm, TFP_i is the dependent variable, #countries is the independent variable, Ω_i is a vector of control variables that include firm size, firm age, and B2B, γ_s are sector fixed effects, γ_r are regional fixed effects, and, ε_i is the error term.

The inverse U-shape hypothesis will be confirmed if parameter β_1 is positive and significant ($\beta_1 > 0$) and parameter β_2 is negative and significant ($\beta_2 < 0$). By using differential calculus and the ceteris paribus condition, i.e. all other explanatory variables remain constant, it is possible to use parameters β_1 and β_2 to compute the number of countries that maximize predicted TFP (denoted with μ).

$$\frac{\partial TFP}{\partial \#countries} = \beta_1 + 2\beta_2\#countries = 0 \quad (2)$$

From equation (2) we can easily derive that the optimal number of countries that maximize predicted TFP is $\mu = -\beta_1 / 2\beta_2$. Hypothesis 2 suggests that by using digital servitization the number of countries that maximize firm productivity will be increased. This means that Hypothesis 2 will be supported if $\mu_{digital\ servitization} > \mu_{traditional}$.

4. RESULTS

Table 3 estimates Equation 1 for the full sample and the two relevant subsamples of this study, i.e. traditional manufacturing and those who adopted digital servitization. The models have a good explanatory capacity as R^2 ranges in between 0.21 and 0.26. In all models, β_1 is positive and β_2 is negative ($\beta_1 > 0$; $\beta_2 < 0$). The parameters are statistically significant at 5% in the full sample, and statistically significant at 10% in the subsamples. This result supports Hypothesis 1.

Table 3: Number of countries with production facilities and firm productivity

	(1) Full sample	(2) Traditional manufacturing	(3) Digital servitization
Number of countries	0.002**	0.017**	0.002*
	(0.001)	(0.007)	(0.001)
	0.014	0.018	0.061
Number of countries squared	-0.000**	-0.001*	-0.000*
	(0.000)	(0.000)	(0.000)
	0.026	0.080	0.079
Employees/100	0.010***	0.010***	0.010***
	(0.003)	(0.003)	(0.003)
	0.000	0.003	0.001
B2B	0.005	0.012	-0.002
	(0.014)	(0.020)	(0.021)
	0.716	0.542	0.943
Firm age	0.060***	0.064**	0.066**
	(0.018)	(0.025)	(0.028)
	0.001	0.012	0.019
Constant	1.652***	1.628***	1.677***
	(0.034)	(0.046)	(0.052)
	0.000	0.000	0.000
Observations	426	262	164
R-squared	0.216	0.222	0.263
Regional FE	YES	YES	YES
Industry FE	YES	YES	YES
Optimal # countries (μ)	133.05	11.08	131.20

Dependent variable: Total Factor Productivity (TFP)
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The parameter μ equals 11 for the traditional manufacturing sample and 131 for the digital servitization sample. This result largely supports the Hypothesis 2; firms with digital servitization´s technological capabilities can manage very large and complex global production systems. More specifically, firms possessing digital servitization can manage twelve times more production facilities than traditional manufacturing firms do. This results suggest that technological change has allowed companies to evaluate their international production strategy from a very different lens. Being able to have and share information in real time with multiple factories that might be located thousands of kilometres apart provide important benefits. It potentially allows reducing coordination costs by improving logistics and transport routes and managing complex supply chains with highly specialized teams.

5. CONCLUSIONS

5.1 Theoretical implications

External knowledge access has largely been connected to productivity and profitability in international production research (Li and Hsieh 2009). In fact, even when may be subject to diminishing returns, knowledge resources are always associated to a learning curve that in general results in positive gains (Asimakopoulos et al. 2020). On this, we argue that the coordination costs of transnational linkages can outweigh the value of external knowledge access and lead to decreasing returns. A theoretical prediction confirmed by our empirical results that demonstrate that such relationship follows an inverted U-shaped pattern. Accordingly, we claim that in GVC contexts external knowledge access may be associated to negatives outcomes due to coordination diseconomies (Meyer et al. 2011).

Transnational Interfirm knowledge transfer research, particularly in the context of GVCs must address the transformative effect of digital servitization technologies in terms of knowledge acquisition, assimilation, and dissemination (Gebauer et al. 2020). Concretely, the absorptive capacity embedded in digital servitization´s technological capabilities facilitating the timely transfer and interpretation of information e.g. via interactive data visualization (Paiola and Gebauer 2020). And by the means of sensors, RFID, and actuators that gather and transfer information, the monitoring all different steps of the manufacturing process in real time (Porter and Heppelmann 2015). Altogether, these technological capabilities will fasten the learning processes and increase the pool of knowledge among GVC linkages.

5.2 Managerial Implications

Our study suggests a number of relevant implications for managers of manufacturing firms participating in a GVC framework. First, they must conceive external knowledge access as a process that might bring decreasing returns as a result of escalating coordination cost. Moreover, they should consider the adoption of digital servitization in order to expand the number of inter-firm linkages to collaborate with and benefit from. In this respect, they must embrace the technological capabilities comprised in digital servitization to facilitate valuable external knowledge access and improve coordination mechanisms.

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IMPROVING PRODUCTIVITY THROUGH SERVITIZATION AND DIGITAL TRANSFORMATION

Dr Philip Davies, Professor Glenn Parry, Dr Joshua Ignatius, Dr Hoang Nguyen,
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ABSTRACT

Purpose: Firms adopt advanced services to gain performance benefits compared to their traditional product sales. Although the literature has investigated the productivity benefits of advanced services, there is a gap in knowledge in relation to benefit realised. The purpose of this study is to analyse the operational efficiency of the UKs Main Line Rail network, focussing on rough ride monitoring (RRM) and track maintenance, from the perspective of lean management. The study performs a data envelopment analysis to compare the existing method of RRM by the driver (subjective) of the trains with an advanced service, underpinned by a technology solution capable of monitoring track condition (objective), proposed by an OEM.

Design/Methodology/Approach: This research conducts a comparative data envelopment analysis (DEA) for UK Main Line Rail (MLR) operational efficiency, with specific focus on rough ride monitoring and unscheduled maintenance tasks. DEA is a powerful analytical technique for measuring the relative efficiency of alternatives based on their inputs and outputs. On the inputs side, we take the time to complete unscheduled maintenance, train delays and train cancellations. On the outputs side, the overall performance of both the Network Operator in terms of maintenance staff productivity, and the MLR network in terms of reliability and availability of trains, best reflects the overall efficiency of the context studied. We obtained input and output data from the Network Operators Track Maintenance Data, and Darwin, the GB rail industry's official train running performance engine that provides real-time information about train departures and arrivals against schedule. Data spans 18 months, February 2019 to July 2020.

Findings: Our paper presents expected findings from our DEA and discusses challenge and future research opportunities moving forward. We expect the servitized business model to improve the UK MLR operational efficiency (productivity). This will result in the Network Operator saving time by more rapidly locating and identifying real issues and removing many false reports that currently exist as a result of subjective Driver Rough Ride Reports. By attending fewer unplanned maintenance jobs and saving time on those correctly reported, the Network Operator is able to keep their staff working on scheduled maintenance, resulting in greater productivity across the UK MLR network.

Originality/Value: The findings of the study have operational and practical implications.

KEYWORDS: digital servitization; lean service, productivity, data envelopment analysis

1. INTRODUCTION

Lean management within manufacturing has been discussed in great detail within the operations management community (Pine et al, 2004; Holweg, 2007). During this time, the application and evaluation of lean as an approach to effective and efficient management of production has extended beyond the focal firms operations and into the supply chain to realise further benefits (Moyano-Fuentes et al, 2020). More recently, the coupling of lean and digitalisation has garnered interest, with early research showing that the interaction of lean and digitalisation through industry 4.0 leads to improved operational performance in comparison to their individual effects. However, whilst lean and digitalisation have been explored on the supply side, very little work has been conducted to explore the benefits of lean management on the demand side.

We argue that servitization, and in particular digitally enhanced advanced services (DEAS), provide a unique context to apply the theoretical lens of lean given the associated aims and benefits of advanced services. First, it is postulated that advanced services can improve the productivity of the customers operations, particularly as the manufacturer has greater knowledge of their asset and can maximise operational performance in line with what the customer values (Baines & Lightfoot, 2014). Second the manufacturer is incentivised to improve performance through the reduction of waste (e.g., downtime, reduction of required maintenance etc) in order to minimise operational costs, maximise firm financial performance and reduce waste within the system (Baines & Lightfoot, 2014; Green et al, 2017). These associated benefits and aims of DEASs align to lean management, as the aim is to specify value for the customer, reduce waste, improve flow and continually seek perfection (e.g., delivery of uninterrupted performance or capability provision). Benefits of lean management include improved responsiveness, engagement of employees in continuous improvement, higher quality and improved productivity. For productivity, Womack et al (1990) highlight the productive benefits of lean management vs. mass production by comparing the GM Framingham Plant with the Toyota Takaota Plant. The results show that the Toyota plant, where lean management is applied, significantly improves productivity in terms of hours spent on producing a car (from 31 hours to 16), defects per 100 cars (from 135 down to 45) and inventories of parts (from 2 weeks to 2 hours).

Within the servitization literature, considerable attention has been given to the benefits of advanced services, including the productivity gains that can be made (Baines & Shi, 2015). However, whilst this benefit is discussed, little empirical evidence has been provided to show the relationship between the provision of advanced services and improved productivity of the provider or customer operations (see exceptions: Opazo-Basáez et al, 2018; Karlamov & Parry, 2020). Further, servitization research has been criticised for being problem driven and lacking theoretical depth (Kowalkowski et al, 2017). Through the adoption of a lean lens, this study addresses these shortfalls in the servitization literature by conceptualising the alignment between digital servitization and lean management before conducting a data envelopment analysis (DEA) for rough ride monitoring on the UK Main Line Rail (MLR) services to evaluate the benefits of a lean DEAS on productivity of the customers' operations.

Driver Reported Rough Rides (DRRR) is a process through which a driver of a train experiences bumpy travel caused by the track defects and reports this to the Network Operator (the owner and infrastructure manager of the UK MLR). The Network Operator then deploys a maintenance team, who are taken off of scheduled maintenance jobs, to assess the area where the DRRR was reported and determine whether maintenance is needed. However, DRRR can (a) often be false reports; or (b) be felt and reported far away from where the causal point actually exists. Both instances lead to unproductive time spent finding the fault and/or finding out it was a false report. Further, whilst searching for and, if needed, conducting unscheduled maintenance, the area of the rail network affected is allocated temporary speed restrictions to allow for safe working conditions, impacting the reliability and in some cases, availability of rail services. This results in reduced productivity of the UK MLR maintenance and as a result, operational efficiency of the overall network. This process for the customer is presented in the following, simplified process map[1].

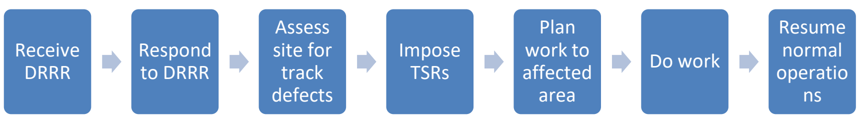

Figure 1. Simplified process map of the customers maintenance task following a DRRR.

[1] The process map depicts the process for repairing a correctly reported rough ride. If it falsely reported, then TSRs would be imposed, but removed slowly after inspection of the track reveals no fault.

To help improve productivity, our case organisation (a rail OEM independent of the Network Operator) has proposed an digitally enhanced advance service (DEAS) that seeks to a) minimise false rough ride reports and b) improve the location accuracy of where the rough ride occurred, allowing more targeted and productive maintenance. This study compares and contrasts the existing method of DRRR with the advanced service proposed by the OEM to identify whether productivity gains can be made from the DEAS.

2. LITERATURE REVIEW

2.2 Lean Management

Lean management has largely been developed within the manufacturing industry but has received interest within the service operations management community (Piercy & Rich, 2009). Within both industries, lean aims to reduce waste and activities that provide no added value for the customer (Womack et al, 1990). Whilst simplified, steps to achieve Lean are presented by Womack & Jones (2003) in their five lean principles of 1) specifying value from the perspective of the customer, 2) identifying the value stream, 3) making value flow, 4) letting the customer pull and 5) continually seeking perfection. To achieve these five principles organisations often standardise processes, minimise inventories and enable employee involvement in continuous improvement. It expected that the successful implementation of lean can lead to improved productivity, improved quality, shorter lead times and greater reliability (Holweg, 2007).

Lean was largely developed prior to servitization and digitalisation gaining interest in the academic literature. Whilst largely excluded from studies on servitization, recent research has focussed attention on the benefits of digitalisation in combination with lean production (Buer et al, 2020). For instance Kamble et al., (2020) find that the benefits of digitalisation through industry 4.0 on firm performance is mediated by successful implementation of lean production, whilst Buer et al., (2020) found that the interaction effect of digitalisation and lean production on operational performance is greater than their individual effects. In sum, operational performance increases when a company combines digitalisation of operational processes with lean management.

2.3 Servitization and Productivity

Servitization is described by Vandermerwe and Rada (1988) who observed organisations “adding value to their core corporate offerings through services” and offering “integrated “bundles” or systems, as they are sometimes referred to, with services in the lead role”. Within servitization, manufacturers provide different types of product service system (PSS) to meet various customer needs. Baines & Lightfoot (2014) classify three types of PSS, base, intermediate and advanced. All vary in their respective levels of complexity for service delivery. This study focusses on advanced services, whereby the offering is focussed on the provision of an assets capability to support the customer in co-creating value in use (Ng et al, 2009). Whilst focussed on capability and customer operations, advanced services can be found under various guises such as risk and reward sharing contracts, availability based contracts, or use orientated contracts (Baines & Lightfoot, 2014).

To date, servitization literature has largely focussed on organisational change (Bigdeli et al, 2017), business model innovation (Visnjic & Van Looy, 2013), digital servitization (Kohtamäki et al, 2020a; Kharmalov & Parry, 2020; Davies et al, 2020) and modular solutions (Salonen et al, 2018; Rajala et al, 2019). Whilst advancing the knowledge base, little research has been conducted as to the productivity benefits of advanced services even though this is recognised as a potential benefit of servitization (Baines & Shi, 2015). Further, there is an implicit assumption that advanced services improve the productivity of customer operations rather than purchasing the asset outright, operating and maintaining it themselves.

Recently, a small amount of research has sought to quantitatively analyse the productivity benefits of advanced services. For example, Opazo-Basáez et al (2018) investigate the automotive industry and seek to understand the benefits of servitization on an organisations productivity and sustainability performance. Their results found that firms willing to offer green services (e.g., sustainability orientated PSS) should first focus on a strategy of digital servitization if they wish to unlock both green and productivity benefits of advanced services. In addition, Karmalov & Parry (2020) investigate the productivity benefits of digital servitization in the context of the publishing industry. Focussing on the provider, their results indicated that servitized and digitally servitized firms are more productive than pure firms (product only). However, whilst more productive, only digitally servitized firms were more profitable than pure firms, raising questions around the combined benefit of servitization on productivity and profitability. In both instances, productivity gains of servitization focus on the firm and do not address productivity benefits for the customer and their operations. Further, whilst these two studies address the need for more empirical research analysing the productivity benefits, the knowledge base remains scarce. There is therefore a need for further research to understand the productivity benefits of servitization. To help fill this gap, we draw on lean management as our theoretical frame, where the focus is on improving value for the customer and minimising waste within the system with the ultimate goal of improving productivity of the system. In this study, we focus on improving productivity in the customers system through the use of an advanced service.

2.4 Theoretical Framework

For this study, we draw on the five lean principles of Womack & Jones (2003) as a lens through which to evaluate the proposed advanced service and inform our research methodology. The five lean principles are depicted in figure 2. For each of the five steps, we first discuss them in the context of servitization broadly, before specifically focussing on the context of our study.

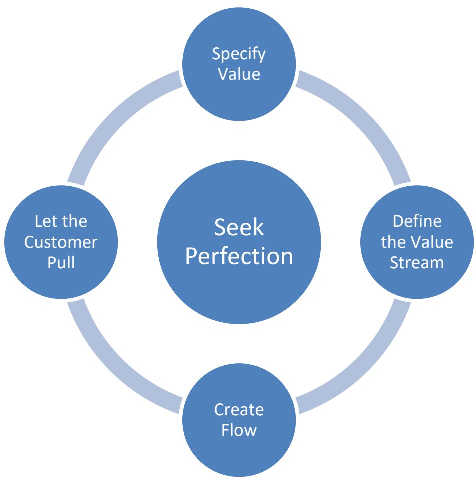

Figure 2. Five lean principles (adapted from Womack & Jones, 2003).

First - specify value. Advanced services are focussed on supporting the customers operations and providing capability (Baines & Lightfoot, 2014). Given this is the aim of an advanced service, there is natural alignment between specifying value from the perspective of lean and providing a capability in advanced services, given the objective of these services is to deliver uninterrupted access to a capability that supports the customers operations. For this study, we focus on what is important to the network operator who is the OEMs customer. Drawing upon published public reports, the primary value driver identified for the customer, and the customer of the customer (e.g., the train passenger), is on time departure and arrival of trains on the UK MLR. This can be seen as a measure of reliability.

Second - Identify the value stream. A value stream map analyses current and future state processes that take a service from its beginning, when an input enters the system, to an end when the input has been transformed into an output. In this research, the value stream was crudely developed as the process changes are minimal, with figure one representing both the current and future state processes. This study focusses on the efficiency of the UK MLR and in particular, on DRRR. DRRR can (a) often be false reports; or (b) be felt and reported far away from where the causal point actually exists. Both instances lead to unproductive time spent finding the fault and/or finding out it was a false report. Therefore, to improve the customers operations, it was important the proposed advanced service can a) reduce the number of false reports and b) improve location accuracy of correctly reported rough rides. Both would reduce the amount of time temporary speed restrictions were placed on the network, leading to reduced delays from DRRR as trains can travel at scheduled speeds. Further, it could reduce the amount of time taken away from scheduled maintenance, as the operators maintenance teams typically move from scheduled maintenance to unscheduled maintenance when a DRRR is made. In this instance, the cause of waste can be seen as 'muda', as the process can be wasteful and add no value to the customer as resources have been used inefficiently, and the type of waste can be seen as process inefficiency, as the subjective process of DRRR can lead to inefficient use of resources and loss of productive time for the network operators workforce and assets (trains). The introduction of the OEMS advanced service would not necessarily modify the number of steps in the existing value stream, but the objective nature of monitoring and analysing track condition from the advanced service is expected to mean the number of false reports provided would reduce, sending only confirmed rough ride demand signals to the customer, and would improve the location accuracy of where maintenance is needed, improving the efficiency of resource use (e.g., maintenance teams) when deployed to investigate the RRR. In some respects, the advanced service acts as a form of 'poke-yoke' by eliminating waste 'in process' through the elimination of false reports. This is expected to improve the time it takes to take an input and transform it into an output in the process of RRR maintenance work.

Third – make value flow. The primary change from current to future state that enables flow is the demand signal that enters the system and the reliability of that signal to pinpoint whether it is a correctly reported rough ride and to pinpoint a more accurate location as to whether the fault occurred. Within the existing system, the driver reports rough rides and as such, the inclusion of a human in decision making leads to errors such as false reports and the location of faults. In the future system, the demand signal (e.g., the rough ride report) is measured via the technological solution provided by the OEM that can measure track geometry and more precisely pinpoint fault location.

Fourth - letting the customer pull. The current system responds to 'demand' from the driver, but that demand is not for value creation (pull), rather, it is the late identification of a failure more common in 'push' systems. The automation enables the early identification of potential areas of track that are in need of maintenance. The system allows for close monitoring of all areas of the track and recognition of the emergence of an issue ahead of it becoming essential maintenance. This leads to scheduled maintenance and failure prevention that are common in lean manufacturing systems.

Fifth, with respect to seeking perfection, this service is in the development phase and the service is evolving. As such, the design team is mindful of developing a solution that maximises value for the customer, and remains flexible allowing for future modifications that move it closer to perfection.

Building on this framing, we conduct a data envelopment analysis to compare and contrast the productivity of the existing DRRR process vs. the proposed advanced service from the OEM.

3. METHODOLOGY

Given the aim of this research, a comparative data envelopment analysis (DEA) for UK Main Line Rail (MLR) operational efficiency, with specific focus on rough ride monitoring and unscheduled maintenance tasks, is conducted. DEA is a powerful analytical technique for measuring the relative efficiency of alternatives based on their inputs and outputs (REFS). On the inputs side, we take the time to complete unscheduled maintenance and train delays for each month from February 2019 to July 2020. On the outputs side, the overall performance of both the Network Operator in terms of maintenance staff productivity, and the MLR network in terms of reliability of trains, best reflects the overall efficiency of the context studied. Reliability in this case is defined as trains arriving on time/to schedule.

We obtained input and output data from the Network Operators Track Maintenance Data (NOTMD), and Darwin, the GB rail industry's official train running performance engine that provides real-time information about train departures and arrivals against schedule. NOTMD for the time period February 2019-July 2020 was provided by the OEM whilst Darwin data was open source and publicly available. Darwin data as downloaded during the period specified, resulted in 16 million train and bus journeys. Following data cleaning, where all bus journeys, trains with missing data and trains not running at the time maintenance work following a DRRR took place according to the NOTMD, we were left with approximately 200,000 train journeys that would have been affected by the DRRR unscheduled maintenance work. The analysis is ongoing.

4. CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

This study is an ongoing, early piece of research into the productivity benefits of an advanced service on customer operation.

We argue that advanced services can support lean management in the downstream side of the customers operations due to the incentives given to the provider. Notably, we believe this is one of the first studies to explore lean and servitization together and conceptualise servitization as an 'operationalisation' of lean downstream from the OEM and in the customers operations. This framing opens up future avenues for research and provides a theoretical basis through which to explain the performance benefits of advanced services, addressing calls from the literature to theoretically enrich the field (Kowalkowski et al, 2017) and to explore alternative narratives (Luoto et al, 2017).

Second, our study is one of the first within the field of servitization to evaluate the productivity benefits of servitization on a customer's operations using data envelopment analysis. Data envelopment analysis is a powerful technique to understand the productivity of a decision making unit. Our approach opens up avenues for future research by showing how this technique can be used to analyse productivity in the context of advanced services. An interesting avenue for research could consider whether a servitized firm is more productive than a non-servitized firm, given there is an assumption in the literature that servitized firms are more productive. Interestingly, Kharmalov & Parry (2020) found servitized firms were more profitable but less productive than pure product firms, suggesting there is a performance paradox here worth exploring and one that could be enriched by a paradox theoretical approach (Kohtamäki et al, 2020b) and evaluated using DEA.

Whilst future research directions have been detailed, a further opportunity has been identified within this research. Research is needed to understand why providing something as an advanced service is better than providing it as a product for the customer to operate and own. Whilst our analysis assumes this is an advanced service as per the case companies strategic intent, we are not able to determine whether this proposed solution is best offered as a service or not and whether the expected productivity gains would improve further when implemented as an advanced service, rather than just being attributed to the technological solution that is simply superior to the existing DRRR approach. This remains an underexplored area of research and an assumption remains that advanced services are automatically better than a product-orientated business model for both the provider and customers' operations.

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DEVELOPING CAPABILITIES FOR DIGITAL SERVITIZATION

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ABSTRACT

Purpose: Many manufacturers invest in digital technologies to advance servitization and achieve competitive advantage; however, their ability to utilise these technologies often lags behind the potential of them. Research has only begun to explore the capabilities for digital servitization and this study investigates the mechanisms through which these capabilities can be developed both internally and through collaborating with other actors.

Design/Methodology/Approach: This paper presents an exploratory study based on interviews with eight managers from large manufacturers who have significant knowledge of their companies' digital servitization efforts.

Findings: The findings illustrate three capability development mechanisms for digital servitization: learning, building, and acquiring and show that these mechanisms are inherently tied with which capability is being developed.

Originality/Value: Developing capabilities for digital servitization requires a more extensive reconfiguration than for traditional servitization, particularly with regard to partner collaboration.

KEYWORDS: Digital servitization, Capabilities, Capability development

1. INTRODUCTION

Digital technologies such as the Internet of Things (IoT), Cloud computing, and predictive analytics have been recognized as enablers of servitization (Lenka, Parida and Wincent, 2017). This is often termed digital servitization, which can result in changes to a manufacturer's strategies, operations, value chains, and business models (Martín-Peña, Díaz-Garrido and Sánchez-López, 2018; Kohtamäki et al., 2019). Digitalisation has helped manufacturers to enhance servitization through improved products, improved operational efficiency, improved services, revenue generation, and reduced operational costs (Cenamor, Sjödin and Parida, 2017; Hasselblatt et al., 2018; Kindström and Kowalkowski, 2014). While digital servitization creates various opportunities for manufacturers, their ability to adapt and grasp these opportunities often lags behind the potential of these technologies and creates a gap (Martín-Peña, Díaz-Garrido and Sánchez-López, 2018).

Digital technologies and data have become integral parts of a manufacturer's journey to become a solution provider, which means products, services and information should work together to create and capture value (Kohtamäki et al., 2019). This transition demands certain capabilities in manufacturers to deploy and exploit digital technologies (Ardolino et al., 2018). In this study, capabilities are defined as *socially complex combinations of interconnected resources that are deployed to achieve a desired end goal* (Helfat & Lieberman, 2002). Many digital servitization activities depend on the capabilities of other companies within a network (Kohtamäki et al., 2019). Thus, a focal manufacturer needs not only internal capabilities but also those developed with customers and other partners, which necessitates collaboration with other actors (Raddats et al., 2019). For example, some partners may provide access to relevant information and technological innovation (Benitez et al., 2021). A relational view on digital servitization highlights the importance of such complementary capabilities (Kamalaldin et al., 2020), and these capabilities are also of interest in this paper. However, work has only recently begun to explore the specific capabilities for digital servitization. Hence, the purpose of this study is to investigate *how firms develop different capabilities for digital servitization.* The study contributes by revealing three patterns of developing capabilities for digital servitization and connecting capability types with development mechanisms.

2. THEORETICAL BACKGROUND

2.1 Digital Servitization

With advanced technologies such as the IoT and Big Data, more services and solutions depend on data analytics to enhance manufacturers' and customers' operations (Coreynen, Matthyssens and Van Bockhaven, 2017). These digital services are scaleable and can create novel business models for manufacturers (Vendrell-Herrero et al., 2017). Thus, digitalisation becomes an enabler of servitization strategies (Kohtamäki et al., 2019), which is termed digital servitization. Digital servitization is defined as *the utilisation of digital technologies for transformational processes whereby a company shifts from a product-centric to a service-centric business model and logic* (Sklyar, 2021, p. 2).

While digital servitization enhances the manufacturer's offerings and operations (Cenamor, Sjödin and Parida, 2017; Hasselblatt et al., 2018), the transition towards digital servitization is a difficult journey due to the challenges and complexities in developing the related business models, capabilities and routines (Kohtamäki et al., 2019). Moreover, digital servitization requires extensive collaboration across the manufacturer's organisational boundaries (Sklyar et al., 2019) as digital solutions interact with the solutions of other manufacturers, used by the customers, delivered and maintained by different service partners, and developed and/or operated by technology partners (Kohtamäki et al., 2019). This study focuses on manufacturers' efforts at developing capabilities for digital servitization, including those in collaboration with partners.

2.2 Capabilities for Servitization

Servitization capabilities can be divided into two main categories: strategic and operational. Strategic capabilities imply the effective use of critical and distinctive resources that are highly valuable to the firm and its network and may include fleet management, technology-development, mergers and acquisitions, value quantifying, project management, supplier network management, and value co-creation (Huikkola and Kohtamäki, 2017; Parida et al., 2014; Sjödin, Parida and Kohtamäki, 2016). Previous research has largely focused on the operational capabilities in terms of service capabilities to develop, sell, and deliver services (Kindström and Kowalkowski, 2014; Paiola et al., 2013; Raja et al., 2020) and integration capabilities to integrate services into a customer solution (Paiola et al., 2013; Raddats et al., 2017). Moreover, the literature has also explored the capabilities required for advanced services in multi-actor settings; for example: balanced product and service innovation, co-creating innovation, and customer intimacy (Story et al., 2017).

Servitization has often been described as an explorative development path that needs significant changes in strategies, business models, and organisational capabilities (Parida et al., 2014; Sjödin, Parida and Kohtamäki, 2016). A few studies also provide evidence that servitization may take place through incremental changes in organisational arrangements through adaptation and replication (Kowalkowski, Kindström and Witell, 2011; Kowalkowski et al., 2012; Raja et al., 2020; Jovanovic et al., 2019). Previous literature has prominently focused on the internal development of capabilities (Jovanovic et al., 2019; Raja et al., 2020) but also considered external collaboration (Kowalkowski, Kindström and Witell, 2011; Kowalkowski et al., 2012; Raddats et al., 2017) and outsourcing (Paiola et al., 2013). Internal development of capabilities helps firms to be in control of all service components and processes and requires the interaction between front- and back-office to realise efficiency and capability replication among subsidiaries to leverage learning (Jovanovic et al., 2019). In a collaborative approach, capabilities are co-developed with partners (especially customers) through service development, operations, or knowledge sharing (Kowalkowski, Kindström and Witell, 2011). An outsourcing strategy (i.e., using external service providers to offer certain operational services) can be more efficient than internal provision, with lower fixed costs that enable firms to focus on their core competencies (Paiola et al., 2013). Manufacturers have a focal role in a servitization network with strong collaborative relationships with downstream partners, such as customers and intermediaries (Story et al., 2017). However, it is not yet clear whether this is also applicable for digital servitization, where it is possible that new partners may possess core capabilities through making technological innovations or having significant infrastructure resources.

2.3 Capabilities for Digital Servitization

Digital business models in manufacturing firms consist of three main components: products, services, and information (Cenamor, Sjödin and Parida, 2017). For digital servitization, the information component becomes key and is, in some cases, replacing product and service components (Cenamor, Sjödin and Parida, 2017). Thus, recent research has highlighted the importance of exploring specific capabilities for digital servitization (Ardolino et al., 2018; Kohtamäki et al., 2019). Capabilities for digital servitization can be divided into three main groups: digital, operational, and strategic. First, *digital capabilities* are central and enable other types of capabilities and include: intelligence, connect, and analytic capabilities (Ardolino et al., 2018; Baines and Lightfoot, 2014; Lenka, Parida and Wincent, 2017). Intelligence capabilities refer to intelligent functionalities through embedding smart components and monitoring and collecting data (Ardolino et al., 2018; Lenka, Parida and Wincent, 2017). Connect capabilities are the ability to transmit data to the Cloud through wireless networks and the ability to connect intelligent products at a network level (Lenka, Parida and Wincent, 2017). Analytic capabilities include processing information through rules and algorithms into predictive insights and visualising value through simulated scenarios (Ardolino et al., 2018; Lenka, Parida and Wincent, 2017). Second, *operational capabilities* refer to the ability of the firm to use technical capabilities to determine appropriate interventions and actions based on predictive insights, such as remote control or optimisation (Baines and Lightfoot, 2014). Third, *strategic capabilities* are those used to develop competitive advantage and differentiate the firm from its competitors. Strategic capabilities include digital business model development, building scalable solution platforms, digital value selling and value delivery, and business intelligence and measurement (Hasselblatt et al., 2018).

Digital servitization needs a significant reconfiguration of capabilities, radically changing a firm's business model (Kohtamäki, Einola and Rabetino, 2020), and altering its position in the value chain (Kohtamäki, 2019). However, some firms may implement digital servitization through incremental development, for example, to increase efficiency or incrementally improve their current value proposition (Coreynen et al., 2020). The few studies on developing capabilities for digital servitization reveal two strategic choices: internal through R&D and coordination of front-office and back-office (Cenamor, Sjödin and Parida, 2017) or external through collaboration (Ellingsen and Aasland, 2019). The collaborative choice can occur through an alliance, cooperation, joint-venture, licensing agreement, consulting, etc. (Benitez et al., 2021; Ellingsen and Aasland 2019). Since digital servitization requires novel capabilities, firms need to interact with new actors, such as third-party software providers or R&D centres (Benitez et al., 2021; Raddats et al., 2017) beyond those it already interacts with (Sklyar et al., 2019). Though these new partners sometimes do not have any products of their own, they can enable the creation of digital platforms that connect different components into an integrative offering (Coreynen et al., 2020).

The existing literature has identified capabilities for digital servitization, especially digital capabilities and their link with different servitization trajectories (Ardolino et al., 2018; Lenka, Parida and Wincent, 2017). Although there is some knowledge related to developing capabilities for digital servitization (Coreynen, Matthyssens and Van Bockhaven, 2017; Coreynen et al., 2020), less is known about different mechanisms that manufacturers use to develop these capabilities.

3. RESEARCH METHODOLOGY

A qualitative multiple-case study approach was adopted to collect data for this study (Beverland and Lindgreen, 2010). The sample comprised eight large UK manufacturers that offered complex industrial systems and services, which were developing capabilities for digital servitization. We aimed to have companies from several sectors to help assess the prevalence of capabilities for digital servitization. The focus was on identifying interviewees actively involved with either developing, selling, or delivering services using digital technologies and who, thus, had significant expertise about this topic (Bogner and Menz, 2009). Table 1 shows the manufacturers and participants that agreed to take part in the study.

Table 1: Participants and manufacturers that took part in the study

Company	Sector	Participant's job title
MechengCo	Plant automation	Service Manager
ITCo	Corporate IT	Head of Service Delivery
PrintCo	Industrial printing	Logistics Specialist
ConstructionCo	Construction equipment	Vice President
PaintCo	Surface treatment	Chief Executive
HeatCo	Energy transfer	Director, Digital Services
OfficeCo	Office printing	Head of Services
DocumentCo	Office IT	Technical Service Director

Interviews were used to collect data, in addition to company documentation such as websites, brochures, and news articles. Interviews were conducted using a semi-structured guide and lasted between 45–60 minutes each. They were audio-recorded, transcribed, and then shared with participants and any clarifications in the conversations were clarified. The data from the interviews and other sources were analysed and are presented in section 4. This analysis process identified three main capability development mechanisms for digital servitization (Learning, Building, Acquiring), which appeared equally important for the interviewees. Also, each capability development mechanism was analysed in terms of the capabilities they were used for. *A learning mechanism* represents the exploitative and internal development of existing servitization capabilities. *A building mechanism* denotes the exploration of new capabilities jointly with downstream internal and external partners. *Acquiring* is a mechanism to obtain and utilise upstream external partners' capabilities to facilitate digital servitization.

4. FINDINGS

4.1 Learning

The learning mechanism concerns how manufacturers develop capabilities for digital servitization in-house and was used for developing two capabilities: change management and internal process improvement.

Change Management refers to the internal changes that have to be made in light of developments brought about by the introduction digital technologies. For example, PrintCo underwent a major corporate change in its go-to–market strategy when it introduced a subscription-based business model that was driven by remote monitoring and data analytics. This change was not easy to make for PrintCo as it is a traditional manufacturer used to selling capital equipment. However, it is a change that mirrors those made by many traditional manufacturers when transitioning from a product to service focus, but in this case it was the application of digital technologies that led to the change. The introduction of digital technologies leads to changes in manufacturers' sales and service processes. For example, for pre-sales activities, augmented reality (AR) and virtual reality (VR) enable a manufacturer to demonstrate what a customer installation could look like before it is built and customers can contribute to its design (PaintCo). If the manufacturer has changed its main customer offerings from product to service (see PrintCo example), then the salesforce has to move to selling value from the service rather than the capital equipment. Realistically, this may not be easy for some salespeople. Changes in service processes are also likely as manufacturers may need fewer field service engineers as more faults can be fixed remotely and this requires that they (ideally) need to be moved to other roles within the company (OfficeCo).

Digital technologies also play a role in manufacturers' *internal process improvement*. While a service offering (e.g., maintenance) may not change in terms of the customer offering, the way it is delivered may, with more remote diagnostics (MechengCo). Predictive maintenance can help the manufacturer's service team to optimally target on-site maintenance to improve efficiencies (DocumentCo). However, one of the biggest weaknesses in remote monitoring is the likelihood that there may not be sensors attached to all the products its needs to monitor, particularly if these are older or of low value, making retro-fitting uneconomic (ITCo). In general, the use of telematics has quite wide applicability for process improvement, including logistics, forecasting spare part requirements and product design (PaintCo). Indeed, the interviewee from ConstructionCo noted that internal process improvement, rather than enhancing or developing new customer offerings was the focus for one of its competitors from using digital technologies.

4.2 Building

The building mechanism concerns how manufacturers develop the required capabilities for digital servitization through working with internal business units, distributors or customers. It was used for developing capabilities concerning business case modelling, new service development and data skills development.

A key concern for many customers is the payback from investing in digital technologies. Thus, *business case modelling* is a critical capability to demonstrate how value can be captured, since it is difficult for customers to quantify the benefits of digital implementations (MechengCo). For example, while a customer may know that it has inefficiencies in vehicle utilisation, it may not know the scale of them and how much they cost (ConstructionCo). Equally, the customer may not know the impact of equipment downtime without careful modelling (HeatCo). Business case modelling requires the use of operational data from products and the interviewee from ConstructionCo noted how most value was obtained from captured operational data from the customer's entire (multi-vendor) estate. However, this raises an issue about who 'owns' data captured from sensors and there were some concerns expressed by customers about data confidentiality, data storage and manufacturers having too much power from having this data for all customers (HeatCo).

A clear opportunity from introducing digital technologies is *new service development*. For example, ITCo specialises in developing solutions through integrated customers' legacy IT systems and the public Cloud. PrintCo developed a Web portal that enables customers to view consumable stock levels and, using QR codes, order new stock via its ERP system. PaintCo developed a 'process bot' to analyse customers' operational processes to ensure they are running at optimum efficiency. HeatCo developed a predictive maintenance service using historical data about equipment failures and regulatory information for each region (e.g., how long a part should be in service). ConstructionCo works with its distributors to jointly develop new service offering, so a basic 'data wrapper' (e.g., equipment performance data) is provided and then distributors can offer a 'value-added' condition monitoring service. This service would include additional data from visual inspections of equipment captured by customers using mobile phones. These new service developments are created through close alignment with customers and distributors: for example, OfficeCo gets its customers to do some of the remedial work when there are equipment failures.

A requirement for many manufacturers is *data skills development* and it is possible that these skills are newly required by the company with the advent of digital servitization. The interviewee from ConstructionCo noted the difficulties in hiring 'data scientists', with recruitment of these people arguably easier for ConstructionCo than it is by its customers but harder than for the technology 'giants' such as Google and Amazon, which the interviewee perceived as the employers of choice for such people. The interviewee from PrintCo stated that his company had set up a new data business unit, responsible for recruiting data scientists. Several interviewees noted that their companies' digital scientists resided with their R&D organisations (DocumentCo, HeatCo). These organisation are, thus, responsible for hiring data scientists and acquiring data-focused businesses to strengthen their capabilities (OfficeCo).

4.3 Acquiring

The third capability development mechanism, acquiring, requires the manufacturer to utilise the capabilities of other actors particularly in the upstream of the value chain, for example, developed through working with other manufacturers, technology providers and technology knowledge partners. These capabilities include system inter-operability, specialist digital provision and digital knowhow.

To take advantage of the collected data from the systems produced by different manufacturers, customers with multi-vendor product estates may wish for one provider to monitor the entire estate (MechengCo). In order to being able to monitor other manufacturers' products, *system inter-operability* between remote monitoring technologies is required. To achieve this in a holistic manner, manufacturers in some industries are working to develop common application programme interfaces (APIs) (ConstructionCo, ITCo). While there are clear benefits for customers from having common APIs, for manufacturers the benefits are less clear cut and there may be a reluctance to develop full open standards in an industry as there are benefits in having proprietary equipment and services; for example, manufacturers may be unlikely to grant other manufacturers or third party service companies access to performance data for their proprietary products.

Digitalisation results in huge amount of data being generated by products. To take advantage of this data, manufacturers need *specialist digital provision* from technology providers to support the creation and delivery of customer solutions. For example, most of the organisations in the study (e.g., PaintCo, PrintCo) use Cloud offerings from providers such as Amazon and Microsoft, since they have established datacentre infrastructure and running them is not a core competence for most companies, even IT providers such as ITCo. In addition to Cloud capacity, some manufacturers partner with software companies to develop their predictive maintenance algorithms (ConstructionCo, OfficeCo).

A key opportunity for the manufacturers is developing *digital knowhow* through working with technology knowledge partners such as universities and consultancies. This provides an additional approach for manufacturers to understand different technology opportunities (ConstructionCo). For example, OfficeCo is working with a university on a 3D printing application for parts that need to be replaced quickly. Universities, in particular, can provide research about specific applications that may not yet be commercialised.

5. DISCUSSION

This study investigated how firms develop different capabilities for digital servitization. The findings are framed as three mechanisms for capability development: learning, building and acquiring. The study complements previous studies of digital servitization, which have mainly focused on digital capabilities (Ardolino et al., 2018; Lenka, Parida and Wincent, 2017), rather than the mechanisms to develop them. While this study acknowledges the need for significant reconfiguration of resources for digital servitization (Kohtamäki et al., 2020), the findings show that the manufacturers develop capabilities for digital servitization through both exploration and exploitation. This aspect has been acknowledged to some extent in previous research (Coreynen et al., 2020). Importantly, the findings of this study identify the capability development mechanisms and show that these mechanisms are inherently tied to which capability is being developed. A learning mechanism is used for incremental changes to exploit existing servitization capabilities (Coreynen et al., 2020). A building mechanism is used for the exploration of new capabilities in collaboration with partners (Benitez et al., 2021). An acquiring mechanism is mainly used for the exploration of new digital capabilities (Ellingsen and Aasland 2019), although this reveals an interesting dilemma. While developing capabilities such as Cloud computing is a significant development for manufacturers (Lenka, Parida and Wincent, 2017), it is not necessarily a new knowledge base for the partners, who already have these capabilities and exploit them through learning and refinement. Our findings indicate that a manufacturer's explorative capability development efforts are tightly connected with their upstream partners' exploitative capability use, intertwined in a process of collaboration for capability development during digital servitization.

The findings of this study complement the discussion about the multi-actor perspective on capability development (Story et al., 2017), in this case by offering new insights on different types of actors and their positions in the value chain. The findings of this study confirm prior servitization research that proposes the need for internal capability development (Jovanovic et al., 2019; Raja et al., 2020) and joint-building of capabilities with customers (Kowalkowski, Kindström and Witell, 2011; Kowalkowski et al., 2012; Raddats et al., 2017). However, the findings reveal that developing capabilities for digital servitization requires a more extensive reconfiguration than for traditional servitization, particularly with regard to partner collaboration. First, capability development for digital servitization extensively depends on acquiring capabilities from different partners due to the complexity of the required technology. An acquiring mechanism is different from an outsourcing strategy where, for example, the manufacturer outsources some of its own processes (e.g., service delivery) to be operated by a third party (Paiola et al., 2013). Manufacturers use acquiring mechanisms to utilise partners' specific resources and knowledge (e.g., APIs) and develop certain capabilities for digital servitization (e.g., inter-operability between different systems). Second, while our findings confirm the importance of collaboration with partners downstream in the value chain (Story et al., 2017), it shows the need for extensive collaboration with upstream partners, such as technology providers, other manufacturers, and technology knowledge partners. Digital servitization changes the value chain of the manufacturer, so that these formerly weakly-tied partners have a stronger position in developing the capabilities of the manufacturer (Sklyar et al., 2019). Finally, the findings show that acquiring capabilities through collaboration with upstream partners creates new questions and risks for manufacturers and their customers, such as data confidentiality, ownership and management and related contractual risks.

6. CONCLUSIONS

For digital servitization, information is an increasingly important component (Cenamor, Sjödin and Parida, 2017), which demands specific capabilities. Developing knowledge and skills can be a long process for firms and thus can constrain the opportunities presented by these new technologies (Ardolino et al., 2018). This study shows three capability development mechanisms, which highlight the exploitation and exploration nature of capability development both within the manufacturer and in cooperation with its partners. While servitization capabilities are an enabler and prerequisite for digital servitization in manufacturing firms, the development of capabilities for digital servitization specifically is likely to open up firm boundaries, may demand new power structures in the business network, and drive strategic transformation even at the industry level (Kohtamäki et al., 2019).

Novel digital technologies allow manufacturers to advance servitization through improved products and services, revenue generation, and reduced operational costs, but they may struggle with the development of capabilities to exploit the opportunities enabled by digitalisation. The findings of this study indicate that to develop capabilities for digital servitization, manufacturers need to use different development mechanisms with respect to the type of capabilities. The findings could help manufacturers in their digital servitization development plans by emphasizing the importance of collaboration with upstream partners through acquiring mechanisms.

Notably, conducting multiple-case study with a limited number of interviews limits the generalisability of the findings. This study included data from manufacturers, but it would have benefited from data also from their different partners. Additional multi-actor studies are needed to improve the validity of the findings. Future research should seek to uncover the reasons for choosing certain capability development mechanisms and the links between the mechanisms. Future research should also investigate the risks and challenges of collaboration with upstream technology and knowledge providers and their impacts on the manufacturer's value chain.

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ORGANIZATIONAL SOLUTIONS IN THE SERVITIZATION AND DIGITAL SERVITIZATION JOURNEY

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ABSTRACT

Purpose: The paper assesses different organizational solutions allowing customer contact over both servitization and digital servitization journey of well-established manufacturers.

Design/Methodology/Approach: The study is exploratory and based on two case studies. The first case refers to servitization taking place in the pre-digital era and it has been retrieved in the servitization literature. The second refers to a manufacturer that recently entered a digital servitization journey. This in-depth case study has been developed by applying a longitudinal approach. Empirical data has been collected through company's reports, observations and a focus group.

Findings: Servitization and digital servitization trajectories have a different nature despite the journey rests in both cases on the same traditional set of product-service systems (PSS). By disentangling the different types of PSS, the comparison of the two journeys shows that organizational solutions overlap until service modules are not commodified. Specifically, in the servitization journey the deployment of front-office staff in the delivery of advanced services is crucial. On the other hand, in digital servitization journey, R&D department is the core of service capability development and it is the servitization driver.

Originality/Value: The resulting differences coming to light from the comparison of these two journey offer manufacturers a more comprehensive understanding about the organizational solutions allowing the delivery of PSS in both servitization and digital servitization strategies.

KEYWORDS: Servitization, digital servitization, PSS, commodification of services, service capability development

1. INTRODUCTION

Servitization is not a recent phenomenon of manufacturing transformation, but the current digital transformation has dramatically enlarged the scope and the nature of this strategy of manufacturing value creation and caption (Raddats et al., 2019; Kohtamäki et al. 2020). Servitization refers not only to strategies aiming at adding services to material artefacts for customizing usability of existing products, but it implies the delivery of an heterogenous set of customer solutions based on a variety of services (Baines and Lightfoot, 2013).

Traditionally, servitization focuses on downstream extension of original equipment manufacturers (OEM) that add usability services to material artefacts. In such literature, manufacturers adopting integrated solutions rely on an internal development of service-oriented capabilities, or acquire externally service-related knowledge, asking for complex business and relational solutions (Visnjic et al., 2016; Crozet and Milet, 2017; Bustinza et al., 2019a). Servitization strategies allow indeed manufacturers to offer on the market a constellation of product-service systems (PSS), a combinations between material artefacts and a variety of more or less advanced services (Baines et al., 2017; Brax and Visintin, 2017). Despite the growing efforts of manufacturers to implement servitization strategies, many authors highlighted that the increased customer interaction at the core of the implementation of PSS opens areas of uncertainty for manufacturers often lacking service related capacities and many manufacturing firms fail providing service innovations (Neely, 2008; Benedettini et al., 2017).

Today, scholars are focusing more and more on the exploration of the main drivers fostering a service capability development, especially in relation to the servitization journey (Martinez et al., 2017; Baines et al., 2020). One crucial element seems to be related to the variety of organizational solutions allowing manufacturers to effectively taking advantage of servitization strategies, where servitization can be investigated by applying to PSS both an integrated and a modular perspective (Brax et al. 2017; Rajala et al. 2019; Bustinza et al., 2019b; Sjödin et al. 2019).

Building upon the touched upon literature, recent papers are showing how digital technologies are complexifying the meaning of servitization and the nature PSS modules (Paiola and Gebauer, 2020; Kohtamäki et al., 2020; Hsuan et al., 2021). Recently, Hsuan et al. (2021) underline the importance to look at PSS by taking into account software modules as well and explore the operational characteristics of product-service-software (PSSw) modules through the digital servitization journey.

In such debate, digital technologies foster a different way to deliver services where indirect interactions between customer and service provider allow service and therefore servitized manufacturers to reduce the need for having strong person-to-person customer interactions (Sampson and Chase, 2020).

Despite the recent literature is stressing the dynamical nature of this manufacturing strategy, our knowledge about the dominant organizational configurations along the process and path of servitization and digital servitization is still limited. Specifically, there is still a lack of in-depth longitudinal studies of individual manufacturers. This paper aims to fill the gap and assesses different organizational solutions allowing customer contact over both servitization and digital servitization journey of well-established manufacturers.

By disentangling the servitization journey through the different value configurations of PSS, the paper offers two exploratory case studies. The first case refers to the servitization journey of Océ taking place in the pre-digital era. The second refers to an important global player specialized in the design and production of machine tools for industry and recently entering a digital servitization trajectory.

The paper is structured as follows. In Section 2, we explore the theoretical background and the development of the propositions and the hypothesis. Section 3 presents data, methodology and section 4 provides discussion on findings of the empirical analysis. Section 5 concludes by adding some insights for future research.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

2.1 The Servitization journey and organizational strategies

The efforts of manufacturers to implement servitization strategies are increasing and manufacturing transformation through servitization is expanding worldwide (Baines et al., 2017). Several case studies and empirical analysis underlined the risks and opportunities opened by servitization, and literature has explored both the types of capabilities necessary for entering servitization trajectories and the stages of the organizational transformation during servitization of well-established manufacturers (Raddats et al., 2017; Jovanovic et al., 2019).

Focussing on specific configurations of customer solutions, many authors highlight that service capability development do not rest on a unidimensional business strategy, but multiple paths lead to superior financial performance (Sjödin et al. 2019). In this regard, Bustinza et al. (2019b) underline the strong relation between organizational strategies and levels of advancement of delivered services. Specifically, the authors suggest that the introduction of base and intermediate services in the delivery of customer solution is more effective by outsourcing to KIBS firms the delivery of service related modules. When instead the customer solution asks for the integration of advanced services, the manufacturer benefits from maintaining in-house related service activities (*idibem*).

In servitization, the organizational transformation is not a trivial process. The co-existence of these organizational models has been empirical addressed by several papers and a part of the servitization literature opens the discussion around servitization as a strategic trajectory characterized by a variety of combinations characterised by different degrees of integration between services and products (Crozet and Milet 2017; Lenka et al. 2018). Martinez et al. (2017) have paved the way for the exploration of servitization as a linear and progressive journey, through which a manufacturer define the path of service capability development and the service innovation approach. Here, the authors underline that recently several firms focus their structural reorganizations by developing in-house service skills and gradually enlarging the services portfolio, moving from product-based to results-oriented services.

Consistently with Martinez et al. (2017), Baines et al. (2020) underline the importance of considering the organizational change process of manufacturers competing by adding advanced services in their portfolio. The authors open the debate on the servitization progression model explaining how five forces interplay and collectively determine progress through the servitization journey. The journey is characterised by linear and unidirectional steps which are defined by organic, intuitive and repetitive activities at the core of the service capability development.

At a macro-level, following Brax and Visintin (2017), this journey rests on the different configurations of PSS, from the 'least servitized' on top to the 'most servitized' on the bottom. Specifically, the metamodel propose by the authors is made up of eight generic value configurations where the operational responsibility over the PSS life cycle relates to customers, suppliers, and third parties:

I. Products with limited support, the supplier manufactures the equipment and sells it to the customer. Services, mainly 'base services' such as break-fix and maintenance services, are provided by the customer, the supplier, or a third party;
II. Installed and supported products, the manufacturer delivers the solution system installed and provides support services;
III. Complementary services are other services that a manufacturer provides as separated offer from the main solution system;
IV. Product-oriented solutions are comprehensive packages including solution design, implementation and support and this category of services is relational;
V. Systems leasing, the supplier provides without the transfer of the ownership the customer a fully implemented system and provides the support services;
VI. Operating services, the customer receives a fully integrated solution and supporting services, and the provider takes care of operating it;
VII. Managed service solutions are output- or outcome-based solutions in which the customer owns the system and the systems can be produced in collaboration with third parties or completely sourced from them;
VIII. Total solutions is similar to managed service solutions but in this case the solution provider owns the systems and typically the contract period for the solutions is very long.

P1: Servitization can be identified as a trajectory mapped by different value configurations of PSS.

By implementing a literature review and disentangling the different value configurations of PSS, Brax and Visintin (2017) underline how these categories refer to specific kind of organizational configurations. Clearly, PSS are not a homogenous set of customer solutions, but there are several value configurations characterised by a flexible equilibrium in the operational responsibility where service modules are delivered by different actors. Here, modularization enables different organizational units, external or internal to the manufacturer, to develop specialized service capabilities and innovate on them.

The development of these PSS modules requires indeed to take advantage in an effective way of a network of external suppliers throughout the system's life cycle (Paiola et al. 2013). The design of the solution delivery process requires the definition of the role of both the focal firm and the specialized component suppliers, subcontractors and service providers (Davies et al., 2007; Pawar et al., 2009). Therefore, depending on the distribution of the operational responsibilities between manufacturers, service providers and customers, the optimal organizational solution can vary. Evidences collected by Brax and Visintin (2017) highlight that in the case of product-oriented solutions, one of the most diffuse and effective organizational solution for manufacturers entering servitization is to be a system integrator (Matthyssens and Vandenbempt, 2010; Vicintin, 2012; Kowalkowski et al., 2013). Moving instead to the total solution, the system integrators are mainly service firms and manufacturers might benefit from being pure system seller (Davies et al., 2007).

These evidences made clear why it is important to investigate service capability development by disentangling the different PSS. Servitization literature agrees on the fact that integrated solutions are not the only organizational configurations possible and that breaking down PSS into modules allows to reduce the complexity of such variety of costumer solutions, increasing flexibility and scalability in the implementation of PSS (Rabetino et al. 2018).

P2: Different value configurations of PSS mirrors different organizational structures.

2.2 The digital servitization journey and the customer contact

Combining the insights related to the digital servitization literature with the literature on PSS and modularity, Hsuan et al. (2021) put forward the debate of servitization journey and introduce the concept of Digital Servitization Cube (DSC). Here, digital technologies entering the decomposable 'traditional' PSS define a manufacturers' servitization journey that rely on product-service-software (PSSw). Following the authors, PSSw are made of modules related to product, service and software that can be mixed and matched through the manufacturer's journey. The paper revealing the operational characteristics of product-service-software modules underlines how during the journey digital technologies allow a degree of modularity in compliance with the needs of open or proprietary systems.

Paiola and Gebauer (2020) exploring servitization by applying a digital lens (i.e. digital servitization) underline that in such a framework product knowledge and specific manufacturers' resources and capabilities are a starting point for service business development. However, in the servitization literature, the success or failed of servitization strategies is mainly identified by the acquisition of specialized skills mostly related to customer interaction (i.e. front-line or front-office) rather than by exploiting skills related to the manufacturing processes (Sampson, 2014).

Consistently with this view, Jovanovic et al. (2019) highlight that the process of service capability development over the servitization journey relies on an internal ecosystem where "the way front- and back- office capabilities are developed as well as the interdependencies are important considerations for servitizing firms" (*ibidem*, 474). Several papers present case studies, such as IBM and Nokia, confirming that at the core of servitization there is the formation of a strong 'front-office' unit in charge for developing and delivering integrated solutions (Sampson, 2014). In this regard, literature shows a sort of consensus on the fact that the servitization journey rests on front-office solutions units and relationship-based capabilities.

However, as suggested by the recent paper of Samson and Chase (2020), the massive diffusion of advanced digital technologies fosters a radical change in the customer contact approach. Here, IoT technologies, related to what Porter and Heppelmann (2014) called "smart" and "connectivity" components, create value allowing manufacturers to increase the replicability of information gearing. The main point here refers to the power of digital technologies to shape the nature of service modules, defined as interactive business processes.

Traditionally, service has been defined according to customer contact and it was in need of a well-developed front-office in the structural organization of the customer solution provider. Today, however, interpersonal interaction with customers are going to be replaced by automated systems, especially in the case of more complex and advanced services (Samson and Chase, 2020). Chase (2010) recognises that interactions are mainly supported by digital systems allowing remote interaction with providers, and self-service.

Following the reconceptualization of service imposed by the recent technological wave characterised by IoT technologies, it seems that software modules not only enlarge the complexity of PSS by opening to product-service-software trajectories (Hsuan et al., 2021), but support a sort of commodification of services radically changing how the service is delivered. In such a context, service capability development does not pass through the establishment of front-office and the adjustment of service related skills. Profitable services capabilities base on the industrialization of the back- office allowing the exploitation of the potential of new technologies and the development of service platforms flexible enough to fit individual customer contexts (Reinartz and Ulaga, 2008).

These arguments open the debate about the similarities between the organizational strategies in place during the digital servitization and servitization journey. As indeed suggested by Samson and Chase (2020), "offerings that involve customer interaction are fundamentally different from those that do not involve interaction, and should be managed differently, even if in the same industry" (*ibidem*, 1064).

Hp1: Servitization and digital servitization journeys do not foster similar service capability development of manufacturers especially for the most advanced PSS.

3. CASE STUDY: METHODOLOGY AND DATA COLLECTION

We explore service capability development in both servitization and digital servitization journey by applying a qualitative research method (Miles and Huberman, 1994). Specifically we implement a comparative and exploratory analysis by exploiting a quite well known case study of servitization and conducting a more in-depth longitudinal study of an individual manufacturer entering servitization in the former days.

The purpose of exploratory research is not to provide an accurate description of a phenomenon, but it is to establish the relationships between different variables and "assess phenomena in new light" (Saunders et al., 2009, p. 139). This method allows therefore to explore relation between service capability development and both servitization and digital servitization journeys.

The first case bases on the servitization journey of Océ (Visintin, 2012). Specifically, we have exploited data related to the Océ's Wide Format Printing Systems business unit (WFPS) selling Wide Format (larger than A3 size) equipments, and offering software and services such as workflow and output management software, consulting services, maintenance services and financial services. Océ WFPS has been the market leader in the Wide Format segment for several years and today is part of the company Canon Solutions America. The servitization journey of Océ dates back to 1997 moving from the delivery of basic services to more complex solutions. The case offers several information regarding the way front- and back- office capabilities are implemented as well as how the interdependencies between the two change over time.

Consistently with this case study, we have developed a comparative case by collecting secondary and primary data and by taking advantage of a variety of sources, such as reports published on the web sites of the selected company (in what follows Alpha). Company Alpha is an important global player specialized in the design and production of machine tools for industry providing different services, such as technical assistance, maintenance programs and training. Primary data have been collected through both semi-structured interviews, a focus group and participatory analysis. Interviews lasted on average an hour and are digitally recorded to facilitate the use of transcripts for data analysis. The of analysis of this second case cover the period 2019-2021.

4. RESULTS AND DISCUSSION

As suggest by the literature, the analysis results of the service capability development in the two cases are presented by focussing on three main components: the front-office (i.e. service department), back- office (i.e. R&D department), and the interdependencies between the two.

Taking advantage of the two presented propositions, we map the two journeys through the different PSS proposed by Brax and Visintin (2017). Literature suggested indeed that servitization can be identified as a trajectory consisting of different steps that can be mapped by the value configurations of PSS mirroring different optimal organizational structurers. Since we do not focus on the payment model, we decided to do not consider systems leasing (V) in our analysis.

Our results show that in both cases, the two basic types of PSS, i.e., products with limited support (I) and installed and supported products (II), open the servitization journey. However, in Océ services related to support and delivery referred to two separate service departments, in Alpha these services were in charge to a single office taking advantage of a strong relation with both back-office and specialised external providers.

In the servitization journey of Océ, it is clear that the jump from these basic PSS to more complex configuration of PSS has relied on the definition of a leader with a service oriented background. This leader was indeed the vice president for customer service and his first move was to merge the two service departments into one organisational unit, under his direct control. On the contrary, Alpha shows that the leading role is taken by some leaders of the R&D department driving the company through the servitization journey:

"R&D department started in 2019 to develop a software able to codified all the information related to our products and collect them into micro-modules. This can allow us to interact with our customers over the life cycle of our machines and offer to them different kinds of solutions in a more efficient way" (Informant A, Alpha)

Despite the two cases underline that complementary services and product-oriented solutions are delivered by the straightness of respectively service and R&D department, in both cases, a crucial role is played by the interdependencies between the two department. Both Océ and Alpha have indeed presented in this phase of the journey a strong attention in the building of a solid and effective alignment between the service and R&D departments (see Figure 1).

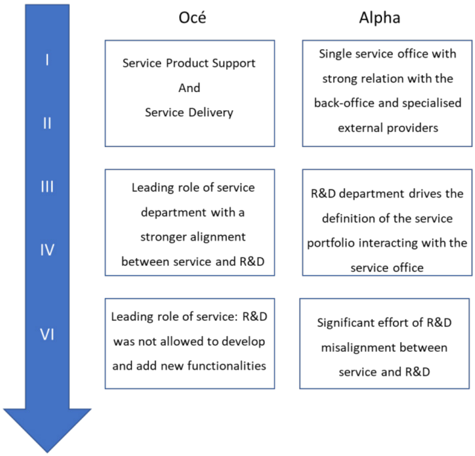

Figure 1: The servitization and digital servitization journeys

In that point in time Océ recognized that it was important to become a system integrator and effectively integrate its own hardware and software modules. The stronger alignment between service and R&D allowed moreover to go further, according to the servitization strategy, R&D was not allowed to make software innovation adding new functionalities without the service engagement.

On the contrary, in the Alpha case, the most important strategy was to build up a proprietary system made of hardware and software modules allowing the back-office to independently and promptly interact with the customer. Currently, the company is providing solutions which allow to configurate the product though modularity, both at machinery and software side. These highly customized configurations have been possible through the significant effort of R&D department in the digitalization of the firm, especially regarding the whole production process. Indeed, data collection throughout the assembly of the machinery allows the tracking of all phases, disposing of all the information of the product necessary for the implementation at the customers' site and support. Besides, the service office is not exploiting all the potential provided by the tools developed by the R&D, showing that the latter is pushing the digital servitization trajectory. Furthermore, the R&D department is ongoing in the developing a digital platform for the monitoring of the data exchange between Alpha and its customers, laying the foundation for a shift toward phase VI. However, service seems to lagging behind, underling a possible misalignment between the service and R&D department.

5. CONCLUSIONS

5.1. Theoretical implications

The analysis opens the debate for the differences in the servitization and digital servitization journey. This distinction is increasing in importance since digital technologies are making the interactions between customer and PSS provider may be more refined and complex. Moreover, the case study confirms that despite the customer interactions remains still a central element, the degree of customer contact is lower (Samson and Chase, 2020). The comparison between the two cases underlined that in a first phase, the two journey overlap. However, when the service modules are commodified thanks to the exploitation of the potential of these technologies, the two journeys strongly differ. Specifically, in the servitization journey the development of a strong and leading service department is crucial. On the other hand, in digital servitization journey, R&D department is the core of service capability development and it is the servitization driver.

5.2. Managerial implications

The paper tries to guide practitioners in the developing of a roadmap for developing servitization and digital servitization trajectories, making clear the complexity of PSS and the different role played by software in the definition of PSSw. Literature recognises PSS as a heterogeneous set of customer solutions, but there is not a scheme for managers, and responsible for developing and operating PSS, describing difficulties and risks through a generic servitization trajectory. This is more complex considering digital servitization as a related but different phenomenon. Furthermore, the findings from this study suggest that the digital servitization relies on the inner competences of the back-office and that exploiting skills related to the manufacturing processes is still important.

5.3. Limitations and further research

The main limitation refers to the fact that the case with qualitative case study research opens issues related to the broader generalizability of the findings from this study. Moreover, we did not go further the exploration of the internal and external service ecosystem of the two explored manufacturers. Specifically, it is interesting to known the role of distributors and suppliers in delivering advanced services. In addition, an interesting point refers to the role played by leadership in the delivery of PSS as modular solutions and the alignment and misalignment between the service and R&D departments. This is an important research line since it can affect the sustainability of digital servitization trajectories.

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APPENDICIES

Appendices here, if required, appendices are included in the 9 page limit.

WHAT DRIVES SERVICE CO-CREATION IN B2B? THE ROLE OF CUSTOMERS IN CO-CREATING SERVITIZED OFFERINGS

Lisa Bakir, Raymond P.A. Loohuis & Lambert J.M. Nieuwenhuis

ABSTRACT
Purpose: The purpose of this study is to identify key factors for understanding the involvement of customers in service co-creation in business markets.
Design/Methodology/Approach: This study uses a case study and in-depth interviews with customers engaging in a service co-creation process in the servitization context.
Findings: The findings show the identification of three factors that drive customers to participate in the co-creation of servitized offerings, thereby explicating the underlying reasons for customers to get involved.
Originality/Value: The study proposes three drivers for understanding the customer's role in service co-creation as a groundwork for research and practice.

KEYWORDS: service co-creation, business-to-business, servitization

1. INTRODUCTION

Servitization underscores the collaborative nature in providing increasing service offerings to customers. Indeed, in order to support customer's value creation by supporting their core activities, manufacturers need to develop a devoted understanding of their customer's business activities (Mathieu, 2001; Raddats & Easingwood, 2010). Hence, customer relationships in servitization result in closer collaboration and increased customer intimacy (Martinez, Bastl, Kingston, & Evans, 2010). As a result, these co-creation efforts not only result in developing more customer-oriented solutions, meeting customer needs, but also facilitate in enhancing service novelty by integrating customers' skills and knowledge (Hedvall, Jagstedt, & Dubois, 2019; Heirati & Siahtiri, 2019; Tuli, Kohli, & Bharadwaj, 2007). Evidently, academics and practitioners have been widely noticing the importance of engaging customers in co-creating products and services (Payne, Storbacka, & Frow, 2007). Furthermore, the notion to involve customers in innovation finds its expressions in concepts like voice of the customer.

However, while research recognizes the importance of customer embeddedness in servitization, research paid only little attention to the role of customers in co-creating services. The co-creation of services denotes the collaborative activities in the provider-customer interface, associated with the service that is being developed (Oertzen, Odekerken-Schröder, Brax, & Mager, 2018). With a few notable exceptions (Palma, Trimi, & Hong, 2019; Sjödin, Parida, & Kohtamäki, 2016; Sjödin, Parida, Kohtamäki, & Wincent, 2020), little is known about customer's role in co-creating services and how they participate (Oertzen et al., 2018). The paucity of literature only scratches the surface of knowing how providers and customers interact in this instance, and as a result of knowing this, can be managed better.

Therefore, the purpose of this study is to understand what drives customers to participate in the service co-creation process of servitized offerings.

This study contributes to body of literature on service co-creation and servitization by explicating the underlying reasons of customers to be involved in the co-creation process of servitized offerings

2. THEORETICAL BACKGROUND

In the domain of services, the co-creation of services refers to the joint creation in the service process. While the co-creation of value makes the activities secondary to the value that is created, the focus on co-creating services puts the act of collaborative creation of the services at its forefront (Oertzen et al., 2018).

Collaboration in developing services in servitization is undoubted. As customer needs are more complex, collaborating becomes increasingly important (Morgan, Anokhin, & Wincent, 2019). Underlying this logic is the driving notion of catering towards the processes of the customer, meaning that a better understanding of the customer's processes is required as more advanced services are offered (Baines & Lightfoot, 2013). Inherently, this also advocates a customer orientation. Indeed, as services expand from supporting the product to the actual customer's processes (Mathieu, 2001) the focus on the product changes to the process of the customer's business. Consequently, as service offerings take more form of a solution, incrementally the service will be co-created.

Typically, the process of developing services entails different phases which require collaboration. Generally, these phases, denote the actual defining of the service, its design, deployment, and finally, debriefing the service. Collaboration is needed over the whole range of phases in the process. Naturally, the earlier stages of development, like the defining of the requirements would require more intense collaboration versus the operative phase of the development process of creating a service offering. For instance, the expectations and ambiguities in responsibilities are usually very unclear in the beginning of the development of servitized offerings for the involved actors (Sjödin et al., 2016). Customers may play or adopt different roles in the process of co-creating servitized services, contingent on the service at hand. As such, their extent in participation also differs. Indeed, the nature of a service is a determinant for the degree and level of participation in the co-creation of services (Dadfar, Brege, Sarah, & Semnani, 2013). Passive customers, may only provide information on their needs, while active customers may provide technical knowledge (Cui & Wu, 2016) in essence, being highly engaged in service creation.

3. RESEARCH METHODOLOGY

3.1 Research Approach

This study presents an exploratory single case study to probe how customers participate in co-creating servitized offerings. Case studies enable to focus on the complexities and dynamics of phenomena in the setting (Eisenhardt, 1989).

Our case entails a Dutch construction company, BuildingSmart, that is pursuing to transition into providing Building-as-a-Service proposition. We purposefully selected this case as it is developing new services in which they collaborate with customers. The construction industry makes an interesting case, as they are subject to a tender process, making their customer relationships usually contain of newly formed relationships.

3.2 Data Collection

Data was gathered on five projects with different phases in the co-creation process, mainly through semi-structured interviews with customers. The semi-structured interviews were held with a range of informed actors of the projects from the customer side. If possible, multiple informants per projects were interviewed to ensure nuanced and different views in the process. Participants were selected based on their active involvement in the projects. In total, seven interviews were conducted over the five projects. The participants usually entailed maintenance and facility managers. Table 1 provides an overview of case characteristics and key informants.

The semi-structured interviews revolved around the ways of collaborating with the provider targeting interaction and communication, resources, and responsibilities throughout the process. Supplementary to the interviews, observations took place in customer meetings and daily work routines to develop a comprehensive understanding of the everyday work activities and project process.

Data were triangulated by using multiple data collection techniques. Data were complemented by performing document analysis, project documents, customer projects including tenders, contracts and other project descriptions. This data was necessary for the researcher to familiarize with the products and services, and to collect information on the particular customer projects.

Table 1: Overview Case Characteristics and Key Informants

Case	Project	Service Process	Service Level	Key Informants
ResiCare	Residential Care Facility	Construction Phase	Intermediate Service	2 (Manager Building and ICT; Project Manager)
GreenWorks	Secondary Vocational Education	Exploitation Phase	Intermediate Service	1 (School Director)
CollegeX	Secondary Vocational Education	Construction Phase	Advanced Service	1 (Manager Management and Maintenance)
CollegeZ	Secondary Vocational Education	Construction Phase	Advanced Service	2 (Team Leader Teachers; Representative Construction)
CollegeY	Pre-secondary Vocational Education	Development Phase	Advanced Service	1 (Manager Administration and Maintenance)

3.3 Data Analysis

We began our analysis by an in-depth analysis of the interview transcripts. For this analytical step, we used first-order codes (Gioia, Corley, & Hamilton, 2012), i.e., terms and language adequate at the level of meaning of the informants. Next, we engaged in developing second-order themes, wherein we searched for relationships between and among these categories and assembled them into higher-order theoretical themes. Finally, we merged them into aggregate theoretical dimensions. During the analytical process, we sought to differentiate between overlapping themes, although, inherently, the themes are interconnected. We did so, by asking ourselves what the main motive was to be involved in the co-creation process, thereby seeking to properly structure the codes. Furthermore, our focus was on identifying voluntarily underlying reasons for customers to participate. Figure 1 shows the emergent data structure.

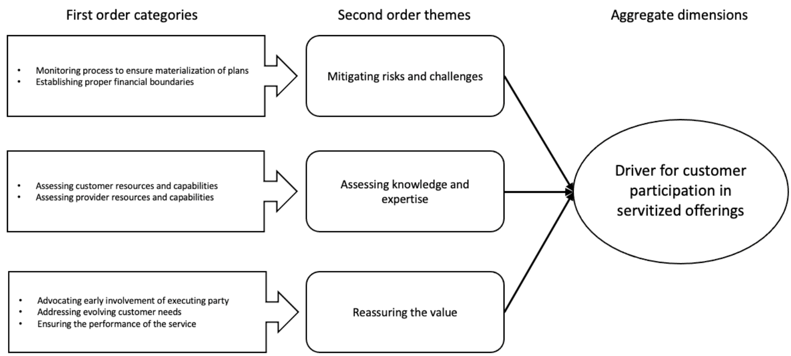

Figure 1: Emergent Data Structure

4. RESULTS

Participating in service co-creation by customers is highly impacted by a number of activities. Inherently, the nature of the service is a determinant for the way in which customers participate in collaborative activities

Herein, a distinction can be made between voluntarily and mandatory participation in the process of collaborative activities for the service that is being created at hand. Our findings show the identification of three dimensions that drive customers to participate in the co-creation of servitized offerings.

4.1 Mitigating Risks and Challenges

Successful co-creation of offerings entails the mitigation of challenges and risks over the course of the development of the offering. Here, customers ensure to counteract any uncertainties present over the project. As such, customers tend to attune to the provider and interact as a way to monitor the activities and progress over the course of the projects. Furthermore, to not run in any risks related to costs, customers ensure to make proper financial boundaries resulting in extra ways to monitor the progress of the project. For example, GreenWorks purposefully kept financial space for unforeseen things that might occurred during the project. However, due to the large nature of stakes in responsibilities in which the provider is responsible for the performance of the building and possible previous negative experiences, customers like to stay on top of things, as the school director of GreenWorks stated:

"As a client you still want to stay on top of things … we eventually have to use the building, so we cannot completely blindly afford what a provider offers and how they think how the building would best be developed."

Nonetheless, to offset any potential uncertainties, customers describe that it is important that, in principle, the trust and the relationship with the provider is key. For example, the manager administration and maintenance of CollegeY described that:

"If there is trust between the client and the contractor, if there is that basis, if we continue to communicate with each other, if we know what to expect …"

4.2 Assessing Knowledge and Expertise

To determine the needed operant resources (i.e., skills, and knowledge) on both sides of the relationship between customer and provider, customers assess the present knowledge and expertise that is present at the customer's side and provider's side. Hereby, the required input for co-creating the service is estimated and allows for the customer to determine their interaction profile. However, this process even starts before the actual co-creating process takes place. In case certain knowledge is lacking, third parties are brought in to enable an informed plan of action. For example, CollegeX brought in a construction management bureau to help with setting up a plan of action after they conducted feasibility studies themselves.

As such, customers make sure to fill in the gaps in terms of their knowledge and expertise which provides a solid basis for the co-creating process. In terms of lacking knowledge and expertise, customers tend to rely more on the resources of the provider in which they provide more space for them. For example, the manager of management and maintenance of CollegeX stated that:

"So, BuildingSmart has steered us in that, of course we did not have the insight to introduce these things [design specifications] on our own initiative."

Furthermore, the process of co-creating servitized offerings is guided by interactions of a joint team of key people from both the provider and the customer to make sure that over the course of the project to consolidate knowledge from both ends. As the director from Greenworks College, described:

"*That means that you have a group of people at the table with some regularity, let me call it construction team. The construction team includes BuildingSmart, the construction team includes our consultants, from energy, in the field of work power construction, they are included, and we are there as an organization, housing and I myself as director."*

4.3 Reassuring the Value
Inherently, establishing the value-in-use that the offering will bring is foundational for any exchange process. Customers interact and communicate about actions and possible needed interventions to make sure that the potential value-in-use will be deployed. Having the desire to control the process, customer tend to check in with the provider to ensure the activities that will guarantee the value taking place once provided. For instance, customers tend to probe into the process to ensure that the performance of the service is guaranteed. The manager of management and maintenance from CollegeX stated that was very important to probe in to the process to ensure meeting set out needs:

"*You also have to make certain agreements, so for example we wanted to have two moments in which we will test the entire design, both functionally and technically, whether it meets the requirements*."

Furthermore, the project manager of ResiCare explained that they wanted to tap deeper into the wishes that they had established in the tender phase:

"*… and when you then go into the preliminary design, it really goes deeper into the wishes and which building you want*."

As such, it means that customers want to reinforce the activities that contribute and facilitate the assurance of value. Correspondingly, to thoroughly instil this, they advocate early involvement of the executing party. To illustrate, the manager management and maintenance of CollegeX explained the value-in-use of early involvement of the provider at the beginning of the project:

"*I am convinced that with building well and following with the long-term maintenance, that the provider already makes decisions at the front [end of the project] , which you benefit from in the course of the exploitation phase*. *Look, if they deliver bad frames and are approached every day in the next five years, then they better think about it in advance. Then you go and see, in consultation with the client [CollegeX], what can we best do together? Then the win-win situation arises."*

5. DISCUSSION
This study investigated how customers participate in the co-creation of servitized offerings, thereby understanding their underlying reasons for involvement throughout the process. The results show a multifaceted and dynamic logics for customers to participate in co-creating services in the context of servitization.

5.1 Theoretical Contributions
First, this study contributes to the literature on co-creating services (Oerzen et al., 2018; Aarikka-Stenroos & Jaakkola, 2012), thereby responding to a calls to explore the dynamics of co-creating services in practice (Oertzen et al. 2018) and understanding the antecedents of customer participation in business-to-business (Mustak, Jaakkola, & Halinen, 2013). The results reveal how customers get involved in co-creating services, further nuancing previous research on the topic. Broadly, the results indicate that much of the will to participate and get involved in the co-creation of services is driven by reducing uncertainties and the customer's desire for control (Hakanen & Jaakkola, 2012). In line with research stating that the involvement of customers is dependent on the nature of the service (Dadfar et al., 2013), the higher the degree of complexity of the service naturally would yield more uncertainties. Connected to that, the results uncover the use of customer resources in the co-creation process tapping into the breadth and depth of customer participation (Wang & Yu, 2019).

Second, this study adds to the emergent body of literature on value co-creation in the context of servitization (Parry, Bustinza, & Vendrell-Herrero, 2011; Sjödin, Parida, & Wincent, 2016; Sjödin et al., 2020) as empirical investigations into the co-creation process in servitization are scarce. The results highlight the importance of iterative process and joint team of experts throughout the process (Sjödin et al., 2020). Furthermore, the drivers of customer participation in such co-creation process in servitized offerings offer insights into the customer perspective of servitization. Namely, servitization research is highly dominated by the provider perspective (Valtakoski, 2017).

5.2 Managerial Contributions

This study providers advice to managers in terms of how to manage and improve the collaborative activities in service offerings, specifically in the context of servitization. As such, managers can analyse the drivers into their own context, in order to determine room for improvement as to facilitate the co-creation process. The study underscores the focal point of reducing uncertainties at the end of the customer, thereby aiming to improve trust and the overall business relationship. Furthermore, yielding the set out value-in-use is central to the collaborative activities, especially in when the provider takes over the responsibilities of the customer.

5.3 Future Research

The current study builds on an in-depth case study of a solutions provider, operating in the construction industry. In order to apply transferability, one should be cautions to consider the results to be applied to similar settings characterized by similar conditions. Namely, the construction industry is impacted by governmental factors and a tender process, possibly shaping the collaborative activities in very specific ways. As such, future research could tap into the drivers of customer participation in service co-creation in other industry settings.

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UNDERSTANDING THE CHALLENGES OF DIGITAL SERVITIZATION IN HEALTHCARE

Judy Zolkiewski, Jamie Burton, Ghazi Ausaf, Steven Rogers, Richard Pole & Vicky Story

ABSTRACT
Purpose: Servitization research has a tendency to focus on manufacturing and often fails to consider how servitization can be necessary to support service development in other sectors. This research is following the innovation, development and implementation of a digitally-supported new service that aims to transform healthcare service provision and delivery.; it draws upon network and relationships dynamics alongside research into servitization and capabilities to explore the process.
Design/Methodology/Approach: This paper adopts an exploratory, action research, case study approach to understanding this transformation and associated challenges of servitization in action.
Findings: Key to the transitioning process is a resilience capability.
Originality/Value: Examining the processes and capabilities for traditional service providers attempting business transformation through servitization**.**

KEYWORDS: digitally-enhanced service, servitization, action research, case study, healthcare, capabilities.

1. INTRODUCTION (FONT: CALIBRI 11 BOLD ALL UPPERCASE)

The generally accepted wisdom is that servitization is about the transformation process followed by product-centric firms (usually manufacturers) as they introduce new service-led business models (Raddats et al., 2019) or develop revenue streams around advanced services (Baines et al., 2017). However, it can be contended that it is not only manufacturers and product-centric firms that require the transformation that servitization engenders; services firms also may need to transform in order to develop advanced services and solutions (cf. Baines & Lightfoot, 2014). This paper explores such a process by following a healthcare service provider as it begins a transformation from a hands-on deliverer of services towards a digital solution provider, that has required them to exploit new capabilities and develop a new business model. The paper explains the process decisions made and argues that action research (Gill & Johnson, 2002) provides the best avenue to achieve the project aims, which are to understand the capabilities needed to support the transition of a firm from a hands-on service provider to that of a digital solutions provider. Our contributions relate to the identification of a resilience capability and the articulation of the process through which new capabilities are developed. We also explicate how servitization applies in an existing service context and illustrate that the fundamental driver of servitization success is the change process that is at its core.

2. THEORETOCAL BACKGROUND

Servitization continues to garner increasing attention (e.g. Raddats et al., 2019). The term was first used by Vandermerwe & Rada (1988) to emphasize the role that combinations of products and services were increasingly playing in business offerings. Notwithstanding this, the importance of 'industrial services' was previously acknowledged as early as the mid-1970s (Cunningham & Roberts, 1974). Servitization involves a transformation process and moving to a service-centric view and "represents a significant change in the business model and mission of the firm, whereby the service business serves as a growth engine of the firm" (Raddats et al. 2019, pg. 209). It is not universally accepted as a successful process with this 'engine of growth' not always providing the expected growth or returns (Gebauer et al., 2005, Neely, 2008, Kastalli & Van Looy, 2013).

Exploration of servitization has also encouraged consideration of the services employed in or enabled by servitization. For example, early work by Mathieu (2001) suggested that the purpose for which the service was employed was an important factor, i.e. whether the services supported the product [SSPs] (e.g. provision of replacement parts) or supported the customer [SSCs] (e.g. training) and that services that supported the customer needed more relational skills, the ability to customize, and a holistic understanding of the customer. Cusumano et al. (2015) view the additional services that manufacturers add differently, suggesting that a slightly different typology (that, in essence, adds support to the SSPs and SSCs proposed by Mathieu 2001)) in which services that complement products can be seen as 'smoothing or adapting services', while, on the other hand, there are 'substitution services' that transform the ownership model of the service. An example of such a substitution service would be the 'Power by the Hour' model proffered by Rolls Royce. Related to this is the need for an understanding of the different manifestations of services and how they can be made tradable (Spring and Araujo, 2009), their relative sophistication – base to advanced (Baines & Lightfoot, 2014), and the emergence of outcome or performance based contracts (e.g. Datta, 2020).

A recent trend that is acknowledged to be further accelerating moves to servitize is emergent digital technology; these technologies are widely accepted as drivers of servitization (Kamp & Parry, 2017; Skylar et al. 2019a, Tronvoll et al. 2020). However, there is still a lack of consensus on the success of servitization and its enablers and challenges, including how other actors in the service network impact upon this transition; exceptions being the insight into servitization strategies identified by Reim et al. (2019) and resource integration and organizing within service ecosystems (Coreynen et Al. 2017; Skylar et al. 2019b). Thus, it is somewhat surprising that limited attention is given to the process of servitization (Baines et al., 2017). Although recently, researchers have begun to focus on these processes. For example, Baines et al. (2020) propose a servitization progression model that recognised different stages of servitization maturity, and endogenous and exogenous processes that support or hinder the evolution of a company through these phases. Brax and Visintin (2017) note that the servitization process varies across firms, with some making gradual transitions while others progress in a stepwise manner through these various stages. On the other hand, Kowalkowski et al. (2015) see this as an altogether more fluid process, where the organizations have to find a balance between expanding the business whilst standardizing as many processes as they can and managing a number of different supplier roles simultaneously.

As yet there seems to be no consensus about how these progressions manifest. It is widely acknowledged that research into business change processes and their associated dynamics is challenging (Chou and Zolkiewski, 2012) and that there is a need to consider both internal and external drivers of the change (Baines et al., 2017). This requires an exploration of both intra- and inter-organizational relationships and thus, in addition to extant servitization literature, concepts from the field of interaction, relationships and networks research are drawn upon to support this understanding. This includes understanding resource and activity combinations as well as actor roles and capabilities, alongside the underlying dynamics driving these, e.g. Håkansson et al. (2009), Halinen et al. (1999), Raddats et al. (2017), Raddats et al. (2018) and Story et al., (2017).

Another area that is attracting increasing attention is the facilitating role of capabilities in both organizational dynamics generally and servitization specifically (e.g. Spring & Araujo, 2014, Story et al. 2017). In-line with Ulaga & Reinartz (2011), we use Helfat & Lieberman's (2002, pg. 275) definition of capabilities: "the firm's capacity to deploy resources for a desired end result". For manufacturing firms, servitization requires the development of new capabilities as they develop new skills and learn to effectively bundle both product and service resources (Baines & Lightfoot, 2014), although this can be a challenge as they move to the deployment of advanced services (Sjodin et al. 2016). It is also recognized that these capabilities may require a firm to deploy indirect capabilities, i.e. from their wider network (Spring & Araujo, 2014) and/or work closely with partners, thereby developing interactive capabilities (Raddats et al. 2017).

2.1 Research Context and Questions

Traditionally, servitization has focused on the addition of services in manufacturing firms (Vandermerwe & Rada, 1988; Kapoor et al., 2021). However, we contend that it can also apply to other business contexts, such as where new services that are not in line with the normal operations of the business are introduced. Such organizational changes require a considerable business transformation (Baines et al. 2020), the introduction of new business models (Palo et al., 2019) and the development of new capabilities (e.g. Spring & Araujo, 2011, Gebauer et al. 2014). Note that here, the focus of this discussion and research is on operational rather than dynamic capabilities (cf. Coreynen et al. 2020). In effect the challenge in all servitization is not the addition of a new service per se, but that of transforming to a new mode of business operation requiring the introduction of new resources, processes and capabilities. This area can be seen as a gap in our knowledge. Hence, the objective of this research is to explore how servitization can manifest outside of manufacturing and the capabilities needed to effect servitization in such a context. Our research questions are:

- **RQ1:** How does the servitization journey of a non-manufacturing business evolve?
- **RQ2a:** What capabilities are needed to servitize in a non-manufacturing context
- **RQ2b:** How do non-manufacturing business servitization capabilities compare to capabilities manufacturers' employ in their servitization journey?

3. RESEARCH METHODOLOGY

How relevant management research is to practitioners can be a source of heated debate (Zolkiewski, 2018), as opposed to simply focusing on "clever sums" (Piercy, 2002, pg. 357) or exploring a wicked theoretical problem (McMilland & Overall, 2016). In reality the best approach is the one that is best able to solve the problem at hand (Gill & Johnson, 2002). This research is based upon a formal opportunity to apply our research in practice and this, in combination with our research questions, mandate the need to follow a process over time. At the same time, the practical application of our knowledge requires collaboration with and intervention in the firm's processes, i.e. is action research (Gill & Johnson, 2002).

Action research attracts controversy and covers a range of different approaches during the iterative cycles it involves (Gill & Johnson, 2002). These cycles begin by entering the problem domain, collecting data, feeding back on the problem, analysis, planning, acting and reflecting on the outcome (Coughlan & Coughlan, 2002). It does not purport to be replicable, because the unit of analysis changes over time, i.e. it is the change process, and thus, blurs "the distinction between the researcher and the researched" (Checkland & Holwell, 1998, pg. 11).

The project was designed following the principles outlined by Coughlan & Coughlan (2002) and revolves around a Knowledge Transfer Partnership (KTP). KTPs are a UK Government initiative designed to transfer knowledge from universities to the business community[1]. The project scope (framework) was framed in the context of the KTP by the Local Management Committee (LMC), comprising the senior management team from the company, the university researchers and support staff involved, and a representative from Innovate UK (the Government sponsor of the project). Once the project was underway, the LMC was extended to include the Associate who was employed to work on the project. An initial plan, designed around a number of iterative steps, each building on the previous step, was established and, once the transformation process was underway, was constantly reviewed (equating to the emergent process of action research). As the stages of the project were implemented, data were collected, analyzed and evaluated and used to engender further change. The project planning began in spring 2018 and has been in progress since November 2019; it is due to conclude at the end of October 2021.

The action research approach implemented in this project involves both insider and external change agents. The insider agent is facilitated through the use of a KTP Associate working within the firm and the external agent role is through input from academics who are well versed in servitization and service innovation processes. This moves beyond the most frequently invoked forms of action research where the agent is either external, e.g. a consultant (Abrahamsen et al., 2016) or internal, a manager undertaking a further degree (Coghlan, 2001). The action research context is a purposefully chosen single case study design to illustrate a revelatory case. Within the case, the unit of analysis is the transformation processes needed to introduce digital services (Yin, 2009).

Data used to analyze the case include: formal project plans, e-mails, meeting minutes and project progress reports, as well as project outputs such as service blueprints and customer engagement

[1] https://www.gov.uk/guidance/knowledge-transfer-partnerships-what-they-are-and-how-to-apply

maps. In addition, researchers' experiences noted during the process are also captured. Thematic analysis has been used to identify the material used in the findings (Miles & Huberman, 1994).

4. CASE COMPANY

The case company (hereafter named, company Z for reasons of confidentiality) is a clinician-led National Health Service (NHS) spin-out that provides non-invasive vascular investigations across the North West England region. They employ around 50 people, and as such are classed as an SME. Company Z specialise in the provision of high quality, comprehensive vascular services to the NHS and Private Sector with a team of highly experienced clinical vascular scientists. They are the largest independent vascular diagnostics provider in the UK and are leaders in vascular ultrasound provision, typically performing Carotid and vertebral Deep Vein Thrombosis (DVT) scans etc. Company Z have invested heavily in software and associated technology to enable digitalization and through this see possibilities for developing digital services for both existing and new markets, but lacked the management and services support capabilities to effect this. In order to gain the capabilities needed and to put these new service in place, in 2019 a KTP, supported by Innovate UK and Alliance Manchester Business School, was put in place. This has allowed for the development and operationalization of the new digitally-enabled services. The project was initially launched in early November 2019. It needs to be noted that by the end of March 2020 COVID-19 was rampant in the UK and the country was placed under a complete lockdown. The North West of England has been very badly affected by this infectious disease and has been under a high level of restrictions since then. At the same time, the pressure placed on the NHS by the influx of COVID-19 patients has resulted in many routine services being suspended as hospitals strive to cope with the ravages of the pandemic. Both these factors have posed additional challenges to capability development and resulted in changes to the project direction.

5. FINDINGS & DISCUSSION

This research is still in progress and, as such, the findings presented here are work in progress. Prior to the start of the project, the LMC identified the following capability gaps (these were the capabilities regarded as necessary to bring this new form of service on-line). Table 1 below provides an overview of the key findings to date. It lists the overarching capability developments identified during the project, but space does not permit the inclusion of many of the new operational capabilities that were needed as part of the process.

Table 1 High-level Summary of Current Findings

Capability development requirements	When identified	Current state of development	Notes
Management practices for cultural/role change	identified before the project began	Ongoing	COVID-19 delays through furloughs. Some changes being introduced in early 2021
Risk management for both company and potential NHS customers	identified before the project began	On-hold	COVID-19 induced project plan changes through changes in service requirements of customers
Design/Co-create service models for customer and Company Z	identified before the project began	Originally envisaged models put on hold for future	COVID-19 both hindered initial plans but opened avenues

		development, new models in development, first new model launched in spring 2021	for implantation of different services. Sensing capability employed
Management of cultural change	identified before the project began	Ongoing, new ways of working in preliminary stages of operation	COVID-19 has made face-to-face explication of change difficult
Changes in historic practices to facilitate delivery	identified before the project began	New protocols developed via Delphi consensus of key staff members	Aiming to gain buy-in from staff members as part of the required culture change
Documentation/recording of new capabilities	identified before the project began	On-going	
Embedding new capabilities into the company	Identified before the project began	Ongoing	
New business model development	Identified in Quarter 1	Ongoing	First new business model launched in April 2021
Establishing a new internal company area to manage the new services developed (Corelab)	Identified in Quarter 1	Public launch in Spring 2021, through revamped	Has synergies with the establishment of new SBUs or divisions by manufacturers

The findings indicate two core elements (although the analysis is far from complete). Firstly, the identification of what can only be described as a resilience capability, which involves constant refining and replanning in the face of major external threats that helps to give new direction about how to employ newly developed capabilities in innovative new ways. Secondly, that the process is slow and involves the development of many new operational capabilities (not included in the table above). Examples include: capabilities to gain customer insight, e.g. through customer journey mapping, and communication capabilities, both internal, e.g., internal video communication capability, and external, e.g., promotion material.

6. CONCLUSION

This ongoing action research describes the initial transformation processes that Company Z has begun to go through during the exploratory stages of the transformation process (Baines et al., 2020). Thus, we provide partial answers to our research questions. With respect to our first research question (How does the servitization journey of a non-manufacturing business evolve?), it is clear that many explorative capabilities need to be developed in order to servitize. We also highlight the importance of a resilience capability in this context, but note that this may be a peculiar feature of the current pandemic. With respect to the second question (What capabilities are needed to servitize in a non-manufacturing context? and How do non-manufacturing business servitization capabilities compare to capabilities manufacturers' employ in their servitization journey?), our preliminary findings illustrate some similarities between the capabilities employed by manufacturing companies. As the project is not yet complete, these findings can only be considered to be partial and they also have to be considered in the light of the current economic and health challenges that the whole world is facing.

However, the work has potential to contribute to our understanding of servitization by illustrating the transformation process needed to add a very different service to a healthcare service business.

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AGILE MANAGEMENT PRACTICES FOR SOLUTIONS DEVELOPMENT: MANAGERIAL CHALLENGES IN AN INTERORGANISATIONAL CONTEXT

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ABSTRACT

Purpose: Solutions development among several actors gives rise to a tension between stability, that is, the need to standardise and synchronise development activities, and agility, meaning the need to respond and adapt to a changing environment, which is represented, for example, in agile management practices. This study focuses on agile solutions development in an interorganisational context to investigate and characterise this agility-stability tension.

Design/Methodology/Approach: This study bases its insights on findings derived from two focus groups and interviews with managers and specialists within the area of study.

Findings: The findings show strong challenges deriving from the agility-stability tension. These can be organised in a typology of artefacts, roles, and processes.

Originality/Value: The results of this study contribute to the servitization literature on co-creation, solutions development, and agile management practices, by providing a novel understanding of the challenges arising in interorganisational solutions development through the identification and characterisation of the agility-stability tension.

KEYWORDS: Solutions, Interorganisational Development, Agile Management Practices

1. INTRODUCTION

In a context characterised by rapid development of technology (e.g. AI and electrification), new business models (e.g. circular business models) and new regulation (e.g. for improved sustainability and cyber security), firms are forced to adjust their operations and develop new offerings. As part of this transformation, many firms strive towards offering a higher proportion of services and to develop customer-adapted solutions (e.g. Sawhney 2006; Cova and Salle 2008). Solutions are often described as a combination of products and services (e.g. Brax and Jonsson 2009; Gebauer, Paiola and Saccani 2013), and by adding services to their (core) products, providers aim at increasing the value of offerings from a customer perspective (Oliva and Kallenberg 2003; Vandermerwe and Rada 1988). The development of such solutions often takes place in business networks involving multiple actors (Cantù, Corsaro and Snehota 2012; Jaakkola and Hakanen 2013; Raddats et al. 2019). Among the actors involved, the focal provider and its customer(s) are key, but also suppliers, partners and the customers of the customers (e.g. the end user) comprise important roles.

Scholars have highlighted that solutions development in an interorganisational context is non-trivial (Ramírez Hernández and Kreye 2020) and that increased attention to the interaction and interdependencies within the network is needed (Hedvall, Jagstedt and Dubois 2019). Solutions development in general often involves high complexity in terms of the offering provided, and through the involvement of an increased number of actors, this complexity is amplified. To navigate this complexity and the thereto associated uncertainty, actors often strive towards stability. This stability focuses on the ability to standardise and synchronise the development activities in order to increase productivity (Kuula, Haapasalo and Tolonen 2018) and has since long been recognised as the basis for several coordination mechanisms, for instance through standardisation of work processes, output or skills (Mintzberg 1993). However, at the same time, companies also seek agility in order to respond to rapidly shifting environments and competition which drive them to achieve shorter lead-times and faster adaptations to customer needs. In the context of providing solutions, companies increasingly turn to agile management practices (AMP) to enable agility (Sjödin et al. 2020). However, research highlights the difficulties involved in applying AMP within a dyad of organisations (Ardakani, Hashemi and Razzazi 2018), and it can therefore be expected that solutions development involving multiple actors magnify those challenges.

In this paper, we suggest that the simultaneous drive for agility and stability during solutions development in an interorganisational context results in an *agility-stability tension* within and among the collaborating actors. To guide managers navigating the implications of such tension, *this study investigates and characterises the tension through identifying and describing managerial challenges when agile management practices are used for solutions development in an interorganisational context.*

To address this aim, this study draws upon extant research on solutions development and AMP together with qualitative data from focus groups and interviews which highlight the managerial challenges arising from interorganisational solutions development. The study thereby responds to calls for deepening understanding around both agile solutions development (Huikkola and Kohtamäki 2020; Sjödin et al. 2020) and interorganisational solutions development (Kuula et al. 2018; Ramírez Hernández and Kreye, 2020).

2. THEORETICAL BACKGROUND

This paper focuses on challenges related to use of agile management practices for solutions development in an interorganisational context. Accordingly, the paper is positioned in the intersection of solutions, agile management practices and interorganisational collaboration. This chapter therefore first accounts for solutions development in an interorganisational context on one hand, thereafter turning to solutions and agile management practices on the other. The section concludes in a discussion of the *stability-agility tension* in interorganisational solutions development.

2.1 Solutions development in an interorganisational context

Solutions are often described as bundles of products and services adapted to address specific customer needs (e.g. Gebauer et al. 2013). To provide solutions enabling a surplus value, that is, a customer value beyond what can be achieved if the components were to be provided separately (e.g. Brax and Jonsson 2009), therefore involves both the integration of solution components as well as the customisation corresponding to the specific needs of the customer. To address customers' operational needs however, there is commonly also a need for integration of external actors contributing to – or are involved in – the solution (e.g. Miller et al. 2002; Brax and Jonsson 2009; Jagstedt and Persson 2018). This, apart from the components supplied by the focal solution provider, the components of a solution may also be provided by several different actors, e.g. the suppliers and partners of the solution provider.

Solutions development in an interorganisational context is non-trivial and gives rise to a multitude of challenges such as increased complexity with respect to planning and coordination of scope and development (Hedvall et al. 2019), complicated technical integration of the elements involved in the integrated offering requiring extensive integration competences (Shepherd and Ahmed 2000; Geum et al. 2011), or even hidden agendas of the participating actors (Ramírez Hernández and Kreye 2020). To navigate challenges like these, organisations commonly turn to measures of stability, such as standardisation and synchronisation of development activities. The focus of such measures lies on structured industrialisation of the solutions development to achieve operational efficiency, predictability, and increase productivity among the diverse actors (Kuula et al. 2018). Firms with a product focused tradition moving into solutions typically have a legacy of processes characterised by plan-driven approaches wherein requirements are defined up front with the development work arranged in linear models. These processes and associated tools and mental models carry over to some extent to the new context, and a shift in process approach is therefore a tall order.

2.2 Solutions and agile management practices

While the aim for stability enables some control over the complexity that arises in interorganisational solutions development, it comes at the expense of agility. The notion of AMP (agile management practices) stems from a small scale software development context, and as it gets more traction in larger organisational complexities, the challenges take on other forms. For example, on top of previous team-focused research we now also need to understand how teams relate to other teams inside (Dingsöyr 2014), as well as outside its own organisation. The rather limited research on agile collaboration between teams of different organisational locus identifies that long communication paths inhibit coordination (Figalist et al. 2019). A suggested solution is to employ an ”ambassador”, for organisational representation. However, that is most often used between sites within the same organisation, (Nisar and Hameed 2004) or between organisations with a more transactional type relationship (Ghobadi and Mathiassen 2016).

Agility is crucial to handle the dynamics of solutions development (Sjödin et al. 2020). For example, as solutions are highly customised offerings aimed at adressing the customer needs – and, the needs of customers vary over time – the scope and features of a solution might need adjustments throughout the development phase or even after its implementation (e.g. Tuli, Kohli and Bharadwaj 2007). Moreover, actors developing solutions need to adapt to rapid changes caused by technological developments which can potentially impact the solution (Sjödin et al. 2020). As such, iterative and incremental development activities are imperative to successful solutions development (Palo, Åkesson and Löfberg 2019). This logic underpins the recent introduction of AMP for solutions development. In AMP, governance is increasingly distributed, with the development carried out in an incremental manner that relies heavily on interaction among actors (Huikkola and Kohtamäki 2020, Sjödin et al. 2020).

2.3 Striving for agility and stability in solutions development

It becomes obvious that an iterative and dynamic approach to solutions development results in more complex challenges with respect to coordination and organising of the scope, responsibilities and activities of the actors involved. Moreover, the collaborative creation of value in interorganisational solutions development (Vargo and Lusch 2008) leads to a tension between the need for stability and agility among the different actors. This agility-stability tension gives rise to a multitude of challenges during the interorganisational solutions development. Additionally, applying AMP that involves the engagement of multiple actors amplifies the complexity to be navigated (Ardakani et al. 2018) and achieving synchronisation among a larger number of actors while still enable agility is increasingly difficult (Roser, DeFillippi and Samson 2013). Thus, while AMP have the potential of responding to the dynamics of solutions development and have been tested for pure in-house or dyadic settings (Sjödin et al. 2020), they appear to result in challenges in a larger interorganisational context.

While the extant literature hints towards the limitations of AMP in a scaled, interorganisational context beyond a dyad of organisations (Ardakani et al. 2018), no research, to the best of our knowledge, has yet focused on investigating agile interorganisational solutions development. Moreover, calls for furthering the understanding around challenges arising in interorganisational solutions development and the application of AMP to solutions development have been raised (Kuula et al. 2018; Ramírez Hernández and Kreye 2020; Huikkola and Kohtamäki 2020; Sjödin et al., 2020). Consequently, to address this gap and respond to the recent calls, this paper sets out to characterise the challenges faced by managers facing the *agility-stability tension*.

3. RESEARCH METHODOLOGY

This ongoing explorative study with a qualitative research design (Maxwell 2013) sets out to highlight challenges for managers concerned with applying AMP in interorganisational solutions development. Reflecting the explorative approach, the study took its point of departure in two focus groups (Morgan 1996) involving managers and development engineers. Herein, the researchers took a moderating role, relying on the group interaction as source of data (Morgan 1996). The key objectives of this first step was to gain initial insights into the experiences and concerns of the participants and to establish data that would guide the scope and focus of the continued investigations. In a second phase, interviews were performed with managers and experts in the industry to collect supplementary and in-depth empirical material allowing for a specific focus on the area of interest and to gain insights on the reasoning of individual interviewees (Kvale and Brinkmann 2009). For the semi-structured interviews (Bryman and Bell 2011), an interview guideline based on the outcome of the initial focus groups was developed, focusing on the intersection of the three areas; solutions, AMP and business networks.

The three companies purposively selected for the second phase were all known to develop high-tech solutions drawing heavily on R&D. For each firm, we identified interviewees with insight into the processes and governance of solutions-development. The three firms chosen represent different industries and scope: one being a large multinational supplier in the automotive industry; one being a multinational supplier of components and systems for the aerospace industry; one being a multinational supplier of industrial components to e.g. the automotive and mechanical industries.

4. TOWARDS A TYPOLOGY OF MANAGERIAL CHALLENGES IN AGILE INTERORGANISATIONAL SOLUTIONS DEVELOPMENT

The results from the focus groups confirmed that AMP are indeed challenging to implement at scale, even within the boundaries of a single firm. Consequently, scaling agile management practices for collaboration in a wider business network was commonly seen as tall order requiring measures to counter the negative effects from complexity and fragmentation with respect to targets, language and agile practices. In the analysis of the discussions of the two focus groups, three categories of managerial challenges in agile interorganisational solutions development emerged: artefacts, roles and processes. First, artefacts relate to the materialisation of interorganisational agreements or the solution and its components itself. Second, organisational roles are about the different perspectives and stakes related to the development of solutions. Third, processes exist that either support or hinder agility in solutions development to different extents. We allowed the three categories to inform our interview guideline to be provide focal themes for the interviews and validate the focus group findings. Below, we reflect upon the outcome of the focus groups as well as the interviews in relation to the three categories. Table 1 provides an overview of the key challenges identified.

Table 1: Typology of the challenges in agile interorganisational solution development

Artefacts	Roles	Processes
Collaboration contract - Stability: Clearly defining the scope of the collaboration incl. time, resource investment, risk-reward-split - Agility: New insights during the project might require the initial contract to be revised and hard to define in the initial stages	**Project management roles** - Stability: Project management methods describe roles, responsibilities and accountabilities - Agility: These roles might need to be revised based on the employees' own capability to fulfil these, but also based on the needs/ requirements of the local context/ project	**Frequency of interaction** - Stability: formalised process definition of diversion and conversion intervals - Agility: Additional, ad-hoc informal touchpoints as needed to resolve urgent matters
Requirement specifications - Stability: defining clear requirement specifications upfront helps guiding and aligning the development team in its efforts - Agility: New findings might require a redefinition or continuous adjustments of the initially defined specifications	**Functional roles** - Stability: Organisations have functional role descriptions to outline the general responsibility and capability of each employee - Agility: AMP often require a broadening of these roles (responsibilities and capabilities) to understand the implications of the own work on the work of the collaboration partner	**Frequency of deployment** - Stability: The project forecasts certain milestones where sub-components of the solution are integrated and deployed - Agility: Progress in the project might require an adjustment in scope or timing of the deployment
Scope and backlog of the solution - Stability: The collaboration partners typically define the scope and an initial backlog of the solution upfront to guide the development efforts - Agility: Progress in the development might require a change of scope and thus an adjustment in the backlog of the solution due to e.g. technical feasibility or ability to contribute as a collaboration partner		

4.1 Artefacts

In the interviews, a challenge associated to contracting was discovered. Contracts are illustrative artefacts of the agility-stability tension as they are characterised by a desire to strictly regulate the interaction between actors, often also by anticipating the end result in advance. This contradicts assumptions underlying an agile development, which unfolds incrementally. Accordingly, agile solutions development challenges the assumption that requirements of solutions can be fully defined upfront in contracts, and instead, stresses the need for flexible, process-oriented contracts wherein changes in requirements are navigated, rather than avoided.

However, while companies aim for stability in their product architecture to thereby enable economies of scale and scope, there is a need for a capability to respond to dynamic and changing customer needs. A pre-defined architecture with "frozen" interfaces could result in a lock-in that prohibits the development of more effective architectures. In a focus group, a "platform approach", i.e. an approach drawing on sharing assets among solutions, or a modular approach was suggested as means to address the complexity of a larger solution. The ideas were however countered by arguments expressing a fear for complex interdependencies between actors and instead, a "service-based" approach was favoured, focusing on the customer needs.

Alike, different traditions between actors of strictly regulated contracts with clear specifications on one hand, and a collaboration performed towards a more open objective on the other is perceived as an obstacle in collaborative solutions development. A manufacturer of industrial components argued that different agreements are reached with different actors, but to be able to adapt to changing requirements and use additional insights, a focus on mutual benefits are crucial.

This is also highlighted by the company in the aerospace industry, wherein the following three key enablers for agile cross-organisational development were identified; 1) *Trust* is a key enabler for agile practices – all through the concerned organisations. All communication must be done on an appropriate level, e.g. engineer-to-engineer. It should also be clear when Project Managers or others must get involved, e.g. for issues regarding economy or contracts; 2) A shared "*company culture*", involving aspects concerning delegation and interaction, is crucial; 3) Customers and partners that share a *common understanding of agile practices*. The same company also identifies issues associated to the customers' demands. Customers often require quotes reflecting "build-to-spec" (i.e. an offering matching the specification provided up-front by the customer) and with "firm-fixed-price", all of which make the use of agile practices difficult.

Accordingly, challenges associated to artefacts are about the contracts set up to structure the collaboration, but also about the specifications of the solution itself. As the requirements are set up to divide the work, they aim towards increased efficiency. However, in AMP there is a need to be more fast-moving and while clear interfaces might be important, the most effective architecture may not be known up front but are rather evolving, which might be contradictory to the assumption of stability of platform and modular architectures.

4.2 Roles

In the focus groups, trust and transparency were identified as two critical enablers for successful solutions development. To improve the collaboration required in joint solutions development, it was suggested that the cooperation should be facilitated by an actor that is considered to be "neutral". However, such an actor might be hard to identify and the industrial components manufacturer stressed the importance of rather seeking mutual benefits and synergies. This means that while solutions commonly requires collaboration to address more overall needs, each actor needs to also be able to turn down customers wherein their part of the solution would be minor.

A similar approach was also suggested for addressing the complexity of interorganisational solutions development with respect to the heterogeneous contexts of customers and users. It was argued that limiting the scope, by selecting and prioritising specific "niches" of customers, could help reducing the complexity of the solutions developed.

Also with respect to the interaction between suppliers and customers, tensions could be observed. In the company belonging to the aerospace industry, an argued tension between a legacy governance structure with two clear roles for interaction with customers (a project manager and a systems engineer) and the AMP instead encouraging "engineer-to-engineer" dialogue on a lower hierarchical level was identified. Customers are used to these two interfaces and do not manage to interact with development teams. A possible reason for this tension could be that even if AMP appears to be commonly known in the aerospace industry, neither the customers of the supplier, nor its partners or suppliers, have yet applied such methods in their organisations. Being a supplier implementing AMP therefore involves challenges, which needs to be navigated for instance through reducing the roles interacting with the customer or other actors in the network.

At both the industrial component manufacturer and the automotive supplier express, there appears to exist distinct differences between how agile practices are approached by different roles within the same firm. In general, agile collaboration between engineers from different organisations does not seem to be a headache for management. Engineers are relatively used to handling problem solving as they go, to deal with changes as they appear and are often savvy users of development methods such as AMP. However, on the commercial side, a different logic with different incentives is dominating. The logic seems to be more based on a transactional view of the relationship - striving for the stability and aversion of risk. Accordingly, while the commercial side encourage the application of AMP in the development (based on the potential effects on speed for instance), they argue that the applicability in their work is limited. Preparation for interorganisational collaboration is thus driven by a transactional and risk averse logic, while the actual practice during the collaboration is less transactional and of a more partnering type. These type roles seem to embody the stability-agility tension.

4.3 Processes

The processes applied when providing solutions compared to a more traditional plan driven approach results in important challenges associated to the stability-agility tension. This is especially important seen in the light of a network perspective, considering other actors and their expectations. For instance, the company in the aerospace industry witnesses that customers are used to projects applying a plan driven approach with well-defined milestones and design reviews. The activities in a subsequent development phase has typically not commenced until after successful completion of the preceding design review. Implementing AMP with shorter cycles and planning horizons thus involves major challenges in communicating with the customers about their needs and demands.

Also for the interface towards suppliers in this company, the shortened lead times enabled by AMP are challenged as the company experiences a conflict between the ambition to work agile and reduce development time, as the lead-time of specialised components from sub-suppliers can be up to 24 months. Accordingly, the lead times and the iterations are highly incompatible.

The process-related challenges also include issues related to the view on expected outcomes. One of the issues discussed by the focus groups regards how to establish a common view on the scope and targets of the solution development. To enable a common view and shared objectives, joint innovation involving partners of the ecosystem was suggested as a possible means. Participants in the same focus group also point out that common processes provides the collaborating parties with a shared language on how work is carried out, which in turn alleviates coordination.

Solutions development is also concerned to drive software update frequency. In the automotive industry, Over-the-air updates to the software means that OEMs can continuously improve their solutions. It also means that the forms for interorganisational collaboration are put to the test. The automotive supplier in our study expresses an increasing pressure to reduce interorganisational coordination costs to enable frequent over-the-air updates powered by the OEMs and suppliers in collaboration. Enabling such close collaboration will be a key for the suppliers to avoid seeing OEM's increasingly turn to inhouse development. The situation is somewhat complicated by the fact that suppliers often work in parallel with blueprint type orders (low uncertainty, close to standard components) and very complex integration of nascent technologies in their relation with the OEM.

These type of collaborations demand different processual stability. Blueprint projects expectedly come out with less friction and smoother workflows than the more uncertain projects. The preparation processes of these differing types of projects thus need to be sensitive to the fundamentally different types of development work that will take place in the respective projects.

5. CONCLUSION

This paper is about managerial challenges arising when agile management practices are used for solutions development in an interorganisational context. Firms developing solutions in such a context find themselves in a situation where they need to increase their interorganisational collaboration, thus expanding scope and system boundaries, and – at the same time – increase their use of agile management practices, thus fragmenting the development process into shorter iterations and delegating the decision making to teams of developers. These two prevailing trends do not combine neatly. The agile strive for short iterations and frequent feedback rather than an ex-ante defined plan does not apply frictionless across organisational boundaries. Agile practices requires, for example, the possibility to initiate work without a detailed plan for the execution of the entire project. This can lead to difficulties in the relation to other customers, suppliers and partners, as these relationships often are regulated through contracts and quotation procedures. This is especially true when establishing new business relations, without any previous, formal or informal, legacy structures.

Several of the challenges identified can be associated to two different phases with partly different characteristics – “preparation” and “practice”. *Preparations*, concerns the initial and overarching governance with respect to scope, plans and resources, as examples, while *practice* regards the development of the solution to be. We argue that these two phases with their corresponding artefacts, roles and processes are at the core of the stability-agility tension. Thus, a challenge of applying agile practices for interorganisational solutions development comes down to 1) how collaboration is prepared through contracts, plans and pre-project coordination, and 2) how collaboration is practiced through the communication and coordination between teams and individuals in the different organisations during the project.

The preparation of collaborative efforts appears to be predominantly driven by a stability logic. The organisational roles involved in that phase generally favour stability through the design of artefacts like contracts, legal documents, cost/profit share agreements, as examples. How these artefacts are practiced on the other hand, is predominantly driven, at least on an engineering level, by agility – the design of work processes, for example how engineers coordinate their work, solve problems and continuously learn about their own design.

Thus, it all comes back to different coordinating mechanisms being in play aiming for stability on one hand (either in form of output, processes or skills; cf. Mintzberg 1993), and agility on the other (relying heavily on mutual adjustments and intense communication within and between the development teams). It appears as the crux of the matter is about on what level to aim for stability, and wherein to open for the flexibility and agility needed to address an ever-changing context influenced by changing customer needs, technological developments and new business logics. The collaborating partners must ask themselves which interfaces and specifications that need to be stable over time to reduce the complexity and provide opportunities for economies of scale, and which that are to be managed and continuously developed by individual actors and development teams.

6. THEORETICAL AND PRACTICAL IMPLICATIONS

This paper shares the initial findings from an ongoing study, contributing to the extant literature in two ways. First, it characterises and problematises the *agility-stability tension* arising in interorganisational solutions development when AMP is applied. It illustrates the tension through examples from three types of industries. Through this, the paper contributes with a novel perspective on interorganisational solutions development (Kuula et al. 2018; Hedvall et al. 2019; Ramírez Hernández and Kreye 2020) and expands the literature on servitization, co-creation and solutions development. Second, it identifies and scrutinises key managerial challenges arising from this tension in an interorganisational context. Specifically, this study proposes a typology for such challenges (artefacts, roles, processes) and links them to the overarching agility-stability tension. This deepens the understanding around the challenges arising in agile interorganisational solutions development (Huikkola and Kohtamäki 2020; Sjödin et al. 2020), and contributes as such to the servitization literature on AMP specifically, as well as solutions development generally.

For managers specifically, the initial findings shed light on – and acknowledge – the challenges encountered when implementing AMP for solutions development involving multiple actors. The examples discussed point to the importance of addressing the diverse logics encountered in *preparation* and *practice,* and the artefacts, roles and processes they are associated with. Moreover, managers in collaborative networks should strive for a common understanding of what the agile practices contains and identify the challenges that could arise due to legacy interfaces, structures and processes.

Similar to many studies in an initial phase, this study is subject to several limitations. First, the initial findings depend on a limited range of sources and a narrow scope with respect to industrial contexts. Second, hitherto, only focal suppliers have been investigated without shedding light on the views of other actors. Hence, as Huikkola and Kohtamäki (2020) and Sjödin et al. (2020) we advocate for further research approaching other industrial settings and additional actors in the respective business networks.

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DIGITAL SERVITIZATION FOR SUSTAINABLE VALUE CREATION

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ABSTRACT

Purpose: Compared to the traditional linear production economic model of the "take-make-waste" process, servitization is recognised as an innovative business model to achieve sustainable production and consumption. Despite increasing interests of digital servitization and its expected economic return on investment, little is known about its sustainable value creation potentials.

Design/Methodology/Approach: This study focused on a UK based heating manufacturer and their digital servitization development. We adopted established framework for advanced service delivery as theoretical lens to understand its potential sustainable value creation opportunities.

Findings: We identified five areas of information assets associated with advanced service delivery systems, involving connected product, field service process, supply chains, customer relationships and new service development. We then developed propositions to assess its impact on sustainable value creation.

Originality/Value: Contribute to understand the role of digital servitization and development of advanced service delivery information asset for sustainable value creation.

KEYWORDS: Digital Servitization, Sustainable Value Creation, Advanced Service Delivery, Information Asset

1. INTRODUCTION

Servitization is recognised as an innovative business model to achieve sustainable production and consumption, because the more manufacturers move from selling products to the result-oriented offerings, the greater potential to capture sustainability value (Yang & Evans, 2019). Studies suggest firms can adopt manufacturing servitization to decouple environmental pressure from economic growth, and moving toward an outcome based economy, such as focusing on asset use and outcome rather than ownership (Tukker 2004, Kirchherr, Reike et al. 2017, Yang, Smart et al. 2018, Genovese and Pansera 2020). By retaining the ownership of the product, manufacturing firms are incentivised to prolong the lifetime of the product, result in a total reduction of material consumption throughout the product lifecycle (Baines and Lightfoot 2013, Yang, Evans et al. 2017). Celebrated industrial icons such as Rolls-Royce, Xerox and Alstom, all offer some form of service contracts for prolonging asset lifecycle and gain long term profit (Baines and Lightfoot 2013).

Recently, manufacturing service growth has taken up many of the new digital technologies offered through the digital transformation (Gebauer, Paiola et al. 2020). Digital servitization is equipped with industrial digital technologies (Schroeder, Naik, Bigdeli, & Baines, 2020), sensors that monitor and observe the production process, AI that predict product performance, track and trace for real-time advanced service delivery, and machine learning to advise customer use behaviour. The application of industrial digital technologies will enable manufactures to harvest sustainable information beyond remote monitoring of products and the information from assets and data captured within a production facility can be reused to create complementary environmental and socio-economic value in the advanced service delivery systems (Iansiti & Lakhani, 2020).

Companies can develop strategic capabilities in digital servitization (Kohtamäki, Parida et al. 2019), to either exploit or explore the opportunities to support manufacturing servitization development (Fischer, Gebauer et al. 2010), develop service related data processing and interpretation capabilities (Ulaga and Reinartz 2011), offer advanced services by exploiting field service data such as product location, condition and use behaviour analytics (Baines and Shi 2015), and develop dynamic capability in sensing service opportunities, seizing service opportunities, and reconfiguration capabilities (Teece, Pisano et al. 1997, Fischer, Gebauer et al. 2010, Coreynen, Matthyssens et al. 2020). However, these contributions failed to describe digital servitization and its impact on sustainable value creation relates to environmental, social and economic benefit.

Manufacturing companies developing digital servitization capability for sustainability benefit is far from easy (Fischer, Gebauer et al. 2010). Understanding sustainability performance requires a large amount of information, some information is already available but fragmented, or are not publically available due to protection of know-how and intellectual property (Heinrich and Lang 2019), thus prevent the execution of maintenance, reuse activities, for example, original equipment manufacturers (OEM) may prevent third party access to their manuals, spare parts and engineering tools (Bressanelli, Perona et al. 2019). The technical challenge relates to improper and complex product design for disassembly, reuse and remanufacturing, quality concerns to use recovered materials, for example, materials used for aerospace manufacturing tend to avoid recovered materials because of uncertainty about their performance characteristics in extreme condition (OECD 2019). Uncertainty of reverse flow volume, mix, quality, time, place and low-value character of many waste streams decreases the probability of achieving an economic scale in circular activities (Bressanelli, Perona et al. 2019, OECD 2019).

In this study, we adopt established advanced service delivery framework (Baines and Lightfoot 2014), to explore potential sustainable value creation opportunities by developing information assets in advanced service delivery systems. Following section discussed the theoretical background, Next the case-study methodology is described and discussed, and findings are presented. Finally, conclusion with a discussion of the implication of theoretical and practical contributions.

2. THEORETICAL BACKGROUND

The concept of sustainable development was described by the 1987 Bruntland Commission Report as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Three key dimensions in sustainable development relates to balanced economic, environmental and social benefit. Servitization is recognised as an innovative business model to achieve business sustainability, because the more manufacturers move from selling products to result-oriented offerings, the greater potential to capture sustainability value (Yang & Evans, 2019).

The economic benefit of the servitization largely pertains to manufacturing firm having control of products and service delivery with aligned manufacturer-buyer incentives for product longevity, optimized for a cycle of disassembly and reuse that renders them easier to handle and transform (Baines, Bigdeli et al. 2017). Servitization increases revenue, better fulfilment of customer needs, improved customer relations and reduced ownership responsibility for the customers (Yang and Evans 2019). For example, remanufacturing for capital intensive machinery is economically cheaper than equivalent newly manufactured objects, Caterpillar along with many other companies are selling their remanufactured products at a discount with an identical warranty, the gross profits can be up to 2.75 times higher than selling original equipment (Lacy and Rutqvist 2016, OECD 2019).

Servitization encourage manufacturers to adopt a result oriented product-service systems, by changing the pattern of asset ownership, a manufacturer takes on the responsibility for product end of life disposal, it also incentivises manufactures to design for sustainability, minimise resource requirement during service delivery, improve the environmental efficiency of the product in use, change the customer’s in use behaviour (Baines and Lightfoot 2013, Shi, Kandemir et al. 2020). Significant reduction in environmental GHG emissions and industrial waste cannot be achieved by transitioning to renewables alone but with augmentation with servitization strategies (Baines and Lightfoot 2013). For example, secondary material production requires considerably less energy than the energy used in the respective primary process (OECD 2019). Servitization by OEM retaining the ownership of the product help to preserve most embodied resources such as energy, material and water (Stahel 2019). Maintenance, repair and remanufacturing activities tend to slow material flows because reduced demand for new products translate into reduced environmental impact from extraction, processing and disposal (OECD 2019). Social benefits of servitization are mainly through an increased number of customer and end user related social benefit, for example reduce the number of fuel poor household (Shi, Kandemir et al. 2020).

Increasingly, government commitment for Net Zero (OECD 2019), demand for sustainable operation of global supply chains (Lacy and Rutqvist 2016), are suggesting manufacturing firms needs to gain and integrate their resources in response to changing environmental context (Kohtamäki, Parida et al. 2019). Given the convergence of digitization and servitization (Sklyar, Kowalkowski et al. 2019, Gebauer, Paiola et al. 2020, Paiola and Gebauer 2020, Tronvoll, Sklyar et al. 2020, Hsuan, Jovanovic et al. 2021), and market demand for sustainable and green business model (Yang, Smart et al. 2018, Yang and Evans 2019, Shi, Kandemir et al. 2020). This study adopts established advanced service delivery framework, such as those provided by Baines and Lightfoot (2014). We identified five areas where digital servitization information assets can be developed against advanced services delivery (1) connected product (2) field service process (3) supply chains (4) customer relations (5) new service development. Each of these topics are now discussed individually and summarised as a key finding.

3. RESEARCH METHODOLOGY

We set out to investigate in the heating technology sector by focusing on a UK based heating manufacturer and their digital servitization development. We adopt a design science approach to allow us to identify the problem space and solution space simultaneously (Hatchuel, Weil et al. 2013). The research centred on a collaboration between the academic team and a manufacturer of domestic heating products. These parties met frequently over a 9-month period to develop information requirements and digital enabled advanced service value propositions for the heating system manufacturer.

The manufacturer – referred to as HeatCo. – produces a wide range of heating products, for domestic and industrial use. With many thousands of products in use, there is a large installed base, but no contact with the customers and hence no opportunity to deliver additional value through service. Currently, manufacturers receive payment based on delivery of product and aftermarket service warranties of the product. HeatCo's products are normally sold to independent contractors that deal directly with a customer, organising installation and maintenance services, including an annual inspection to maintain the warranty. These products are typically guaranteed for up to 10 years, yet HeatCo gains only limited insight due to a lack of direct customer interactions.

Digital servitization is seen as a promising strategy for HeatCo to improve their business sustainability. For HeatCo the first step has been to install sensors into the control board of the heating device, to gather data on the product and facilitate service delivery. The research in this setting involved capturing some of the available data – from approximately 700 domestic customers – for analysis. This helped to reveal current potential and further data requirements for developing digital servitization for sustainability oriented benefit. The lens through which we set out to investigate focusing on identifying information assets for advanced service delivery systems.

4. FINDINGS

Shown in Figure 1, we have identified five areas of advanced service delivery, and developed potential value propositions where digital servitization information assets can help to create sustainable value.

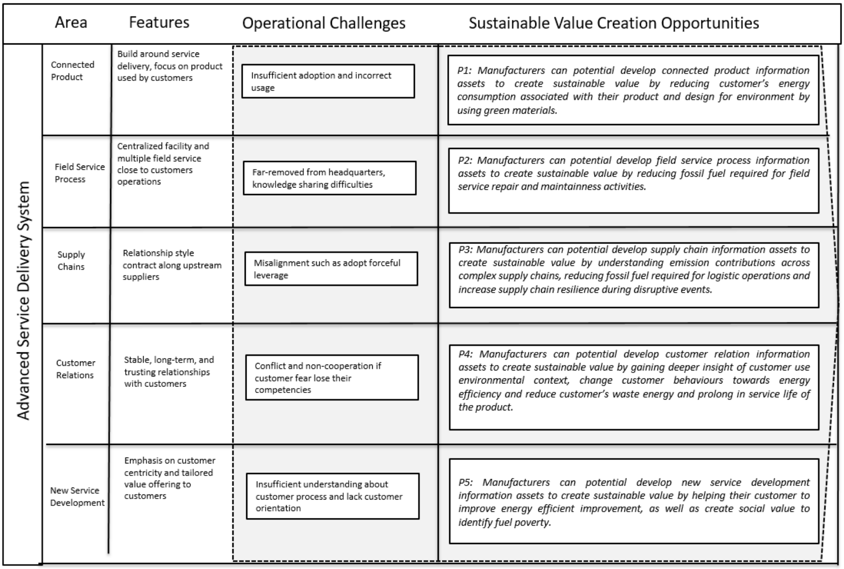

Figure 1: Advanced service delivery system and sustainable value creation

Connected product focus on digital technologies providing the manufacturer with visibility of their product as it is used by the customer (Baines and Lightfoot 2013). Customer incorrectly use manufacturer's product can result in higher level of energy consumption, frequent service calls, manufacturers are developing connected product technologies to capture information about the way in which the product is used and use this to reduce customer's energy consumption associated with their product. Connected products are linked through IoT devises can support real-time monitoring of machinery utilization, its energy usage, lighting and heating requirement in the form of metadata that records the history and context of the data, thus human decision-makers can interrogate the dataset to support accountability.

The manufacturer can create substantial sustainable value by developing information assets associated with connected product (Ulaga and Reinartz 2011). For example, understand deterioration behaviour of the assets and apply machine learning to continuously refine the accuracy of connected product information assets (Shi, Kandemir et al. 2020). Because, advanced service manufacturers often 'own' the product architecture, such as access to all product information, and, therefore, the power to design interface protocols by deciding which green materials and components of innovation are adopted and which ones are not (Pisano and Teece 2007). For example, in the construction sector, modular building manufacturers are increasingly adopting integrated product-service-software design and make for customised buildings based on green materials and technologies in a factory environment, this allows the manufacturer to enhance customised design capabilities, more product variety, improve construction processes and earlier project completion time (Shi, Hughes et al. 2020). Therefore, we develop proposition 1:

P1: Manufacturers can potential develop connected product information assets to create sustainable value by reducing customer's energy consumption associated with their product and design for environment by using green materials.

Advanced service is delivered through centralised facility and multiple maintenance and repair service facilities close to customer's operations (Baines and Lightfoot 2013) to increase the utilisation of existing product and assets (Lacy, Long et al. 2020), and keep the useful life of the product for as long as possible and reduce impact while in use (OECD 2019). Reactive maintenance represents stocks of unplanned repair activities, proactive maintenance represents scheduled maintenance activities, manufacturing firm can integrate connected IoT devises to their physical repair processes, for example apply augmented reality to help field service teams to reduce the need for on-site maintenance and repair, reduce the number of second repair visit, and reduce the time and specialist resource required for swapping of parts (Shi, Kandemir et al. 2020). Transportation simulation and optimisation can be applied to estimate service level performance against customer expected repair process lead times, as well as lowering the fossil fuel consumption by improved planning and scheduling. Therefore, we develop proposition 2:

P2: Manufacturers can potential develop field service process information assets to create sustainable value by reducing fossil fuel required for field service repair and maintainness activities.

Supply chain operations for advanced service delivery is not just about investment in the latest off the shelf ERP systems, outsource most expensive consultancy boutiques, and buy-in best in class manufacturing process technologies. According to The-Royal-Society (2020) report building environmental accountability require to monitor and control emissions across complex global supply chains to allow different parties accountable for their emissions. Currently, manufacturing organisations have no obligation to report emissions occurring upstream in the supply chain. Industrial digital technology can help to address this issue, where networks of sensors collect accurate data on energy use from industrial machinery (The-Royal-Society 2020). This creates transparent information of carbon footprint to support aligned incentives and penalties with multiple stakeholders at various organisational levels, from suppliers, manufacturers, distributor, employees, customers, end-users, communities and regulatory bodies (Freeman, Martin et al. 2007, Yang, Evans et al. 2017).

Reducing the environmental footprint and waste generated in goods flow, as well as develop inventory control policies in warehousing to reduce supply chain vulnerability if part of the supply is disrupted or demand suddenly increased. For example, apply dynamic simulation to identify supply chain risk to ensure sufficient food supply for socially vulnerable groups during the global pandemic, and using dynamic vehicle routing to reduce congestion, emissions and accelerate delivery timeframe (Ivanov and Dolgui 2020). Therefore, we develop proposition 3:

P3: Manufacturers can potential develop supply chain information assets to create sustainable value by understanding emission contributions across complex supply chains, reducing fossil fuel required for logistic operations and increase supply chain resilience during disruptive events.

Advanced service delivery systems requires stable, long-term and trusting relationships with customers (Baines and Lightfoot 2013). Manufacturing companies can implement digital strategy to collect data about energy usage monitor carbon hotspot and reduce wasted energy and resource consumptions of their assets in the use environment. Often, improper use and overuse lead to a shorter product lifecycle (Baines and Lightfoot 2013). Data about processes and behaviours from the mapping of physical assets to understanding user behaviours could enable the development of digital technologies to support for user's behaviour change, such as reduce, optimise, and control emissions from unprofessional use of products, and reduce customer's missed application of the product (Yang and Evans 2019, The-Royal-Society 2020). For example, by systematically extract data from use behaviours, Nest Thermostats with the addition of an electronic sensor to monitor temperature and motion and Wi-Fi connectivity to learn user behaviour, and adjust the temperature automatically to reduce household energy consumption (Iansiti and Lakhani 2020). Therefore, we develop proposition 4:

P4: Manufacturers can potential develop customer relation information assets to create sustainable value by gaining deeper insight of customer use environmental context, change customer behaviours towards energy efficiency and reduce customer's waste energy and prolong in service life of the product.

Advanced service delivery requires new service development to emphasis on customer centricity and tailored value offering to customers (Baines and Lightfoot 2013). Developing connected physical assets will benefit data about similar assets and processes. For example, digital twin of the heating systems continuously generate data to the simulated assets to reduce heat loss in the buildings, optimise service delivery and share data for wider stakeholders to help alleviate fuel poverty (Shi, Kandemir et al. 2020). However, to combine shared data across different stakeholders, there is a tension between value drivers for individuals and value drivers to benefit all (The-Royal-Society 2020), industrial users can be wary of sharing their processing and emission data with the entire supply chain, for fear of potential vulnerability to reputation damage and that other organisation might enjoy greater financial benefit than themselves.

According to Baines and Lightfoot (2013) Xerox's "managed print services" by streamlining their print environment and process to help customers become more productive, improve energy efficiency and reduce material usage (Baines and Lightfoot 2013). Centrica business solutions offer an 'energy as a service' bundle, including the design, installation, and financing of on-site power generation (The-Royal-Society 2020). The sustainable value created through new service development can go beyond the basic functioning of the industrial equipment (Ulaga and Reinartz 2011), such as advisory services to help social housing landlords to identify number of fuel poor household (Shi, Kandemir et al. 2020). Therefore, we develop proposition 5:

P5: Manufacturers can potential develop new service development information assets to create sustainable value by helping their customer to improve energy efficient improvement, as well as create social value to identify fuel poverty.

5.THEORETICAL AND PRACTICAL CONTRIBUTION

This study set out to explore what are the sustainable value creation opportunities of digital servitization. Specifically, we identified information assets in five areas of advanced service delivery system, and their potential impact on sustainable value creation. The research used the case of a heating manufacturer to understand the specific information related challenges. Several key insights have been generated by this research.

The research has provided considerable insights into developing information assets for advanced service delivery. Building on established advanced service delivery framework (Baines and Lightfoot 2014) our research complement to the operational assessment on the advanced service value delivery system, by addressing sustainable value creation opportunities. An advanced service delivery system can potentially comprised of five potentially interrelated information assets (1) connected product information asset (2) field service process information asset (3) supply chains information asset (4) customer relations information asset (5) new service development information asset. By highlighting the sustainable value creation opportunities in creating these information assets. Our study shows digital servitization can potentially contribute to sustainable business model, allowing practitioners to gain insight about sustainable opportunities in their digital servitization effort.

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EXPLORING THE ALIGNMENT BETWEEN SERVITIZATION BASED VALUE PROPOSITIONS AND CONTRACTS

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ABSTRACT

Purpose: The purpose of this research is to provide further insight into PSSs and the contracts regulating their delivery (in part or in full), through the development of a model linking the characteristics of value propositions associated with basic, intermediate and advanced services to the offer and the contract. Having a clear understanding in this context would lead companies to offer services without a mismatch between the value proposition promised and the contract itself. The motivation for the study comes from a prior study where the service leaders interviewed expressed concerns with the contracting process when moving from basic to advanced services.

Design/Methodology/Approach: The research design adopts a multi-step approach that integrates the analysis of literature, the investigation of secondary data sources, and expert interviews.

Findings: Through the creation of a conceptual map based on a literature review and secondary sources analysis, this paper provides a holistic view of the distinctive components of the value proposition and contracts in PSS contexts. Furthermore, by exploiting the information from interviews with experts, it contributes to improving knowledge on the relationship between these components. Finally, it contributes to the definition of an effective standard service contract editing process, supporting companies in commercializing their services in complex PSS environments.

Originality/Value: There is limited published work in this area, so the link between the value proposition and the contracts appears to be weak. Marketing often speaks of the value propositions for service, although there often appears to be a gap between the value proposition, the offer and the legal binding agreement.

KEYWORDS: Servitization; Value Propositions; Service Contracts, Offers.

1 INTRODUCTION

The provision of Product Service Systems (PSSs) has been recognized over the years as a major business opportunity for many manufacturing companies (Vandermerwe & Rada, 1988; Baines, et al., 2009). Research has underlined that an appropriate configuration of the value proposition is fundamental to achieve successful PSS (Da Costa Fernandes et al., 2019). Conversely, service providers often fail to articulate their value proposition into proper service contracts, thus generating dissatisfaction and difficulties in contract management (van der Valk, 2008). Advanced (often referred to as outcome-based) service contracts, long-term service agreements and Operation & Maintenance (or O&M) agreements) are used to regulate the relationships between the provider and the customer within PSS environments. They link the value proposition to the offer via legally binding obligations on both parties (Stremersch, Wuyts, & Frambach, 2001). Product contracts are, in general, focused on the tangible goods that are delivered to the customer by the supplier. In contrast, service contracts are often outcome-focused, with significant value co-creation and intangibles, making them different from conventional supply contracts (van der Valk, 2008; Ng, Maull, Yip, 2009).

The purpose of this research is to provide further insight into PSSs and the contracts regulating their delivery (in part or in full), through the development of a model linking the characteristics of the value proposition associated with services to the distinctive features of service contracts. Having a clear understanding in this context would lead companies to offer services without a mismatch between the value proposition promised and the contract itself. The motivation for the study comes from a prior study where the service leaders interviewed expressed concerns with the contracting process when moving from basic to advanced services (West, Gaiardelli, & Mathews, 2019).

2 BACKGROUND

Growing competition is driving manufacturing companies toward servitization, a transition from selling standard products to selling advanced product-service systems, to secure competitiveness (Baines et al., 2009). Companies are increasingly offering advanced service solutions rather than the traditional business model of standalone physical products with basic add-on services. Advanced services are defined as complex combinations of products, services, software, support processes, and knowledge that work together to achieve the outcomes desired by the customer. Such examples have been described by Anderson & Narus (1995) in terms of maintenance, repair and overhaul services. They are required to have a clear value proposition, associated with them, an offer that supports the delivery of the value proposition, capabilities and resources underpinning them, and a contract describing the obligations of parties (Kindström & Kowalkowski, 2014).

2.1 Value proposition for services

A value proposition indicates why a customer should do business with a provider, making clear the achievable benefits and emphasizing the ultimate positive effect that emerges from the trade-off between gains and pains (Da Costa Fernandes et al., 2019). As a value proposition is the first thing that customers encounter when selecting a PSS offer, making it relevant and qualified emerges as essential. Consistently, a successful value proposition has to be communicated properly, adopting the customer's language to connect it to their expectations and needs. Indeed, service providers usually develop complex and carefully articulated contracts to manage relationships with their customers in the product-service delivery (Kowalkowski, 2011). Specifically, when advanced services are provided, contracts may be formulated to explicitly state how future critical events will be handled, in order to avoid any uncertainty and misleading situations and to discourage opportunistic behavior by one or both parties involved (Latonen & Akpinar, 2019). A value proposition (Anderson & Carpenter, 2010) is a clear statement that provides: relevancy (e.g., explanation of how the product or service solves customers' problems or improves their situation) and a qualification of value delivery.

An offering represents the bundle of goods or services that in totality deliver the value proposition (Ulaga & Reinartz, 2011). For many buyers the value proposition is the first thing they encounter when selecting an offering and thus, having a clear value proposition is essential. An advanced service offering is a hybrid that is built from the provider's (or their partners') resources and capabilities and these may be realized within basic service offers. The bundle of goods or services (i.e., the offer) necessary to deliver the value proposition, may be effectively built from service modules (Heikka, Frandsen, & Hsuan, 2018).

2.2 Taxonomy of value propositions and offers

Kindström & Kowalkowski (2014) developed a taxonomy that helps to classify service offerings, based on their main characteristics, the service focus and the revenue model. Product focused services try to ensure that a product functions and performs as expected, customer process-oriented services, instead, support customer's real business processes. The second dimension is given by the revenue model: input-based services are sold with the promise to perform a certain input with that specific input being charged; output-based services are, on the other hand, charged by focusing on the product's availability or performance.

2.3 Contracts for long-term and outcome-based agreements

Service providers draft contracts to regulate relationships, which emphasizes written documents regarding the description of the roles and obligations, payment and performance commitments (Zou et. al, 2019; Ng & Nudurupati, 2010; Stremersch, Wuyts, & Frambach, 2001). Examples of such contracts include price inflation clauses regarding actual costs, and performance guarantees that address solution failure or penalties. Contracts reduce uncertainty concerning behaviors and outcomes by providing formal rules and procedures to govern the relationship (Zou et al, 2019). The advanced contracts include some or all of the following goods and services: planned and unplanned inspections, spares, repairs, technical support, system analysis and face-to-face customer management. Service contracts describe the offer in sufficient detail that demonstrates the resources and the capabilities (either internal to the supplier or sub-contracted) required to deliver the value proposition (Stremersch, Wuyts, & Frambach, 2001). Allocation of resources, roles and responsibilities to support value co-creation and co-production/co-delivery associated with the offer is important, and must be described within the contract (Ng, Maull, & Yip, 2009; Grönroos, & Helle, 2010). Considering the buyer's perspective, van der Valk (2008) identifies the importance of contracts in services, yet Stoll, West, & Hennecke (2021) confirmed in their exploratory study that that contracts for outcome-based agreements were poorly researched.

3 METHODOLOGY

The research design adopts a multi-step approach that integrates the analysis of literature with the investigation of secondary data sources and some expert interviews. First, a benchmarking review was conducted, adopting a snowball method to avoid the disadvantages of retrospective research (Yin, 2009). The benchmarking included analysis of websites, reports and brochures of industrial companies operating within the context of PSS. The value propositions, the offers identified, and the underlying basic offers (or modules) of spares, repairs, field services, and monitoring and diagnostics, were assessed. The results were then used to categorize the value propositions based on Kindström & Kowalkowski (2014). Finally, seven semi-structured interviews with experts in service contracts were carried out to gain insights into the process of translating the value proposition into the contracted offers, to gain an understanding of the contracting process within firms. The analysis was then used as the basis for the discussion and building a model that translates the value proposition and the (hybrid) offer into a contract that could be successfully fulfilled.

4 RESULTS AND INITIAL ANALYSIS

All the firms studied manufactured capital (or investment) products, where the cost of a new product runs into millions of dollars and where the operational life of the product is at least 15 years. The results initially describe the findings of the benchmarking of the firms' offerings and respective value propositions before providing insights from the interviews on the offer-to-contract process.

4.1 Benchmarking

Each company's website was organized and their offerings were clearly described; the study started focusing iteratively on companies belonging to a specific industry segment, classifying their services offered and identifying the value propositions guaranteed for each service. Each service offered by a company belonging to a specific industry field was analyzed along different dimensions: value proposition, risk allocation, revenue model, and service category. Interestingly, the language to describe the different value propositions, offers, building blocks, and underlying resources and capabilities was not consistent between the firms. The summary of offers is given in Table 1 and the classification of the value proportions in Table 2.

The firms active within the rail segment were analyzed for their offers and value propositions, each supplier had their own names for their offers. They all provided the basic building blocks of spares (also called material solutions at Bombardier, spare parts services at Siemens), repairs (component repair and overhaul at Bombardier, parts and repairs at Alstom) and upgrades (modernization at Alstom, asset life management and vehicle modernization at Bombardier) for the products that they sold. All the firms provided different forms of maintenance services based on product availability, they also provided O&M services that focused on process availability (operational services at Siemens). Monitoring and diagnostics were provided under a range of names and could be integrated into the maintenance, O&M or upgrade services (or rolling stock refurbishment and maintenance at Hitachi, dynamic maintenance at Alstom). Asset management, a service based on reconditioning and product performance, was supported through digital services and linked product and process performance. Testing services were also common in this segment, called qualification services at Siemens.

Table 1: Summary of the offers from the firms studied

	Rail				Shipp-ing		O&G			Power		Aero				
	Alstom	Bombardier	Hitachi	Siemens	ABB Turbo	Wartsila	Burkhardt	MAN	Sulzer	GE Power	Siemens	Airbus	Boeing	Bombardier	GE Aero	Rolls-Royce
Basic offers/ modules																
Spares	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Repairs	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Field services	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Monitoring and diagnostics	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hybrid offers																
Upgrades	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Exchange					X					X	X	X	X		X	X
Consultancy/training	X	X	X	X		X		X	X	X	X	X	X			
Maintenance (framework)	X	X	X	X	X	X		X	X	X	X				X	X
Maintenance (input focused)	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Maintenance (output focused)	x				x			x		x		x	x	x	x	x
Operations and maintenance		X	X	X						X						
Asset management		X	X		x		x					x				

X = fully, x=partially

Table 2: Classification of the value proportions from the firms studied

	Rail				Shipping		O&G			Power		Aero				
	Alstom	Bombardier	Hitachi	Siemens	ABB Turbo	Wartsila	Burkhardt	MAN	Sulzer	GE Power	Siemens	Airbus	Boeing	Bombardier	GE Aero	Rolls-Royce
Process																
Support	X	X		X		X	X		X							
Availability		X	X	X	X					X	X	X	X		X	X
Performance					X			X		X	X	X		X	X	X
Product																
Lifecycle	X	X		X	X	X	X	X	X	X	X	X	X	X		
Availability	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Performance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Shipping was similar in many respects to rail, (with ABB naming spares original parts), while repairs were again referred to, and often integrated into the maintenance services along with exchange services (referred to as customer part exchange and exchange units at ABB). Exchange for the system was not possible, however the subsystems could be exchanged. To improve the value proposition both firms provided in-service upgrades to reduce ongoing maintenance requirements and better match the equipment with the actual operational requirements. This approach was supported via the asset management services based on reconditioning the products to maintain product performance. The more advanced service-based value propositions were based on multiyear agreements focused on product availability (maintenance management agreement, fixed rate service agreement at ABB). More advanced services based on "per hour use" (called turbo lifecycle care at ABB) were described, whereas the lifecycle solution from Wartsila aimed to reduced total life cycle costs. Training was provided by both firms, covering routine maintenance as well as operational training.

The O&G segment (based on three firms) had basic services based on transactional spares, repairs and field service, digital services (or condition-based monitoring and diagnostics at Burkhardt also called digital solutions at Sulzer) were also offered, although on a longer-term relationship basis. Conversions, modifications and upgrades were offered to provide improved product performance (revamps and modifications at MAN, revamps and upgrades at Burkhardt). All of three firms provided their hybrid offers on the basis of transactional or multiyear programs from basic framework agreements to availability-based agreements (digital and service agreements at MAN, maintenance contracts/ LTSA at Sulzer), MAN reactor services also supported lifecycle asset management. Training for maintenance and operational support was provided by all the firms.

Power confirmed similar trends to O&G: within this segment value propositions from Siemens and GE Power were assessed, and as with O&G both firms provide offers based on spares, repairs and field services on transactional basis. Digital services (diagnostics services at Siemens) were provided on a multiyear basis with upgrade services being offered on a project basis, albeit with an outcome basis. Multiyear maintenance programs (hybrid offers) based on availability of inputs were described, as were more advanced "power-by-the-hour" agreements (contractual service agreement at GE).

The aero segment suppliers included Airbus, Boeing, Bombardier GE Aero, and Rolls-Royce, and included airframe OEMs and engine manufacturers. In this segment many of the services were offered both directly and via a third party such as Lufthansa Technik. Again, spares and general maintenance, repair and overhaul services as well as training were described, suggesting that offers were both basic and hybrid in form. Maintenance services, hybrid offers based on product availability value propositions (e.g., preventive maintenance and maintenance, repair and overhaul at Airbus, maintenance inspections and product enhancements at Bombardier) were described. Upgrade services were also described on both the airframe and the engine, "by-the-hour" service agreements were offered by all the vendors (smart services at Boeing). Lifecycle asset management was a service from all vendors (maintenance and engineering at Boeing. Exchange services and leasing were described by both airframe OEMs and engine manufacturers.

By breaking down the different hybrid offers into the basic building blocks, it can be seen that many of the constituent capabilities and resources are common: products (or product modules); spares and consumables; field service; repairs; and training. Monitoring and diagnostics are enabling resources (technology) that support the delivery of more advanced services as well as being a service that can be sold in its own right. The basic and enabling resources are the core building blocks for the more advanced value propositions: framework agreements; multiyear maintenance agreements; exchange and leasing (products or sub-systems); "per-operation" maintenance agreements; operations and maintenance; asset management.

The value propositions from different firms have been assessed, and the firms provide a range of services that can be classified accordingly, allowing the different value propositions to be assessed on a common basis. Here it must be noted that the data were secondary data and that additional interviews from both the customers and the suppliers would further support the analysis.

4.2 Understanding the translation of value propositions to contracts

Interviews were conducted with seven experts in the area of commercialization of advanced services and a summary of the results is given inTable 3. The interviewees were selected to provide a spread of experience across a range of industrial B2B services and due to their experience with services. They were selected to give a balanced view of the process of translating the value proposition into an offer and then contracting the offer.

5 DISCUSSION

Many or all the advanced value propositions were based on hybrid offers, where individual modules (or building blocks) were integrated together, which is therefore in agreement with Heikka, Frandsen, & Hsuan (2018). The mix of language and combination of value proposition with underlying capabilities and resources made much of the assessment initially difficult to achieve. In all of the cases investigated the product ownership was transferred from the supplier, making all the service value propositions more "traditional" than with some of the more advanced "rental" based advanced services. In the case of the aero segment, ownership was often with a financial owner, whereas in power, the ownership of the power plant could be separated from the local operations and maintenance team. The difference here needs to be further investigated, as firms such as Caterpillar and Hilti offer rental services on their products and this may be an artifact of specific market segments.

Table 3: Summary of the interview insights and quotes

Interview	Direct quotes and insights
A. Engineer Service development Global manufacture	— Value propositions are stated in the communication part but not in the contract — The scope of the service is the core part of the contract; the contract is structured based on that and adjusted based on customer capabilities. — Tried to harmonize the service contracts across the firm — "*Service contacts, they are very often custom-designed*"
B. Engineer Service Leader Global manufacture	— Contracts do not match every value proposition. — Value propositions contain many aspects in addition to the core scope. — Provide a range of contracts (e.g., call-off contracts, middle ground contracts, advanced ones) co-developed contracts. — "*Service contracts come from a tradition of a product [business] and a poorly structured*".
C. Lawyer General counsel Global manufacture	— Value propositions are [only] a communication tool, the starting point for negotiations. — Customers like to use their negotiation power to impose their terms and conditions. — Large suppliers have negotiation power and can standardize their contracts. — "*Contracts don't do the complete job of describing the entire value propositions*".
D. Business Consultant Service leader Regional consulting	— Value propositions should be [reflected] in the contract. — Service contracts should be standardized. — Forms of contract need to reflect activity-based, performance-based and outcome-based value propositions. — "*[there is a] lack of understanding of what service really is, this leads to problems in developing and commercializing services*".
E. Engineer Service leader Consultant Service software Global manufacture	— The [ITIL] framework helps to decompose the contract into building blocks, and for each block, there are options for the customer. — A menu card serves as a configure-to-order tool to balance standardization and personalization. — Important to understand the risk both parties bear in the contract. — "*Create a standardized framework for the delivery organization and which is flexible enough for the customers*."
F. Science IT manager Data analytics Global manufacture	— Value propositions are not stated in the contract because it is impossible to commit to delivering the value described. — Suppliers generally align with customer's business derivers when agreeing on a service agreement. — Outcomes depend on how the customer operates the asset (you can't control their behavior) — "*Negotiation with customers should be based on a specific framework that you can adapt depending on what the customer wants*".
G. Engineer Service leader Global manufacture	— It is crucial to demonstrate the value to the customer. — Forms of contracts are based on frameworks that were followed and adapted to specific cases. — Every industry sector/ every company has their way of approaching the contract. — "*Value propositions are part of the deal presentation, but they are not written into the contract - they are legal terms"*.

The results confirm that the value propositions can be classified using the model from Kindström, & Kowalkowski (2014) and that this model provides a useful approach for understanding the characteristics of the solutions offered. Interestingly, different value propositions can be built using similar modules, even when the hybrid offers are different. This suggests that basic service offers (and the underlying capabilities and resources) provide the basic blocks for the advanced or outcome-based contracts. A clear example of this was the difference between two of GE Power's offers and their value propositions (e.g., Multi-year Maintenance Program or MMP and Contractual Service Agreement or CSA) where they are nearly identical in terms of the inputs, but they provide very different value propositions to the customer. The MMP's value proposition provides certainty with fees and lead times, whereas the CSA is a "power-by-the-hour" outcome-based contract. The bundling of modules provides the opportunity to create different hybrid offers that support different value propositions (e.g., new revenue models, risk transfer, and value proposition focus). The contracts that support the service delivery therefore are required to be different in content and can be built from similar modules.

Digital technologies (e.g., monitoring and diagnostics) can be considered enabling technologies to allow more advanced service-based value propositions to be built from the basic modules, even though monitoring and diagnostics were offered on a standalone basis. When part of a hybrid offer, monitoring and diagnostics creates a recurring relationship customer, as well as supporting risk transfer and proving the conditions that allow new revenue models, both of which are necessary for advanced services. Similarly, the availability of a "spare product" (e.g., exchange unit) provides additional risk transfer in the form of a "real option" and allows a new value proposition to be built, along with its hybrid offer, all of which must be reflected correctly within the contract. This is in general agreement with Zou et al., (2019) and van der Valk (2008).

In effect, the contract defines the relationships between the parties to the contract as well as third party obligations, and must be clear to both the provider and the buyer (Stoll, West, & Hennecke, 2021). Without the clear definition of the relationships and the obligations of the parties towards each other the delivery of the "offer", which comprises a set of goods and services with a specific revenue model, will not be successfully delivered and therefore the supplier will have failed to have fulfilled the value proposition associated with the offer. For advanced services to successfully deliver the value proposition promised, the firm needs to have the mindset necessary to draft a contract around the hybrid offer or solution (e.g., the bundle of goods and services). Advanced service should build upon service dominant logic as it is necessary to understand and reflect the value co-creation process based on multi-actor interactions towards the beneficiary(ies), which in effect defines the "rules" described within the multilayer service framework of Frost, Chang, & Lyons (2019).

5.1 Managerial implications

Due to recurring maintenance requirements, customers in these capital goods markets may prefer a "framework agreement", which in effect bundles together the basic modules into an offer. Here there is limited additional risk transfer to the supplier, and many service level agreements could be considered typical examples as they define minimum service commitments, such as lead time; other examples are "call-off" agreements. These are essentially simple offers with goods and services bundled together for a series of transactional purchases and are focused on supporting the product. The translation of basic input-based service value propositions was found to be closely related to the "product mindset" of many of the manufacturing firms interviewed. Legal teams in place for the equipment sales were more used to the development of transactionally-based value propositions, including upgrade contracts.

The translation of the outcome-based hybrid offers into a contract is a complex process where many firms do not understand what is needed. The hybrid offers require the ability to integrate commercial capabilities, including commercial management, risk and legal, and logistics management with the basic models. This allows risk to be transferred to the supplier and for the revenue model to move to a "pay-per-input" or "pay-per-output" model. The allocation of contractual roles and obligations is according to Ng, Maull, & Yip (2009) and Stremersch, Wuyts, & Frambach (2001), otherwise, the likelihood of delivering the value proposition sold to the customer is low. This again supports the requirement for more sophisticated commercial capabilities in the firm as advanced services are offered via hybrid offers. Where there is a mismatch between the value proposition, the hybrid offer, and the contrast, there is a risk of the legally binding agreement between both parties will at some point unravel.

A commercial team who are able to bundle the necessary modules together for the hybrid offer and convert the value proposition into a binding contract is no longer “nice to have” but a requirement for the contracting and execution of intermediate and advanced service contracts. The literature on this subject is rather sparce, focusing on the design of the value proposition and the revenue model, and is silent on the contracting aspects. NEC4 from the UK provided some insights into contract structures for advanced service agreements, others (van der Valk, 2008; Zou et al., 2019) provide some insights, although not fully applicable to this study. Therefore, it is recommended that a multi-disciplinary study is considered, to examine the area of “*contracting advanced services in a PSS context*” and that such a study should consider how this should be integrated with the design of the value propositions and the underling capabilities necessary to design, develop and deliver advanced services in line with Stoll, West & Hennecke (2021).

6 CONCLUSIONS AND RECOMMENDATIONS

There is a paradox when converting value propositions to a contract, as the contract must reflect the value proposition but cannot just copy and paste one into the other, (although it should be reflected clearly in the “preamble” of the contract). For this reason, there is often a gap between the value proposition (what was sold) with the hybrid offer and the contract. Ng, Maull, & Yip (2009) suggests that service dominant logic can support here, as contract preparation requires strong customer involvement of, as their preferences play an important role in assigning roles and responsibilities to parties involved. In addition, the analysis suggests that contractual obligations and requirements for both the service provider and customer can differ significantly in accordance with the characteristics of the hybrid offer, the revenue model, and the form of the focus of the value proposition. Finally, the study confirms the difficulty in creating standard forms of contract, however, some standard elements can be identified in the contract drafting process.

A recommendation for future research would be to focus on case studies and/or specific companies and have access to their service contracts, in order to be able to evaluate them and come to a result on how contracts change ranging from basic, intermediate and advanced service offerings, particularly with the integration of digital technology. To do this, more access to the contracts themselves would be required, along with a research team that included law and finance specialists.

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ENABLING DECISION SUPPORT SERVICES IN INDUSTRIAL ECOSYSTEMS BY DIGITAL TWINS

Jürg Meierhofer, Simon Züst, Jinzhi Lu, Lukas Schweiger, Dimitris Kiritsis

ABSTRACT

Purpose:

The goal of this paper is to elaborate a new concept for value creation by decision support services in industrial service ecosystems using a digital twin. The aim is to design and integrate an architecture of digital twins that is derived from the actors' needs and that leverages the potential of the synergies in the ecosystem.

Design/Methodology/Approach:

The conceptual framework presented in this paper is elaborated based on a multiple case study with ten cases (West et al., 2020). Based on a modelling of the ecosystem and the actors' decision jobs, technical modelling approaches are developed and integrated to an ecosystem perspective.

Findings:

In a service ecosystem comprising several enterprises and a multitude of actors, decision making is based on the interlinkage of the digital twins of the equipment and the processes. In order to foster the full potential of the digital twins in an ecosystem, they are integrated in a hierarchical concept using ontology approaches.

Originality/Value:

The findings of this study integrate the modelling approaches for digital twins and extends these to a new modelling approach on the level of service ecosystems. This provides a practical blueprint to companies for developing digital twin based services in their own operations and beyond in their ecosystem.

KEYWORDS: digital twin, smart services, data modelling, decision support, service ecosystems.

1. INTRODUCTION

The goal of this paper is to elaborate a new concept for value creation by decision support services in industrial service ecosystems using a digital twin. The aim is to design and integrate an architecture of digital twins that is derived from the actors' needs and that leverages the potential of the synergies in the ecosystem.

The Digital Twin is defined as a virtual representation of a connected physical equipment that represents in real-time its static and dynamic characteristics (Romero et al., 2020). It has the potential to add value to many applications and, in particular, to industrial processes and thus attracts increasing interest of practitioners and scholars (Barbieri et al., 2019). There is a wide range of understandings and definitions of the Digital Twin and its applications (Tao et al., 2018). The research streams of industrial services, data-driven services and Digital Twins converge in the field of decision support services. The Digital Twin can be considered as an implementation of data-driven services that enable the exploration of scenarios and alternatives and thus support decision taking in business environments (Kunath & Winkler, 2018). Therefore, changing the perspective and conceptualizing the Digital Twin as an approach for value creation from a service perspective is a promising new research direction.

Decision Support Systems (DSS) are information systems that help users in their decision activities, which can extend to highly automated decision taking. The steps of the decision making process are described in (De Almeida & Bohoris, 1995; Dong & Srinivasan, 2013; Holsapple, 2008; Power, 2004, 2008; Sala et al., 2019) and can be simplified to: 1. Describe the set of possible actions or alternatives. 2. Evaluate these actions. 3. Select the preferred action. Step 2. of the simplified decision process points to the application of the Digital Twin, in particular Digital Twin-based simulation, which allows to explore the variants and evaluate their consequences. This is supported by (Sala et al., 2019), which states that simulation is a very common decision support instrument, in particular for decisions in maintenance or capacity planning in product-service-systems, for instance.

According to Service-Dominant Logic (S-D Logic), value is created by actors integrating resources to create new so-called operant resources which create benefit for other actors (Vargo & Lusch, 2008). The support for decision taking can be considered from this perspective as a way of creating benefit for the decision taker. The resources integrated are: a) the expert knowledge of the human actors in the system, b) the data created by the actors, in particular by the equipment, people and processes that are to be managed, c) the analytics applied to this data, d) the decision making process based on the integration all these resources.

This process of integrating knowledge and data from their raw formats up to supporting decisions is based on (Holsapple, 2008). The structure is comparable to the DIKW (data-information-knowledge-wisdom) scheme based on (Rowley, 2007). According to (Holsapple, 2008), the traditional conception of decision making has to be differentiated from the knowledge-based conception, which – according to S-D Logic terms – integrates knowledge resources other than pure data from the systems.

The approach discussed in this paper is based on the concept of “Service-Dominant Logic” (S-D Logic). With the transition from products to services, the economy moves from the concept of “Goods-Dominant Logic” (G-D Logic) to S-D Logic. In S-D Logic, service is considered the fundamental purpose of economic exchange. The focus of value creation is moved from the manufacturer as creator to co-creation through customer interaction (Vargo et al., 2008), i.e., the concept of industrial companies as service providers has emerged (Lay, 2014). S-D Logic states that operant resources – e.g., knowledge and skills - are the fundamental source of competitive advantage for the actors in the ecosystem. Service providers apply their knowledge and skills for the benefit of another entity or the entity itself (Vargo et al., 2008). In the context of industrial services, the ability to use a digital twin based on data-based models and analytics represents an operant resource.

Given these concepts, the research question of this paper is: how can decision support services in industrial ecosystems be conceptualised using the digital twin?

2. RESEARCH METHODOLOGY

The conceptual framework presented in this paper is elaborated based on a multiple case study with ten cases (West et al., 2020). Based on a modelling of the ecosystem and the actors’ decision jobs, technical modelling approaches are developed and integrated to an ecosystem perspective.

The hierarchical concept for modelling the digital twins and their interrelationship in an ecosystem is derived using a top-down approach from the concept of systems engineering (Züst, 2004) and developed by means of an incremental differentiation of the internal structure. Building upon the systems engineering approach, the interplay among the different digital twins is conceptually modelled using the approaches from ontology modelling (Suárez-Figueroa et al., 2011).

Additionally, based on the then cases studied in this research, a generic, representative model of an ecosystem comprising archetypes of actors and digital twins is developed. The theoretical approaches conceptualized in this paper are applied and discussed using this model.

3. FINDINGS: HIERARCHICAL DIGITAL TWIN MODEL

3.1 Finding 1: Business Questions Related to Decision Problems

In the industrial cases where decision making is centered around operations processes, the decision chain extends from the equipment to the operations processes (Meierhofer & West, 2020). The Digital Twin of the equipment (see Figure 1) receives data from the real equipment and presents an indication of its performance, e.g., a health condition. However, this is raw information and does not support decisions until it is interpreted. The actor managing the asset needs to decide on which actions to take by trading off resource constraints. Information provided by the digital twin of the processes provides support for this and is integrated with other knowledge resources (Holsapple, 2008).

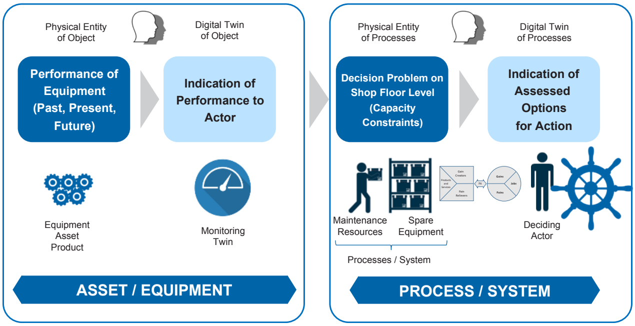

Figure 1: Digital twin of equipment vs. processes (terms according to (Jones et al., 2020))

An actor managing the asset makes a decision by trading off resource constraints. The actor can trade-off between two extremes: immediate maintenance – requiring available maintenance resources; or immediate replacement – requiring available spare equipment, or any point on the continuum between these. With the help of the process twin, the decision maker may, e.g., judge whether there are spare equipment or maintenance resources available and at what cost.

3.2 Finding 2: Integrating the Domains to a Hierarchical Concept

In a service ecosystem comprising several enterprises and a multitude of actors each having jobs to be done and decisions to be taken, usually a multitude of digital twins is required for providing decision support services to these actors. This decision making is structured in a hierarchical way following the structure of the ecosystem. The overall performance metrics can be divided into sub-metrices for the different hierarchical levels. E.g., a company sets a goal for the annual production output. This goal can be divided into required outputs and delivery time for the different actors in the ecosystem, which may be business units of the same company or from different companies. This structure is indicated in Figure 2 by the pyramid and the KPI tree. The KPI tree includes the main KPIs, as well as the derived basic KPIs and key performance parameters (KPP) on the shop floor level as suggested by (Svantesson, 2008).

This results into several specific business challenges for different actors on different hierarchy levels, each with specific decision support needs. Depending on the information and data available, a digital twin lends itself for supporting these decision. This will result into a digital twin landscape over the entire ecosystem with each digital twin serving a specific process owner. The individual digital twin is represented by the vertical boxes labelled “DT sequence” in Figure 2. The digital twin is thereby not limited to the hierarchy level of the process owner. It might reach over several underlying hierarchy levels depending on its scope, as well as on the system topology. A systematic development procedure consisting of six steps for the DT sequence is discussed in (Meierhofer & West, 2020).

While isolated digital twins might have a significant value-add to the process owners, fostering the full potential requires connecting and integrating all the digital twins. In other words: An isolated twin represents untapped potential. Thus, the digital twins need to be coordinated and integrated across the entire service ecosystem. Doing so enables the prediction of the effects made on a specific hierarchy level onto the performance of the processes of other hierarchy levels or ecosystem actors. This enable decisions to be made not only focusing on the local KPIs but on the overall performance of the ecosystem.

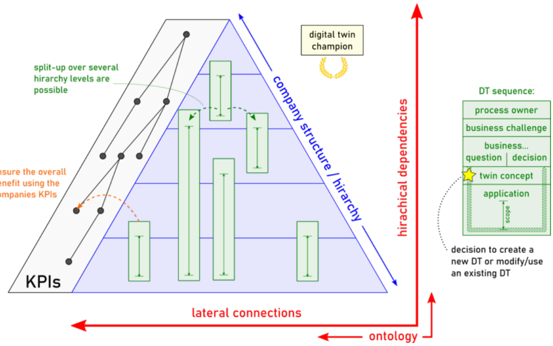

Figure 2: Hierarchical Interplay between the different modelling domains.

The connection and integration of different digital twins requires the implementation of a new role, the digital twin champion (DTC). The DTC manages and synchronizes the implementation and integration of different digital twins. Further, the knowledge transfer in-between different process owners regarding digital twin conceptualization, implementation and application is organized and facilitated by the DTC. This role is of strategic importance, since the DTC has a significant effect on fostering the full potential of connected and integrated digital twins. Moreover, the DTC enables to identify and use synergies in-between process owners with similar requirements and/or scopes on the digital twins to be implemented. In the framework of S-D Logic, the DTC can be considered a task of the ecosystem orchestrator who coordinates the collaboration through institutional arrangements.

3.3 Finding 3: The Role of the Ontology in the Hierarchical Concept

As discussed in section 3.2, the digital twins reach over several underlying hierarchy levels and enterprises, even up to the entire ecosystem. The formalisms, connections, and relationships among the different digital twins in an ecosystem are defined by knowledge graph models which are developed based on the defined ontology concepts. The ontology is defined as: "an explicit, formal specification of a shared conceptualization of a domain of interest" (Guarino et al., 2009), which provide formal models of domain knowledge exploited in different ways. The domain specific knowledge is represented in a unified ontology (J. Lu et al., 2020), which can be reused efficiently without waste of R&D cost caused by non-shared knowledge. Therefore, ontology plays a significant role for many knowledge-intensive applications particularly for supporting digital twin integration.
Ontology engineering is the general discipline including methodologies and methods for building ontologies. Ontology engineering refers to "The set of activities that concern the ontology development and the ontology lifecycle, the methods and methodologies for building ontologies and the tool suites and languages that support them" (Suárez-Figueroa et al., 2011). The ontology engineering provides a guideline to define domain knowledge representations which are reused efficiently and represent the digital twins and the related systems completely. It is the base to provide knowledge graph models for Information Technology (IT) to operate with interoperability and standardization.

Across the modelling domains of digital twins, ontology represents the nature of organizations, systems engineering, system lifecycle, digital twin models and simulation models in the way of philosophy:

- Semantic modelling based on ontology can help defining entities and the relationships between entities which refers to digital twin concepts and data. Based on the total set of ontology entities and their topologies digital twins are described by the taxonomy of the defined classes (Jinzhi Lu et al., 2020).

- Information or system modelling based on ontology provides the ability to abstract different kinds of data and provides an understanding of how the data elements are related, with a good scalability.
- A semantic model is a type of information model that supports the modelling of digital twin entities and their topologies through structuring formalism. Knowledge graph is one of the specific semantic models which represent things using semantic triple. Through knowledge graph, semantics reasoning enables to infer logical consequences from a set of asserted facts or axioms. Thus, IT platforms can obtain more query capabilities for data analysis based on knowledge graph models when managing the digital twins.

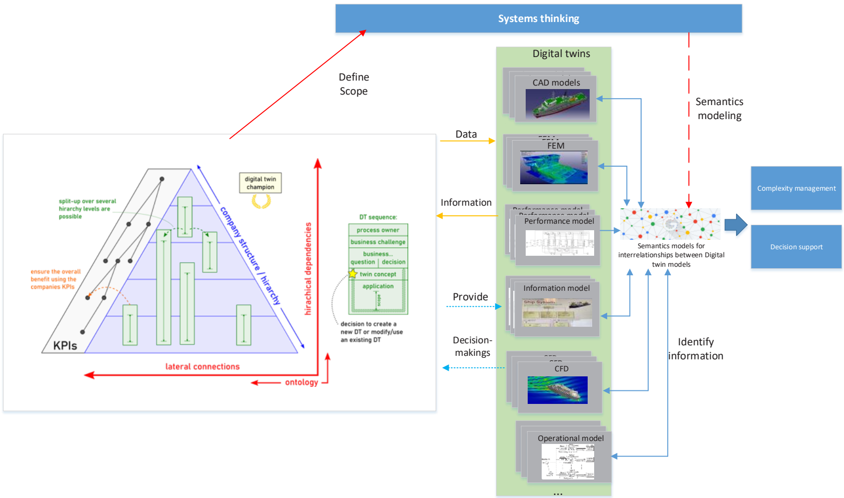

Figure 3: Semantics modelling for digital twins.

When managing digital twin models, semantic modelling is used for defining the meaning of data and the context of the digital twins, and to model the domain knowledge of the real world related to the digital twins in the abstract level. Through exploiting semantic models for digital twin management and application, several benefits are mainly found as follows:

- Avoiding misunderstanding: by providing a clear, accessible, agreed set of terms, relations as a trusted source and discussions, misunderstandings can easily be resolved.
- Conduct decision-makings through reasoning: by being machine understandable and through the usage of logic statements (rules), ontologies enable automatic reasoning and inference which leads to automatic generation of new and implicit knowledge for decision-makings.
- Leverage resources: by extending and relating an application ontology to external ontological resources, via manual or automatic mapping and merging processes, the need for repetition of entire design process for every application domain is eliminated.
- Improve interoperability: semantic models can serve as a basis for schema matching to support systems' interoperability in close environments where systems, tools and data sources have no common recognition of data type and relationships.
- Improve complexity management: based on the unified semantics models， the entire information related digital twins is captured for traceability management and consistency management.

4. APPLICATION CASE

Based on multiple case studies with ten companies from the industry, a generic model was created to demonstrate the multiple aspects of the models. The generic model is embedded in an artificial business case. The case revolves around a Swiss manufacturing SME, MillerMills, that is in the process of Servitization. They already have a basic understanding of their installed base. For this purpose, they have been collecting machine data from 100 machines located in Switzerland for several years. Based on this data, they are already able to use machine learning to detect any component failures 24 hours before they occur. The information about the installed base and the prediction of failures in components are already helpful for the operation of the service offer that the company sells to the customers. However, there are still many unanswered questions regarding service operations, especially in dealing with the predicted failures in the components and the appropriate response to them. This is where the digital process twin comes into its own. In this case, it has two tasks that involve different actors from the internal ecosystem of the company. On the one hand, the digital process twin must map the entire service operations field that has been established in Switzerland. This includes the customers where the machines are located as well as the condition of the machines with their history from maintenance and errors. Furthermore, the twin must also be able to map the service technicians, their location, and routes to and from the customers. Based on these fundamentals, the following business questions need to be answered for the SME with the simulation of the digital process twin: (1) Based on the current situation, what is the best response to a predicted disruption? (2) With how many service technicians can we meet the service level promised to the customer? (3) How many spare parts do we need to have in stock to meet the service level promised to the customer? For space reasons, this paper is limited to these three selected questions; the list of questions could be extended at will.

Based on this foundation, an agent-based simulation model was created. The structure of agent-based models allows the different hierarchical levels of the digital twins to be represented logically. For the digital twins in the ecosystem, agents are created which represent them in the model. These agents are partly directly nested or interact with each other via the so-called main-agent. The following agents are used in the model: (1) Main, (2) MillerMills, (3) Customer, (4) Machine, (5) Component, (6) Service Technician, and (7) Vehicle. In Figure 4 the model structure is depicted with the nesting of the different agents, which can be mapped to the hierarchical concept shown in Figure 2.

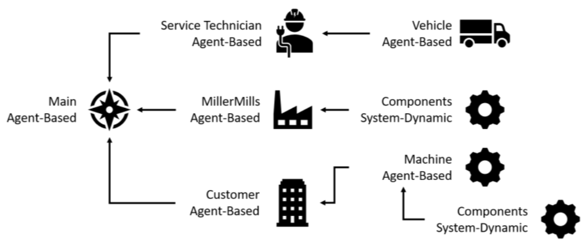

Figure 4: Model Structure, Agents with their Simulation Method.

The various digital twins are embedded in the main agent and simulated there based on a GIS environment. This GIS environment allows to directly simulate the interaction of the service technicians, the vehicles and their route to the customers. This allows conclusions to be drawn about travel times and possible optimization at the service technicians' locations. Each customer is captured as an independent agent in the GIS environment and contains the machines in operation. To each machine belong four different components, which are simulated directly nested in the machine.

MillerMills is the headquarters of the SME where the warehouse of spare parts and their production is located. The various agents act independently of each other and communicate their needs or inventory and availability when requested. The service technicians, for example, receive orders such as standard maintenance from the headquarters, which they have to carry out. The working hours, as well as the travel times to the customers, are simulated so that a realistic basic behavior can be created in the model. If extraordinary events occur, which are detected by the machine learning algorithms in the customer's machines, the model suggests different action variants. Based on this decision support, those responsible for the process can now plan the response in the "physical" world accordingly.

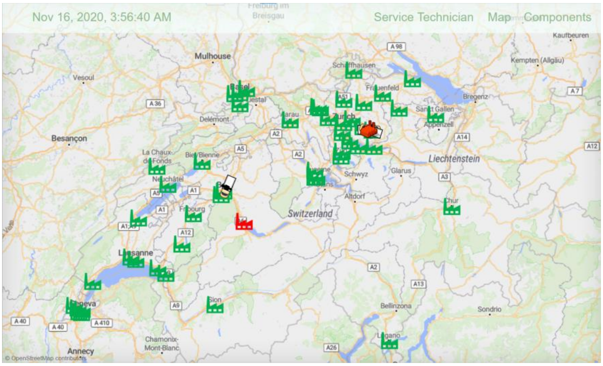

Figure 5: View of the Main Agent of the Model with the GIS Map and the nested agents.

Furthermore, different scenarios can be simulated. For example, it is possible to improve or worsen the lead time of the machine learning algorithm. In this way, the consequences for service operations can be tested. Alternatively, the financial impact of an improvement of the algorithms can be shown. Besides, one can also play with the capacity to produce spare parts to prevent any bottlenecks or overproduction. Finally, it is also possible to adjust the number of service technicians and their training and simulate the resulting changes to the ecosystem. A detail of the model with the GIS environment is shown in Figure 5.

5. DISCUSSION AND FURTHER DEVELOPMENT

The findings of this study integrate the modelling approaches for digital twins and extends these to modelling on the level of service ecosystems. This new modelling approach provides a practical blueprint to companies for developing digital twin based services in their own operations and beyond in their ecosystem. Integrating the hierarchical concept with the concepts of ontology modelling allows for leveraging the benefit of the multitude of digital twins systematically.

The new conceptual model was applied in an application case that comprehensively covers the different aspects of the then case studies. This application shows that using the new conceptual model, different operational states in the ecosystem can be simulated, thus supporting the decision-making process for the optimal response to events. It becomes evident that comprehensively modelling the entire ecosystem system is not required. Instead, it is sufficient to concentrate on the elements in the system that are relevant to the business questions. This leads to savings in the development of such process twins and reduces complexity.

Future research will zoom into the box named “DT sequence” in Figure 2 and focus on the question how the underlying data and the choice of analytics methods including algorithms impacts the value creation for the business challenges. Additionally, further investigations can shed light on how patterns of business challenges translate into patterns of digital twins.

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SYSTEMIC DIGITAL SERVICE DESIGN: EVIDENCES FROM THE MACHINE TOOLS INDUSTRY

Donatella Corti, Gianpiero Mattei, Mauro Sala Danna & Enrico Tumminaro

ABSTRACT

Purpose: in this paper the step-wise design approach adopted by a company leader in the precision machine tools industry to internally develop an IoT device as a component of a modular digital platform is presented. The analysis covers the whole design process from strategic considerations to the service specification and validation.

Design/Methodology/Approach: the methodology followed to develop the IoT device in the analysed case study is organized around a bimodal process combining the agile development of new services with the strategic management of the service platform lifecycle. In particular, the SWOT analysis, the Kano model, the house of quality and the economic analysis for both the manufacturer and the user.

Findings: the implemented methodology allowed to design a promising solution as confirmed by the analysis of the expected performance improvement for both the company and its customers. Revenues coming from the new device are expected to increase 5% the service turnover. The economic return supports the envisioned positive impact from the strategic point of view. Foreseen gains for the customer have been analysed taking a specific customer as a reference. The most ambitious goal will be reached when an algorithm comparing data acquired and saved in the database allows to order autonomously the spare parts needed to perform predictive maintenance. Considering the impact on a single machine tool, savings of the order to 35’000 chf per year and reduction of 14 hours of setup would be achieved thanks to this smart tool management.

Originality/Value: the paper contributes to the digital servitization literature topic with empirical evidence in the machine tool industry. It also provides hints for practitioners.

KEYWORDS: digital servitization, IoT, machine tools, systemic service design

1. INTRODUCTION

Digital advancements brought by the Industry 4.0 revolution have unclosed new opportunities to enrich the service offer of manufacturing companies either improving performance of existing services or developing new data-driven services. In order to realize the full potential inherent in digital servitization, it is not enough to address technological issues, a strategic approach has to be adopted that could identify how technologies fits into a wider change plan covering also strategic and business model issues.

Aim of this paper is to present how a Swiss company leader in the production of precision machine tools adopted a step-wise methodology to internally design and develop an IoT device that could enrich the service offer exploiting digital technologies while satisfying strategic goals. The developed solution is a system that monitors the wear and breakage of a tool mounted on an electrospindle. When installed on a machine tool, the device constantly monitors the tool’s status and stops the system when necessary reducing the need of expensive spare-parts, increasing production quality and reducing the downtime. This solution is one of the components enabling the exploitation of a service-led digital platform, a technological infrastructure that allows to develop, configure and deliver advanced services that is being built within the company. The platform has been identified as the winning solution for innovating the service offer and it is the outcome of a careful analysis process that allowed to fit the platoform’s features with the customers’ needs and, at the same time, with the internal expertise.

Services enabled by the real-time acquisition of data are not new in the servitization realm, yet it is not trivial to create value out of it. In this paper a successful case study is reported pointing out the importance of supporting the introduction of data-driven services with a proper digital strategy and a structured analysis.

The remainder of the paper is organized as follows. Section 2 provides a brief literature review on the digital servitization topic, before introducing the case study (Section 3). Section 4 describes the methodology used to develop the new service, whilst Section 5 focuses on how the different methodological steps have been implemented in the company. Eventually, Section 6 discusses some managerial implications and draws concluding remarks.

2. AN OVERVIEW OF DIGITAL SERVITIZATION

Digitalization, as evolved in the Industry 4.0 era, is broadly defined as the use of digital technology to change business models and to provide new value-creating and revenue-generating opportunities (Gartner, 2021). Servitization shares with digitalization the aim of redefining the value proposition of production companies and, indeed, representing it a business model innovation has gain momentum with the exploitation of digital technologies.

Even though manufacturing companies are increasingly experimenting the combination of servitization and digitalization, the academic research on the new domain called digital servitization that has taken shape to investigate the impact of digital technologies on servitization, is relatively recent and fragmented (Tronvoll et al., 2020; Pashou et al. 2018). This research stream considers technologies as a driver and enabler at the same time (Vendrell-Herrero et al., 2017). The expected innovation is brought in the form of new digital business models, novel ways of creating value, generation of knowledge from data or improvement of firm’s operational and environmental performance (Pashou et al., 2020).

The majority of papers on digital servitization are based on qualitative empirical studies and the most frequently examined sector is the one of machinery and industrial equipment as it constitutes one of the most promising domains for exploring and/or exploiting the benefits of digital servitization (Pashou et al., 2020). In the same literature review, it was found out that IoT is by far the most frequently addressed technology in the empirical studies. Leagult et al. (2019), recognizing the huge potential of IoT for machine tools producers, investigated to what extent specialized IoT solutions perform better than generic solutions in terms of perceived value.

Barriers preventing a smooth diffusion of digital servitization are identified in Peillon et al. (2019) and are clustered in four categories, namely technological, organizational, human resource-related and customer-related barriers. Sklyar et al. (2019) recognize that, despite the growing research interest in organizational aspects of the move to servitization, the issue of organizing specifically for digital servitization remains underexplored and provide empirical supports in this direction investigating the role of embeddedness, centralization and integration. Kohtamäki et al. (2020) confirm the importance of the organizational perspective stressing the need of collaboration across firms boundaries for delivering successful smart solutions.

The use of a platform approach by Cenamor et al. (2017) is considered as a possible way to overcome the service paradox, the challenge of simultaneously enriching the value proposition by adding services while maintaining cost levels. In particular, the use of a modular architecture is considered to bring benefits in terms of both customization and operational efficiency. They highlight, in particular, the central role of information modules in successfully accomplishing servitization and the need to redefine organizational roles s for both back-end and front-end units.

The empirical study presented in this paper fits in the main stream of the recent literature on digital servitization critically analysing the design process for a new IoT-based service type by a machine tool manufacturer that is building a company-wide and proprietary platform for the service offer.

3.THE CASE STUDY

The analysed case study is the machining division of an holding employing around 1000 people. The local branch, producing industrial machining systems for chip removal, counts an installed base of around 4000 systems around the world. The local service area is a business unit with 47 employees and takes over each sold system starting from 3 months after the installation. A CRM system has been integrated in 2018 to improve the customer management and, in particular, a ticketing system allows to better monitor performance. The service turnover has grown steadily in recent years with a significant increase in 2018 and 2019 due to both a higher demand for machines and a renovated attention towards service innovation based on the Industry 4.0 principles. In the service portfolio offered by the company, reflecting the typical situation for a machine tool producer, the sale of spare parts accounts for more than 50% of the turnover. The exchange service, that is the replacement of a defective component with a completely overhauled one, and the revision & repair services have experienced increasing rates in the last years as well as the changeover service, the big revision processes of existent systems. The request for Industry 4.0 services are currently a small percentage of the tickets, but are expected to grow in the future.

3.1 The service platform

In order to exploit the potential of digital technologies to empower the service offer, the company has strategically decided to invest in the development of an internal platform enabling the connection of hardware and software components in such a way modular packages are offered according to the needs of single customers. Sharing information between customers and suppliers in smart factories is seen as an essential ingredient for the future of service. The platform development, manged by the service area, is still in progress and in the current version a basic set of services is offered for the remote diagnosis: data from the customer’s equipment are acquired through a data acquisition and analysis module that stores the information and allows to share them with the customer's server. It is also possible to display the data on a private device or fixed stations with an interface. All the produced NC machines are equipped with this module and the oldest ones in the installed base are being adapted to take advantage of the service in such a way several problems can be fixed remotely.

A next version of the platform that foresees the introduction of predictive services is currently being tested in the field. Basic features are extended to allow the acquisition of customer’s process data for creating a database for consultation and analysis of machine data in the cloud with the aim of providing suggestions for process improvement through status and alert notifications, analysis of the most frequent stoppages, real-time display of the status of critical machine components and proposal of corrective actions. The most ambitious goal will be reached when a plant, by comparing the data acquired and saved in the database through the elaboration of an algorithm, will be able to autonomously order the spare parts necessary to perform predictive maintenance.

Considering the type of produced machine tools, the most important data are those monitoring the wear of recirculating screws, motors and all moving parts by controlling their absorption in terms of torque and power. By controlling tool/spindle absorption, it is possible to prevent premature breakage that compromises the quality of the finished part and, on the contrary, to extend its useful life by maximizing its performance.

The following sections will detail how an IoT device that will support the platform extension towards the introduction of predictive services has been designed and validated in the field.

The architecture of the device is relatively simple: the electrical unit of the machine is equipped with the control module that collect the data coming from the machine’s actuation system that are processed and then returned as output. A software module installed on the on-board computer is the interface for the user timely showing data available in graphic and statistical format. A tool is mounted on an electrospindle whose efforts are translated into current absorption values plotted on curves.

4. THE SERVICE DESIGN METHODOLOGY

As mentioned before, the analysed service based on an IoT device is added to the existing service platform. The design and the development of the platform itself and of its services follow a systematic approach based on a bimodal process combining the agile development of new services with the strategic management of the platform lifecycle (see Figure 1). The implementation of the different activities is supported by a set of tools whose combined use paves the way for the integration of digitalization and servitization concepts from strategic analysis to specifications definition. The tools are the pillars of the overall method.

The method shown in Figure 1 combine a set of agile activities aimed to fulfil the needs of a specific customer, with a set of more strategic activities related to manage the service platform design and evolution. According to the modular approach, the first set of activities is typically triggered by the needs of important customers and in collaboration with them a new service is designed to maximize the value added creation for them, while the opportunity to enrich the platform with a new module is assessed. The activities defined as "Agile new service development cycle" are performed for every plant or customer starting from the definition of needs and value. Service quality attributes are then identified before implementing the service. A field validation of the service is then carried out followed by the profitability analysis for the customers as a proof of the efficacy of the new service. If both technical and economic aspects are satisfactory, then the service is integrated into the platform to be offered to other customers.

In parallel, a second set of activities of a strategic nature is performed at the company level to make sure each added service can contribute to pursue the company's strategic goals. They are:

- Business model improvement: services added to the platform are analyzed from a strategic point of view in order to identify the business model changes that can maximize the value creation for both the customer and the company. Needed changes (i.e. employee training or technical adjustments) are introduced to make the most out of the new modules.
- Economic and financial analysis to analyze the value contribution of the platform's modules to the profit generation.
- Update of the service platform development framework: improvements are done at the level of the platform architecture to make the service delivery smother and smother.
- Technology management (forecasting, assessment, planning and acquisition) aimed at improving the service offer on a continuous basis.

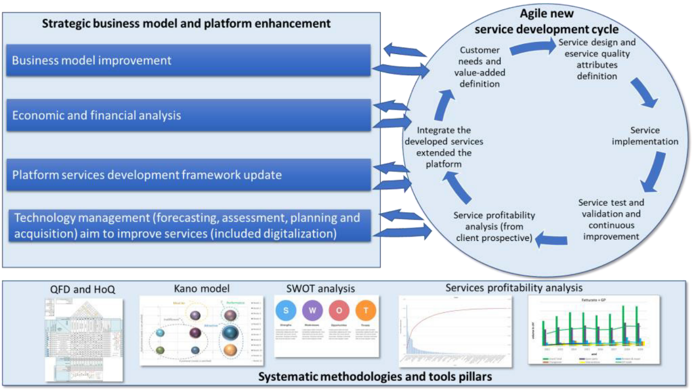

Figure 1: The bimodal process used to develop the services platform and supporting tools

5. TOOLS APPLICATION FOR THE IoT DEVICE DEVELOPMENT

The origin of the project has to be traced back to the development of a tool for internal use in reply to the low level of satisfaction with the market offer of tool breakage monitoring systems applied to the company's machines. The success obtained with this tool led to the idea of developing a standalone version to be offered in the market. In this section the implementation of some tools used to support the whole decisional process to of the IoT device are presented. In order to assess the idea from a strategic point of view, a SWOT analysis has been carried out followed by a financial analysis. An experimentation has been then launched in collaboration of an important customer, a big manufacturing company working for the automotive sector, to better define the bundle of tangible and intangible elements to be included in the service to meet the customer's expectations. The customers' needs and the technical requirements have been analysed adapting the Kano model and the house of quality. Eventually, the analysis of the investment from the user's point of view is based on an NPV calculation. In what follows the above-mentioned analysis are discussed.

5.1 Economic and financial analysis

A rough evaluation of the possible economic contribution brought by the sale of the new device has been carried out considering also the market position of the main competitors. Assuming in the first years only machines sold by the company will be equipped with the new device, a 5% increase of the service turnover is expected, generated by 60 devices mounted on new machines or retrofitted ones. When the new device and related services will be more mature and a dedicated organization will be set up within the service area, the same device can be offered also as a standalone product for competitors' machines leading the turnover growth to 10%. This evaluation is a conservative one and does not take into account additional revenues coming from the additional services enabled by the processing of data coming from the device itself. The contribution to the profitability is even higher foreseeing a 60% margin.

5.2 SWOT analysis

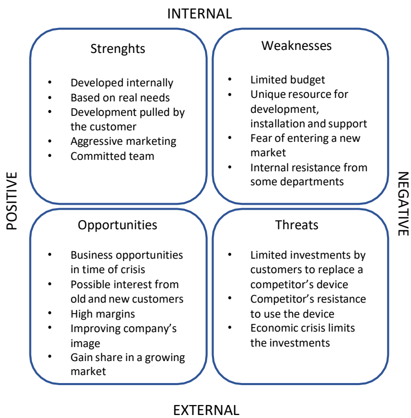

Figure 2: Result of the SWOT analysis

From a strategic point of view, the introduction of a new service based on the IoT device is highly valuable. The internal development of the device allows the company to keep control over the development phase and to ensure that the product features reflect the user's needs, being the company itself the first user. The modular approach used to integrate the service into the platform makes it easy to reach both new and old customer, so to make profit out of the installed base. Cons are mainly due to the scarce experience in this kind of projects and to the economic crisis due to the covid-19 pandemic that is limiting the investments of companies, thus holding back the interest for the new service.

5.3 Definition of design requirements with the Kano model

The Kano model is used to prioritize features of a product based on the degree to which they are likely to satisfy customers. The model has been further refined during the years (see for example Cadotte and Turgeon, 1988; Brandt and Scharioth, 1998 or Venkitaraman and Jaworski, 2003), but slightly modifications have been introduced by Bartikowski and Llosa (2004). The original model has then been considered in this paper and it includes the following categories of requirements:

- Must-be: missing to meet must-be needs, customer satisfaction decreases
- Performance: the better the product performs, the happier the customers will be.
- Attractive: when present, they cause a positive reaction bordering on delight.
- Indifferent: the fulfilment impacts neither positively, nor negatively on customers.
- Reverse: customers are happier when they're absent.

In this analysis the Kano model is used to understand how the product-services characteristics, called engineering characteristics or design requirements, influence the customer satisfaction. Even if the method can be also used to prioritize customer needs (see for example Sireli et al., 2007), in this case it was more relevant to consider product's features since a prototype was already in place in the customer's premises and it was easier to collect preferences referring to them.

The implementation of the model has been organized around the following steps:

- identification of the list of features (see Table 2)
- classification of product features according to the Kano classes. The questionnaire, used to gather the customer's feedback, included two questions for each feature: a functional one assessing the customers' reaction to the feature inclusion, and a dysfunctional one determining user's reaction in case the same function is not included. By combining the two answers in the evaluation table (see Table 1) product features can be classified (Table 2).
- The customer was also asked to rank the product features.

An alternative view that consider at the same time the Kano categories and the weight assigned by the customer to the features is provided in Figure 2 where functional and dysfunctional values are on the axis and the size of the bubble reflects the customer's importance.

These results were useful to integrate into the product two features that were not integrated in the original design (features 4 and 12).

Table 1: proposed modified version of the needs evaluation table

		Dysfunctional question (feature is not included)				
		I like it (-2)	I expect it (-1)	I am neutral (0)	I can tolerate it (2)	I dislike it (4)
Functional question (feature is included)	I like it (4)	Q	A	A	A	P
	I expect it (2)	R	Q	I	I	M
	I am neutral (0)	R	I	I	I	M
	I can tolerate it (-1)	R	I	I	Q	M
	I dislike it (-2)	R	R	R	R	Q

The features is:

A: attractive P: performance
M: must-be I: indifferent
R: reverse Q: questionable

Table 2: Features categorization based on Kano's class and customer's weight

		Customer's weight	Functional	Dysfunctional	Kano's class
1	No. of communication channels	2	4	2	Attractive
2	Hardware performance	2	2	0	Indifferent
3	Software performance	4	2	2	Indifferent
4	Measure accuracy	4	4	4	Performance
5	Measure stability	3	2	4	Must be
6	Dimensions	2	0	0	Indifferent
7	Energy absorption or consumption	2	0	2	Indifferent
8	Reading measure efficiency	3	2	2	Indifferent
9	Cost (LCC from client point of view)	3	2	4	Must be
10	Interruption lead time of monitoring process	5	4	2	Attractive
11	No of plots of the graph's can be stored	5	4	0	Attractive
12	Mean visualization for every channel	5	4	4	Performance

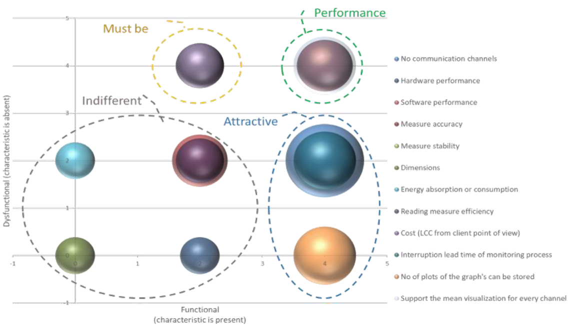

Figure 3: Combining the Kano classification and the customer's weights

5.4 The House of Quality (HoQ)

As a next step, the design of the IoT device has been analysed through the house of quality. The complete house is shown in Appendix 1, while the main steps of the process are here analysed.
The first part of the process is dedicated to the definition of the customer needs fulfilment strategy. This part of the table represents: i) the complete list of the customer needs, ii) the needs' relative importance based on customer' interview, iii) a valuable competitive analysis that compares the IoT device (MiTool) against the competitors' solutions. The scores are based on the authors' evaluation validated by experts' and clients' interviews.
The definition of the "Relative weight" values is crucial since they affect the QFD process impacting directly on engineering characteristics. They are traditionally defined following the most popular approach proposed in literature (see for example King, 1989 or Goetsch and Davis, 2014). The risk of this approach is that that the vision and the strategy of the team can distort the customer wants. An alternative solution is to maintain the weight defined directly by the customer. In this work, a mixed approach was used in which the customer's weights have been adjusted considering the competitivebenchmark only.

After defining the customer needs importance, in order to rank also the engineering characteristics the second part of the matrix has been developed including: i) the engineering characteristics listed on the top of columns of the HoQ, ii) the relationships between the engineering characteristics and customer needs mapped into the relationship matrix in the central part of the HoQ, iii) the relative importance of the engineering characteristics that takes into consideration both the relative weights of the customer's needs and the relationship matrix. The final results of the HoQ is the table at the bottom of the scheme where the "Technical Importance Rating" is defined again carrying out a benchmark analysis against the competitors. The relative importance of the technical requirements reflects the results of the Kano model, thus further confirming the results of the previous analysis.

5.5 User's value analysis

In the development of a new service, the definition of the value proposition for the customer is an essential step. In this case, the value created for the user of the device has been quantified considering the customer who validated the device in the field by testing it in three different plants. The type of production can be defined as high volume and high precision and, as such, machines breakdown can have heavy consequences. Improvements have been identified considering a gradual adaptation of the customer's process for a full exploitation of the tools' potentialities. In particular, three phases have been identified: digitalization of the process, achievement of the stability of the process and continuous improvement. The continuous monitoring of the tool's wear allows to optimize the cut tool's cut capacity in such a way the tool is replaced exactly when it does not cut anymore or the cutting quality is lower than the desired one. The life cycle of the tool is variable and depends on the actual production. It has been possible to pass from a predetermined life cycle of 10'000 pieces to one ranging from 13'700 to 14'300. Considering the impact on a single machine tool, savings of the order to 35'000 chf per year and reduction of 14 hours of setup would be achieved thanks to this smart tool management.

6. CONCLUSIONS

This paper provides empirical evidence of how the service offer can be enriched by exploiting opportunities brought by digital advancements for a machine tools manufacturer. The implemented bimodal methodology allowed to design a promising solution as confirmed by the analysis of the expected performance improvement for both the company and its customers. The economic return supports the envisioned positive impact from the strategic point of view. The main advantage compared to generic solutions lies in the possibility to leverage on internal expertise of the working process and the integration of this solution into a wider digital strategy for the service development based on a modular platform that is growing over time. On the one hand, practitioners in the machine tools industry can find hints on what path to follow to analyse new service opportunities and can compare their position against the described one. Furthermore, the literature discussion in the field of digital servitization is supported by additional empirical evidence on the use of the platform approach. The steps followed to develop the device have a general validity as a design methodology within a digital strategy.

6.1 Managerial implications

Some lessons learnt by the case study company can be used as guidelines for other organizations interested in smart servitization in the same sector:

- the development of the new device is rooted in a wider plan of smartification of the service area started three years ago. The adoption of digital technologies is a gradual process that takes into consideration the market readiness, the level of maturity of internal resources and the fit with the strategic objectives of the company.
- Among the several opportunities the Industry 4.0 makes available for the service development, only the ones that fit with the strategic company's should be selected. This strategic alignment has to be assessed carrying out a set of analysis before starting the development phase. The methodology derived from the approach used by the case study's company fits this purpose.
- Even for the most promising service, a pilot phase is essential to fine tune the initial idea based on field validation. The collaboration with an existing customer allows to experiment the new device in a protected environment and assess its benefits before launching it to the market.
- The adoption of a modular approach based on a platform for the service development is a winning one since it allows to expand the service offer over time and to offer a more and more rich bundle of products and services.
- The knowledge of the customer's process facilitates the identification of the best service configuration to be offered including the support to make the transition towards the full exploitation of a smarter set of services. This is possible thanks to the collaboration with experienced service employees.

6.2 Limitation of the study

The study methodology proposed is based on the process followed by the case study company. Further empirical validation is needed to generalize it and make it more robust. The assumptions made for the economic analysis would need to be supported by a wider benchmark analysis and a more in depth internal collection of data. In the future, also, it has to be kept in mind that such modular design of the platform risks to limit the radical innovation. A continuous revision of the proposed system has to be carried out periodically not only to update the customer needs and, accordingly, the value proposition, but also to encourage more radical changes.

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APPENDICIES

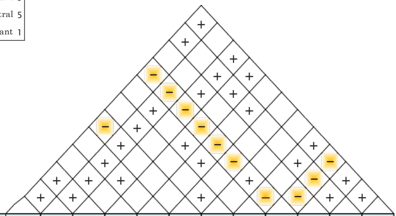
The House of Quality

Correlations	
Positive	+
Negative	−
No Correlation	

Customer Importance	
Very Important	9
Neutral	5
Not Important	1

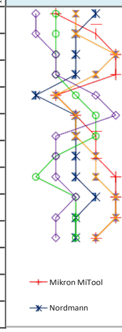
Relationships	
Strong	●
Moderate	○
Weak	

irection of Improvemen	
Maximize	▲
Target	
Minimize	▼



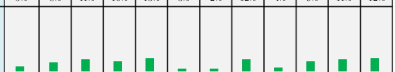
Column #	1	2	3	4	5	6	7	8	9	10	11	12
Direction of Improvement			▲	▲	▲	▼	▼	▲	▼			▲
Engineering characteristics	№ comunication channels	Hardware performance	Software performance	Measur accuracy	Measur stability	Dimentions	Energy absorption or consumption	Reading measurre efficency	Cost (LCC from client point of view)	Interruption lead time of monitoring process, due to set-up, update the system	No of plots of the graph's can be store	Support the mean visualization for every channel

Row #	Weight Chart	Relative Weight	Customer Importance	Maximum Relationship	Customer Requirements (Explicit and Implicit)	1	2	3	4	5	6	7	8	9	10	11	12	Mikron MiTool	Nordmann	Marposs	Digital Way Wattpilote	Techna Tool	Row #
1		4%	3	9	Compatible with most of numeric control	○	●	●				○					○	2	4	2	3	1	1
2		6%	4	9	Covers all mechanical machining	●	●	○	●	●			○		○	●	●	4	3	2	3	1	2
3		10%	7	9	Is suitable to small diameter cutting tools		●	●	●	●			●		○	○	●	5	3	2	5	2	3
4		12%	8	9	Ansures measurement repeatability		●		○	●			●		○	●	●	5	3	2	4	2	4
5		4%	3	9	Low purchese cost	●	●	●			●			●	●	○	○	2	1	3	2	4	5
6		6%	4	3	Low mantenance cost			○				○		○				3	3	4	3	5	6
7		6%	4	9	Low implementation cost	○		●	○	○			○		●	●	●	4	3	4	3	2	7
8		1%	1	9	Is a high complexity system	○		●	○ ○	○			○	●	●	●	●	4	3	2	4	2	8
9		12%	8	9	HMI user friendly			●						○	○	○	○	5	3	1	4	2	9
10		12%	8	9	Allows quality cost reduction	○	○	○	●	●			●		●	●		5	4	3	5	3	10
11		13%	9	9	Maximize cutting tool usage and efficiency	○		●	●	●			●			●	●	5	3	3	5	2	11
12		13%	9	9	Reduce the unplanned downtime			○	○	●			●		●	○	●	4	3	3	4	2	12

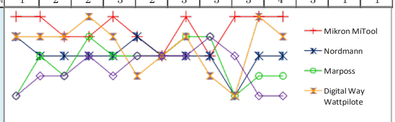


	1	2	3	4	5	6	7	8	9	10	11	12
Max Relationship	9	9	9	9	9	9	3	9	9	9	9	9
Technical Importance Rating	255,88	429,41	576,47	494,12	644,12	135,29	120,59	608,82	182,35	473,53	579,41	635,29
Relative Weight	5%	8%	11%	10%	13%	3%	2%	12%	4%	9%	11%	12%

Weight Chart



Technical Competitive Assesment	1	2	3	4	5	6	7	8	9	10	11	12
Mikron MiTool	5	5	4	4	5	4	3	5	3	5	5	5
Nordmann	4	3	3	3	3	4	3	3	3	1	3	3
Marposs	1	3	2	4	3	3	3	4	4	1	2	2
Digital Way Wattpilote	4	4	4	5	4	2	3	4	2	1	5	4
Techna Tool	1	2	2	3	2	3	3	3	4	3	1	1



Column #	1	2	3	4	5	6	7	8	9	10	11	12

AN EXPLORATIVE INVESTIGATION ON THE ROLE OF ECOSYSTEM RELATIONSHIPS IN MEDIUM-SIZED MANUFACTURERS DIGITAL SERVITIZATION

Marco Paiola, Roberto Grandinetti, Christian Kowalkowski & Mario Rapaccini

ABSTRACT

Purpose: IoT technologies (IoT, Cloud, Data analysis, Big data) have an increasing role for service-led growth, and in particular for enabling BtoB advanced solutions. This paper analyses interfirm relations taking place in digital servitization (DS).

Design/Methodology/Approach: The study draws on qualitative empirical research regarding medium- to medium-large sized Italian firms driven Digital Servitization projects. Seven DS projects focalized around medium-large BtoB manufacturers are considered in the analysis.

Findings: Empirical data shows that inter-organizational relationships play a critical importance for the survival and success of DS projects, highlighting different ideal-typic relational settings with different relational structures, challenges and strategic evolutions.

Originality/Value:

The paper makes theoretical and managerial relevant contributions in the field of inter-organizational solutions adopted in DS by medium manufacturers. A strategic map helping managers to navigate digital servitization projects in relation to internal and external contributions and alignment strategies is provided.

KEYWORDS: Digital servitization; ecosystems; Medium-sized firms.

1. INTRODUCTION

The paper analyses the role of service ecosystems' in digital servitization (DS). A service ecosystem relational perspective is adopted in the study, with the aim of investigating roles, strategies and dynamics of multi-actor contributions, also highlighting specific relevance and relational activation modes in DS. The empirical focus is on an under-investigated dimensional category of firms, namely medium-sized companies, a particularly dynamic category within manufacturing firms. The research question this paper aims at answering is: what is the contribution of inter-organizational relationships to DS in medium-sized manufacturing firms?

2. THEORETICAL BACKGROUND

IoT technologies (IoT, Cloud, Data analysis, Big data) allow new advanced BtoB services, digital Product-Service Systems (PSS), and business models (BM), enabling digital servitization (Paiola and Gebauer, 2020; Pirola et al., 2020; Paschou et al., 2020). Technological and managerial evolution affects different aspects of contemporary servitization research (Kowalkowski et al. 2017), unveiling the urgency of considering the increasing relevance of the ecosystem perspective (Sklyar et al., 2019) and systemic value designs (Leminen et al., 2020). This entails a revisitation of the servitization narrative (Baines et al., 2017) that: considers the importance of collaboration (Tronvoll et al., 2020); extends the focal manufacturer perspective with a multi-actor capabilities approach (Story et al., 2017); and integrates key customers contributions (Grandinetti et al., 2020). Notwithstanding the mentioned contributions, literature has so far overlooked to dedicate a specific research effort to understand modern technology-based service development strategies in medium-sized BtoB manufacturing firms (Sjödin et al., 2020).

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

Digital servitization impose incumbent manufacturers to modify their value proposition, offering new data-based product-, process- and customer-oriented services (Paiola and Gebauer, 2020). These can have different impacts on firms' BM, from simply lowering the cost of traditional product-service related services, to enriching products and services with unprecedented features (for availability and remote controlling), to radically changing the revenue model by enabling completely new relations with the market. This can enable the transformation of the value proposition towards use- or output-based types (Adrodegari et al., 2015).

DS can leverage internal resources, existing inter-organizational relationships, and newly formed partnerships. Previous studies have highlighted the role of relational embeddedness in service ecosystems (Sklyar et al., 2019), referring to the impact on economic outcomes of the socially-rooted overall participating actors' relational structure and dynamics (Granovetter, 1992). Relational embeddedness can be related both to internal and external actors involved in service ecosystems: internal relational embeddedness influences the manufacturer to access and combine resources from corporate counterparts and sustain internal learning processes (Forsgren et al., 2005). Little intra-organizational embeddedness is only one of the circumstances that bring medium-sized manufacturing firms to turn to external actors to initiate and sustain DS.

2.1 Towards Digital Servitization Ecosystems?

While driving successful DS projects with internal resources may be fit to large multinational enterprises, minor manufacturing firms may have different ways of approaching DS, due to a series of limitations related to their slack resources; their internal capabilities, especially in regard to digital technologies; and their traditional manufacturing culture and low familiarity with advanced service logics (Paiola and Gebauer, 2020; Peillon and Dubruc, 2019).

In this scenario, external contributions can play a crucial role for medium-sized manufacturers in order to approach the complex and new capability-related challenges related to digitalization and servitization (Parida and Wincent, 2019). New specific external relationships may have to be established in order to start and/or sustain the evolution of new digital services in the offering, leading to the formation of Digital Servitization Ecosystems (DSE), that is dedicated networks of firms that are specifically aimed at DS business models.

Inter-organizational contributions may have the form of dyadic relationships (Raddats et al., 2017), multi-actor relationships (Story et al., 2017), or ecosystems of multi-actor coupling engaged in reciprocal value proposition (Tronvoll et al., 2020). Defining the ecosystem as the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize, we refer to Adner's (2017) definition of "ecosystem as structure" for describing the relational networks involved in DS. In these ecosystems a focal value proposition, belonging to a focal firm's BM, has a pivotal role in the network construction and directly affects its boundaries and its future geometry. Members of the ecosystem include stakeholders like manufacturers, suppliers, and customers, whose capabilities and roles tend to coevolve and to align themselves with a focal leader, that enables members to share visions, to align their strategies and investments, and to find mutually supportive roles (Moore, 1996), and eventually create a reciprocal value proposition (Tronvoll et al., 2020).

Ecosystems evolve overtime in a continuous search for value (Oskam et al., 2020): this means a constant need of alignment of temporarily agreed upon structures of position and flows, complying with the different actors' changing aims and end goals (Adner, 2020). Partner alignment is assessed relative to the focal firm's ability to bring its partners into the positions and roles that its ecosystem strategy envisions. Given the potentially disruptive nature of DS, the effect of learning processes and the consolidation and maturation of value propositions, DSEs are expected to evolve accordingly, with a frequent need of alignment in order to overcome collaboration barriers (Gebauer et al., 2020). Defined set of partners may vary overtime, following different balances in joint value creation and ecosystem traits can be or can become latent overtime whenever ecosystem's partners dynamic alignment ceases to represent an issue.

3. RESEARCH METHODOLOGY

The study draws on in-depth face-to-face multiple interviews with different informants belonging to incumbent Italian manufacturing firms involved in DS. Specifically, the research focuses on DSE created around DS projects held by medium-sized manufacturing companies, a particularly innovative and dynamic firm category in Italy. The firms are leading industrial firms, located in the North of Italy (in particular: Veneto, Emilia Romagna, and Lombardy), belonging to dynamic and world-renowned Italian industries, like packaging machines, professional cooking, commercial refrigeration.

Given the explorative approach, our empirical setting favoured theory-building considerations over statistical sampling, selecting cases for their relevance for our research questions, their contribution to represent conceptual variety, and their convenient accessibility and proximity to the researcher. Sampling process ceased at theoretical saturation, as indicated by information redundancy (Silverman, 2005). In-depth interviews were conducted with relevant informants belonging to the most relevant components of the DSEs, between September 2020 to March 2021. Interviews were registered, transcribed and coded following scientific qualitative protocols (Voss et al., 2002)

3.1 Case selection and description

We analysed seven ecosystems specifically related to ongoing DS projects that started between 2014 and 2016. These innovation projects involve various manufacturers using IoT, Cloud and Data analysis technologies in order to craft new service-oriented value propositions. The solutions envisioned vary from RCM platforms able to increase visibility and reporting of production processes, to performance-based contracts linked to agreed-upon service levels with bonus-malus mechanisms. The value proposition is designed around availability-, energy-, or performance-oriented data-based service innovation. Ecosystems are crafted around an emerging digitally based value proposition by a Focal Firm (FF). Our Digital Servitization Ecosystems (DSE) are composed of 7 to 10 relevant actors, actively participating in the design and deployment of the DS. Table 1 shows basic features of the DS projects and focal firms involved in the research (see appendix 1 for ecosystem actors' details).

Table 1. Basic features of DSEs

Case	Starting year	Type of PSS	Value proposition and Revenue model	Industry (FF)	# of firms involved
1	2015	RCM platform, visualization and reporting, ML applications	Energy efficiency-related; Subscription	Commercial refrigeration	10
2	2016	RCM platform, visualization and reporting, cloud based services	Availability-related; Subscription	Packaging machines	8
3	2016	RCM platform, visualization and reporting, integration with CRM omnichannel, cloud based services	Availability-related; Subscription	Professional cooking	7
4	2015	RCM platform, visualization and reporting, cloud based services	Availability-related; Subscription	Water processing equipment	9
5	2014	RCM platform, BI and reporting (suite in 5 separate modules)	Availability-related; Within product	Raw material processing machines	7
6	2014	RCM for Customized PBC, visualization and reporting, , cloud based services.	Performance-based; subscription	Packaging machines	8
7	2015	Digital environment for helping customers to develop digital RCM and reporting solutions; ML applications for industry benchmarking	Availability-related; Within product	Commercial refrigeration	8

4. FINDINGS

The research reports the main organizational and strategic choices firms have made regarding variables relevant in this research, such as relations construction and management, capability development and acquisition, solution development and replication, highlighting challenges and opportunities.

Findings show that DS produce a significant networking activity that involves internal divisions and external firms, in search of the useful capabilities for DS. Internal divisions promoting the change may vary from R&D to Service dep.t to IT dep.t, and the ownership may vary overtime. Internal teams dedicated to DS may vary amply from 2 to over 10 depending on the type of value proposition and service envisioned. Intra-organizational embeddedness of the promoting BU may vary substantially, especially at the corporate level (some of the firms are independent firms belonging to diversified groups): however, it has to be noticed that C-level managers seem not to be the main promoters of the innovation, even if their support is fundamental for the project to grow.

The actual leverage of internal resources is extremely variable and our cases show examples of fully internal management to full externalization of initial and consequent DS activities, depending on the availability of internal capabilities for the project (quality and quantity) and the level of intra-firm structural embeddedness. The extent and embeddedness of inter-organizational networks can vary significantly. External relationships can involve a differentiated array of technology related firms, such as global suppliers (cloud services, ERP/CRM systems, IOT platforms, TLC companies), their local partners, local or national KIBS (HW devices designers and producers, system integrators, software houses, start-ups, individual ICT consultants), Universities and Research Centres. Specific actors of the service ecosystem are searched for and involved in the project on the initiative of the focal firm's basing on the desired value proposition, and these relations feed back into value proposition evolution. In particular, relations with global technological suppliers, their third parties, or other software and hardware related companies (KIBS) have a significant role in shaping the present and future architecture of the envisioned solutions.

Customers, especially lead users and key clients, impact the inception and development of DS projects, where the technology-based solution envisioned by the supplier is in fact the result of an intense and deep operational co-creation with the key-customer, that involves a profound and ongoing transformation of supplier-customer relations.

Table 2. The evolution of the DSEs

Case	Evolutionary features from the FF point of view
1	Internalize core software activities and open new advanced specific collaborations for data
2	Local third parties are substituted by internal team, with direct relations with the technology supplier; the team/BU is relocated in a new staff position for the corporate
3	Balance extant and new relationships. Internalization of critical capabilities through hiring and organic growth
4	Empowerment of internal IoT team with capabilities related to UX/UI and sales BD; better involvement of the R&D division; increase internal orchestration of external contributions
5	Internalization and specialization of software activities with horizontal coordination; incorporate data-driven mechanisms and create service propositions
6	Internalization of architectural and value-related competences, direct access to the code and orchestration of different types of contributions (from generic to specific)
7	Internal control and leverage of existing relationships on a project-based logic

The fundamental element of the ecosystem is the focal firm (FF), or the manufacturer that promotes the use of technology for innovating its value proposition. The centrality of the manufacturer's business model affects two relevant aspects of the ecosystems: the type of relations and their evolution. As regards the type of relations, FFs tend to prefer managing direct dyadic relations with relevant external actors, like technology suppliers, service providers and selected key customers. External integration of sub-networks is relatively more frequent in the first phases of the projects.

In addition, data show that relational approaches change overtime in the selected firms, following the evolution of the firms' offering as regards digital services - especially concerning the transition from prototypical and replicable versions - and the changes in the BM. As shown in table 2, all the FFs are using external collaboration in order to foster co-learning in the new knowledge domain, aiming at progressively internalizing core activities (above all software architecture design and integration capabilities) and orchestrate external competences that require massive code writing, or related to specialistic knowledge (e.g. UX/UI or more recently, ML data analysis algorithms). Having the access to the source code is mandatory in all cases.

5. DISCUSSIONS AND CONCLUSIONS

Findings show that, although the ecosystem approach is a valuable theoretical perspective also for investigating DS in smaller firms, not all the innovative projects may be considered within the ecosystem perspective. In fact, while some cases are perfectly reflecting the “ecosystem as structure” concept (Adner, 2017), altogether a more fragmented and differentiated discourse has to be made.

As figure 1 shows, DS is at the base of four different approaches to internal- vs. external-contribution management, resuming different situations from dyadic to multi-actor ecosystems (Raddats et al., 2017; Story et al., 2017; Tronvoll et al., 2020). Using the level of openness to external contributions and the level of relational innovation connected to DS, we distinguish the cases of: Organic transformation, Extant relationships leverage, New Business Unit and New ecosystem.

Firms adopt one of the above mentioned approach depending on different contingent circumstances, such as: prior knowledge related to the required software and hardware components of the digital solutions; the availability and extent of useful internal capabilities; the extent of available financial resources; the commitment in the new value proposition; the reaction to external solicitations from customers and technological partners.

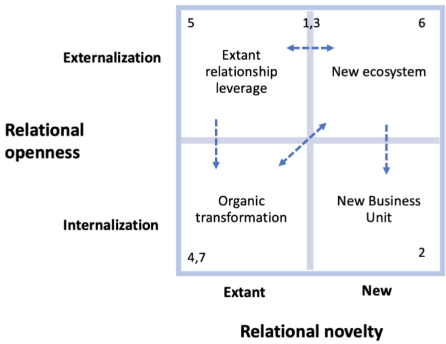


Figure 1: A map of ecosystems governance: openness and novelty in relations

Depending on the approach, DS may lead to an almost independent organic transformation by the focal firm, that prevalently manages all the activities at an internal level with project-based relations to external actors for specific subjects (cases 4 and 7); the construction of an entirely new Business Unit, built with an initial effort with external actors then internalized with specific hiring (case 2); the prevalent leverage of pre-existent external relationships that are in different ways involved in the new project, depending on their capabilities (case 5); the creation of an ecosystem where participants are prevalently new to each other (new ecosystem, case 6); the extension of extant inter-organizational networks with new participants (cases 1 and 3). The approaches are evidently differing in terms of challenges due to ecosystems’ novelty and in particular evidencing: strategic alignment for new relationships, lock-in effects for extant resources; lead time and SLAs for external contributions and knowledge update investments for internalized solutions.

Some evolutionary elements also emerge from the cases, showing that inter-organizational choices are strictly connected to the evolution of the value proposition and the diffusion of the offering in the market. At this regard, we register three main transitional changes in the examined firms: co-learning and co-evolution (in the case of partnering the solution expenses with the supplier) processes, present in all the cases with significant external participation in the founding stages of DS; progressive internalization of core capabilities, and relational simplification from multilateral to dyadic, with orchestration of external specialized firms in the cases of firms starting with higher inter-organizational propensity (that may lead to an organic development or to a new BU); an overall cyclical shift in the balance between internal and external, extant and new contributions depending on the evolution stages of the project (for all the approaches).

5.1 Implications and limitations

From a theoretical perspective, the research confirms some previous evidence and offers some advancements. First, DS is particularly challenging for medium-sized firms, due to ongoing technological exploration, dynamic strategic processes, and complex intra- and inter-organizational networks. Second, DS strategies may be designed within specific relationships, where original co-evolution processes are in place. Third, empirical evidence indicates that inter-organizational relationships and ecosystems structures depend on the value proposition evolution, and we highlight three transitional processes taking place in DS in our firms. Finally, medium-sized manufacturing firms indeed deserve a specific attention, facing peculiar technology- and market- related challenges and opportunities, and evidencing inherent balances and different transformational shifts between hierarchy and partnership (Tronvoll et al., 2020).

From the managerial point of view, our cases show that a series of different contingent approaches apply to medium-large manufacturing firms in order to start and develop DS. Each approach has advantages and challenges and may fit contingent firm's conditions. However, considerations may change depending on the stage of the transformation process, asking for a dynamic modulation of openness and closeness in light of what competence may become relevant for different stages of the DS transformation journey. Customers, especially lead users and key clients, can represent relevant ecosystem's actors whose role is particularly significant for piloting and solution debugging. A progressive increase in the manufacturer's ability in selecting and orchestrating external partners as the new value proposition establishes indicates a learning process that allows the firms to focalize their position and align the ecosystem partners. A risk of being trapped in a sub-optimal technological lock-in are present for the more autonomous firms (in particular for the organic transformation case).

Main limitation of the study pertain to the restricted number of cases, that could be extended by enlarging the sample, and the need for better codifying the specific conditions that affect firms' DS inter-organizational strategies (e.g., prior related knowledge), as well as the specific elements affecting their evolution.

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APPENDICIES

Appendix 1: DSE's firms involved in the research.

Cases	Actors	Facts (2020)	Relation with FF: features	Relation within ecosystem
1	Focal Firm	medium large co. Commercial refrigeration equipment		
	Internal main promoter of innovations	Service division and IT division; 3 technicians, 2 managers; 22 FS technicians; head of IT (main technology manager, signs contracts)		
	Cloud technology provider	VL MNE	Starting 2020	
	Cloud provider local partner	50 people, team 4 people for FF	Direct relation, starts 2020 specifically for data analysis	Relation with local software firm for integration with ERP.
	Local software firm (historical captive firm)	10 people, interfunctional	Direct relation; historical captive partner (2007), for custom vertical ERP, post sale service management	Technical coordination with 4; limited competition with others (coopetition)
	Datacenter and ICT services	3 people	Historical captive partner (2000s), for datacenter and telemonitoring	Few relations; interacts with local software firm
	local web service related firm	SME Kibs	direct, spot	none
	Specialized in data analysis	SME Kibs	direct, spot	none
	Freelance consultant	Individual IT consultant	Historical (captive) consultant for IT related subjects, continuous	Operate in staff with FF's IT manager
	Key customer	VLE	direct, continuous, lead user	none
2	Focal Firm	SME, packaging machines		
	Internal main promoter of DS	digital services division; 4 people software, 1 BD		
	FF corporate company	VLE, packaging machines	Limited (for the DS)	none
	Local IoT SW provider III party (dismissed)	VL MNE	Initially unique interlocutor (then disintermediated)	no relations
	IoT-related software technology provider	VL MNE	Initially no relation (mediated by local party); then direct	no relations
	Spin off for data related services	Small start up	Mission of coordinating and orchestrating different corporate digital projects	few
	Cloud technology provider	VL MNE	direct	no relations
	Key customer	VL MNE	direct, piloting	no relations
3	Focal Firm	LE, professional cooking equipment		
	Internal main promoter of DS	IT division (CEO mandate), 10 people dedicated; IoT part developed internally		
	Cloud technology local III party	30 people (the firm is part of a larger ICT group)	Counseling on technological selection	Orchestrate other external contributions; coopetition.
	Cloud data analysis technology provider	VL MNE	indirect and direct	With cloud local partner
	Data analysis and visualization SW firm	SME, Kibs	direct, project based: starts 2018, ends 2020	none
	ERP technology provider	VL MNE	indirect	with ERP local partner
	ERP provider partner	SME, Kibs	direct	with ERP provider
	Cloud service provider	VL MNE	direct	none
4	Focal Firm	LE, water processing equipment		
	Internal main promoter of DS	R&D manager original promoter; new IOT and connectivity division in 2019, 10 people		
	Corporate company	VL MNE, water pumps	direct, collaboration	none
	University accelerator	SME	direct	none
	University spin off start up for digital agile processes and UX consultancy	SME, Kibs	direct, starts 2020 for UX	none
	ERP and BI technology provider	VL MNE	direct and indirect	with local SW consultant
	Local SW consultants	SMEs	direct	none
	Cloud technology provider	VL MNE	direct	none
	Key customer	External Service network, SMEs	direct	none
5	Focal firm (corporate)	LE, Raw material processing machines		
	Internal division involved in DS	Overall R&D involved and specific division for DS production; 100 people (45 for software in 8 teams); 8 people for the DPSS		
	Industry-vertical platform developer	M	Direct, specific vertical aspects	none
	Technological system integrator	150 people; 2 people for FF; partner MS and Wonderware; historical partner	Direct; parnership 50% ownership of the software (non competitive)	with alle the three following actors
	External SW consultants	SMEs	collaboration / codesign, specific tasks and activities not covered internally	with the system integrator
	Process related technology provider	VL MNE	Collaboration for the design of the suite	with the system integrator
	Key customers	Usa and Corea: pilot customers	direct	with the system integrator
6	Focal Firm	SME, packaging machinery		
	Internal division involved in DS production	4 people; 10 on premises		
	Corporate company	LE, packaging machinery		
	IoT-related software technology provider	VL MNE	indirect (then dismissed)	with the local partner
	Local IoT-related software technology provider partner	40 people; 4 inteam for FF	direct, daily	with IoT tecnhlogy provider
	Local ERP and software partner (dismissed in 2015)	LE	direct, daily (dismissed in 2016)	none
	Cloud technology provider	VL MNE	direct	none
	Local software firm provider	LE, divisional	direct (dismissed)	none
	Local data and UX service provider	4 people	direct, started 2020	none
7	Focal Firm	LE		
	Internal division involved in DPSS production	R&D, specific team 5 people for IOT-based services;		
	Data analysis and visualization SW firm	SME, Kibs	direct, project based	none
	Local University research center	2019, then interrupted	project based	none
	Specific telemonitoring HW and SW BU	group firm, 2005-2011 (ceased)	direct	none
	TLC company	VL MNE (still present but dismissing)	project based	none
	Cloud technology provider	VL MNE	technological supplier, extant	none
	Visualization platform technology provider	VL MNE	technological supplier, extant	none

COLLABORATING WITH SERVICE AND DIGITAL SUPPLIERS FOR SMART PRODUCT-SERVICE SYSTEMS DEVELOPMENT: COLLABORATIVE CONFIGURATIONS BASED ON THE SOCIAL EXCHANGE THEORY

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ABSTRACT

Purpose – This paper aims to define the main configurations of inter-firm collaboration to develop Smart Product-Service Systems (PSSs) in the digital servitization context.

Methodology – We propose four configurations of inter-firm collaboration for Smart PSS development, considering the level of value creation joint activities and value capture interdependence among the actors. We conducted four case studies, one for each type of collaboration. These cases were analyzed according to the four elements of Social Exchange Theory (SET): trust, commitment, reciprocity, and power.

Findings – We show four main types of inter-firm collaboration: expanded business, enhanced business, platform business and symbiotic business. Our findings show that the type of configuration for inter-firm collaboration chosen by product firms varies according to the level of innovation sought in the Smart PSS offer. Additionally, during each type of collaboration, different arrangements of the elements of trust, commitment, reciprocity, and power can be found.

Originality/value – Our study provides an in-depth analysis of inter-firm collaboration for Smart PSS offering and show how service and digital suppliers interact with the servitized company.

KEYWORDS: Digital servitization, Collaboration, service supply chain

1. INTRODUCTION:

Smart product-service systems (PSSs) – the outcome of the digital servitization process – are considered advantageous for product firms, creating, as they do, new ways to create and capture value in innovative business models (Kohtamäki et al., 2019). However, in order to develop and benefit from Smart PSSs, product firms need to develop capabilities in different domains, which can become too costly for them (Coreynen et al., 2017). Instead, through collaboration, product firms can combine synergic capabilities from different partners, such as service providers and digital technology suppliers, to co-create and capture value, obtaining competitive advantage without the need to master every knowledge domain (Dyer et al., 2018).

In general, the extant literature has considered inter-firm collaboration to be an important strategy for traditional servitization (Ayala et al., 2018). However, it is only recently that such an approach was first studied within the context of a Smart PSS (Kohtamäki et al., 2019). In this context, the question emerges: *How can inter-firm collaborative networks be configured for the offering of Smart Product-Service Systems?*

This article analyzes the relational and power-dependence aspects of collaborative networks for Smart PSSs. First, we develop a framework for business model inter-firm collaborations, taking into account two dimensions: value creation joint activities and value capture interdependence (Dyer, Singh, and Hesterly 2018). Based on this framework, we propose four main collaborative configurations: (i) expanded business, i.e., an independent inter-firm collaboration that generates additional benefits; (ii) enhanced business, i.e., inter-firm collaboration with joint activities oriented to the digital servitization of a focal firm; (iii) platform business, i.e., an inter-firm combination of products and services with lower relationships among the actors but higher value capture interdependence; and (iv) symbiotic business, i.e., inter-firm collaboration for integrative co-business.

2. THEORETICAL BACKGROUND:

Inter-firm collaboration is considered an important strategy in servitized environments (Paiola et al. 2013), especially in contexts involving digital technologies (Sklyar et al. 2019), where traditional 'make-or-buy' decision should be updated to a 'make-or-collaborate-or-buy' decision (Kohtamäki et al., 2019)., By means of inter-firm collaboration, networked companies can co-create and capture value and thereby obtain a possible joint competitive advantage for the whole network (Dyer and Singh 1998). The understanding of value creation and value capture dynamics is crucial for inter-firm collaboration (Dyer, Singh, and Hesterly 2018). The creation of value is related to the required activities performed outside the boundaries of a focal firm, collaborating with partners, suppliers or customers. For value capture, the bargaining power between actors will determine the extent to which each actor can appropriate the common benefits of the collaboration outcomes (Dyer, Singh, and Hesterly 2018; Zott and Amit 2010). Different configurations of inter-firm collaboration are possible in the servitized business models. External partners can be useful for value creation, value capture, or for both (Tangpong et al., 2015). In this sense, we propose the framework represented in Figure 1 to describe these different types of inter-firm collaborations.

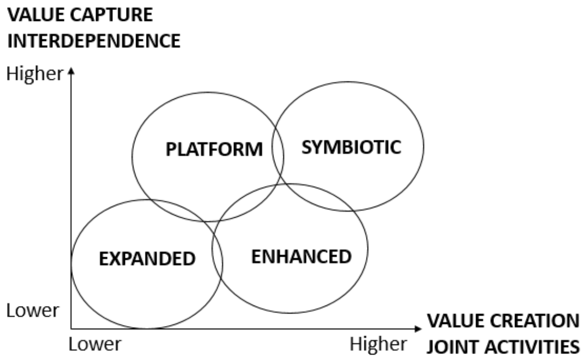

Figure 1: Inter-firm collaboration

In the Expanded business, each actor has an independent value proposition for the customer, but their relationship brings benefits through the expansion of their business model. It has lower levels of joint activities for value creation and lower value capture interdependence. The Enhanced business is a collaboration with unilateral dependence, in which the focal firm depends on its suppliers (Tangpong et al. 2015), forming an hierarchical collaboration with joint planning activities for new product development (Whipple and Russell 2007; Pathak, Wu, and Johnston 2014) to a greater extent than the previous arrangement. This collaboration follows a classic supply chain configuration, in which the actors provide their solutions to one actor, who delivers the value to the customer. The Platform business is based on a foundation of products, services, and/or technology for external actors to develop innovative complementary value (Gawer and Cusumano, 2014). This approach enables actors to be connected, sharing resources and integrating systems in a synergic way (Allmendinger and Lombreglia 2005) and is a viable solution for them to complement their offerings and increase both their value creation and their value capture. Lastly, the Symbiotic business has a strategic/bilateral partnership, characterized by joint decision-making (Tangpong et al. 2015; Whipple and Russell 2007), in which companies belonging to multiple competing supply chains join in consortium (Pathak, Wu, and Johnston 2014). Unlike Platform business, this collaboration has high investments in relational assets by each partner, as they engage in activities ranging from engineering to after-sales. The network configurations are shown in Figure 2.

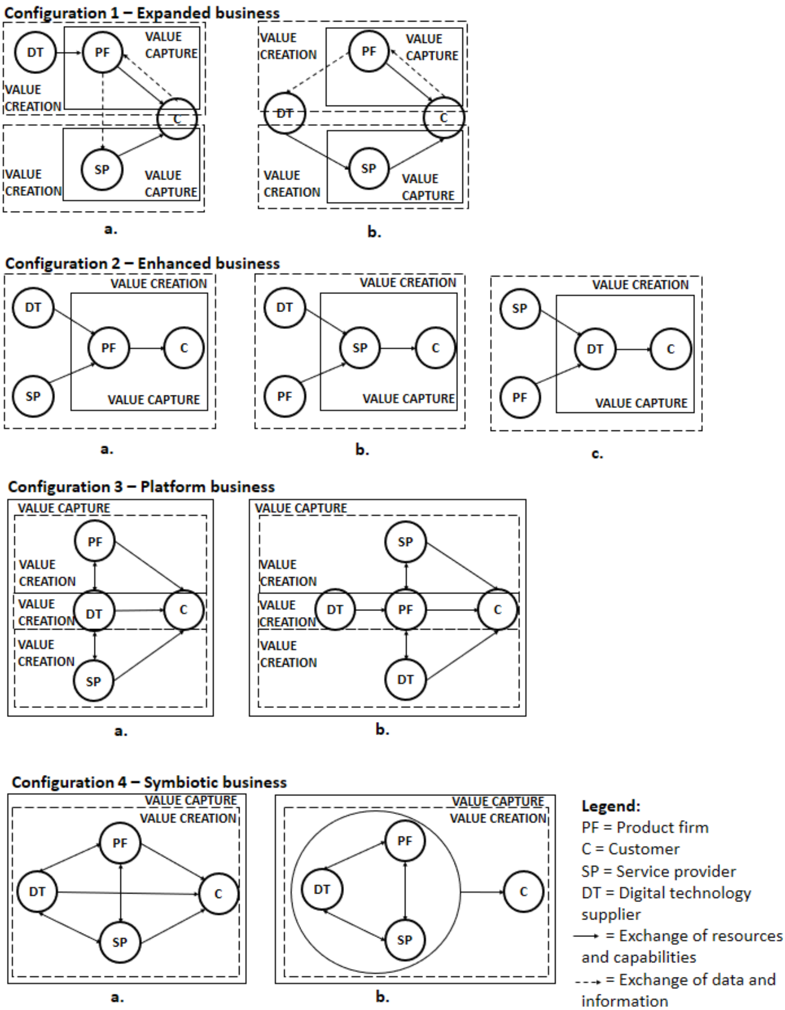

Figure 2: Network configurations of the typology

3. RESEARCH METHODOLOGY:

Based on the proposed typology, we conducted four case studies, one for each type of collaboration. Case studies were selected according to a theoretical sampling approach, where cases are selected due to their suitability for explaining the constructs. We conducted interviews with companies that operate in collaborative Smart PSSs, in which we identified and selected four of them as the most suitable cases to the purpose of this study and that shows differences between them, allowing us to categorize in the four predefined configuration types. In Table 1, we show the four selected case studies for this article, listed by their aliases, one for each type of collaboration.

Table 1: Case studies for the research

Collaboration type	Company	Description	Sources	Interviews
Expanded business	ElectricCo	Multinational manufacturer specialized in electrical distribution (products and services)	2 procurement managers and 1 marketing director	3 interviews of 1 hour
Enhanced business	MoldCo	Multinational manufacturer for molds development and assessment	1 sales manager and 1 R&D engineer	2 interviews of 1 hour
Platform business	IndustrialCo	Multinational supplier of digital solutions, automation and electric distribution for industries	2 managers of cloud applications solutions	2 interviews (1 hour and 1,5 hour)
Symbiotic business	AutomationCo	Multinational supplier of automation solutions in sensors, software integration and machine vision	1 CEO of regional subsidiary	2 interviews (1,5 hour and 0,6 hour)

We analyzed how the actors from each supply chain configuration organize themselves using the Social Exchange Theory (SET) view with its four internal elements (i.e., trust, commitment, reciprocity, and power). In order to collect data to analyze the relationships, we conducted semi-structured interviews with the selected companies. These interviews were divided into two parts. The first part of each interview consisted of questions on: (i) general information about the company's business; (ii) details about their offerings, including identification of the products and services of which these were comprised, and how they were enabled by digital technologies; (iii) types of revenue and relationships with customers; (iv) the relationship with suppliers and how the company engaged in collaboration with them. After analyzing the possible collaboration with suppliers according to the product firms' offerings, we proceeded to the second part of the interview. We posed questions about the relationship with their suppliers and other external companies, including a general description of the relationship, the frequency of interaction with them, their expected capabilities the type of agreement and questions about the SET elements, and its outcomes. Data was collected from multiple information sources to ensure the reliability of our analysis. Before the interviews, we gathered information about the companies from their websites and reports, in particular with regard to their offerings and investments in the areas of service development, digital technology acquisition and development, and their partnerships within these contexts. Deriving information from a range of sources resulted in data triangulation, which supported construct validity.

4. FINDINGS AND DISCUSSIONS:

In the area of electrical distribution, ElectricCo usually sells products intermediated by electricians, the service providers for electrical installations. In order to form a closer connection with its end customers, ElectricCo has been investing in digital services across all business units, offering remote monitoring services integrated with manufactured products such as switchboards, aiming to create large systems with connected products. By acquiring connectivity modules, cloud solutions and network services from digital technology suppliers, ElectricCo has developed connected switchboards that allow customers to have real-time information about electricity distribution in their buildings via digital services. These services generate data about the energy system and use predictive analytics to avoid supply disruption. The new solution proposed by ElectricCo brings the company closer to its end customers and generates new revenue through the provision of additional services. Moreover, the Smart PSS developed by ElectricCo brings the prospect of benefits beyond its core business: the generated product data can be used for new collaborations, to expand the business model and become a data provider. ElectricCo considers selling this data to external actors, such as insurance companies (Configuration 1A of Figure 2), which can use this product data to improve their predictions about power distribution safety. ElectricCo has no dependency on this type of revenue, which represents an additional revenue source for its business model, increasing the importance of its position in the supply chain. As dependency lies with the data buyer, this type of relationship represents a low value capture interdependence and the mere provision of data represents lower levels of value co-creation.

The case chosen for the Enhanced business collaboration type has MoldCo as the focal firm, as represented in the Configuration 2A of Figure 2. MoldCo designs and manufactures injection molds for plastic components, and offers different types of contract for warranty and maintenance according to customer needs. In some cases, the customer is responsible for the maintenance of the molds, but the services provided by MoldCo represent more than 50% of its current revenues. In order to optimize service provision, MoldCo collaborated with a supplier with expertise in sensors, IoT connectivity modules and infrastructure, and artificial intelligence, in order to develop a smart mold. By means of embedded sensors, cloud connection and digital services, this offering can collect data from operations and communicate with humans and machines, improving the performance metrics of the current solution. Thus, the smart mold provides a cost-reduction in service provision, improvement in product quality and the customer process, and a reduction in the energy consumption of the customer process. The smart mold offering is a highly innovative solution for the company and the market, requiring a close working relationship with the digital technology supplier: during the six-month solution development process, the two companies usually interacted on a daily basis.

In order to boost its Digital Solutions business, IndustrialCo has developed a digital services platform. This platform is cloud-based and works with IoT open standards. The main goal of this solution is to provide customers with access to a wide variety of digital applications, using customer data collected in the cloud. Thus, through the platform, the company provides access to digital services related to products, such as machines and equipment, and digital services related to industrial processes. IndustrialCo follows a strategy based on open-source software, anticipating widespread adoption of its solution. Thus, as shown in in the Configuration 3A of Figure 2, IndustrialCo promotes a common platform, with internal and external developers offering digital applications to industrial customers. The platform works with a model based on annual licenses, providing three different types of access: customer, developer and operator. Customers buy and use the applications available, which are built by the developers. Operators provide these applications. Thus, operators and developers offer their solutions to the customers, who buy these on the platform. The solution is also of interest to device manufacturers, who can provide digital applications for their devices on the platform. Users and developers can also work together to develop solutions for specific issues. In this way, IndustrialCo offers an innovative solution to the market with great flexibility, since joint activities with customers or external developers are not required.

In one business unit of AutomationCo, the product firm offers optical sensors for machine vision solutions, along with commissioning services. In this business, the company has to collaborate with the machine manufacturers to provide the solution for the customer – the interviewee describes collaboration as taking place within a "(…) *magic triangle, where there is the knowledge provider, the machine builder, and the end-user*". For more advanced solutions, especially for customers in the life sciences sector, AutomationCo must also collaborate with specialized system integrators who provide more advanced software in machine vision technology. This case is therefore symbiotic, as all actors need each other's resources to create and capture value from the customer, with each actor offering their solution to the customer, while remaining integrated with the others. The system integrators provide the software, carry out the installation on the customer's site, and are responsible for the functioning of the system. The machine builders provide the equipment into which the machine vision technology will be integrated, with

AutomationCo providing the sensors and supporting validation of the solution in the customer's process through commissioning. This collaboration is shown in the Configuration 4A of Figure 2.

The elements identified in SET are summarized in Table 2. The differences regarding the different types of collaboration, in terms of SET elements, are discussed subsequently.

Table 2: Summary of the results

Collaboration type	Value exchange	Social Exchange Theory (SET)				Value reward
		Trust	**Commitment**	**Reciprocity**	**Power**	
Expanded business	Data for third parties	Contractual	Long-term - low interactions	Low	Imbalanced - manufacturer	Additional revenues
Enhanced business	New solution development	Competence	Long-term - higher interactions in development phase	Medium	Balanced	Innovation and capability development
Platform business	Flexible solutions	Contractual	Long-term - low interactions	Medium	Balanced	Innovation, capability development, access to new markets and cost-reduction
Symbiotic business	Development of more advanced solutions	Goodwill	Long-term - continuous interactions	High	Imbalanced - digital service provider	Innovation and access to new markets

The *Expanded* business represents an inter-firm collaboration with low joint-activities for value creation and low-value capture interdependence. In this case, companies exchange information about product-related services, which does not demand intense interactions. Relation-specific investments are not present in this type of collaboration, resulting in low informal trust mechanism requirements. Only contractual mechanisms of *trust* are required because external parties need to access internal data from the company and the customer. Security issues are an inherent challenge of digital offerings, being cybersecurity an increasing concern. In this context, the demanded *trust* is not necessarily implied in opportunistic behavior from the other party. However, for this type of collaboration, the company must also feel confident about its partner's data security. The companies form a strategic *commitment* to expand the existing business, resulting in a network with low reciprocity, in which the expectations are limited to a firm that requires a complementary resource or information from another firm. The rewards are new revenues and more *power* to the servitized company. Prior research has stressed the importance of data for the future of business models, with some companies interested in acting as a data provider and having a central role in the ecosystem, creating dependency among other actors on the company (Deloitte 2014). Thus, we developed the following proposition:

> *Proposition 1: Expanded* business is a type of collaboration among partners with low requirements of trust, commitment, reciprocity, and power. Collaboration can be unbalanced, favoring one partner over the other, but power is not a defining mechanism of the relationship, being one of the drivers of this type of collaboration.

On the other hand, *Enhanced business* has joint-activities for value creation. Companies share information regarding customer process-related services, developing relation-specific assets that require more interactions among the actors, and informal trust mechanisms. However, this collaboration is marked by unilateral dependence and moderate level of *reciprocity,* not requiring a goodwill level of *trust*. The companies form a *commitment* due to a technical need, with the product firm retaining a cooperation agreement to have support from a partner to improve the efficiency of an existing business (Zott and Amit 2010). As the servitized company also relies on the partner's solution for the after-sales phase of the Smart PSS life cycle, collaboration demands a long-term commitment with event types of interactions. This partner is no competitor in the market, not requiring the servitized company to rely on strong power mechanisms to obtain more benefits. However, *power* is more important in this type of collaboration than the *Expanded* business, as the servitized company has the dependence on the partner's resources and expertise. We developed the following proposition:

> *Proposition* 2: *Enhanced business* is a type of collaboration with moderate requirements of trust, reciprocity, and power. The digital servitized company might require a strong commitment from the partner, depending on the importance of the resource and the phase in the life cycle in which the resource is required for the Smart PSS.

The *Platform* business is a strategy to create value with other companies without joint activities, becoming dependent for value capture. This dynamic reduces the need for informal trust mechanisms, requiring only contractual mechanisms for the same reasons as the *Expanded* business. The platform approach requires the companies to have access to the platform in order to profit from it. The *commitment* is then long-term oriented, but with low interactions among the actors. This type of collaboration is a trend for digitalized environments, in which companies can autonomously develop their Smart PSSs that are complemented with solutions from other product firms, digital technology suppliers, and service providers (Zott and Amit 2010). The network has a medium-level of *reciprocity*, as the platform is valuable with actors' engagement, but a significant number of actors is available. *Power* can be determined by the strategy of the digital platform provider: open or closed-source. In closed platforms, the company has more control of the solutions incorporated in the platform, providing more differentiation to the customers. However, in open platforms, many players can be engaged, offering more solutions to the customers and reducing specific companies' bargaining power (Gawer and Cusumano 2014). Considering this, we developed Proposition 3:

> *Proposition 3*: *Platform* business is a type of collaboration with low trust requirements, a long-term oriented *commitment* with low interactions. The engagement of partners can adopt several options, reducing the *reciprocity* to a medium level. *Power* will also be determined in function of the platform's dynamics, in which open-source platforms have more balanced *power*.

Lastly, *Symbiotic* business is the most integrative type of collaboration, consisting of exchanges regarding customer process-related. This collaboration requires higher levels of informal trust mechanisms with high relation-specific assets and bilateral dependence for value creation and value capture. The *commitment* is long-term oriented, usually with continuous interactions among the engaging partners that shared operational linkages through their combined solutions. The *commitment* has a technical and strategical driver, as the companies involved create an interdependent ecosystem, with high *reciprocity*, to provide a more advanced solution to their customers, developing new activities and/or new business models (Zott and Amit 2010). The dependence is defined by many factors, in which in a Smart PSSs, the innovative degree of the solution is an important determinant for the *power* dynamics. Among all types of collaborations, *power* is more determinant in the symbiotic business, as the engaged actors can also be competitors in their markets. Thus, we developed the following proposition:

> *Proposition 4*: *Symbiotic* business is a type of collaboration in which the strong integration among the engaged actors results in high requirements of *trust*, *commitment*,

and *reciprocity*. *Power* is an important determinant for the relationship, in which companies with the most innovative solution can obtain more benefits from the collaboration.

5. THEORETICAL AND PRACTICAL CONTRIBUTIONS:

By identifying elements that distinguish differences between the types of collaboration, we propose a framework for inter-firm collaboration in digital servitization, considering different configurations in terms of value creation and value capture for each type. We offer advances in literature gaps on collaboration in digital servitization. Many authors have highlighted inter-firm collaboration as an important strategy for this context, but, as pointed out by Kohtamäki et al., (2019), further studies are necessary. Our study provided new insights in this direction, showing how the interaction between the firms occurs within each type, by using a SET perspective for the first time in a digital servitization context. Thus, we extended the current literature of inter-firm relationships and business model innovation.

Our results also offer practical information for managers and practitioners. By showing the ways in which some companies are collaborating, and explaining their objectives and relationships, we provide the means for other manufacturers to identify what they need in terms of external support with specific actors (product firms, customers, service providers and digital technology supplier) and to understand the different forms of value creation and capture, considering their relational implications. With a clear presentation of the interactions among the engaging actors, practitioners know what to expect when collaborating with other companies.

We analyzed the current dynamic of the four cases and categorized them using the SET. We suggest further cases studies to corroborate or not our propositions. Moreover, we did not consider how companies arrived at the configurations and their transition and transformation. Future studies could consider the dynamic aspects of collaborations to capture such effects.

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INDUSTRY 4.0 TECHNOLOGIES, SKILLS AND TRAINING AND THEIR INFLUENCE ON THE SERVITIZATION OF INDUSTRIAL FIRMS

Bart Kamp & Juan P. Gamboa

ABSTRACT:
Purpose: We break the concept of Industry 4.0 down into a series of technologies and look whether their adoption influences industrial firms' servitization. Likewise, we assess whether the existence of prior digital skills and training initiatives to work with the adopted technologies influence company scores on two indicators of servitization: developing intelligent services and obtaining income from services.
Design/Methodology/Approach: We formulate hypotheses to test relationships between the adoption of Industry 4.0 technologies and skills and training initiatives, on the one hand, and servitization, on the other, on a sample of 271 Basque industrial firms. As the dependent and independent variables were measured on a dichotomous scale: Yes (1) No (0), we test the study hypotheses by means of hierarchical logistic regressions.
Findings: Results show that the adoption of four out nine technologies raises the chances of developing intelligent services but only one of them raises the chances of obtaining income from services. In terms of skills, the implementation of training strategies only raises the chances of developing intelligent services. These findings confirm the importance of technology adoption and training implementation for the servitization development in the industrial field.
Originality/Value: **T**he study introduces an operationalization of Industry 4.0 that allows connecting digitalization with servitization from a broad-based technology perspective. As such, it goes beyond the discursive or piecemeal treatment of these concepts.

Keywords: Smartization, servitization, digitalization, Industry 4.0, skills and training

1. INTRODUCTION

Digitalization has been hailed many times as a catalyzer for servitization. Studies highlight the interplay between digitalization and servitization (Martín-Peña et al., 2019; Opresnik and Taisch, 2015; Rymaszewska et al., 2017). Similarly, Adrodegari et al. (2017) as well as Kohtamäki et al. (2019) argue that digitalization enables new innovative services, business models and pricing models, which are required to capture the value from digitalization. However, the role of digital technologies (DTs) in the service transformation of industrial companies remains a valid research topic (Akaka & Vargo, 2014), as little research has specifically focused on the contribution of DTs in such service transformation (Ardolino et al., 2018).

Similarly, Industry 4.0 has been portrayed as an enabler for smart service development (Kamp et al., 2017). However, digitalization and/or Industry 4.0 are often referred to in generic terms or as container concepts. Rarely are they broken down into a series of constituent technologies to see their relationship with (forms of) servitization. As far as individual DTs are concerned, Ardolino et al. (2018) laid a basis, although their investigation only looks at a small range of DTs: Internet of things (IoT), cloud computing and predictive analytics.

Therefore, in our contribution we follow Rüssmann et al. (2015) and dissect Industry 4.0 into nine technologies that companies can apply and look whether these have an impact on company's servitization behaviour. Additionally, we look whether prior availability of specific (digital) skills inside the company adopting the respective technologies influences servitization practices. Similarly, we look whether the companies count with a training strategy and programmes to prepare the employees for working with the technologies adopted.

2. THEORETICAL BACKGROUND

Our work combines insights from studies that look into the concept of Industry 4.0/digitalization and servitization. Furthermore, it builds upon studies that investigate the role of skills and training for service business development amidst industrial companies (Marcos-Martínez & Martín-Peña, 2016). Since digitalization and servitization represent change and development processes (Kohtamäki et al., 2019; Sklyar et al., 2019), training and investment in the skills of personnel to cope with these changes seems relevant. Notably as dealing with changes requires absorptive capacity (Cohen and Levinthal, 1990) and competence development on behalf of employees (Baines et al., 2013). In a similar vein, Brynjolfsson and McAfee (2012) and Wamba et al. (2017) assert that the implementation of new digital systems requires development of human skills and competencies: personnel needs to learn how to use the new systems, which requires training, coaching and development of new IT skills. Accordingly, Kohtamäki et al. (2019) as well as Porter and Heppelmann (2014) argue that the implementation of digitalization requires investments in human resources. By extension, Orlikowski and Scott (2018) contend that in these instances, competence development is emphasized. Industry 4.0 refers to a family of technologies that entail the use and coordination of information, automation, computation and sensing activities (Acatech 2015; Posada et al. 2015). Although the term or concept of Industry 4.0 is much used, a clear operationalization of what it stands for often lacks. Consequently, the present paper adheres to a comprehensive breakdown of Industry 4.0 into nine technologies, as introduced by Rüssmann et al. (2015): Internet of Things, Cloud computing, Big data analytics, Virtual simulation systems, Augmented reality, Additive manufacturing / 3D Printing, Cyber-physical systems, Robotics and Cybersecurity.

Servitization refers both to industrial firms expanding their service business and income from services (Vandermerwe & Rada, 1988), the transformation of firms to improve their abilities to deliver services (Baines & Lightfoot, 2013), and the infusion of services with digital/smart dimensions (Coreynen et al., 2017). Key indicators in this regard are the development of intelligent services and revenue generation from such services, as a way of appropriating value from digitalization (Cenamor et al., 2017).

Taking the former theoretical background into account and based on the assumption that digitalization enables industrial firms' servitization processes whereby ensuring the right skills should form an added value, we posit the following hypotheses:

Hypothesis 1: those companies that have introduced new technologies in the last three years are more likely to develop intelligent services.

Hypothesis 2: those companies that have introduced new technologies in the last three years are more likely to obtain income from services.

Hypothesis 3: the available skills and the implementation of training strategies and actions for the right utilization of new technologies introduced by the companies in the last three years raise the chances of these companies for developing intelligent services.

Hypothesis 4: the available skills and the implementation of training strategies and actions for the right utilization of new technologies introduced by the companies in the last three years raise the chances of these companies for obtaining income from services.

3. RESEARCH METHODOLOGY

We used data from a large-scale survey drawn from 271 industrial firms that are located in the Basque Country (Spain). Data were collected in 2019. The sample included several types of industrial firms: machining and mechanization enterprises (10%), manufacturers of finished products for other industrial firms (56,5%), suppliers of parts or components to other industrial users (20,3%), system providers to other industrial user (13,3%). In terms of size, the sample mainly comprises firms up to 49 employees (61,6%) with an annual turnover up to ten million euros (59,8%).

As independent variables we look at: the adoption of nine technologies that correspond to Rüssmann et al.'s (2015) categorization of Industry 4.0. Similarly, we enquire after the existence of prior digital skills to work with the adopted technologies in the company, and whether the company counts with a training strategy and/or programme to allow employees getting to grips with the implemented technologies. As dependent variables, regarding servitization behaviour, we look at income generation from services and the development of intelligent services as a consequence of the adoption of the respective technologies. We control for company size in terms of number of employees and annual turnover because these variables can have an impact on the dependent variables. Both the dependent and independent variables were measured on a dichotomous scale: Yes (1) No (0). Due to the dichotomous nature of the variables, we tested the study hypotheses by means of hierarchical logistic regressions.

4.FINDINGS

The results of the logistic regression analysis conducted to estimate the relationship between Industry 4.0 technologies adoption, on the one hand, and the development of intelligent services as a consequence of the adoption of the respective technologies, on the other, are displayed in Table 1. More concretely, this Table presents *b* coefficients, Wald test and Exp (*B*) statistics.

First, the control variables were entered into the regression equation (Step 1). This model explained 3,2% of the variance in the development of intelligent services (Nagelkerke's R2 = .032) and it is statistically significant according to χ2 statistic: χ2 (2) = 6,453, p <. 05 However, none of the control variables introduced in this step shows a significant relationship with the dependent variable, only the constant term of the regression equation.

Next, we entered each of the nine technologies that could be adopted by companies (Step 2). This model explained 23.1% of the variance in income generation from services (Nagelkerke's R2 = .231). Together with the control variables, the regression equation yielded the following χ2 statistic: χ2 (11) = 50,678, p < .01, explaining 23.4% of the variance in intelligent services development (Nagelkerke's R2 = .234).

Finally, we entered the variables regarding available skills, the implementation of training strategies and actions for the right use of the technologies adopted (Step 3). This model explained 3.9% of the variance in intelligent services development (Nagelkerke's R2 = .039). At this point, the regression equation yielded the following χ2 statistic: χ2 (14) = 60,484, p < .01. Altogether, the three factors under consideration explained 27.5% of the variance in the development of intelligent services (Nagelkerke's R2 = .275).

The results of the previous steps reveal that four of the nine technologies (Big data analytics, *p* =. 05; Cloud computing, *p* < .05; Internet of things, *p* <. 05 and Cyber-physical systems, *p* < . 01) show a statistically significant relationship with the intelligent services development. Therefore, these results partially support Hypothesis 1. In this particular case, the implementation of Big data analytics raises 1,8 times the chances of intelligent services development Exp (*B*) = 1.8, Cloud computing also raises 1,7 times these chances Exp (*B*) = 1.7, Internet of things raises 1,9 times these chances Exp (*B*) = 1.9, and finally, Cyber-physical systems increases 5.9 times the chances of intelligent services development Exp (*B*) = 5.9. Regarding the importance of prior skills and the training for using the new technologies, the results indicate that only the implementation of training strategies for the right utilization of the new technologies introduced showed a significant relationship with the intelligent services development (*p* < .01), providing partial support to Hypothesis 3. In this case, the implementation of training strategies increases 2.9 times the chances of intelligent services development Exp (*B*) = 2.9.

Table 1: Logistic Regression Results Estimating the Relationship Between Industry 4.0. Technologies adoption and development of intelligent services as a consequence of the adoption of the respective technologies

	b			Wald			Exp (*B*)		
Predictors	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Step 1: Control variables									
Company size	.16	-.00	.01	1.67	.00	.00	1.17	1.00	1.01
Annual turnover	1.0	-.07	-.05	.19	.09	.04	1.10	.93	.95
Step 2: Technologies Adoption									
Big data analytics		.65*	.58*		3.6*	2.7*		1.9*	1.8*
Cloud computing		.66*	.56*		4.6*	3.2*		1.9*	1.8*
Cybersecurity		-.17	-.27		.30	.70		.84	.77
Internet of Things		.66*	.62*		4.8*	4.0*		1.9*	1.9*
Robotics		.18	.09		.28	.07		1.20	1.10
3D printing		.51	.44		2.52	1.77		1.67	1.54

Cyber-physical systems		1.70**	1.78**		8.59**	8.97**		5.46**	5.91**
Augmented reality		.14	.29		.08	.32		1.15	1.34
Virtual simulation systems		-.039	-.11		.01	.10		.96	.89
Step 3: Skills & training									
Prior availability of specific (digital) skills inside the company			.26			.60			1.28
Company counting with a training strategy			1.08**			7.93**			2.94**
Company counting with a training program			-.47			1.56			.63

*p < .05; **p < .01 (two-tailed).

The results of the logistic regression analysis conducted to estimate the relationship between Industry 4.0 technologies adoption, on the one hand, and income generation from services, on the other, are displayed in Table 2. More concretely, this Table presents *b* coefficients, Wald test and Exp (*B*).

First, the control variables were entered into the regression equation (Step 1). This model explained 0.3% of the variance in income generation from services (Nagelkerke's R^2 = .003), and it is not statistically significant.

Next, we entered each of the nine technologies that could be adopted by companies (Step 2). At this point, the regression equation yielded the following χ^2 statistic: χ^2 (11) = 23,254, $p < .05$. This model explained 11.1% of the variance in income generation from services (Nagelkerke's R^2 = .111), and more specifically, the technologies adopted explain 10.8% of the variance.

Finally, we entered the variables regarding skills and training (Step 3). At this point, the regression equation yielded the following χ^2 statistic: χ^2 (14) = 23,481, p < .05. This model explained 11.2% of the variance in income generation from services (Nagelkerke's R^2 = .112). Almost the same amount of variance explained by the model tested in Step 2.

The results of the previous steps reveal that only one of the nine technologies (Cyber-physical systems, p < .01) show a statistically significant relationship with income generation from services. Therefore, these results partially support Hypothesis 2. In this particular case, the implementation of Cyber-physical systems raises 4,1 times the chances of income generation from services Exp (B) = 4.09. In addition, the results indicate that the available skills and the implementation of training strategies and actions for the right utilization of new technologies introduced by the companies do not show a significant relationship with income generation from services, leading us to reject Hypothesis 4.

Table 2: Logistic Regression Results Estimating the Relationship Between Industry 4.0 technologies adoption and income generation from services

	B			Wald			Exp (*B*)		
Predictors	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Step 1: Control variables									
Company size	.07	-.02	-.02	.29	.03	.03	1.07	.98	.98
Annual turnover	-.02	-.08	-.09	.01	.13	.14	.98	.92	.92
Step 2: Technology Adoption									
Big data analytics		.52	.54		2.48	2.60		1.69	1.72
Cloud computing		.08	.09		.09	.10		1.09	1.10
Cybersecurity		.27	.28		.89	.94		1.31	1.32

Internet of Things		.48*	.47		2.79*	2.66		1.61	1.60
Robotics		-.42	-.42		1.63	1.56		.66	.66
3D printing		-.04	-.03		.02	.01		.96	.97
Cyber-physical systems		1.40***	1.41***		6.89***	6.96***		4.06***	4.09***
Augmented reality		.34	.33		.44	.41		1.40	1.39
Virtual simulation systems		-.26	-.25		.58	.52		.78	.78
Step 3: Skills & training									
Prior availability of specific (digital) skills inside the company			.10			.13			1.11
Company counting with a training strategy			-.08			.05			.92
Company counting with a training program			-.03			.01			.97

*p < .05; **p < .01 (two-tailed).

5.DISCUSSION

Based on the obtained results, we find that certain technologies are more likely to boost the servitization of business than others. In addition, we find that the uptake of Industry 4.0 technologies is more likely to foster the development of intelligent services than the generation of income from services. As such, our research supports the idea that companies can fall prey to a kind of digitalization paradox (Kohtamäki et al., 2019).

Alternatively, Industry 4.0 technologies seem to have more impact on the “smartization of services” than on the “servitization of revenues”. This also leads us to think that the offering of intelligent services requires more technology, or are more technology-intensive, than services in general.

As for the relevance of available skills and training schemes, we find that the implementation of training strategies for the right utilization of new technologies raises the chances of companies developing intelligent services, while their impact on increasing the revenues from service business turns out to be a lot less clear. This prompts us to think that such training programmes could generally be more oriented towards learning employees to work with new technologies from a manufacturing, a design and/or an internal processes perspective, than from a commercial thinking regarding the customer-oriented services that these technologies can facilitate, and from a services sales perspective on a whole.

6.THEORETICAL AND PRACTICAL CONTRIBUTIONS

The findings show that developing services is one thing, but that reaping income from them is another thing. This may hint at industrial companies having difficulties of shifting from “services for free” to “services for a fee” (Witell & Löfgren, 2013) or that they tend to offer integrated “product service offerings” or “package deals”, where the service part is not charged or accounted for separately (Kamp, 2020).

They also provide insights on the relevance of skills development to exploit Industry 4.0 technologies for the sake of intelligent service development. Another implication is that when training employees to cope with Industry 4.0 technologies, programmes should also be geared towards market applications and service design thinking.

Finally, the study introduces an operationalization of Industry 4.0 that allows connecting digitalization with servitization from a broad-based technology perspective. As such, it goes beyond the discursive or piecemeal treatment of these concepts.

7.LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

This study comes with certain limitations. The most important is related to the dichotomous measurement of the variables under study, which narrows the scope for statistical analysis, specifically regarding the role that skills development may play in servitization processes. Future research should also expand the analysis to other indicators of servitization as the two that this study focused on. In addition, future studies should also analyze the moderating role of skills capital as part of the relationship between the adoption of Industry 4.0 technologies and indicators of servitization.

Finally, a word on the weight of residual factors. The few variables that we used explain for around a quarter companies’ performance regarding the development of intelligent services and income from service activity, which can be considered “decent” given that many other factors can exert an effect on the dependent variables under consideration. Still, it implies a considerable weight for residual factors. As conjectures on which ones could be in play, we can think of sector affiliation, maturity of the markets on which the companies sell, the knowledge-intensity and level of sophistication of the products that firms commercialize, among others.

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THE ENERGY COMPANY AS A SMART ELECTRICITY SUPPLIER AND SERVICE PROVIDER: INNOVATING EXISTING BUSINESS MODELS OF SMALL AND MID-SIZED ENERGY COMPANIES IN GERMANY

Andreas Ensinger, Max-Robert Salzer, Dr. Karlheinz Bozem, Prof. Dr. Anna Nagl, Prof. Dr. Verena Rath, Prof. Dr. David K. Harrison, Prof. Dr. Bruce M. Wood

ABSTRACT

Purpose: Research into economically resilient and ecologically sustainable customer-centric business models that enable the small and mid-sized energy companies in Germany to differentiate themselves and generate new value creation.

Design/Methodology/Approach: A detailed analysis of the digital transformation framework and the trends relevant for small and mid-sized energy companies in Germany.

Findings: Innovative business models that offer small and mid-sized energy companies in Germany an opportunity for differentiation from competitors and start-up companies, strengthen customer loyalty and market position and help to generate new sales and revenues.

Originality/Value: Establishing the future viability of small and mid-sized energy companies and advancing the energy transition in Germany.

KEYWORDS: Renewables, Business Model Builder, Digitalization, Servitization, Innovation

1. INTRODUCTION

Under the leadership of Dr. Karlheinz Bozem from bozem | consulting associates | munich and Prof. Dr. Anna Nagl, Director of the competence center of innovative business models at Aalen University, innovative business ideas for small and mid-sized energy companies in Germany were developed. The research project “Ecologically and economically resilient business models for citizen energy cooperatives: A best practice model to support the successful energy turnaround in Baden-Württemberg (Citizen Energy Transition)” is subsidized by the Ministry of Science, Research and the Arts Baden-Wuerttemberg (funding code Kap. 1403 title group 75). This research project is carried out in cooperation with Karlheinz Bozem who supports the research activities with expertise in both the renewable energy and competitive strategy.

The background to the research project is that, in addition to other trends, such as big data and digitalization, the energy transition has a strong influence on the business models of small and mid-sized energy companies in Germany due to the increasing share of renewable energies and rising energy efficiency. The energy world, and thus the electricity industry in particular, will increasingly be sorted into a "central energy world" and a "decentralized energy world" (Rath, Bozem, Nagl, 2020), the latter of which will grow strongly due to the increasing share of distributed renewable power intallations and the growing number of prosumers. This change offers opportunities for innovative approaches to business model ideas as well as for new business model innovations.

It is therefore not only on the part of the start-up scene that new competitors, such as Automotive companies, mobility providers, ICT companies, which also offer electricity to electric cars, enter the market (Bozem et al. 2013). Only through the acquisition of new customers and an increasing demand for smarter services, for example for the controlled charging of electric vehicles, can small and mid-sized energy companies in Germany generate additional electricity, strengthen their customers and expand their business base through innovative value-added offers. As a result, electricity sales can be boosted or the sales gap resulting from increasing energy efficiency can be closed.

Thanks to the possibilities of digitalization, platform-based business models can also be developed for small and mid-sized energy companies in Germany, while existing service offerings can be supplemented by attractive services and thereby increase customer loyalty (Bozem, Nagl and Rennhak, 2013). In addition, there is the potentially increasing self-consumption of operators of photovoltaic systems (PV systems) – especially if the intallations fall out of subsidized funding under the Renewable Energy Sources Act (EEG) – as well as the further addition of decentralised PV systems. This will sooner or later lead to a decline in electricity sales via public grids. Increasingly economical stationary battery storage for self-generated electricity accelerates this development even further. If the established small and mid-sized energy companies in Germany do not identify new business models through corresponding innovative approaches to business model ideas, this will have a negative impact on their sales and the company's earnings as well as their viability.

In particular, the small and mid-sized energy companies will no longer be able to be successful as pure electricity suppliers in the commodity market in the future, but must develop beyond the evolutionary stage of the energy service provider into a smart value-added service provider. The energy services include simple advice on energy savings, energy consulting for residential buildings, the preparation of energy identification cards, heat contracting, thermography of PV systems as well as consulting, installation and operation of charging stations up to energy development and the operation of infrastructures in residential quarters (so-called district solutions) etc. At the end of the development, there is the positioning as a smart service provider for smart homes and smart city applications (Rath, Bozem, Nagl, 2020).

In addition to the construction and operation of renewable energy intallations in Germany, existing and new renewable energy intallations were supported by the EEG in 2000. The subsidy was provided by a levy on the electricity price, which had to be paid for each kilowatt hour consumed and was thus supported by each individual consumer (fixed feed-in tariff). The funding was valid for 20 years from the start of the plant. This led to a rapid upswing, especially in the expansion of PV electricity, so that in Germany today, on sunny days, 100% of the electricity demand can already be covered by renewable energies. However, since 2021, support for renewable energy has expired for the first/oldest PV intallations in Germany. These intallations could be operated profitably through the extraction, as they did not have to compete on the market against other conventional forms of energy. This situation is now changing after the expiry of state support, which jeopardises its economic operation. In the worst-case scenario, this would mean that the intallations would be dismantled, which is surely not desired from both an economic and a political point of view, because these small PV intallations, if they continue to operate, will also contribute to achieving climate protection targets and reducing greenhouse gases. In addition, from a technical point of view, these PV systems can be used for the coming years.

As described above, a key part of this research is to identify the relevant trends for new digital business models that will enable energy companies to offset the groundbreaking value creation by establishing new business models. These new business models differ from the classic "commodity business model" of pure power supply, as they are oriented towards the wishes and needs of users instead of technology, thus offering the user real added value and thus the opportunity to strengthen customer loyalty to the energy company.

2. THEORETICAL PRINCIPLES AND DIGITAL TRANSFORMATION FRAMEWORK

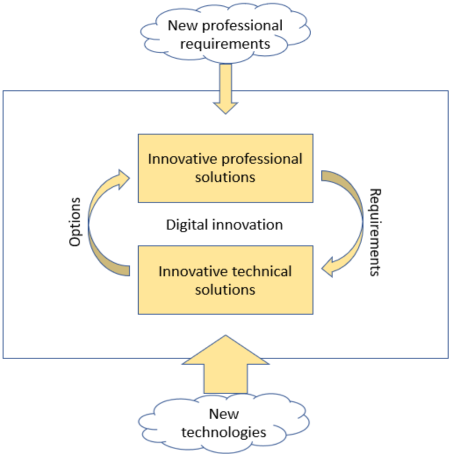


Figure 1: Technology push (based on Hess 2019)

The technology push (Figure 1) shows the two drivers of digital change, while the impetus for digital innovations traditionally often resulted from new professional requirements and led to new innovative technical solutions. Today, the impetus often comes from new existing technologies. As a result of the digital transformation in almost all areas of the economy, new business areas have emerged that the established companies have usually not filled quickly enough, new players, especially start-up companies, have already established themselves in many industries and stolen business shares from existing companies . In the meantime, the established companies are trying to regain lost ground, established retailers are investing heavily in online shops, film producers are checking how they can assert themselves against streaming providers, etc. (Hess T. 2019). Other companies, such as the small and mid-sized energy companies, are still at the beginning of the digital transformation process. Although they are well aware of the need for this and also see the existential threat, the right strategy for the digital transformation process is missing in most companies.

In order to transfer the existing ideas into innovative business models, the first step for small and mid-sized energy companies is to develop a digital transformation framework that describes the essential guard rails within which the transformation must move. Building on this, the existing value creation structures are to be changed through digital transformation and the existing business models using the example of small and mid-sized energy companies in Germany, the commodity product electricity, is being questioned. For this process, the right conditions have to be created. In classic energy companies with a previously rather low degree of digitalization, this poses one of the greatest challenges in the implementation of digital innovations. Figure 2 shows the schematic representation of the Digital Transformation Framework.

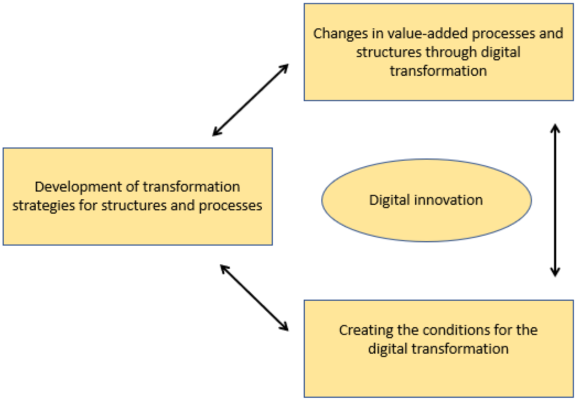


Figure 2: The Digital Transformation Framework (based on Hess and Barthel 2017)

3. Concept

Within the framework of the research methodology as a first step, the factors that lead to the need to provide value-added services in addition to the electricity supply are examined. Then, the business model with the business model builder is conceived and developed in an iterative process. First, a business idea is developed. It identifies current trends as well as the target markets and the necessary competencies for the implementation of the business model. Next the business model is developed. In particular, the value creation process, the key partners relevant for the implementation and the value-added network of the business model must be created. In the final step, a numerical evaluation of the business model is carried out in a business case.

In order to develop suitable business models for users, it is necessary to analyze the main trends in the energy industry: Demographic change describes, among other things, the fact that the age structure of a society is changing. People have a longer life expectancy and at the same time the birth rates are declining, which increases the average age. Older people, who have finished their professional lifed, have mobility and living needs that have to be met. Particularly noteworthy here is an increased need for security and comfort that younger people do not need. Since electricity is a product of daily use and there is often already a relationship of trust with the mostly local / regional providers on the part of the customer, services by the energy companies are conceivable here.

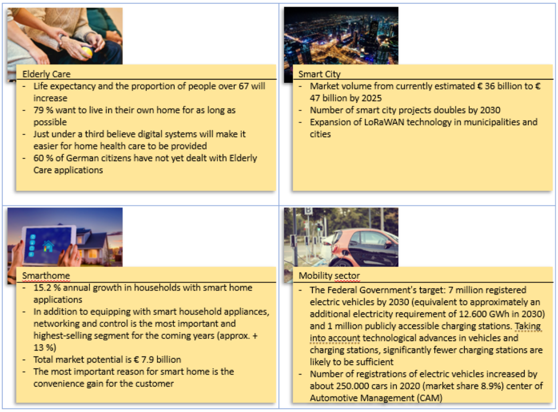
The trend towards decentralization of the power supply leads to an essential change in the generation structure away from large power intallations in the high and extra-high voltage level towards many smaller generation units in the low and medium voltage level. Electricity generation with fossil fuels is increasingly being replaced by renewable energies. Due to the dependence on wind and weather, these power intallations are a volatile generation capacity, which, especially in the case of PV, is distributed decentrally over many small system capacities and is often operated by private individuals. Since green electricity is mainly produced by decentralized intallations, this is an important trend that will influence many other business models based on it.

Another trend is connectivity, which energy companies can use for themselves. Behind this is the networking of society in all areas of life and thus has a decisive influence on it. The trend towards connectivity includes digitalization, which now affects almost every area of life and is therefore also playing an increasingly important role in the energy industry. In addition, platform-based business models can be described as a further trend that is only possible through digitalization. The main difference to business models that do not use a platform is that there is no longer just one company selling its products or services to a customer, but that the business model is based on the fact that a

company, as a platform operator, brings together various market players in a kind of virtual marketplace.
Big / Smart Data is a trend that is closely linked to digitalization and also to the use of sensors and the resulting amounts of data. Many companies and municipalities have recognized the potential that lies in the collection, linking and intelligent evaluation of large amounts of data. Also in the field of renewable energies, large amounts of data are generated. Smart City is another relevant trend for energy companies and infrastructure operators, especially because it has a positive influence that it has a positive influence on many areas of people's lives. Smart City can be described as follows: Through the use of digital technologies, corresponding sensors and the intelligent use of large amounts of data with the help of artificial intelligence, the life for people in cities is made more attractive and efficient (European Commission, 2020). Particular goals are climate protection and a more attractive environment for the population. Moreover, energy and especially electricity play an important role in this context, be it for smart mobility, the decentralized generation of electricity, energy efficiency or the control of load peaks.
The Servitization trend reflects the change away from pure products towards a combination of products and services and is therefore decisive for the “business model: Smarter green electricity supplier and service provider”. Derived from the word "service", it means that a product is supplemented by a service and thus offers an extended benefit for the customer. Since the beginning of the Covid 19 pandemic in 2020, working from home has become an important trend. People work partly or completely from home and thus spend significantly more time in their homes. Associated with this is, for example, an increased need for comfort, the need for a stable and fast communication link and also a higher power requirement. In addition to the supply of electricity, customers are interested in many other services that they can get from a single source. For each of these trends there is also a target market which had to be investigated, as well as the corresponding range of services and products. One of these is discussed in more detail in the following chapter Result.

4. RESULTS

There are several reasons why value-added services, in addition to selling electricity, make sense for the energy companies. One of them is that electricity is a commodity product. A commodity product is a standardized product that can be sold by different companies and does not offer any serious distinguishing features. When a company sells a commodity product, it can usually only differ from its competitors in terms of the price for the customer. As a result, the sale of electricity, for example, is subject to tough price wars. The costs for purchasing electricity are generally the same for all players, so that a lower selling price can usually only be represented with a lower margin or lower costs. Due to the unbundling of the energy industry in 2005, i.e. the organizational and business separation of the network operator and the energy supplier, in principle everyone had the opportunity to sell electricity with a company. This does not have to be generated yourself, but can be purchased on the electricity exchange, for example. This, in turn, has led to the establishment of many new companies, which, however, still share the same market and thus contribute to a considerable reduction in the margin for the energy companies. Many of the new players on the market only offer their electricity tariffs via the Internet and can thus save considerable amounts. The expression of the energy discounter was also created here, i.e. an energy company that can sell its electricity much cheaper. With value-added services, customers could be offered an additional benefit that enables energy companies to differentiate themselves from pure energy discounters.



Source: PwC, Kraftfahrt-Bundesamt, Statistisches Bundesamt, Eurostat, VATM, Dialog Consult, Splendid Research GmbH, CAM 2020

Figure 3: Innovative business models (based on Bozem and Nagl 2021)

Figure 3 shows the most promising business models. A particularly interesting business model is the “Elderly Care Package”, which is discussed in more detail below. This is made up of various services and products that are specifically designed to appeal to the elderly. The number of people in this target group will increase significantly in Germany in the coming years due to demographic change and increasing life expectancy. This development is illustrated in Figure 4 Life expectancy and age distribution.

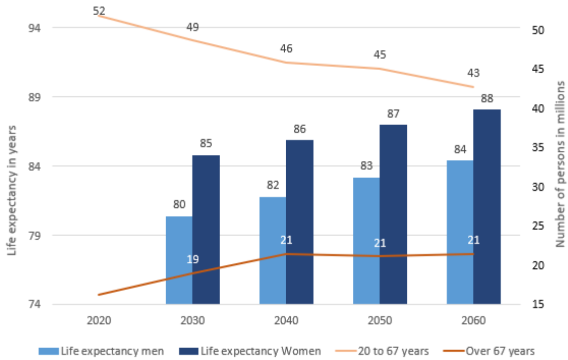


Figure 4: Life expectancy and age distribution (based on Bozem and Nagl 2021)

This target group of the “Elderly Care Package” is already retired, lives alone or with a partner and is partly dependent on outpatient care, but for the most part still wants to manage their daily life independently. For them, the issues of safety, health, mobility, comfort and culture, etc. play an important role. The range of smart products and value-added services is made up of various smart applications and devices. One of these is, for example, a smartwatch, which uses the built-in sensors to detect and record falls if a person who has fallen over can no longer help him/herself. If this is the case, depending on the setting, relatives, friends, neighbors or an emergency call center will be contacted or an emergency call will be sent. Additional health information can be called up permanently via the additional measurement of the heart rate and corresponding recommendations can be given to the customer or carer. In an emergency, medical staff can obtain important

information about the heart rate. For health care purposes, the smartwatch can also be used to send a reminder to take regular medication.
As an alternative to the smartwatch, this information can also be provided via smartspeakers. An additional advantage of the smartspeaker is the extended benefit. For example, calls can be made using voice commands or, if other smart devices are available, they can be operated. The smartwatch can also be used, for example, to send hints if the ringing of the telephone or the doorbell cannot be heard. Thanks to the smart monitoring of household appliances, further information can be obtained via the smartwatch or the smartspeaker, for example if the washing machine or dryer has finished its program or the stove or oven has not been switched off after use. This mainly concerns the security aspect of the offer. Burglary protection is also relevant for the security issue. For this purpose, all windows and doors are equipped with appropriate sensors in order to trigger an alarm in the event of a break-in. Additional security cameras can monitor the house entrance or garden area. Also, a video intercom can be installed at the front door. The use of an order service can be integrated in order to achieve a higher level of comfort in addition to safety and health. This makes it possible to deliver, meals, or groceries. In order to achieve greater comfort in the living area, smart thermostats can control the heating by voice command and regulate the temperature accordingly. The lighting is also accordingly smart and can be operated via the smart speaker. The lighting switches off if nobody has been in the room for a long time. Smoke and fire detectors complete the security offer. For example, driving services can be offered for the topic of mobility. Customers can be brought into town for shopping or cultural events. The mobility service can then either be used according to a regular timetable or ordered as required. For the regular use of a cultural offer, special offers can be put together and, if necessary, a group service can be organized.
However, the real advantage of the Elderly Care package is that older people can live much longer and more independently in their own home without constant care, which would also reduce costs from an economic point of view. The offer can be categorized accordingly so that not everything has to be used. Within this context, various offers can be made with corresponding price levels. In addition, another advantage is that applications that already exist in many cities are routed to an operator platform so that the customer only has one contact person for the mediation of all potential services.

5. DISCUSSION

The energy industry is currently in a transformation process that is steadily gaining momentum not only through decarbonization, but also through digitalization. The previous business model of small and mid-sized energy companies, the pure supply of users with electrical energy, will no longer be sufficient as a sole business model in the future. Rather, the small and mid-sized energy companies will increasingly have to offer innovative digital business models in order to maintain market shares and generate new added value. As the business models described show, demand does not only come from younger, tech-savvy customer groups. As part of the trend analysis and the target market analysis, it was shown that there is a need for innovative business models in many areas, including that of the older target group as well. A detachment from the pure commodity business model of power supply is possible. A large number of other business models can be coupled to the basic business model of supplying users with green electricity, which, in addition to increasing added value, finally also enables the energy company to retain customers through differentiable products.
The inexorably advancing digitalization in the German energy industry, to which the future market penetration of digital intelligent measuring systems belongs as an essential part, offers the potential to introduce a variety of business models. In some cases, however, the emerging niches are already being filled by new competitors. To give an example: The originally Norwegian startup Tibber also offers its customers an electricity tariff at the purchase price and additional smart home applications in Germany and other EU countries. This means Tibber Deutschland GmbH does not make any profit from the sale of the electricity. The customer only pays the purchase price plus the statutory surcharges, levies and taxes as well as network charges. Tibber Deutschland GmbH wants to pass the electricity price on the electricity exchange, which has been falling for years, on to customers. Only a small monthly basic fee has to be paid to Tibber Deutschland GmbH in addition to the consumption

costs. (Hüfner D. 2020) Even if it still remains to be seen to what extent the users actually benefit from the promised monetary added value by passing on the fluctuating electricity prices on the stock exchange, it has already been shown that the established energy companies have so far only little to set against this innovative business model.

6. CONCLUSION

In conclusion, the trend analysis carried out, the target market analysis and the development of possible business models show that with a corresponding design of the business model, a significant increase in added value can be achieved and new customer groups can be developed. The so far often missing customer loyalty, which is difficult to realize by trading with a commodity product even in the regional environment of small and medium-sized energy companies, could be significantly increased. The business models developed cover a large number of different user needs from a wide variety of customer groups, which are briefly shown in Chapter 2. The "Elderly Care" business model offers a particularly interesting use case. Due to increasing life expectancy and demographic change, there will be an increasing need for intelligent solutions in the coming years, which could be satisfied by implementing the "Elderly Care" business model. Only if users can be offered a corresponding added value, they will also be prepared to pay a corresponding additional price. The first providers have already recognized this and are trying to occupy appropriate niches. Intelligent measurement systems that support the implementation of innovative business models, for example by integrating a smart home system, are not yet widespread. In the coming years, however, this will change due to the rollout obligation, which will lead to a higher degree of digitalization at energy companies, which has so far been one of the obstacles in the implementation of digital innovations.

By using these intelligent measuring systems in connection with smart home components, additional service offers can be realized. In the example of the "Elderly Care" business model, this enables users to continue their daily lives independently even in old age. Thus, the needs of these users, in particular in the areas of safety, health, mobility, comfort and culture, can be satisfied which is gaining relevance especially through the increasing number of people in this customer group.

Energy companies that take this development into account will have to develop into smart electricity suppliers and service providers in the future. In turn, the energy companies that do not take these essential trends into account in their developments will increasingly lose market shares to smart electricity suppliers and service providers, which in the long term is likely to threaten the existence of these companies.

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CONTRIBUTION OF SERVITISATION TO CIRCULAR CHANGE

Metka Stare, Andreja Jaklic

Purpose: To identify key challenges related to the gap in the implementation of two interlinked phenomena –servitization and circular change in a transition economy context.
Design/Methodology/Approach: The selection of case study methodology derives from the lack of evidence in academic and business literature in Slovenia, referring in particular to the discussion of advanced servitization. The process of servitization is illustrated in the case both the manufacturing and service company.
Findings: The lag in introducing advanced processes of servitization and related business models in a transition economy context reflects the lack of resources (both finance and skills) as well as the need to broaden the understanding of new sources of values creation. These difficulties not only impede companies in introducing new business models further encouraged by digitalization that could strengthen their competitiveness, but also slows down the implementation of circular changes in the economy.
Originality/Value: The contribution of the paper relates to new knowledge on the multi-dimensional linkages and synergies of goods and services production at the intersection of servitization and circular change in the manufacturing and service companies .

KEYWORDS: servitisation, circular change, advanced services, case study (max 6 key words.

1. INTRODUCTION

Servitization of manufacturing companies extends beyond adding complementary services to goods (e.g. maintenance) by selling services of goods instead of goods themselves (e.g. from Rolls Royce business model »power-by-the hour» to »light as a service« by Phillips). Thanks to digitalization service companies may engage in servitization as well by providing innovative packages to customers (e.g. Netflix subscription model or Teletourguide, Live, interactive teletours). Moreover, large and small and medium sized enterprises (SME) can engage in such process. Servitization activities lead to new value streams improving the profitability of companies, to differentiation from competitors and better addressing customer needs and preferences. To be efficient and sustainable, the servitizations requires deep changes in the management process along the value chain. From the perspective of sustainability servitization contributes to prolonging the lifetime of goods, decreasing the use of materials and energy that are among important characteristics of circular economy even though its concept is much broader. The pioneers of circular change can be found among large multinational companies, start-ups, cities, local communities and NGOs. They are exploiting the potential of circular change (e.g. Ecovative replaces plastic with biomaterial packaging; Triciclos operates the largest network of recycling stations in South America; Amsterdam is developing a roadmap for the first circular city, etc.). The cases illustrate that the shift towards circular economy could be a viable option bringing benefits to diverse stakeholders and the broader community. Irrespective of a large number of activities across countries towards circular change there is an alarming statistics that circularity gap is not closing and that the world is only 8.6% circular (Circularity gap report, 2020). In view of the climate change and unsustainable consumption patterns, faster implementation of circular economy and servitization models could importantly contribute to mitigating these challenges, especially so via facilitating role of digitalisation fostering the efficiency of new business models, networking and collaboration between private, public and civic actors.

On one hand, the implementation of servitization in companies proves to be complex and demanding process bearing effects only in the long term that may be particularly troublesome for SME. On the other hand, circular change that integrates business, public and broad societal aspects requires systemic multi-stakeholder approach and support of different policies. The uptake of both processes differs across companies, industries and countries. Nonetheless, the share of services in total manufacturing output has increased for the majority of the EU countries between 2000 and 2014, but decreased in a number of Central-Eastern European countries (Slovenia, Bulgaria, Croatia, Romania and Austria). Another study of servitization in manufacturing SME in the EU focusing on ten EU economies reveals that on average SMEs in Central and East EU countries show lower extent of servitization than those in old EU member states (EC, 2018)[1]. Furthermore, the gap is deeper when more innovative product-service combinations, such as design and 3D related services are considered. It has been argued that servitisation and digitalization will have profound implications for Central European manufacturing (Qvist-Sørensen, 2020).

The comparative analysis of circular change activities focusing on six indicators related to reduction, reuse and recycling, demonstrates that the progress towards circular economy across EU economies has been heterogenuos in the period 2006 – 2016. In general, findings suggest that the preformance of countries is linked to GDP (in PPS) and ratio of GDP to circular economy investments. Further on, the leading countries reveal higher number of patents and implemented best practices related to circular economy. Nevertheless, some Central and East EU economies are ranked high in individual six indicators (e.g. Estonia, Poland and Slovenia) (Marino and Pariso, 2020). All the same, it needs to be acknowledged that the analysis does not include data on maintenance of equipment, product life extension, or advanced product service combinations that are important for the implementation of both the servitization and circular economy.

In this context, the main objective of the paper is to provide insight into the characteristics of servitistion processes in Central EU transition economy and link it to circular change. We have selected the case of Slovenia where manufacturing industry and technological innovations are highly appreciated in strengthening the competitiveness of companies and economy as a whole. While less complex servitization types, such as after sales services, installation, maintenance and repair are recognized and applied by the manufacturing companies in Slovenia the implementation of innovative product-service combinations and apprehension of their benefits lag behind that is in line with the findings of other Central and East EU economies (EC, 2018). The objective of the paper is to examine the process of servitization in two companies, identify benefits, barriers and challenges of introducing new service business models in Slovenia. Learning from their practice in implementing servitization may inform business strategies in other comanies, as well as policies supporting circular change.

Following the introduction we discuss the theoretical approach to circluar economy and servitisation focusing on the intersection between the two phenomena. We briefly explain the methodological approach of the paper based on case study analysis. The central part of the paper explores the experience of two companies and their approach to integrating servitization and circular change. The context of a transition economy where manufacturing firms prevail in exports and innovation activities provides insight into manufacturing oriented mindset that slows down the adoption of new business models, new sources of value creation as well as circular change implementation. However, the case of service company demonstrates that the start-up mentality is better aligned to venture into the implementation of new business model. The final section describes the main findings and presents some conclusions.

2. THEORETICAL BACKGROUND

The linkages between servitization and circular economy are rooted in the discussions on sustainability from the 1980s onwards, proposing new concepts, such as *service-life extension* of goods through reuse, repair and re-manufacturing (Stahel and Reday-Mulvey 1981); *selling goods as services* to increase the competitiveness of businesses (Stahel, 1982); the *shift to service (cycle) economy* and *closing the material loops* (Giarini and Stahel 1989); *functional economy* that optimizes the use (or function) of goods and services (Stahel, 1996). In the new millennium the research on circular

[1] It distinguishes five types of product-service combinations (updated and extended from Neely 2008): after sales services; maintenance and repair; consulting, design and engineering; logistic and transportation; and full process outsourcing that refers to managing complete production lines or business activities on behalf of clients. The latter type is at the top of the service staircase as it includes multiple types of services.

economy expanded, pointing to other dimensions of the phenomenon, such as industrial symbiosis (Antikainen and Valkokari 2016), circular design enabling the suitability of products for multiple life-cycles satisfying more consumers (De los Rios and Charnley, 2017). Ellen MacArthur Foundation (2015) summarized diverse aspects of circular economy as a systemic approach to economic development designed to benefit businesses, society, and the environment.

Almost in parallel to sustainability debates a business perspective of the growing role of services in manufacturing industries was pointed out as well. Vandermerwe and Rada (1988) coined and defined the term servitization as the "increased offering of combinations of goods, services, support, self-service and knowledge by manufacturing companies that add value to core product offerings for the customers. In the new millennium the literature on servitization proliferated and increasing focus has been put on process dimension suggesting that "servitization involves the innovation of an organisation's capabilities and processes so that it can better create mutual value through a shift from selling product to selling product-service systems" (Neely 2008). In reviewing a large amount of literature on servitization Baines et al. (2009) observed that the phenomenon is addressed from various perspectives and research strands calling to bring together researchers from the different communities to refine the understanding. With the growing importance of digital technologies servitization expanded into more advanced types.

Recent study based on the experience and practice of thirty SMEs from different manufacturing industries and software developing service companies, denotes servitization as "processes through which a business, usually manufacturing and technology-based, innovates its capabilities to compete through services rather than product alone" (Baines et al., 2020). Even if this definition refers to »usually manufacturing business« it does not exclude service companies to servitize further, given the driving power of digitalization in servititizing processes (e.g. software as a service, big data analytics, IOT, cloud computing, AI) in most economic activites. The same study describes the evolution of servitization via changing role of services, from supporting the products (e.g. base services and intermediate services) to supporting the customers (advanced services). As affirmed by Baines et al. (2020) servitization is a paradigm shift that is more organisational than technological. Together with digital transformation this may pose additional challenges to manufacturing. Accordingly, manufacturing companies need to rethink how digital technologies can secure market success on a longer term (Qvist-Sørensen, 2020). Nonetheless, both organisational and technological aspect of servitization need to be taken as complements to be efficient. It remains to be seen how the technological progress may influence the servitization process in future and how it may best contribute to circular economy uptake.

Scholarly discussions are increasingly influenced by pressing environmental issues, intensive global competition and advanced digitalisation giving rise to a large amount of literature that addresses these topics from the perspective of businesses, public policies, technological advance, etc. In this vein, a number of studies explore the intersection and relevance of linkages between servitization and circular economy that bring synergy (Spring and Araujo 2016; Correa 2018; Han et al. 2020; Giardelli et al. 2021) that is also a point of departure of our analysis.

3. METHODOLOGICAL APPROACH

The selection of methodology for exploring the characteristics of servitiztion processes in Slovenia is based on the scarcity of evidence on the phenomenon in academic literature, business journals and anecdotal evidence. This refers in particular to the lack of data and analyses on more advanced types of servitization in manufacturing companies while some studies report on the servitisation related to basic and intermediate services. Slovenia is analyzed in a study on companies from three countries (together with Croatia and Serbia) using data of the European Manufacturing Survey (2015). The findings demonstrate that manufacturing companies offering maintenance, repair and training in these three economies are more product than service oriented (Marjanovic et al., 2020). Also, the evidence from the case study on service company in Slovenia engaged in real estate management and logistic services demonstrates its intensive engagement in a number of servitization processes, from maintenance and repair, circular design, segmentation of waste for reuse of secondary raw material to the provision of e-mobility, in the aim to contribute to circular change (Stare, 2020). The COVID 19 lock-down inspired a new marketing model for “no contact” provision of vegetables to local customers. A number of farmers that could not sell their products in open markets established a website and started delivering boxes of healthy food to customers at their door steps for a monthly fee. Beyond pizza and fast food delivery to customers also high class restaurants decided to offer home delivery to customers during the pandemic. The reason was not only to do at least some business and keep the employees, but also to show the care to customers and keep their loyalty. These and many other cases illustrate that servitization opportunities exist in diverse activities beyond manufacturing that will increase further by digitalisation.

To deepen the knowledge and evidence on servitization process in Slovenia we apply an exploratory analysis based on case study methodology that is considered to enable deeper insight into new phenomena and may contribute to constructing new theories (Creswell, 2008; Yin, 2009). Case study analysis implies the emphasis on processes thus encouraging to learn from implemented practices in companies (Vezzoli et al., 2015). Due to the lack of knowledge on advanced servitization practices in Slovenia that also contribute to circular change our research relies on triangulation of empirical data from interviews, financial reports and online resources. To understand specific features and management processes related to servitization we have selected two case studies of companies, one large manufacturing company and one small service company. The analysis of both cases serve to illustrates how the complementarity of servitization processes and the circular change go hand in hand.

4. CASE ANALYSIS

We study a manufacturing and a service company to examine the link between servitization and circular change. The first case illustrates a large manufacturing firm producing white goods since 1961 and supplied also basic services, such as repair and spare parts provision in home market and to its affiliates abroad. Owing to the participation in EU project the company recently started to test advanced services introducing a new business model for the innovative washing machines – instead buying them the customers are offered to buy the services of the washing machines. The second case relates to printing service start-up established in 2009. Its founders have chosen a new business model at the outset introducing a differentiated offer of services compared to the competitors already on the market. Due to limited space the analysis of the two cases is a very condensed description of key facts and motivations of the process of transformation leading to both more complex servitization and contributing to circular change.

Case 1: Gorenje, Hisense Group

Basic facts. Gorenje company was established in 1961. In 2020 it employed 3150 workers and exported around 95% of total production. Together with affiliated companies the headcount accounted to approx 10,000. After being acquired by Chinese Hisense Group in 2019 Gorenje became part of a large company with 90,000 employees. Hisense Gorenje focuses on white goods manufacturing and with new owner expects further growth in highly competitive industry. Gorenje developed a broad network of repair services to buyers of their products. So far, the management of the company did not consider the advanced services linked to their core products as a potential generator of revenue.

Motive for servitisation of washing machines derives from strong global competition on the market. However, being aware of the complexity of the servitisation process Gorenje company first engaged in the EU project “Resource conservative manufacturing” (ResCom, 2015-2017) aimed at development of a tool assisting the transformation aligned to circular economy. In this framework the company scrutinized an innovative business model that could bring value to the company as well as to customers, at the same time benefiting the environment. A new service business model was proposed where washing machines are not sold but leased to customers. The implementation would result in material and energy saving and decrease in CO2 emissions. These results encouraged the consortium of 13 partners, Gorenje included, to engage in a large demonstrator project “Resource-efficient circular product-service systems" (Horizon 2020; ReCiPSS, 2018-2022) considered as an upgrade to the traditional approach to circular economy. The new business model "pay-as-you-go" (pay per wash) is expected to start the test phase in April 2021 in Denmark and Sweden and later on also in the Netherlands and Slovenia. 350 washing machines adapted for long-life operation (premium brand ASKO) are to be included in the pilot. In addition, user interfaces are developed along with the logistics and information support platform. The interview with the company represenative revealed that in 2015 Gorenje company would not have been interested in the servitization if it weren't for EU co-funding of the project. In addition, participation in two projects benefited the company in terms of learning from other partners in the project that were more advanced in servitisation.

Transformation proces. During the participation of Gorenje in the ResCom project the reactions to the proposal of potentially introducing innovative service model were quite unfavourable and sceptical. They were observed by several company units (research and development, marketing, finance), as well as by the management since the model would present a huge change to traditional perception of the company as manufacturer (e.g. out of the company's comfort zone). The benefits of new model imlementation (e.g. material and energy saving and decrease CO2 emissions) were not considered sufficiently persuasive due to observed invisible costs, questioning financial viability of the model. Yet, the management supported the company's participation in the large demonstration project (ReCiPSS) that was appreciated also by the new owner of the company, Hisense Group. The awareness of the potential benefits of the new model - servitization started to grow with the gradual implementation of the pilot. However, also weaknesses, risks and unpredictability of total servitization costs were identified related to financial resources needed to bridge delayed return on investment and to new skills acquisition. The planning of servitization requires to consider cost/benefit ratio from a medium term perspective that is very different from the imperative of company's monthly reporting.

Potential results. The results of the pilot implementation in four countries, where the understanding and acceptance of advanced servitisation model differ, will enable the company to identify the response of diverse markets and market segments (business and individual consumers) and also to refine the model for global markets. The development of demonstrator project so far shows that servitization is a highly complex process. When adopted in regular business it will require restructuring and transformation of the company units dealing with washing machines in order to adapt the processes to the new business model and also to the role of customers as co-creators of value. The management of the company is increasingly recognizing that the future orientation of most manufacturing companies is heading towards extensive integration of services as value generators that also Gorenje company has to align with. The assessment of the interviewee based on current information of demonstrator project suggests that it the likelyhood of the implementation of the servitisation model of Gorenje company in two Scandinavian economies is very high (95%). The aepectations are that the company may progress with servitization also in the Netherlands given its advanced position concerning the circular change.

It is observed that enhanced digitalization (big data, IoT) provide an enabling and stimulative environment for servitisation that will encourage the company to proceed with servitization also in Slovenia. Nevertheless, pilot project in Slovenia will include only limited number of washing machines (approx. 20) suggesting that the company approaches servitisation very gradually on the domestic market. It remains to be seen how fast the Slovenian market may respond to the pilot given the fact that the notion of "ownership of things" in society is rather strong. Nevertheless, the interviewee estimates, that demonstrator project results will be a good starting point for the company to implement advanced servitisation model more broadly. For the companies in Slovenia the biggest challenge in catching up in advanced servitization refers to overcoming the finance gap due to delayed returns on investment. A viable option is external financing from various EU funds that could accelerate the process as they also contribute to circular change transformation that is among top policy priorities of the EU. In addition, favourable regulation in favour of "repairability" of things could foster the adoption of advanced servitisation as a profitable business model also contributing to circular economy. In big system such as Gorenje, it is essential to test new business models and new solutions in more developed markets before launching them on the home market. Finally, it is important to acknowledge that Gorenje company alone would not have started to walk the advanced servitization process without participating in two EU projects, gradually learning from project partners about the benefits and risks of advanced servitization and piloting the new model.

Case Analysis 2: Optiprint

Basic facts. The company was established in 2009 following the implementation of an idea of a University professor and a student within a project of how to create an entrepreneurial business plan. The company started with minimal capital of the founders and financial support of the Slovenian entrepreneurial fund for start-ups. The founders developed a new business model by offering the effective solution for office printing in the form of optimized rentals of multifunctional printers. For a fixed monthly fee, customers get "a care-free printing experience", i.e. complete service of high-speed printing, without the additional costs of buying printers and consumables. At present, the company and its six franchisees' employs 61 persons in Slovenia. In addition, four franchisees in the Balkan countries report 35 employees. The turnover of the company in Slovenia amounts to 2.5 million € and generates approx. 55,000 EUR of added value per employee.

Motive. While developing an entrepreneurial business plan for printing services the founders identified the gap in the market for printing services as well as the opportunity for a new business model, that would differentiate the company from the competitors. Since the outset, the objective of the company was to reduce the cost of printing by providing holistic services for consumers and at the same time create an eco-friendly solution. In 2009, when the company was established, the cartridges (still) represented significant cost, but also large environmental burden. Using local inputs and knowledge the company's R&D department developed an innovative ink supply system for printing - *Optiprint Ink Supply System* - that enables permanent ink supply for printing without replacing the cartridges. As a result, the printing costs declined for 50 to 80 % enabling a substantial margin (which was larger at the beginning than today). Low cost combined with professional maintenance and printing flexibility allows their customers to gain competitive advantage by saving time and money. Whereas the customers in Slovenia are rather sensitive to green solutions, slow pace of digital transformation in Central and East Europe (resulting in large printing needs) on the other hand offered ample business opportunities. Professional long-term relationship with customers, permanent innovation, fast reaction time and flexible renting packages accommodated to customers' needs enabled the Optiprint to grow rapidly in the last decade, not only in Slovenia, but also in the region. They offer customers a complete package of knowledge, training, equipment, ongoing support, and assistance. At present, the company has six franchisees in Slovenia and four in foreign markets (i.e. Croatia, Romania, Serbia, Bosna and Herzegovina). With a help of the Slovene franchisees the company is present also in Italy in border municipalities. Altogether, Optiprint serves over 4100 businesses, with an average 1.8 printing device per user (each of them accounts for less than 2% of the total revenue), allowing the company to minimize the risk of single customer failure. The experienced guidance and expansion through franchise model proved resilient also during the COVID-19 outbreak. Slovenian Business Club awarded Optiprint as one of the most innovative and inspiring stories during the pandemic in 2020, as they swiftly enabled renting and safe delivery of printers for home-schooling and work offering "printer to-go" for 1€ per day.

Transformation process. Key value added of the company comes from the growing number of services for customers (e.g. servitization) and economies of scale. Over the years they improved their business models introducing a mix of more sophisticated and high quality services enabling "care free printing" for customers. Since the beginning, the company actively collaborates with different printer manufacturers. These activities require constant optimization of processes within the company system, as well as regular monitoring of the changing customer needs. Accommodating to these challenges, the company gradually upgrades its product-service combination leading towards advanced services provision. From the outset, the company contributes directly and indirectly to circular change of Slovenia (also a partner of Slovenian green partnership for recovery). Based on innovative solutions for cartridges (technological change in printers) and fast adaptation of the servitization business model the company prolongs the lifespan of multifunctional printers through regular maintenance and service. With the continuous ink supply system of an endless cartridge, they reduce the number of cartridges in landfills and decrease the harmful environmental effects of cartridges composed mainly of plastics and metals, which degrade extremely slow. So far, the company saved over 3.8 million cartridges. Additional contribution to sustainability comes from the ink jet printing that consumes 90-95% less energy than laser printing. Transformative effects on the economy and society are visible in reduced pollution and in changes of behaviour. Indirect contribution to circular economy by the company relates to attracting companies to imitate their innovative and successful business model. These are micro firms, emerging sometimes also from their franchisees, which serve mainly households and other micro firms, but can hardly accommodate to the printing needs of growing SME and large firms. While the readiness for circular change is generally increasing in Slovenia in both large companies and SME (main customers of Optiprint) the main challenge for sustaining growth of Optiprint relates to diminishing margins and fast technological changes in printing industry. They are forcing the company to constant innovation, adaptation of ink system, organizational change and agility in developing attractive packages for users. Digitalization offers not only large opportunities but also presents a challenge for the company's strategy and the need to explore ways and means for accommodating to changing customer needs by introducing new services to servitization portfolio (for example, documents management system, as well as expanding to more foreign markets).

5.FINDINGS AND CONLUSIONS

The paper explores introduction of advanced services to product service combinations underpinned by innovation. It identifies the obstacles, benefits and drawbacks in two case companies in the setting of a transition economy. Different servitization approaches to creation of new revenue streams that contribute to circular change are illustrated, reflecting a win-win situation for both the company, consumers and the economy. Lack of knowledge, skills and experience in servitization, regulatory environment not encouraging the adoption of new business models and lack of servitization conducive attitude are reducing the the exploitation of the potential of new sources of value creation by companies and slowing down the implementaion of circular change. The findings of the analysis suggest that manufacturing firms in the transition economy context of Slovenia demonstrate higher affinity to implement less complex servitization processes (e.g. focusing on the base services related to product provision) than providing advanced services centred on customers. Such approach could be understood as the former approach to servitization does not require large resources or profound changes of business processes, whereas the latter calls for the overhaul of all business processes.

The transformation includes dedicated and coherent management, employee training and re-skilling in addition to securing substantial finance to bridge the gap of delayed return on investment. Nevertheless, it seems that a mind-set change of the top management and of the heads of departments is a starting point to kick-off the transformation process and support it throughout the implementation of the total process. In this context, one can understand why the large manufacturing company Gorenje has taken a gradual and very careful approach that started with the participation in the EU research project enabling it to learn and better understand what could be the benefits and risks of advanced servitization. The company is engaged in the project also in the second phase, by pilot testing of the servitization model in mature markets (e.g. offering services of washing machines instead of selling them to customers). The experience from the latter will enable the company to adjust the pilot business model and test it also in transition economy context of Slovenia where different behaviour of consumers may be expected.

The paper brings new knowledge on the multi-dimensional linkages and synergies of goods and services production via the application of new business models and processes in the setting of a transition economy not yet adapted sufficiently to the challenges of harsh global competition and multiple dimensions of circular change. Keeping in mind that digitalisation facilitates both the servitization of companies and circular change of economies it is of utmost importance to actively grasp these opportunities by introducing new business models and reaping the benefits. In the case of second company, start-up Optiprint, the link between circular change and servitization was well understood already at the company's entry on the market with the new business model that differed from the one of competitors. As the model turned out to be very successful and profitable the company replicated it via franchises at home and abroad. Despite the emergence of imitators on the home market, the Optiprint succeeded to be ahead of them with agility and service quality.

While the importance of adding services to manufacturing companies' portfolio and progressive engagement in circular change increasingly figure in business strategies of Slovenian companies, these issues are too often addressed separately that may result in slower implementation of new business models based on advanced services. Moreover, the exploitation of the new revenue streams and of the potential of getting a competitive edge are delayed, applying also to the implementation of circular economy. The understanding of circular change and its implementation in Slovenia seems to be catching up well in some areas, such as maintenance, waste collection and management, reuse of materials, energy efficiency, e-mobility services whereas apprehension and adoption of advanced services in servitization of manufacturing companies was so far rarely an option. Large financial resources secured by EU Green Deal prioritize support for circular change activities in the member states that opens a window of opportunity for companies. Slovenia could utilize these funds also to support the implementation of advanced servitization models in companies thereby mitigating an important barrier to carrying out the related transformations and contributing to circular change.

A caveat applies to the applicability of the findings based on the analysis of two case companies engaged in the advanced servitization and circular change. Nonetheless, the validity of our findings transcends specific characteristics of the two companies. They provide valuable lessons and insights from servitization (in manufacturing and service company) that may encourage other companies in Slovenia to accelerate the implementation of digitalization, introduce novel product-service combinations and create new services for customers, in order to step up the competitiveness and at the same time contribute to circular change. Based on the analysis we propose directions of future research, such as to investigate in detail potential sunk and unplanned cost of servitization that might prevent the turning of pilots into an effective transformation (observed in Case 1); examine the optimization process of servitization (noticed in Case 2). Analysis of data obtained by monitoring customer behaviour could provide insight in customer needs and lifestyles which are changing rapidly, also due to the pandemic. Finally, we encourage the research of servitization process in a larger sample of companies, where insights from consumers' perspective could uncover segments with different behaviour and preferences. The second case study of our analysis illustrates that the synergy between servitization and circular change comes to life faster if consumer driven.

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SERVICE OFFER CLASSIFICATION AS A PROCESS RATHER THAN AN OUTCOME: SERVICE DEVELOPMENT IN THE ENERGY SECTOR

Anna Norinder, Árni Halldórsson

ABSTRACT

Purpose: Energy providers face a major challenge at the market end of their supply chain, requiring a transition towards service-oriented organisation. Albeit current theory offers classifications to assist this, services are often presented as theoretical categories, with somewhat unclear conceptual boundaries. This study examines how existing service classifications can be developed into a framework applicable by practitioners.

Design/Methodology/Approach: An interactive research design (co-creation of research problem and co-analysis) of a single case process study over 13 months was applied, analysing 38 dimensions to classify service offerings.

Findings: Advancing service offers in the context of energy sector require an actionable classification framework that builds upon three key features: (1) multiple adaptable dimensions; (2) a set of guiding process steps; and (3) situation of the application for a particular purpose.

Originality/Value: A profile of an advanced energy service offer is partly a result of a picture generated from a classification framework but ought to be integrated with the process that leads to the adaption of that framework.

KEYWORDS: Service offer classification, Framework, Process, Servitization, Energy sector

1. INTRODUCTION

Alongside the transition to sustainable sources the energy sector is undergoing a major transformation calling for approaches from service research. The increased use of renewable sources for energy production has resulted in a more distributed production of energy and introduces new challenges with regards to power supply volatility (Fogelberg and Lazarczyk, 2017). New actors, such as Tesla, stating 'We power everything', enter the sector and large retailers (e.g. Stena and IKEA) become energy producers with parks for wind and solar power to power their facilities as well as offer energy related services to their customers. Roles are changing; consumers producing energy (e.g. solar panels on roofs) are no longer only a customer to energy companies but also suppliers of their surplus energy to the grid, i.e. *prosumers*. Further, electrification of the transport sector introduces customer segments demanding charging infrastructure, new power requirements and great volatility in demand. By this, volatility has increased on both supply and demand side resulting in power transmission and peak management challenges. This calls for better demand management and services for energy resilience. One possible scenario is transforming the energy system into a smart-grid, which was called for a while ago (Amin, 2004). Such a decentralised but interconnected structure would open for a broader participation in the electricity market (Hojčková et al., 2018). Scaling up the smart-grid requires new digital service offers.

New intermediaries are entering the market, taking a rather bold approach in positioning themselves with digital service offers and 'smarter' alternatives to traditional energy companies. To this end, adopting a service perspective is seen as an option for energy providers to not only deliver kWh production and distribution infrastructure but also enhance their customer position and avoid being pushed up-stream in the supply chain to become a mere provider of energy as commodity.

The service concept offers dimensions relevant to analyse these challenges and to guide the transformation required towards increased service provision in the energy sector. Various classifications of service offerings (Cook et al., 1999; Lovelock, 1983) and manufacturing-related services (Raddats et al., 2019) have been developed. However, these are primarily developed as a part of theoretical discourse, and often not presented in a format directly applicable to practitioners. One issue is the great variety of classifications available. Another concern is conceptual slack; some frameworks struggle with a mix of strategies and offerings, calling further clarification (Raddats and Kowalkowski, 2014) or even redefinition (Biemans et al., 2016). Moreover, these frameworks are more concerned with themes and categories rather than processes that put these into play in practice.

On the backdrop of this, the purpose of this study is to examine how existing service classifications can be developed into a framework applicable by practitioners.

2. LITERATURE

The three theoretical building blocks for the classification framework are: energy literature on services, service classifications in service research and service offers in servitization. Putting boundaries around concepts, the literature refers to classifications, including typologies being primarily conceptual (Doty and Glick, 1994) and taxonomies being primarily empirical (Bailey, 1994). We follow Bailey's (1994) broader view on classification as a way of capturing both a process and an end result, and we seek to identify fundamental or defining characteristics to avoid a trivial classification (Bailey, 1994).

2.1 Services in the Energy Literature

Although concepts such as *Power-as-a-Service*, *Energy-as-a-Service* and *Electricity-as-a-Service* (Xu et al., 2018) are used in the energy literature, the conception of *energy services* is all but clear. Here, energy services root back to 1980s (Olerup, 1998), and the view that it is not energy customers need, but rather energy services provided by the energy system, is prevalent in this literature (Haas et al., 2008; Hunt and Ryan, 2015). However, a specific definition of *energy services* is not agreed upon, and its meaning is often explained with reference to examples (Fell, 2017). Herein, *energy services* is used in at least three ways: (1) for provision of the energy itself, (2) for the outcome of the energy usage either focusing *functions performed using energy* or *benefits* from the energy usage such as cold drinks (Fell, 2017) and (3) as a description of services offered alongside energy provision, e.g. advice on increased energy efficiency.

2.2 Service Classifications in Service Research

In order to classify services offered by the energy sector, we use dimensions synthesised by Lovelock (1980). These dimensions, which are also recognised in recent servitization literature (Raddats et al., 2019), include 'breadth of service package' and 'discrete versus continuous customer-provider relationships'. The dimension on *extent of supply and demand fluctuation* is also interesting in with respect to the growing volatility in electricity supply/demand. Lovelock states that 'better insights may be obtained by using two or more classification schemes [dimensions] in combination…combined in matrixes' (Lovelock, 1980, p76) and proposes five questions to be answered (in one matrix each) to classify services (Lovelock, 1983). We follow this idea of using multiple dimensions and matrixes to classify a service offer so as to understand what is the nature of the service. Later, the dimensions were extended by information services relevant for 'collecting, manipulating, interpreting, and transmitting data to create value' (Lovelock and Yip, 1996, p68). Other dimensions include by whom the services are used, i.e. by the buyer or brought forward in the value chain to the buyers customer (Wynstra et al., 2006), capital intensity (Cook et al., 1999) and knowledge-intensity (Glückler and Hammer, 2011).

2.3 Service Offer Classifications, Typologies and Taxonomies in Servitization

Raddats and Kowalkowski (2014) and Raddats et al., (2019) propose dimensions and taxonomies respectively, to 'distinguish between manufacturer's service offerings' (Raddats et al., 2019) . Whilst these provide useful classifications for researchers, it is difficult to combine these or 'further consolidate the disparate frameworks' (Raddats and Kowalkowski 2014, p31) into an actionable framework. More specifically, differences in use of specific terms within and across some classifications, what may be termed as conceptual slack, make it difficult to select amongst them, and then apply in a consolidated way. This challenge is threefold: (1) *Vocabulary.* Specific service dimensions and -types may be defined differently across various frameworks. (2) Classifications contain *latent aspects* that provide clarity needed rather than the dimensions explicitly stated. (3) *Aspects are only used partially*. As consequence, services can be classified into a category where they might not fit well to the overall description. Addressing this challenge and understanding how existing service classification frameworks can be made applicable by practitioners, the classifications identified in Table 1 were reviewed with regards to their use of dimensions.

Table 1: An overview of dimensions used in extant classifications

● = Dimension or Category • = Latent aspect	Mathieu, 2001	Windahl and Lakemond, 2010	Cusumano et al, 2015	Penttinen and Palmer, 2007	Matthyssens and Vandenbempt, 2010	Matthyssens and Vandenbempt, 2008	Ulaga and Reinartz, 2011	Baines and W. Lightfoot, 2014	Witell and Löfgren, 2013	Davies et al, 2006	Oliva and Kallenberg, 2003	Coreynen et al., 2017	Tukker, 2004
Services supporting products vs. services supporting the customer's actions	●				•		●				●	●	
Product oriented vs. service oriented		●			●								●
Customer vs. supplier ownership of equipment		●	•		•		•	•					•
Product complement vs. substitutes			●										
Transactional vs. relational	•			●		•	•	•			●		
Standardization vs. customisation	•		●		●	●	•			•			
Offered individually vs. integrated bundles		•	•	●		●	•		•	•			
Input- vs. output-based					•		●	•			•	●	●
Base vs. intermediate vs. advanced		•					•	●					
Free vs. chargeable							•	•	●				
Own products vs. multivendor							•			●			

This review revealed further that different groups of dimensions to classify services exists, e.g. those focussed on different customer values and other concerning different payment models. To enhance the clarity of our own approach, we explored various structures to organise the variety of dimensions into broad, yet distinct categories. In order to put boundaries around the variety of dimensions offered in the service literature and, the first sorting into distinct categories made use of *elements* of a business model (Ritter and Lettl, 2018). This literature suggests either three (e.g. Bocken et al., 2014) or four elements (e.g. Gassmann et al., 2014). For the purpose of this research, four commonly used elements were selected: customer, value proposition, value creation and value capture. This helped to distinguish between groups while minimising risk of losing dimensions in the empirical analysis.

3. RESEARCH METHODOLOGY

The study was guided by engaged scholarship as research design (Van de Ven, 2007), following the interactive and abductive research process outlined in Figure 1.

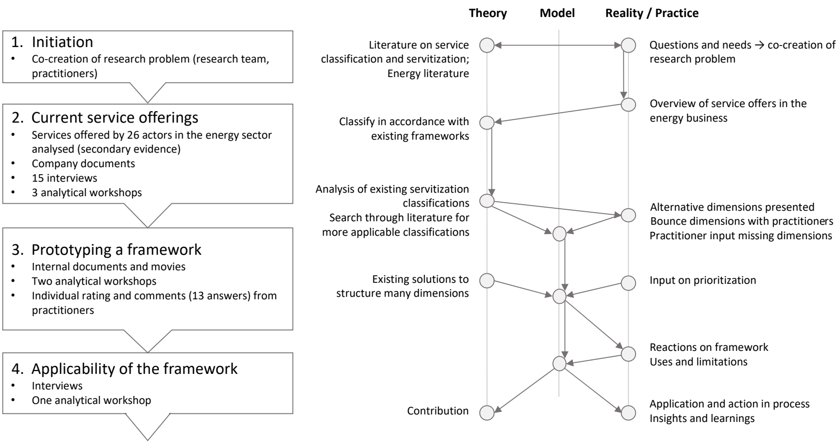

Figure 1: Interactive research design: From initiation to a ready-to-use framework

A large Swedish provider of energy and energy services was sampled as a unique case (Eisenhardt and Graebner, 2007) allowing an in-depth study of an organization undergoing a major change with respect to organization, portfolio of service offers and development. Sampling of individuals within the organization was based upon high-experience level (Van de Ven, 2007), primarily working with development of market offerings. Data was also collected from other parts of the organization with customer interaction. The research problem and parts of data analysis were co-created in an interactive process between practitioners and the research team. As the organisation is going through a transition towards a more customer-driven service development, the research included development of an actionable framework to support this work, with particular attention to the context of the company and its ongoing transition. Multiple sources of evidence were collected over a period of 13 months; semi-structured interviews, analytical seminars and observations. To avoid an idiosyncratic view on services, additional secondary data was collected on services offered by 26 different firms in the energy sector. The practitioners took part in the analysis of the data through a series of workshops in which 38 dimensions for classification of service offers were identified and analysed with respect to relevance and their explanatory power in relation to the participants' particular situation. Enhancement of trustworthiness as a quality criterion followed the guidelines in Elg et al. (2020): catalytic validity (changes to the prototype encouraged as part of the research design), democratic validity (reflection and feedback gathered from participants) and process validity (establishing good face-to-face relationships with participants, carefully record evidence from the workshops).

4. FINDINGS

The findings are here presented in line with the interactive and abductive process approach. Concepts and classifications mentioned in section 2 were used in analytical workshops with practitioners, hence, this section makes a few references to literature so as to place findings in their correct sequence.

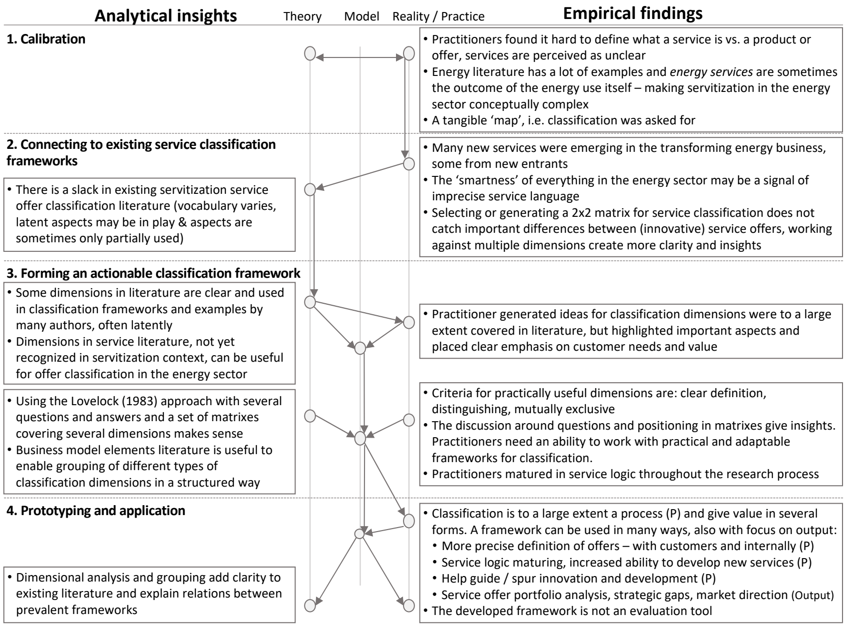

Figure 2: Findings outlined in accordance with the abductive process study approach

Phase 1: Calibration. Key findings here were related to challenges for practitioners in the energy company to define what a service vs. a product offer is, and using a precise language in service development. Services were offered by the energy company, including advanced services such as indoor temperature at a fixed price, but primarily associated to the heating products and less so to the electricity products. However, as a result of past organisational practices, the notion of *energy services* had been given a specific meaning internally in the company, not fully shared across the organisation, and not fully in line with other views in both literature and in the sector. In order to proceed with the work it was decided to take a broader perspective on services in the energy sector and not focus on *energy services* as defined by the company. A tangible map of various types of services, i.e. classification, was asked for.

Phase 2: Connecting to existing service classification frameworks. Going beyond the energy company, mapping service offers in the energy sector with existing classification frameworks resulted in both analytical and empirical insights. First, the conceptual slack observed during the literature review became also an issue here in that practitioners found it difficult to relate to the existing service classification frameworks. Second, it was observed that practitioners could relate very different service offers to the same quadrant in a classification framework. Differences in service offers came through only when one service was mapped using several different classifications. By this, it became apparent that in order to understand the nature and boundaries of a service offer it was necessary to apply a number of dimensions rather than using a 2 by 2 (or 3) matrix. This required a thorough analysis of existing frameworks to find relevant dimensions possible to combine.

Phase 3: Forming an actionable classification framework. Relevant dimensions was gathered from literature on services, servitization and energy, as well as based on input from practitioners (interviews, workshops, secondary data). Dimensions proposed in this process, by practitioners, included: *knowledge vs. hands-on execution*, *soft vs. hard customer value* and a dimension on how to *meet different types of customer needs*, i.e. consultative efforts vs. management of energy systems vs. providing customers with tools for use by themselves. Here, it was noted by the research team that this last dimension is similar to a distinction by Baines and Lightfoot (2014) into: customers who want to do it themselves, customers who want us to do it with them and customers who want us to do it for them, respectively. The dimensions discussed with and presented to the practitioners were rated by them on a 1-5 scale, followed by their comments (after having classified a few of their own services and a few from competitors), as well as on the researchers' effort to classify offers from the 26 benchmarked firms. This created a joint view of the most useful dimensions against the three criteria developed based on challenges identified in previous phase: *Clear* (easy to understand and well defined to avoid ambiguity in classification); *Distinguishing* (separating different service offers); *Mutually exclusive* (dimensions without overlap, to limit number of dimensions needed and enhance adaptability of the framework). Examples of dimensions rated high by practitioners were: *customer needs* (the to, with, for - dimension mentioned above) and *promise* in the form of input vs. output. Example comments from practitioners on these were: 'describes the character of the service' and 'it's important to be explicit on the promise'. Examples of dimensions appreciated by the researchers, but only some of the practitioners were: *where in the energy supply chain is the focal point of service*? (supporting the customer's consumption of energy, the customer's own production of energy, the distribution/network balancing or even customer needs outside the energy supply chain) and the *position of the service offer* in the value chain.

The prioritised dimensions were fitted to a framework guided by Lovelock's (1983) approach to use a set of questions and matrixes to classify services. In order to group the questions and dimensions, the four key elements of a business model discussed in section 2 were considered useful. Figure 3 depicts the overall framework, *a service offer canvas* with four groups of questions and dimensions.

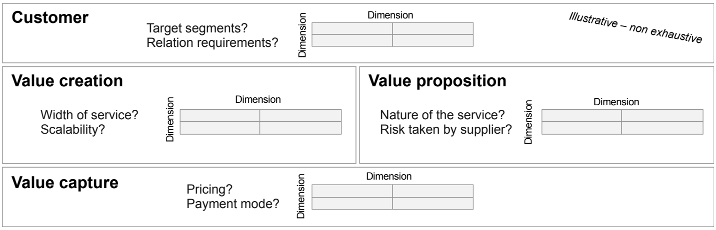

Figure 3: Illustration of the service offer canvas with four groups of questions and dimensions

Phase 4: Prototyping and application. In analytical workshops with practitioners, both limitations of the emerging framework in Figure 3 and the importance of ability to work with it were covered. Although both our intention and that of the practitioners had been to develop a classification from which the output would be of primary use, we found that substantial value lay in the actual process of working with the classification questions in the framework. Practitioners expressed having matured in their language and service logic during the interactive process. When discussing how and where to apply the classification framework, uses related to activities and processes were identified. A finding, which has been tested, was thus that classification is a process where the discussion on and answering of questions give insights. A more comprehensive, harmonised and precise language enables improved internal cross-functional communication as well as external communication with customers and suppliers. For emerging service offer ideas the process of using the classification framework brought clarity of thought both of the idea holder and to the colleagues who needed to be involved in development. We also discovered that when going through the questions and associated matrixes, new ideas for service innovation and development came up along with ideas on improvements and digitalization opportunities for existing services. Of course the output of classification activities is also of use, e.g. for analysis of service offer portfolios. Figure 4 illustrates potential applications of the framework with respect to both the process and output of a service offer classification.

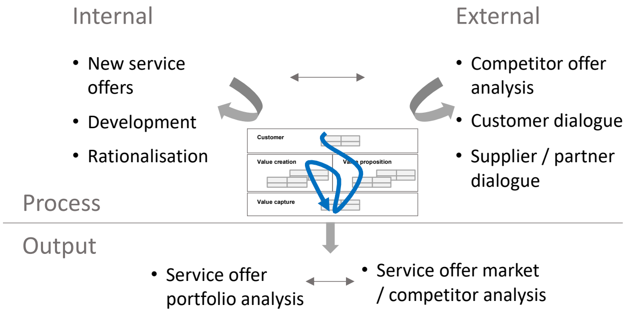

Figure 4: Potential process and output applications of a service offer classification framework

A limitation of the framework is that it focuses on what the service is rather than evaluation of alternative service offers, e.g. strategic fit and profitability. However, to be clear on what the service is or is meant to be, is valuable input to an evaluation and the framework pinpoint several strategic questions necessary to bring along for evaluation and decision, such as what level of risk the company is willing to take.

5. DISCUSSION

This study examined how existing service classifications can be developed into a framework applicable by practitioners. Overall, the study provides an insight into how service classification takes place and the value of such a process. Based on the abductive process-oriented approach, three contributions are presented: a framework with adaptable dimensions for service classification, including dimensions and overall structure; process steps guiding the classification and enhancing the actionability of the framework; and areas of applications for advancing services (internal/external and process/output).

First, selecting frameworks from literature, which often have other academics as primary audience, and adapting to a practitioners' setting is hindered by 'conceptual slack'. The findings offer a clarification of relationships between prevalent classification frameworks, as called for by Raddats and Kowalkowski (2014) and identify a list of dimensions, which is considered important in order to generate insights amongst practitioners during the classification process. To put this into a structure, the form of a *service offer canvas* is used, building on ideas from Lovelock (1980, 1983) and organised into four groups from the business model literature (Ritter and Lettl, 2018). By this, the study presents a classification framework that is adaptable, i.e. modifiable by practitioners who make use of dimensions that are regarded clear, distinguishing and mutually exclusive.

Second, following an interactive research design of an actual service classification in an energy company that is going through major change (market, organisation, customer offer) the study contributes with four distinct process steps to bring theoretical frameworks into application: calibration; connect to existing framework; forming a framework; prototyping and application. Hence, the classification activity cannot only build on a pre-defined list of dimensions but rather a list of potential dimensions that must be situated in the specific context, the practitioners understanding of these and ability to use them for a specific purpose. Considering the framework and the process that leads to it as somewhat inseparable, is in line with Bailey (1994) who regards classification as both an outcome and a process. Similarly, we show how a classification framework must carry both attributes to be adaptable and actionable. Through the process of both developing and using the framework practitioners can gain a more comprehensive, harmonised and precise language to enable improved internal cross-functional communication as well as external communication with customers and suppliers.

Third, during the development of the framework and discussion of adaptability of the various dimensions, the results revealed situations of service advancement in which the framework could be used. Overall, these can relate to *internal* organisation or interactions with *external* actors. Another distinction of areas of use are *process* (ability to understand, analyse and develop service offers with respect to e.g. innovation, development, identifying digitalization opportunities, and rationalization), and *output* of classification (used e.g. for portfolio analysis, aligning services offer with strategy and market opportunities).

6. CONCLUSIONS

Overall, advancing service offers as response to market development and new technological development, as investigated here in the context of the energy sector, requires a framework guiding practitioners in that work. Approaching *service offer classification as a process* helps practitioners to create accurate and common vocabulary across the organisation, which in turn enhances their ability to analyse and understand energy related services, to adopt a service logic and to develop new service offers. This study suggests that it is of great value to view service classification as a process rather than an outcome alone, as services is a multi-dimensional and complex phenomena often acting as a bridging concept in the transformation of organisations towards a more customer-oriented approach to development. First, this study presents *four process steps* that are necessary to arrive at such a framework. Second, whilst a framework always has some general traits it must be possible to situate it in the specific context of the practitioner. This makes the framework *adaptable.* Finally, the framework must provide an array of potential dimensions that are clear, distinguishing and mutually exclusive from which the practitioner can select. These were suggested to enhance the *actionability* of the framework, both in terms of defining dimensions but also to serve as criteria in the actual use of the framework, e.g. in service development. The practical contribution entails a framework but puts emphasis on the process that enhances the practitioners' ability to manoeuvre with a number of dimensions and learning to analyse their own context with respect to these with help from the framework. A key learning herein is both language precision and deeper understanding of a service logic. The theoretical implications seek to address conceptual slack in the academic literature and improve the practical usefulness of its frameworks. One implication herein is to advance our understanding of process concepts in the service literature by using process-oriented and interactive research design. Moreover, it is suggested that a classification framework as a structure must not be separated from its usage; the classification process itself will also provide insights for decision making, and not just a simple recommendation created by a framework. One limitation herein is that in this present study, the process was researcher-led, but a more pervasive use must necessarily have the practitioner leading the process.

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DESIGNING OVERARCHING SERVITIZATION STRATEGIES IN B2B MANUFACTURING INDUSTRY

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ABSTRACT:

Purpose: This paper addresses designing overarching servitization strategies in the B2B manufacturing industry, creating resilience to overcome disruptive events and achieving an overarching servitization strategy for a future business context.

Design/Methodology/Approach: We practised action research, carrying out and evaluating strategic design interventions in the case company.

Findings: We composed a framework to map and assess product-service value propositions co-created by ecosystem actors. We designed and evaluated sequential workshops that foster strategy design by participants without design skills.

Originality/Value: We explore how B2B manufacturers can transition towards resilient organizations and extracts some implications for the servitization and strategic design literature. It contributes to new methods for practitioners to guide overarching servitization design.

KEYWORDS: Overarching Servitization Strategy, Design Roadmapping, Ecosystems, Platform Strategy, Strategic Design, User Experience

1. INTRODUCTION:

This paper reports overarching servitization strategy design in the industrial manufacturing business, as part of a longitudinal case study of servitization design practices within a Dutch B2B company, with ca. 6.500 employees manufacturing capital goods for worldwide aviation business.

Covid-19 triggered the way manufacturers think about their current business (Belhadi et al., 2021; Huang & Farboudi Jahromi, 2020). Suddenly, the Covid-19 pandemic disrupted many businesses, particularly manufacturers that offer product-service value propositions such as the ones based on outcome-based or pay-per-use business models (Bond et al., 2020). Despite the initial advantage of pursuing a servitization strategy as a means of revenue growth, certain business models related to service design seem to have become a disadvantage. The wake-up call of an unexpected pandemic event challenged the resilience of many service-oriented companies (Bond et al., 2020). It catalyzed to reconsider their servitization design strategy as it changed the perspective of their current business. Furthermore, servitization scholars argue that building platform-based ecosystems engaging multiple partners with complementary capabilities and resources are more resilient to a disruptive change (Kapoor et al., 2021; Ostrom et al., 2015).

To address disruptive impact, we explore the case company's resilience and capability to design new business strategies and build overarching servitization-based ecosystems, co-creating product-service propositions and their associated business models.

This paper contributes to the servitization literature to understand the role of design as a driver for business growth and resilience by pursuing overarching servitization strategies and designing product-service ecosystems. It articulates overarching servitization design strategies and shows how servitization strategies and strategic design processes contribute to customer value, thus contributing to the design literature.

2. THEORETICAL BACKGROUND

2.1. DESIGN

Studies in the literature stream of design argued that a design-driven approach successfully creates product-service value propositions (Dong, 2015; R. Price et al., 2018). In particular, the aerospace industry research by Price et al. (2019), triggered by earlier research initiatives by Dong (2015), showed that design-driven innovation leads to successful results for organizations and industries. Price et al. (2019) captured cases across the Dutch aviation industry, analyzing the use of design to promote strategic innovation. She presented a classification of three typologies of innovation results. Increasingly designers have moved beyond integrated product engineering and user-interface design, developing innovation strategies within the organizational context (Calabretta et al., 2017). The field of strategic design is emerging as designers become increasingly involved in strategic innovation activities in companies and industry networks (Micheli et al., 2018). Strategic design distinctively addresses long-term sustainability and meaningful impact of product-service systems (Manzini & Vezzoli, 2003). In essence, strategic design puts designers in a new position of leading innovation closer to business and management (Canales Durón et al., 2019). This calls for designers to develop new processes, organizational capabilities, and methods to perform this role. Design Roadmapping is such a strategic design process that fosters competitive timing and innovation synergy in different organization levels (Simonse, 2018; Simonse et al., 2015), including four strategic design abilities: future visioning, modelling value exchange relations, orchestrating service co-creation, and transforming organizational networks (Canales Durón et al., 2019). In addition to Design Roadmapping of Simonse (2018), the Vision-in-Product method of Hekkert (2014) is another helpful strategic design process primarily focusing on creating value propositions aiming at end-users living in a future business context.

2.2. SERVITIZATION

Servitization is a valuable strategy for B2B manufacturers to extend their current product portfolio with linked services. Kohtamäki et al. (2018) defined servitization as a transition process from selling products to selling product-service systems. New product-service systems often use data platform technologies that open up many opportunities for differentiation in product-service propositions. A particular category focuses on engaging customers in value creation. Setting up data platforms is a servitization strategy newcomers commonly use to disrupt established markets. Therefore, technology-intensive manufacturers in the capital goods industry have shown a growing interest in servitization in their plans to develop a competitive advantage. Previous studies in the stream of the servitization literature learned that manufacturers that adopted servitization could increase their business profitability (Baines et al., 2010; Burton et al., 2017; Visnjic Kastalli & van Looy, 2013). In his servitization scoping review, Bluemink et al. (2020) uncovered a gap in servitization research, introducing overarching servitization strategies, providing product-service ecosystems addressing future end-users' needs and concerns. The case company decided to adopt a servitization strategy to increase its service business by offering services combined with its product offerings. Besides the traditional services like installed-based maintenance and spare parts supply, the company set up a UX design department to explore value propositions that deliver end-user experiences and services.

2.3. ECOSYSTEMS

There is a growing interest among researchers in interpreting and understanding an ecosystem as a collaborative effort in which multiple actors work together to develop and create a user value proposition. The mutual benefit of collaborating with business partners in a networked structure is that all actors in the ecosystem can capture value from the jointly generated revenue stream. Since they individually lack the necessary capabilities and resources to create a value proposition for an end-user in their joint business context, they combine their complementary strengths creating new business opportunities and increasing their resilience. Recent studies of Adler and Kapoor discuss and examine ecosystems in relation to business models, digital platform, coopetition, technology systems, supply chains, strategic alliances, and value networks. They shed light on organizational aspects, risks in ecosystem collaboration, and a framework to structure ecosystems elements (Adner, 2017; Adner & Kapoor, 2010; Kapoor et al., 2021). Other servitization scholars emphasize the vital role digital platforms play in connecting the product-service ecosystem actors in co-creating value propositions for the end-users. (Geliskhanov & Yudina, 2018; Hein et al., 2018; Lehtinen et al., 2019;

Yarali, 2018). In a recent paper, Jovanovic et al. (2021) studied platform technology's value to support and govern ecosystem relations and value transactions.

Despite research efforts in the three above domains, designing product-service ecosystems improving a B2B company's resilience and strengthening its strategic position has not been studied yet. How strategic design processes relate to servitization strategies and product-service ecosystems contributing to B2B manufacturers' resilience is understudied. In particular, we uncovered a lack of understanding of the strategic design's integrative role in creating overarching product-service ecosystems, addressing the latent needs, behaviour, concerns and values of end-users in a future business context (Bluemink et al., 2020).

This paper addresses the research question: how can B2B manufacturers design overarching servitization strategies and build resilient overarching ecosystems. It reports ongoing research as part of a longitudinal case study of servitization design practices. Three years ago, the case company decided to embrace *user-experience design* (UX) and *design thinking* (DT) to think much more from an end-user perspective and integrated UX and DT into the R&D organization. As the next step, the UX department's former manager joined the *systems-architecture* department to set up a strategic design initiative exploring resilient product-service ecosystems scenarios for a future business context. Supporting this initiative, we started designing and evaluating design interventions, articulated in a set of sequential workshops.

3. RESEARCH METHOD:

To answer the research question, we used Coghlan's et al. (2001; 2017) action research method, building knowledge on overarching servitization strategy design. We set up action cycles for the intervention design, following Coghlan's four operational stages: experience, understanding, judgment, and decision. We went through different action cycles, capturing data by observing, understanding, reflecting and learning on three levels; the first-, second-, and third-person's voice (Coghlan & Shani, 2017). The first-person data concerns the researcher's observations, notions of the process, reflections and learnings. We generated second-person data by engaging with the workshop participants, interviewing them concerning their observations, experiences, reflections and learnings. The third-person inquiry concerns observations, notions, reflections of people in the outer circle, not directly involved in the action research.

We began with intervention design to guide the process of strategic design. The goal of the workshop interventions is to design an overarching servitization strategy, manifested by a related strategic roadmap navigating the company into its future business context providing overarching product-service value propositions. The unexpected Covid-19 event catalyzed the intervention design process in April 2020, following the usual concept design iterations and testing steps. A team, consisting of two industrial designers and two user-experience designers, set up a sequential set of strategic design workshops, applying the Design Roadmapping method of Simonse (2018) and the strategic design method Vision in Design of Hekkert (2014). Although the research goal is twofold (the strategic design interventions and exploring an overarching servitization strategy), we do not report the overarching strategy for confidentiality reasons, only the design interventions.

In a first action research cycle, we designed a set of sequential workshops supporting and facilitating innovation project teams to create servitization strategies. We iterated through three design cycles, using online Miro-boards for analyzing, conceiving, testing, and evaluating the strategic design workshops' activities, finally resulting in the workshop program presented in the next paragraph.

4. FINDINGS

4.1. DESIGN INTERVENTIONS

The result of our action research interventions is twofold. First, we created a sequential series of remote strategic design workshops and practised it in the B2B context of the case company. Second, as an (expected[1]) outcome of the workshops, we formulate a shared future vision and an overarching servitization design strategy for the case company's future business (articulated as a strategic design roadmap containing product-service solutions, scheduled on a three-horizons time scale).

As the Covid-19 situation forced employees to work from home during the workshops as of April 2021, we converted the workshops to an online version, using the online interactive Miro-board and the Microsoft Teams™ environment. We faced additional challenges for all participants working remotely and getting familiar with using new online tools. Above that, we set up the workshops in such a way that participants without design skills can contribute to the design process.

We carefully prepared a list of participants ensuring a broad representation of the vital disciplines in the workshops. Because the strategic workshops are new activities and not yet embedded in the existing business processes, we have ensured the managers' commitment to workshop participation of their employees.

To update and align the workshop process's outcome, we scheduled two review sessions with the stakeholders and decision-makers after workshop 3 and workshop 5.

In Table 1 below, we report the workshops program

0	**Kick-Off Workshop**	**Engaging Stakeholders and Workshop Participants.**	
		Team Introduction	Introduction of the facilitation team,
		Ice Breaker	• Introduction of workshop team members, Getting familiar with online tools, • Setting the rules for online collaboration
		Introduction Strategic Exploration Process	• Explaining the why, what, how of the workshop series
		Proces Overview	• Overview of workshops 1, 2, 3, 4, 5 & 6
		Mapping of current Knowledge & Expertise,	• Creating a shared understanding of the current business context, • What do we already know; data exchange between company's silos, • Identifying knowledge gaps, • Latest experts' opinions; sharing interview results
		Current Users	• Aligning on current Personas
		Current Product-Service Solutions	• Mapping of current PSS's in a Servitization Ecosystem Framework
		Presenting preliminary Trend Research and Mapping Results	• Presenting collected trend maps on demographic, economic, political, ecological, technological and social trend clusters
		Sharing Expectations	• Personal Expectations, • Case company's Expectations
		Preparation for next workshop	• Discuss homework and input for Workshop 1
1	**Workshop Trend Research**	• **Discover what trends drive the future user context. Discover relevant and interesting trend patterns.**	
		Deep Dive in Trends	• Discussing homework (trends) of workshop participants, • Discussing Trend Research outcome and Trend Cards, • Identifying Trend Clusters and Patterns, • Trends mapping on a timeline
		Strategic Fit	• Exploring strategic fit of trends, future user values and company's values
		Preparation for next workshop	• Discuss homework and input for Workshop 2

[1] Since the company kicked-off the workshop program in April 2021, we cannot report results yet

2	**Workshop Empathizing with end-user**	**Creating a mutual vision and plan towards the far future, combining strengths with external expertise to conceive user scenarios and explore product-service value propositions creating value for future end-users.**	
		Future Users	• Creating Personas for a future business context, understanding the needs, wants, behaviour, desires and values of future users
		Future User Scenarios	• Exploring future Use Scenarios, • Prioritizing Future Use Scenarios, • Creating Artifacts illustrating Use Scenarios
		Preparation for next workshop	• Discuss homework and input for Workshop 3
3	**Workshop Future Visioning**	**Creating a shared future vision based on trend patterns, future user values and use scenarios**	
		Recap outcome of Workshop 1 and 2	• Future Personas, • Future Use Scenarios, • Relevant Trends on a timeline
		Creating a Shared Future Vision	• Detailing Personas and Use Scenarios • Creating a Future Vision Statement • Creating an Artefact, articulating the Future Vision Statement • Conceiving a Future Business Strategy
		Preparation for next workshop	• Discuss homework and input for Workshop 4
F	***Review Session***	***Update and align decision-makers and stakeholders on the outcome of workshops 1, 2 and 3***	
		Presenting Workshop Results	• *Explain Results of workshops 1, 2 and 3*
		Review	• *Discuss, Adjust Company's Future Vision Statement,* • *Validate Company's Future Vision Statement*
4	**Workshop Brainstorming Product-Service Value Propositions**	**Conceiving Product-Service Value Propositions in the context of Company's Future Business Strategy and preferred Use Scenarios**	
		Brainstorming	• Ideate and Conceive Product-Service Value Propositions, • Define Selection Criteria, • Review and Select
		Resources and Capabilities	• Identify Resources and Capabilities needed to develop selected Product-Service Value Propositions
		Define Product-Service Typologies	• Map and Classify the selected Product-Service Value Propositions on the Servitization Ecosystem Framework
		Preparation for next workshop	• Discuss homework and input for Workshop 5
5	**Workshop Ecosystem Roadmapping**	**Creating a Roadmap with a three-horizons timeline containing the selected Product-Service Ecosystems**	
		Plotting on a timeline, creating three horizons	• Emerging Trends and User Values, • Product-Service Value Propositions, • Resources and Capabilities needed, • Engaged Collaborative Partners in the Product-Service Ecosystem
		Conceiving a Strategic Roadmap	• Company's Draft Strategic Roadmap to its Future Business Context
B	***Review Session***	***Update and align decision-makers and stakeholders on the outcome of workshops 4 and 5***	
		Presenting Workshop Results	• *Explain Results of workshops 4 and 5*
		Review	• *Discuss, Adjust Company's Draft Strategic Roadmap,* • *Validate Company's Strategic Roadmap*

Table 1: Sequential Workshops and Review Sessions

4.2. PRODUCT-SERVICE TYPOLOGIES

During the intervention design process, we tried out all workshop activities. One of the activities in workshop 4 is defining product-service typologies. Based on the product-value propositions we came across analyzing the company's current product-service portfolio and earlier servitization design cases carried out by master students, we built a framework to classify and map product-service ecosystems' typologies. This framework depicted in Figure 1 is a coordinate system plotting the customer value chain's length along the x-axis. Along the y-axis, the number of collaborating partners 'B' involved in delivering the product-service value proposition.

We identified four roles, starting with the orchestrator 'O' representing a manufacturer delivering a value proposition to the second role, the customer 'C'. The third role is the end-user 'E', representing the last link in the value chain. The fourth role is a business partner 'B', delivering complementary capabilities and resources and collaborating with the orchestrator 'O' to provide a product-service solution.

In Figure 1, we mapped product-service typologies based on actors' relations and roles in their ecosystem. To not make the framework too complex, we decided to limit the horizontal x-axes to the lower-right cell (O-nC-E), representing all relationships with one or more (n) customers 'C' in the value chain (f.e. O-C-C-E). We, therefore, limit the vertical y-axes to the upper-left cell (O-nB-C), representing all product-service solutions with one or more (n) collaborating partners (f.e. O-B-B-C). The arrows represent all sorts of values that are in an exchange between the ecosystem actors. The typology framework showing the value transactions in play between all ecosystem actors helps strategic designers identify and create business models for product-service value propositions.

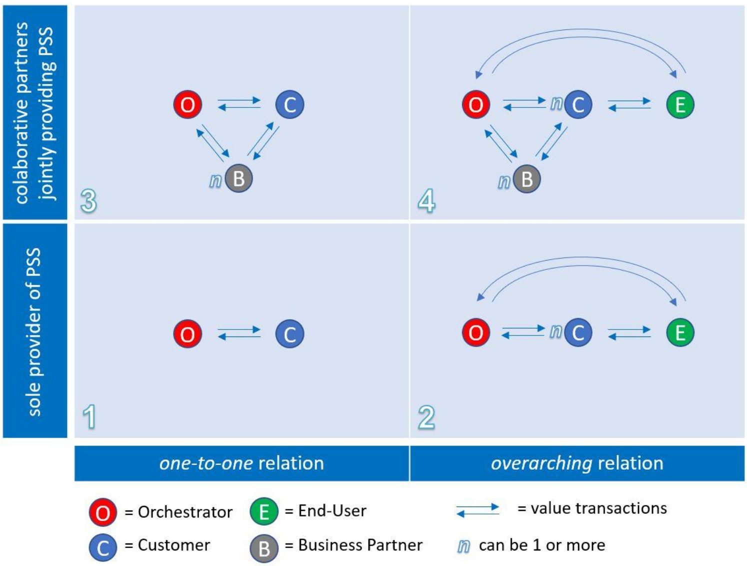

Figure. 1.: Servitization product-service typologies based on the ecosystem actors' roles and relations

1) Typology O-C in the lower-left cell represents the primary relationship of an Orchestrater solely offering a PSS to its direct customer 'C', who sells to an end-user 'E'. In this way, many companies set their first footsteps on their servitization journey by offering services to extend their product value propositions. For example, the company supplies maintenance and spare

parts services and generates a sustainable revenue stream by offering an additional service level agreement during the equipment's lifetime.

2) Typology O-*n*C-E in the lower-right cell represents an overarching relationship; the orchestrator ‘O’ offers a value proposition via its customer ‘C’ to the end-user ‘E’. An example of this typology is Rolls-Royce, described by Visnjic et al. (2017). Its *Pour-by-the*-Hour solution offers a service level agreement addressing airlines' pains by taking care of maintenance services and 24/7 fleet monitoring. In this case, Rolls-Royce (O) collaborates with airlines (C) and the aircraft industry (2^{nd} C) and co-created a product-service value proposition in a platform-based ecosystem.
3) In typology O-*n*B-C of the upper-left cell, an orchestrator ‘O' collaborates with a business partner ‘B’, providing complementary resources or capabilities. Only jointly they can provide a product-service to their customer ‘C’. For example, Company (O) sells baggage handling systems to international airports (C), combined with staff operational services by baggage handler companies (B).
4) The typology O-*n*B-*n*C-E combines quadrant 2 and 3, representing a complex ecosystem in which the orchestrator engages several actors ‘B’, serving several customers ‘C’ throughout its value chain. An example is a *Door-to-Door* baggage handling service by a start-up company (O) providing to an airline (C) the digital platform to manage the necessary data transactions, offering the baggage-as-a-service to an end-user (E), operated by a parcel courier (B).

5. THEORETICAL AND PRACTICAL CONTRIBUTIONS

Servitization is a field undergoing a significant change. This paper explores design interventions to initiate a strategic change towards resilient organizations and extracts some implications for the servitization literature and strategic design literature.

Moreover, it contributes to the field of practice to guide *overarching servitization* design interventions.

First, we developed overarching servitization design interventions, manifested by sequential workshops; companies can conceive a servitization strategy, focussing on value co-creation with the ecosystem partners and customers and update it annually. We set up workshops in a way that participants can develop strategies on different organizational levels or divisions.

Second, the servitization ecosystem framework, classifying and mapping product-service systems' typology, helps B2B manufacturers evaluate their product-service value propositions and compare those with competing companies. The framework is a tool to identify servitization practices in the current business domain and explore future business domains opportunities. It provides a classification of the offered value propositions on a scale of system complexity, indicating the degree of servitization resilience maturity by a degree of partners collaborating in a business domain.

Third, the strategic design method fosters an *outside-in* strategic DT and UX approach among the workshops' participants. Previous research showed that the B2B manufacturing industry tends to think inside-out, staying in its currents comfort zone and building forth on its business legacy (Bluemink et al., 2020; Bustinza et al., 2015; Price et al., 2019)

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ORGANISATIONAL CAPABILITIES FOR SUSTAINABLE SUCCESS IN DIGITAL SERVITIZATION: AN EMPIRICAL STUDY

Jonathan Rösler, Emir Gudic, Mark Grothkopp & Thomas Friedli

ABSTRACT
Purpose: This paper investigates the relationship between the firm-level degree of digital servitization, digital servitization success and various organisational capabilities.
Design/Methodology/Approach: Based on a survey of 137 European manufacturing firms and an extensive review of current servitization literature, a research model was developed, and mediation analysis was implemented to evaluate hypothesis.
Findings: It was found that each of the organisational capabilities analysed were positively related to the level of digital servitization degree and its digital servitization success. Furthermore, the results show that certain capabilities vary in importance depending on the degree of digital servitization.
Originality/Value: Unique from most existing papers, digital servitization success is understood in a sustainable way from a configurational perspective in conjunction with a financial and a non-financial dimension. Addressing current research gaps, applying the adopted systemic and holistic approach to the themes of digital servitization offers new value for practitioners and researchers by overcoming the prevailing fragmented view and delivering specific insights.

KEYWORDS: Servitization, digitalization, capabilities

1. INTRODUCTION
Digital servitization offers organisations new possibilities to innovate and cultivate their offerings to enhance their competitiveness (Manresa et al. 2020). The convergence of the two topics digital technologies and servitization has only recently emerged under the name of digital servitization (Paschou et al. 2020). As examined in the literature, a digital servitization transformation is challenging and requires utilization of specific organizational capabilities (Gebauer et al. 2021). Recent studies in servitization literature have investigated organisational capabilities required for servitization from the perspectives of the manufacturer, intermediaries and customers (Gebauer et al. 2021; Story et al. 2017;). Also, previous studies have investigated the affiliation between organisational capabilities, service strategies, and servitization outcomes. Quantitative studies investigating the influence of these capabilities on the outcomes of digital servitization, whether financial or non-financial, however, are scarce (Ambroise et al., 2018; Zomer et al. 2017). Additionally, only few studies consider more than one capability in their analysis or include the degree digital servitization as a mediator, despite there being many indications that certain capabilities vary in importance, depending on the progress manufacturers have made on their servitization journey (Coreynen et al. 2020; Martín-Peña et al. 2019). Enhancing the understanding in this area through studies that would apply a systemic and holistic approach to digital servitization would therefore derive new value for practitioners and researchers (Paschou et al. 2020). The following research intends to address this identified research gap by providing a more holistic perspective on both the organisational capabilities required to facilitate this transformation and the financial and non-financial outcomes of digital servitization.

2. THEORETICAL BACKGROUND
2.1 Digital servitization
The phenomenon of digital servitization can be understood as "the transformation in processes, capabilities, and offerings within industrial organizations and their associate ecosystems to progressively create, deliver and capture increased service value arising from a broad range of enabling technologies" (Sjödin et al. 2020). As a subfield of servitization research, the concept is still in its infancy, though has recently gained the attention of several academics (Paschou et al. 2017). Digtial servitization is underpinned by digital technologies, which are considered as 'enablers' of

products-service integration (Belvedere et al., 2013; Vendrell- Herrero et al., 2017) and 'facilitators' in service innovation (Ardolino et al., 2018; Kindström & Kowalkowski, 2009). Digital technologies can consequently drive servitization by enabling sophisticated and novel service offerings (Grubic 2018). In other words, digital servitization therefore relates to the introduction of digital or smart services of different types into the service portfolio of a manufacturer, with alternative characteristics and impacts (Paiola et al. 2013; Paschou et al. 2020). The characteristics of the services offered will enhance or completely change service offerings and enable new service-oriented business models (Adrodegari & Saccani 2017; Kohtamäki et al. 2019). However, it is not clear how organizations can confront this digital transformation, hence, there is currently a call for thought-provoking academic research (Coreynen et al., 2020; Paschou et al., 2020).

2.2 Digital servitization success

The success of digital servitization is depicted as the ability of manufacturers to achieve competitive advantages through differentiation (Ulaga & Reinartz 2011). To measure the servitization success of manufacturers, quantitative studies have proposed several metrics, including revenue, profitability, enterprise value or customer satisfaction (Raddats et al. 2019; Visnjic & van Looy 2013). A wealth of research recognizes that considering only financial measures to interpret servitization success might be not enough (Raddats et al. 2015). Rather, several authors call for including both financial and non-financial variables (Gebauer et al. 2009). Often, however, studies do not explicitly highlight the performance criteria used to conceptualise success (Fang et al. 2008; Homburg et al. 2003). Most studies have solely used financial outcome variables (Zomer et al. 2017) as their primary measures (Fliess & Lexutt 2019). These single measures, however, provide an incomplete picture (Eggert et al. 2014) as there are many theoretical and practical indications that the benefits of servitization strategies are not limited to financial outcomes (Lexutt 2020).

2.3 Organisational capabilities

Collis (1994) defines organisational capabilities as the socially complex routines that determine the efficiency with which companies can physically transfer "inputs" into "outputs". Depending on the literature stream and the object under consideration, the authors' definitions of organisational capabilities differ in the respective studies (Gebauer et al. 2010b; Raddats et al. 2015). The organisational resources, capabilities, business network, value constellation, and external environment are among the differentiators affecting the servitization process and its outcome (Kowalkowski et al. 2013; Windahl & Lakemond 2010). Alternatively, Zomer et al. (2017) take a Cartesian view and configuration perspectives and define the organisational capabilities as a part of the internal environment/organisational design category. Gebauer et al. (2005) provide six organisational components for successful service expansion: (1) establishing a market-oriented and clearly defined service development process, (2) focusing service offerings on the value proposition to the customer, (3) initiating relationship marketing, (4) defining a clear service strategy, (5) building a separate service organisation and (6) creating a service culture. Further empirical evidence suggests that there is a broad way of different organisational design components and capabilities, which have a decisive influence on the servitization process (Böhm et al. 2017).

3. THEORETICAL FRAMEWORK

3.1 Hypotheses development

There is a broad consensus in current research that digital servitization can potentially produce financial, strategic and marketing benefits that ultimately result in increased business performance (Baines et al. 2009; Zhang & Banerji 2017). Table 1 provides an overview of organisational capabilities that were investigated in this study.

Table 1: Overview of organisational capabilities

Capabilities	Description	References
Service innovation capabilities	Ability to introduce new products, processes or services into the organisation by providing a recombination of necessary resources that create new benefits and value	Gebauer et al. 2011; Kindström & Kowalkowski 2014
Service orientation	Competence to understand the abstract value of services and the opportunities it offers by the whole organisation and its employees which also includes service-oriented behaviour	Gebauer et al. 2010b; Homburg et al. 2003; Kohtamäki et al. 2015
Co-creation capabilities	Ability to develop, manage and exploit value steams from the complex interaction with customers and other actors and to combine resources from manufacturers, suppliers and customers	Kohtamäki et al. 2013; Raddats et al. 2015; Story et al. 2017
Digital capabilities	The competence to analyse and interpret installed base product usage and process data to help customers achieve productivity and/or cost reductions	Green et al. 2017; Ng 2013; Ulaga & Reinartz 2011
Service sales capabilities	Ability to use appropriate argumentation during the service sales process, which goes beyond tangible product features with using technical and functional information about how one's service creates value	Oliva & Kallenberg 2003; Raddats et al. 2015; Visnjic & van Looy 2013
Organisational adaptability	Competence of a company to flexibly adapt its offer and organisation to customers and different circumstances which enables steady revenue streams	Gebauer et al. 2010a; Kindström & Kowalkowski 2014; Neu & Brown 2005
Organisational efficiency	Ability to allocate efficient and effective resources in the organisation that enables collaborative support and competitive economic activity	Antioco et al. 2008; Böhm et al. 2017; Neu & Brown 2005
Service methods and tools	Capability to use an adaptive back-office infrastructure with intelligent information and communication technology systems that enables more cost-efficient operations and higher service quality	Raddats et al. 2015; Ulaga & Reinartz 2011

Based on an extensive literature review, the following hypotheses were formulated:

H1/H2: Capability X has a positive impact on digital servitization degree, which in turn has a positive impact on digital servitization success (Indirect effect)

H3: Capability X has a positive impact on digital servitization success (Total effect)

H4: Capability X has a positive impact on digital servitization success (Direct effect)

3.2 Research model

The model was developed, and mediation analysis was utilised to test the hypotheses (Manresa et al. 2020; Martín-Pena et al. 2019). Figure 1 summarizes the research model. Drawing upon the literature on digital servitization and its most important related topics, we hypothesize that the embellished organisational capabilities influence the digital servitization degree which in turn positively mediates the relationship between the different organisational capabilities and digital servitization success. Additionally, we predict that different organisational capabilities positively affect digital servitization success in both total and direct effects.

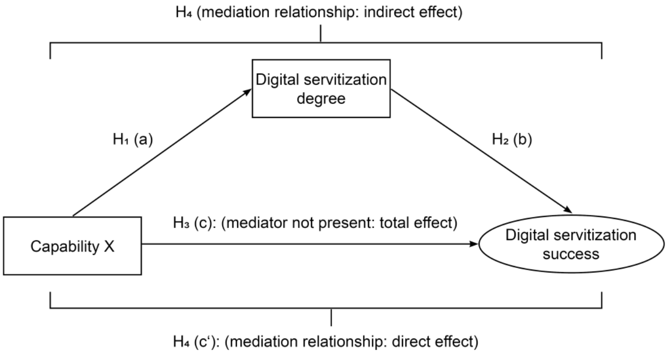

Figure 1: Research model

4. METHODOLOGY

4.1 Data collection

For the empirical analysis, we developed a survey and distributed it among manufacturers with more than 250 employees in Europe. In total, we received 148 responses, leading to a response rate of 21.5 %. We checked the responses for logical errors and cleaned the responses that did not fill in information on their external search (i.e., no answer). After cleaning and deleting responses that were not filled out completely, we considered 137 usable responses.

4.2 Validation of the measurements

The developed questionnaire for the measurements is based on an initial literature review as well as inputs from industry experts. Peer researchers and senior researchers reviewed and helped to improve the survey draft and further tested it with a purposive sample of manufacturing firms. Where it was possible and appropriate, items from previous and valid scales were used for the constructs of this work. As the constructs have been adapted to the latest findings in literature and practice, the constructs that have emerged are additionally subjected to a content validity check, which is based on former procedures and studies (Kohtamäki et al. 2013; Lin 2007). For the calculated content validity index (I-CVI), the interpretation recommendations of Polit et al. (2007) were used. It was also analysed for construct validity using the component factor analysis (CFA). Every of the construct demonstrated a good model fit which includes chi-square ($\chi2$), degree of freedom (d.f.) and p-value (Hu & Bentler 1999; Kohtamäki et al. 2013). The convergent validity was also tested using the average variance extracted (AVE), where the recommended value is to be above 0.5 (Raddats et al. 2015). Reliability was examined used Cronbach's α coefficient, which has a suggested threshold of 0.6 (Pallant 2007).

4.3 Construct operationalization

In this paper the level of success is determined by the extent to which a positive, direct impact on the financial performance of the service business can be observed and the extent to which a positive, indirect, or non-financial impact on the performance of the company can be determined (Lexutt 2020; Raddats et al. 2015). The construct 'digital servitization success' contains 5 items (Growth in service sales; growth in profit; customer satisfaction; service profitability and retention of service customers). The conceptualization of the 'digital servitization degree' is made in terms of the number of different digital services offered, whereby this adjusted procedure is based on the study of Homburg et al. (2003). This construct contains 16 items, in which all are a specific digital service offered of the affected company. 'Service innovation capabilities' contain 7 items (Gebauer et al. 2011; Lin 2007), 'service orientation' contains 3 items (Gebauer et al. 2010b, Homburg er al. 2010), 'co-creation capabilities' contain 4 items (Kohtamäki et al. 2013; Kohtamäki & Partanen 2016), 'digital capabilities' contain 4 items (Ulaga & Reinartz 2011), 'service sales capabilities' contain 4 items (Homburg et al. 2003; Kohtamäki et al. 2015), 'organisational adaptability' contains 3 items (Gebauer et al. 2010a; Kindström & Kowalkowski 2014), 'organisational efficiency' contains 6 items (Antioco et al. 2008), and 'service methods and tools' contain 6 items (Raddats et al. 2015).

5. RESULTS

The research model and the associated hypotheses were tested using regression analysis. Table 2 provides an overview of the results obtained.

Table 2: Regressions results

Variables	Total effect (H3) c	Direct effect (H4) c'	Indirect effect (H1 x H2) a x b	Confidential interval indirect effect ab	Adjusted R^2
Service innovation capabilities	0.4368***	0.3271***	0.3408** x 0.3219***	0.1079 [0.0309;0.1630]	0.3774 (37.74%)
Service orientation	0.3357***	0.2012*	0.3503*** x 0.3839***	0.1345 [0.0540;0.2334]	0.3287 (32.87%)
Co-creation capabilities	0.2421*	0.1554	0.2187* x 0.3966***	0.0867 [0.0083;0.1779]	0.3028 (30.28%)
Digital capabilities	0.1809**	0.0635	0.2839*** x 0.4133***	0.1174 [0.0543;0.1930]	0.2935 (29.35%)
Service sales capabilities	0.5611***	0.4358***	0.4889*** x 0.2562***	0.1253 [0.0520;0.2182]	0.4229 (42.29%)
Organisational adaptability	0.3037***	0.2129**	0.2614** x 0.3473***	0.0908 [0.0251;0.1666]	0.3368 (33.68%)
Organisational efficiency	0.4811***	0.3571***	0.3956*** x 0.3135***	0.1240 [0.0485;0.2204]	0.3773 (37.73%)
Service methods and tools	0.3110***	0.2041*	0.3123*** x 0.3424***	0.1069 [0.0476;0.1778]	0.3330 (33.30%)

*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

6. DISCUSSION

H1/H2: All tested organisational capabilities show to have a significant impact on the level of digital servitization, which in turn has a highly significant impact on digital servitization success. These results were expected due to different reasons. First, a greater variety of digital service offerings could attract additional customers that the company had not previously anticipated. By definition, the digital servitization degree is increasing and has the potential to increase digital servitization success. Second, a company is seen as an innovator by the customers and is, thus, rated by them as capable of being a competent partner for their needs in the present and future (Gebauer et al. 2011). The offer can be adapted to the customer and, thus, generate more value for them in their processes. The acquired specific customer knowledge leads to customer proximity, greater satisfaction and ultimately loyalty (Antioco et al. 2008). Third, the higher margins on services could lead to an overall increase in profitability. The positive relationship between the various organisational capabilities and the level of digital servitization has been expected as well, as many service offerings also require many capabilities within the company (Sousa & Silveira 2017). For example, a condition monitoring service cannot be provided until the right organisational capabilities are sufficiently in place.

H3: The results show high significant total effects for almost all organisational capabilities. These results were also to be expected, as previous studies have additionally suggested that services can provide benefits such as stable sales, increased customer satisfaction or an increase in competitive advantage (Kohtamäki et al. 2015). They require organisational structures and culture to support effective service delivery (Kohtamäki et al. 2013). Servitization also significantly changes the logic of the manufacturer in terms of its identity, power, capabilities and efficiency. Therefore, opportunities generated by servitization should not only be exploited through the view of a single lens (Huikkola et al. 2020; Story et al. 2017).

H4: The results of organisational capabilities in terms of direct effect display interesting findings. Contrary to expectations, certain organizational capabilities are still significant despite the inclusion of the mediator digital servitization level (service innovation capabilities: 0.3271***; service sales capabilities: 0.4358***; organisational efficiency: 0.3571***). This implies that these capabilities play a central role for the companies, regardless of the degree of digital servitization, and that a great deal of focus must be placed on them. Innovation, sales skills and efficiency appear as necessary if one wants to be successful in entrepreneurial activity (Kindström & Kowalkowski 2014; Zomer et al. 2017). The other skills show no direct effect, which can be explained by the meditating effect of the level of digital servitization. These results imply that these skills also become increasingly important as the level of digital servitization increases if companies want to achieve economic success. Firms need sufficient organisational resources, capabilities and knowledge to successfully implement a strategic change in its servitization journey (Böhm et al. 2017). The alignment of these organisational capabilities with the current situation is also of great importance, because this makes it possible to react to the changing economic circumstances, demands and needs of customers without affecting the company's profitability (Gebauer et al. 2010a).

7. CONCLUSION

7.1 Theoretical contributions

This research enhances the existing understanding of digital servitization, with a particular focus on the organisational capabilities required by manufacturers to utilise digital servitization strategies successfully. Therefore, our research provides quantitative insights in a mainly qualitatively researched field. Further, the paper contributes to the conceptual framework of digital servitization with its holistic view on the topic. To address the identified research gap, digital servitization success in this paper is understood by using a multidimensional configurational approach. Our findings show that digital servitization benefits go well beyond financial dimensions and the gained results and impacts can be therefore understood in a more sustainable way. Also, we show that there is relationship between servitization degree and the effect of organisational capabilities on digital servitization success. Therefore, our study offers further starting points for future research in the field of digital servitization.

7.2 Practical contributions

The resulting findings consequently build a more realistic and multifaceted image of the causal relationships underlying digital servitization success, thus, yielding valuable guidance for the management of businesses in the process of servitization. This research extends the existing understanding of digital servitization, with a particular focus on the organisational capabilities needed by manufacturers to successfully use digital servitization strategies. However, all utilized organisational capabilities are fundamental in successfully implementing digital servitization. The results demonstrate that the capabilities examined have a direct effect on the success of digital servitization. Additionally, there is a mediating effect that is exerted via the degree of digital servitization. The capabilities that experience complete mediation through the degree of digital servitization can therefore be seen as necessary in the servitization process. Other capabilities were shown to play an important role regardless of the degree of servitization, thus, these organisational skills can be seen as indispensable for any company that wants to achieve financial and non-financial success through digital servitization.

7.3 Limitations

The limitations of this work results from the chosen research approach. The constructs used for the latent variables are based on prior literature, though were adjusted in conjunction with current service literature to suit the current study. The advantage of practice-oriented, performance-relevant constructs is at the same time a disadvantage, since in some cases dimensions could not be included in the constructs without diluting the scope for interpretation. Due to the rather innovative and specific approach, the significance and the possibilities for interpretation must be viewed with caution. Considering the very limited space available, many statistical quality criteria for the respective operationalizations could not be presented.

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USING FORESIGHT FUTURES AND SYSTEMS THINKING TO EVALUATE DIGITALLY ENHANCED ADVANCED SERVICE CONCEPTS FOR A ROLLING STOCK COMPANY (ROSCO)

Dr Melanie R N King, Dr Sara Mountney and Paul Timms

ABSTRACT

Purpose: This paper reports on a study in conjunction with a UK-based rolling stock leasing company (ROSCO). The aim was to generate and evaluate future operational concepts for digitally enhanced advanced services from the point of view of a ROSCO – one of many stakeholders (or actors) within a future wider mobility ecosystem.

Design/Methodology/Approach: The research design followed the Generic Foresight Process Framework (Voros 2003). Desk-based research and horizon scanning analysis revealed technologies, mobility and transport trends, and other predictions towards 2060. A workshop was developed and participants were presented with a series of future scenarios and design fictions for end-to-end intermodal mobility and passenger carbon quotas. A future Mobility Servitization Systems Architecture was developed.

Findings: Five future megatrends were identified; Decarbonisation, changing traveller needs, digitisation, mobility ecosystems and new business models in digital ecosystems. The 'what-if' activities revealed insights into alternate futures; revealing system of systems (SoS) actors, the role of a ROSCO, integrations, assumptions and operational constraints.

Originality/Value: This research contributes to engineering and design methods for digitally enhanced advanced services, particularly for corporate strategic foresight in a dominant design industry. The Mobility Servitization Systems Architecture was seen to be a powerful model for ecosystem understanding.

KEYWORDS: Generic foresight process, systems thinking, ecosystem architecture, rail, servitization

1. INTRODUCTION

Examples of advanced service provision exist within the rail industry, primarily to augment vehicle production or asset management, repair and overhaul. Digital technologies present an opportunity to develop innovative business models away from this core capability. However, finding suitable methods to navigate and explore the opportunities and potential benefits present a particular challenge, particularly as the industry has an example of dominant design due to its inherent culture of safety and regulation which may make it slow to change (Maull, Godsiff, and Mulligan 2015).

A study was set up with a major UK railway rolling stock leasing companies (ROSCO), in order to test new ways of thinking about the future. This organisation (one of the big three borne out of the 1994 UK rail privatisation) has been at heart of the UK rail network for 25 years and owns almost a third of the national passenger rail fleet. The organisation's strategic goals are to increase their visibility to their customers and become market leaders in digitally enhanced advanced asset management and maintenance services. The company was interested to explore new ways to identify opportunities for organisational and cultural change, as well as barriers and enablers towards advanced services within and between organisations within the transportation and mobility sectors.

The aim of the research was to answer following questions: Does the combination of foresight research methods with systems engineering techniques, shift existing perspectives to future innovative operating possibilities within a wider mobility ecosystem?

1.1 The Servitization and Digitization Context

Servitization has been defined as the shift in focus from a product-based solution to a combination of product and services, known as a product-service system (PSS) on a continuum from use to results oriented (Tukker 2004). Results or outcome-based solutions are known as advanced services (Baines and Lightfoot 2013). A network of actors is responsible for delivering the value proposition (Raddats and Burton 2014). The concept of the network of actors as an ecosystem has been used when considering the role of digital technologies in developing advanced services (Kohtamäki et al. 2019).

Digital technologies can present opportunities to develop additional services from two perspectives. The first is by increasing the capability and support of the product itself through its life (e.g. condition monitoring). However, opportunities to develop further services created by the technology itself and independent of the product can also present themselves which can lead to higher value propositions (Chowdhury, Haftor, and Pashkevich 2018; Coreynen, Matthyssens, and Bockhaven 2017). Product service systems are evolving into smart product service systems; as an IT-driven value co-creation business strategy consisting of various stakeholders as the players, intelligent systems as the infrastructure, smart, connected products as the media and tools, and their generated e-services as the key values delivered, that continuously strives to meet individual customer needs in a sustainable manner (Lerch and Gotsch 2015). Expanding on existing definitions and examples of servitized business models, platform based business models are also being presented which provide servitized solutions through the integration of customers and providers (Kohtamäki et al. 2019)

The primary consideration of servitization has been from the perspective of manufacturing organisations looking to servitize. The Rail industry has seen applications of digital technologies to improve maintenance and reliability, such as condition monitoring applied to track in order to reduce maintenance costs (Groos, Havrila, and Andreas 2018). However, there is a potential to consider rail transportation as an example of servitization in that it produces an outcome-based service for passengers. An example of this can be seen in Lingegård and Lindahl (2015), where the Swedish rail infrastructure is considered as an Integrated Product Service Outcome for better life cycle modelling, sustainability and reliability, although this does not include the use of digital technologies.

1.2 A ROSCO in the context of the UK Rail Industry

The UK operational rail system is widely acknowledged as complex System of Systems (SoS). In the International Standard for Systems and Software Engineering, SoS are defined as a “set of systems or system elements that interact to provide a unique capability that none of the constituent systems can accomplish on its own” (“ISO/IEC/IEEE International Standard -- Systems and Software Engineering -- System of Systems (SoS) Considerations in Life Cycle Stages of a System” 2019). SoS are characterised by the operational and managerial independence of the constituent systems, as well as geographical distribution, emergent behaviour and evolutionary development processes (Maier 1998).

In the UK rail system, while each enterprise within it retains its own ownership and objectives, all enterprises are responsible to a set of managing organisations that oversee the overall ‘design’ of the industry to manage safety and to meet government policy on passenger service provision (e.g. UK Government’s Department for Transport, the regulator (www.orr.gov.uk), co-ordinating bodies (www.raildeliverygroup.com) etc.). Most elements of a rolling stock specification are informed through top-down cascading requirements; from government agency (e.g. DfT), to the Train Operating Company (TOC), to the rolling stock leasing company (ROSCO), to the vehicle manufacturers and overhaullers (e.g. Bombardier, Wabtec), to manufacturing suppliers and subcontractors. All spending on rolling stock traces back to the requirements of the franchise / concession agreement, with “delay minutes” tending to be used as the principal indicator of contract performance. This strongly managed, top-down oversight, results in an industry that ultimately treats the government as the most important stakeholder, rather than the end customers (i.e. the passengers).

The organisation’s understanding of their current service provision (as with most ROSCOs), is primarily rooted in an understanding of the engineering maintenance provision offered by the company. However, the adoption of future advanced services requires an appreciation of the wider UK heavy rail ecosystem that organisation exists within, as well as consideration of the future needs of passengers.

2. METHODOLOGY

2.1 Research Design

Future-oriented knowledge creation underpins innovation activities, relying upon cognitive and visioning power, as well as a deep understanding of the present organisational operational environment and how it may evolve in the future. The research adopted the Generic Foresight Process Framework (GFP) (Voros 2003), which allows for the adoption of a variety of specific methods at each stage. Figure 1 depicts the research design for this study.

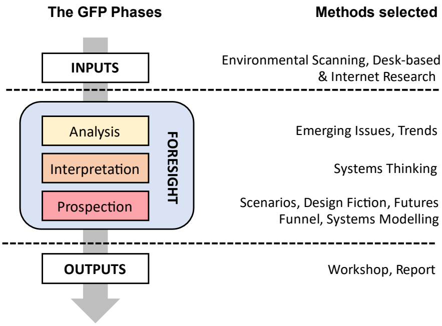

Figure 1. Study design using the Generic Foresight Process (GFP), adapted from (Voros 2003)

2.2 Methods selected

The first phase of the research concerned gathering of information and intelligence using desk-based research in order to ascertain near future possibilities. Information sources included; Industry reports, corporate strategies, government policies, academic literature and professional magazines. From this material, emerging issues and trends were derived.

Interpretation of the information was done using *systems thinking* techniques. Systems thinking is concerned with understanding or intervening in problem situations, based on the principles and concepts of the systems paradigm. It enables a 'big picture' understanding of a system of interest from a viewpoint (or viewpoints) outside a defined system of interest. It is an outsider-looking-in approach to analysis, that builds upon the idea of Holism; the need to consider a system as a whole because of observed phenomena such as emergence (Hitchins 2003). Systems thinking is an action research methodology and has proven transformative in systems evaluation (Cabrera, Colosi, and Lobdell 2008).

Prospection, a term coined by Voros (2003), is the "activity of purposefully looking forward to create forward views" (ibid p15). Various methods were selected to present visions of the future to research participants. Firstly, *scenarios* were chosen as they tend to be the most popular in corporate strategic planning activities (Heijden 2005). Secondly, a *design fiction* was generated to explore one particular scenario in more depth, from the perspective of a passenger. Design fiction is one of a number of terms that describes the process by which designers, researchers, engineers and technologists devise scenarios and design artefacts to provoke debate about future technologies in a complex world (Grand and Wiedmar 2010). Thirdly, *systems modelling* was used, which is a central process of Systems Engineering ("ISO/IEC/IEEE International Standard - Systems and Software Engineering -- System Life Cycle Processes" 2015). A servitization systems architecture was developed, depicting the ROSCO as the System of Interest, within the context of the wider mobility system of systems. Finally, an online activity based focus group was chosen (as an alternative to an in-person workshop) in order to; add to the data gathered on emerging trends and issues; assess the range of prospective futures presented; and most importantly, to trigger changes in thinking engendered by the whole process.

3. FORESIGHT INVESTIGATION

3.1 Environmental Scanning, Megatrends and Predictions

From the desk-based review and analysis, five future megatrends were identified that will have an impact on the future of the rail industry; Decarbonisation, changing traveller needs, digitisation and automation, mobility ecosystems and new business models in digital ecosystems. The Williams Rail Review evidence papers (UK GOV 2019b, 2019a) and the Department for Transport's Future of Mobility Strategy (DfT 2019) describes many of these trends in detail. New business model investigation was centred on digital servitization models provided by Kohtamäki et al (2019). These models demonstrated both a strategic shift as well as contractual shift from product-oriented, agreement-oriented, availability-oriented through to outcome-oriented.

3.2 Scenarios, Design Fictions and Systems Modelling

Two scenarios were developed. The first scenario, based on the intermodal mobility ecosystem trend, was 'Rail as the backbone of mobility services' adapted from a Williams Review Evidence paper (UK GOV 2019b, 31). The second scenario, 'Good Intentions', was based on the Decarbonisation trend and adapted from The Intelligent Infrastructures Futures UK Government Foresight Project (Office of Science and Technology 2006, 5). A further Design Fiction (Figure 2) was developed based on scenario 2 as decarbonisation has now become an imperative for the whole transportation industry. Inspirations for the design were taken from recommendations made by The Rail Delivery Group (2020) towards Net zero carbon emissions by 2050. Also, The Green Party's (2006) outline of how citizen Carbon Quotas would work.

The scenarios and design fiction were presented to research participants across three time horizons (2030, 2045, 2060) and overlayed on to a futures funnel (Voros 2019) in order for participants to discuss and categorise proposals as either; projected, probable, plausible, possible or preposterous.

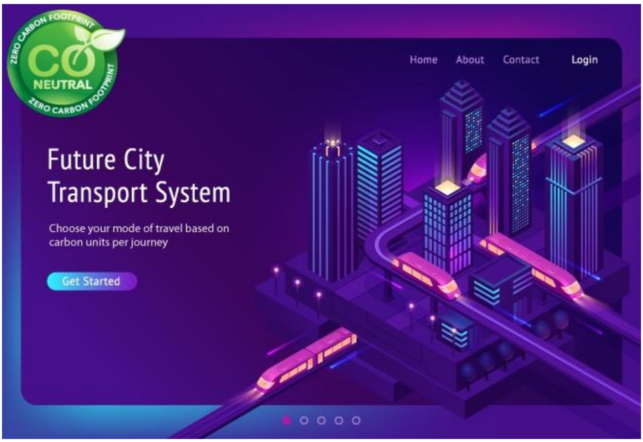

Figure 2. Design Fiction – a multi-modal journey booking system based on carbon units

The future mobility ecosystem was modelled and presented in two ways. Figure 3 shows the roles that companies fulfill within the five layers of McKinsey's emerging mobility landscape (Heineke et al. 2017). The authors have adapted this idea and depicted the specific relationships between players as well as the essential nature of the data assets and data products that need to interoperate between players.

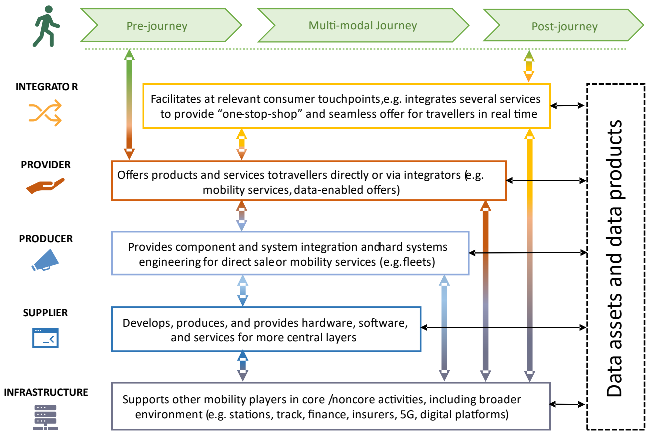

Figure 3. Roles and partnerships in future mobility services. Adapted from McKinsey's five layers of the emerging mobility landscape (Heineke et al. 2017)

The layered model was developed further to depict a servitization systems architecture, depicting the ROSCO's in the role of 'Producer', with a servitized offer as the service System of Interest (SOI), within the context of the wider mobility System of Systems (SoS) (Figure 4). This Mobility Servitization Systems Architecture demonstrates the complex partnerships and functions that combine to deliver an overall SoS capability. The diagram has been developed using methodology provide by the Systems Engineering Body of Knowledge SEBoK (https://www.sebokwiki.org/wiki/Types_of_Systems).

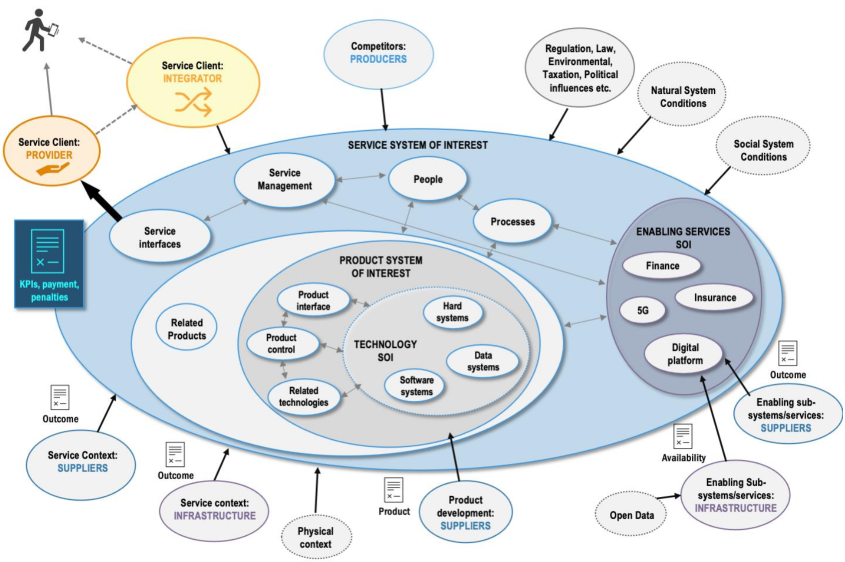

Figure 4. A Mobility Servitization Systems Architecture

3.3 The Workshop

The workshop was a two hour activity which was designed to run online. The format was a mix of short introductory presentations from the facilitators, followed by a discussion around a specific questions. The outline of the workshop, including the questions asked [as shown in Table 1]. The workshop was attended by two members of the research team as facilitators, and two senior members of the organisation, who between them represented the digital and engineering functions. The workshop was run via Microsoft Teams and recorded with consent from all parties. The recording was then run through caption capture software (Panopto), with corrections made, for full transcription.

Table 1: Workshop Outline

Session Summary	Question Prompts
Part 1 – Setting the Scene	
Short presentation - Introduction to megatrends. Discussion: Organisational context (questions 1-3).	Q1: Can you give us some examples of your future strategic plans in relation to the following? • Decarbonisation • Mobility Ecosystems • Changing business models Q2: What is the current time horizon of your strategic or development plans? Q3: Have you adopted any particular standard approaches to digital innovation or strategising about the future?
Part 2 - Exploration of future scenarios and design fictions	
Short presentation – future scenarios, design fictions and systems thinking. Discussion: Scenario 1 – decarbonisation (question 4). Discussion: Scenario 2 – intermodal mobility ecosystem (question 4). Design fiction: further exploration of decarbonisation (questions 5 – 7).	Q4: Within each future scenario assess the likelihood and timing of the proposed ideas. • Decarbonisation • Mobility ecosystems Q5: What are your immediate thoughts? What are the implications? Q6: In a carbon quota-based mobility ecosystem, what might the organisation need to consider? Q7: What constraints might there be to implementing this?
Part 3 - Exploration of systems thinking using intermodal mobility as an example	
Discussion (questions 8 – 10).	Q8: To what extent will your role have to adapt or change significantly in these future horizons? What will the purpose of rolling stock companies be in the future? What type of change is needed? Q9: Does this way of modelling a service-system of interest as a player in a mobility ecosystem help to develop ecosystem thinking? E.g. what type of partnerships? What type of ecosystem role? Q10: Will you be operating more like a digital company than engineering company?

4. PRELIMINARY FINDINGS AND DISCUSSION

4.1 Part 1: Megatrends and the organisational context

Both megatrends were already under consideration for the organisation, with key areas of work summarised below.

Decarbonisation

This is primarily being driven by external deadlines – the withdrawal of diesel units in 2030 and the move to a carbon-neutral network by 2050. The focus of projects in this area is therefore on developments to traditional engineering hardware units. There is a recognition that there needs to be a gradual transition in technology to meet the deadlines. To some extent technology readiness is being thwarted by current legislation and frameworks. Some projects are taking place with customers. There are related digital projects looking at the supply of carbon usage data to Network Rail and the Department of Transport. They are also working with some customers (train operating companies) to look at best practice maintenance to reduce carbon consumption.

Intermodal mobility

Examples of projects to share data with customers were given, including incorporating track monitoring information in addition to train monitoring, for sharing with Network Rail. There was also an initiative on looking at passenger loading on trains for better prediction of service requirements, including across other forms of public transport. With intermodal mobility, there are current initiatives in outcome-based services, however the successful commercialisation of these remains challenging. Digital services are being piloted as small case studies to prove the concept, before being rolled out more widely. This gives some opportunities for more agile methods of development.

4.2 Part 2: Future Scenarios and Design Fiction

Scenario 1: intermodal mobility.

The scenario was used to think of future capability which would be required to fit the future scenario presented. Two examples had been listed as a starting point, but the participants were invited to add more, then consider the likelihood from the 'plausible' to 'preposterous' scale. Towards the end of the discussion, some elements of decarbonisation also began to feature as it was recognised that that this was an outside driver which would impact on this area.

Scenario 2: Decarbonisation

In this scenario, the participants plotted the availability of data on a scale, from network to route to journey to person, with estimates of when this would be available (by person being the last in the list). Tensions were identified in volunteering and buying into carbon reduction versus the forced quota scenario being presented. The forced quota scenario was seen as improbable.

Design fiction: decarbonisation and carbon quotas

Although the design fiction presented was considered further, it was recognised that it had already been categorised as a preposterous future scenario.

In terms of immediate thoughts and implications (question 5), implications raised over how the use and 'spending' of carbon would impact on patterns of transport use. Concerns were raised over individual's access to carbon, particularly if they could not pay for extra carbon credits. It was suggested that strategically, companies would think of ways of buying and selling extra carbon.

These implications were expanded further for question 6. Initially the primary focus was on services concerned with rolling stock and passenger movement. There would be a need for vehicles with a low carbon footprint. This may contradict performance based (outcome) services if it created a reduction in demand for services, aggravated by a need to save carbon. Carbon use would need to be linked to individual trains to give accurate picture. From a business perspective, there may be a requirement for new initiatives for obtaining extra carbon credits for use, to give more freedom in movement against the quotas.

In terms of digitalised services, business benefits were identified in the capability to proactively identify and resolve infrastructure problems to save carbon. This would be a remapping of the current 'delayed minutes' performance measure to 'saving carbon'. A further potential additional service would be adding forecasting data for passengers so they can make decisions in advance about carbon usage.

Three constraints of implementation in question 7 were raised: concerns with GDPR / data protection and ethics, consistent data availability for collection across the network and varying age of rolling stock. A need was identified to calculate whole life carbon usage for rolling stock and work out what is required for the targets (i.e. carbon cost of keeping existing fleet vs. building new non-diesel replacements). There was a discussion that other factors may also be equally, or more important than decarbonisation.

Observations on the use of the future scenarios and design fiction technique

This approach worked the most effectively when the scenario presented was deemed as plausible. It may be useful to add an evaluation step to the scenarios presented to filter through those which are suitable for further exploration. In identifying future requirements, the method was being used in a similar way to technology road mapping, in that requirements could be staged along the timeline and fed into the next. Overall, the method highlighted what was needed in terms of new technology or capability development, but not how this could be achieved. As one scenario was considered using design futures, it is suggested that perhaps the scenarios considered need to be multi-faceted when considering development of future advanced services, in that an outcome based service may not be designed specifically for one situation only. Given that other equally important factors may need to be considered, these would need to be worked into the technique.

4.3 Systems Thinking

In terms of adapting the role of the organisation to meet the requirements identified by the megatrends (question 8), the move to providing more outcome-based services were seen as key. The primary driver was the ability to add more value for the customer. This was also a response to a current situation to compete with new entrants who are disrupting the market by competing with a low-cost, lean offering for the first seven years of the franchise. This is an attractive offer for the early stages, but the impact after then is unknown. As a comparison, the outcome-based propositions from the case organisation were considered as a way of competing with a different, higher value offer, which better satisfy the longer-term requirements of the two megatrends identified and discussed in the workshop.

In terms of how the organisation would see themselves in the future – as a digital or an engineering company (question 10), the answer was both. There may be an opportunity to develop more agile methods of product development, i.e. transferring some of the methodologies from the digital industry. The engineering provision would continue as a core capability, but would be supported by, and enhanced by, additional digital services. New capability requirements in terms of digital architecture and upskilling of people in the organisations were identified.

Observations on the use of the systems thinking technique

The System of Systems model was found to be a “powerful model for ecosystem understanding” by the participants, in that it enabled some capture of the complexity in the network of relationships and considerations in developing outcome based services. In addition to concerns about identifying other actors in the network who would be involved, some elements of people, developing expertise based services and change management were also highlighted. These may need to be areas of future focus in developing a system of systems.

The business model categories presented in the McKinsey framework were helpful to the participants, in that they enabled them to consider the characteristics of their organisation, what it was currently offering, and potential ways in which it could develop offerings. However, it was also seen as being linear and not so helpful, as the category in which the organisation fitted was not clear. However, by being able to distinguish between different types of business models, it uncovered the range of services and customers being developed within the organisation. This meant that different categories could apply depending on the service. Ultimately the combination of having both the engineering and the digital offerings were seen as being core to the organisation's capabilities, with the digital services enhancing the engineering provision.

4.4 Reflection on Approach and Next Steps

The foresight approach of combining future scenarios, design fictions, systems thinking and systems modelling yielded an opportunity for a detailed exploration of consideration for developing outcome-based services. The observations of their use highlighted situations where they were effective, but also how they could be developed further. Particular areas of improvement are:

- Introducing a method of screening future scenarios for plausibility before continuing to a design future stage.
- Discussing combined scenarios of several themes, so that service development can be considered to meet a range of requirements, and the timelines associated with these.
- Use the 'design fiction' method to add the detail to the selected design scenario, to identify 'what' and 'when' needs to be added as requirements across the timeline.
- Consider the design of the service using the system of systems approach to identify the main actors within the organisation, and the impact on the external network of actors. This would establish the 'how' and the 'whys' in developing the outcome-based service.

4.5 Conclusion

The call for passenger-centric incentivisation across the industry is growing. This should push the industry towards a much more joined-up, intermodal way of thinking, as a passenger's whole journey is rarely from station to station. The public need for travel is evolving (Preston 2018), and the rail industry may see a seismic shift in the types of passenger as various social and economic issues take hold (UK GOV 2019b). These changes, once predicted over 30-year horizons, may happen even sooner given the impact of the pandemic (Davies 2021).

The authors' propose that the foresight approach and methods, piloted in this study, could form the foundations of an operationalised methodology for further development and evaluation in organisations considering developing future digitally enhanced advanced services.

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FINANCING SERVITIZATION: ENSURING A SUSTAINABLE ECOSYSTEM APPROACH

Phil Godsiff & Zena Wood

ABSTRACT
Purpose: The EPSRC funded Digitally Enhanced Advanced Services (DEAS) Network Plus aims to create a community of researchers and practitioners working collectively across various disciplines (computer science, engineering and business) and sectors (manufacturing, transport and finance services) to co-create a comprehensive research agenda that accelerates the development of DEAS within the UK. This paper presents some of the initial learnings from the Network's work, particularly work in financial services.
Design/Methodology/Approach: The work described in this conceptual paper is based upon a review of work of the DEAS Network Plus to date. This includes thirteen commissioned projects, four research agendas, a series of virtual roundtables, conversations with industry experts and attendance at industry webinars.
Findings: The need for an ecosystem view for servitization that includes a wider group of stakeholders (especially financial services), and the need for guiding principles for servitization that are sector agnostic.
Originality/Value: The theoretical contribution is the proposed new financial services ecosystem and the associated ecosystem approach in the transformation journey. The practical contribution is the consideration of a wide group of stakeholders in the development of the theoretical work and understanding its implications when applied by the stakeholders.

KEYWORDS: Servitization, digital, sustainability, ecosystem

1. INTRODUCTION

The Digitally Enhanced Advanced Services (DEAS) Network Plus focuses on how products or services are used rather than how they are produced. People and organisations are moving from buying conventional products and services and are seeking to buy the 'outcomes' enabling them to create value (e.g., rather than 'buying a car' they want 'mobility'). An opportunity exists for new and innovative business models that exploit digital innovations to create Digitally Enhanced Advanced Services.

Working with academics from computer science, engineering and business, and industry representatives from three sectors (manufacturing, transport, and finance services), the EPSRC funded DEAS Network Plus has produced three research agendas[1], with a fourth in production (charity/voluntary), that highlights the research priorities for each of the relevant sectors. Each research agenda is designed to be: broad enough to cover a wide range of related areas; inclusive to look at challenges from multiple disciplines; balanced in order to be guided by theory; exploratory to be aligned with the overall objectives of DEAS project; and, relevant to lead to impact on business and make a contribution to knowledge.

Through conversations with industry experts, attendance at industry webinars, the research agendas and the commissioning of collaborative research projects between industry and academia, the DEAS network has learnt from newer sectors (charity/voluntary sector), whilst also gathering learnings from one established sector (i.e., manufacturing), with the aim of forming a two-way exchange between those sectors where servitization is established and those where it is not (e.g., transportation and financial services).

[1] www.deas.ac.uk/outputs

The DEAS Network Plus is currently exploring common learnings from the research that it has commissioned. It is emerging that there may be benefits if the principles of Advanced Services and DEAS could be considered sector agnostic. DEAS began with the manufacturing sector but now understand that this is an exemplar, rather than the only model that could be followed. Servitization is a journey with different parts of the ecosystem starting at different points moving at different speeds.

This conceptual paper presents some of the initial learnings from the Network's work in the financial services sector, namely the need for an ecosystem view that includes a wider group of stakeholders (especially financial services), and the need for guiding principles that are sector agnostic.

2. METHODOLOGY

The DEAS Network Plus aims to position the UK as the internationally leading research hub for Digitally Enhanced Advanced Services. To do this, the network has created a community of researchers and practitioners working collectively across various disciplines (computer science, engineering and business) and sectors (manufacturing, transport, finance services and charity) to co-create a comprehensive research agenda that accelerates the development of DEAS within the UK.

The work described in this conceptual paper is based upon a review of work of the DEAS Network Plus to date. Four research agendas have been produced by the network, one for each sector: manufacturing, transportation/mobility, finance and charity. Each of the research agendas has been developed to be: inclusive to look at challenges from multiple disciplines; balanced in order to be guided by theory; broad enough to cover a wide range of related areas; exploratory to be aligned with the overall objectives of DEAS project; and, relevant to lead to impact on business and make a contribution to knowledge. To ensure that these characteristics were met, a three-step process was adopted: step 1) a suitable theoretical framework was developed based on the Empathise phase of the design thinking methodology to ensure the viewpoints captured were balanced and inclusive; step 2) academics and industry representatives were brought together (either physically or virtually) to help understand the challenges and opportunities faced by organisations who are trying to adopt DEAS; and step 3) validate and refine what was captured in step 2 using a Delphi methodology. The projects that were commissioned by the DEAS Network Plus were those that worked with an industry partner to address at least one of the research questions in the published research agendas.

The review of work of the DEAS Network Plus to date includes thirteen commissioned projects, the four research agendas, a series of virtual roundtables, conversations with industry experts and attendance at industry webinars. The outputs from the thirteen commissioned projects that have been included in the review include the regular project updates and reports to the DEAS project investigators, presentations to the DEAS Network community and any publications that have been produced as part of the project. Copies of the research agendas, and outputs of the commissioned projects, can be found on the DEAS project website[2]. The review of the project outputs have allowed different viewpoints and different sectors to be considered.

3. A SERVITIZATION JOURNEY

Baines et al (2017) offer a description of servitization comprising three themes: *Base*, (post sales service); "*Intermediate* (ongoing maintenance); and "*Advanced Services*" ("customer support agreements", ongoing close relationships and "outcome [based] contracts"). Servitization is a process, rather than a destination. The Advanced Services Transformation Roadmap (Figure 1), developed with manufacturing companies is a tool for organisations moving from being product-focused to service-based.

[2] www.deas.ac.uk/outputs

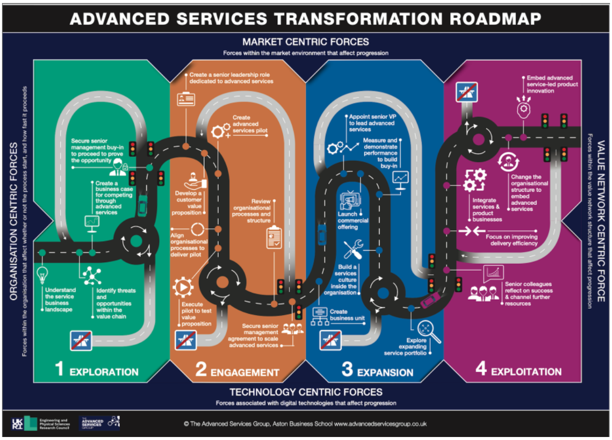

Figure 1: Advanced Services Transformation Roadmap (The Advanced Services Group, 2021)

The transformation focuses on the transition of a single company with four stages (exploration, engagement, expansion and exploitation) and four relevant 'forces' that would affect progression: market-centric, organisation-centric, value network-centric and technology-centric. The servitization progression model presented by Baines et al (2020) depicts the same four stages but with five forces (customer pull, technology push, organisational readiness, value network positioning and organisational commitment).

4. THE IMPORTANCE OF FINANCIAL SERVICES

The financial services sector includes insurance, banks, investment, firms offering accountancy and advice, and real-estate. The institutions and organisations within the sector provide financial services to customers both in retail and commercially. To protect stakeholders (i.e., consumers, investors and institutions) and the wider economy and society, financial services is highly regulated.

In 2019 the financial services sector contributed 6.9% of total economic output to the UK economy (£132 billion) making the UK financial services sector the ninth largest in the OECD (Hutton and Shalchi 2021). In Q1 2020, 3.2% of all jobs in the UK (1.1 million) were financial services jobs (Hutton and Shalchi 2021).

The financial services sector will play a key role in helping the UK economy recover post COVID. Chancellor Rishi Sunak, on 9th November 2020, announced three steps "to renew the UK's position as the world's pre-eminent financial centre": the use of technology to support better outcomes for businesses and consumers, market access by markets overseas and the tackling of climate change within the sector (Hutton and Shalchi 2021).

As more organisations seek to move towards a servitization business model, financial services providers play a key role in stimulating and supporting their customers transition. They must also consider whether they should also adopt an advanced services model themselves (DEAS, 2020). The work undertaken the DEAS Network Plus in relation to financial services has focused on banking and insurance, two of the largest industries in the sector.

3. THE NEED FOR AN ECOSYSTEM

An ecosystem can be considered 'a complex network or interconnected system' (Ecosystem, 2021). Research agrees that servitization is a journey. Our research has also shown us that an ecosystem must be taken into account. There is a need for the role of finance not just to support the servitization journey but also to undertake the journey themselves. This lead to a complex servitization ecosystem with a wide group of stakeholders involved (Hullova, 2019; Kohtamäki, 2019). This section will begin to explore this ecosystem and identify who we believe are the key actors within it.

The basic model in a product-based system has three principal actors: the Original Equipment Manufacturer (OEM), the operator and the end customer. Figure 2 depicts the basic model of pushing products (opposed to selling services). The arrows relate to the flow of asset. The OEM builds the equipment, which it then sells to the Operator. The operator sells the operation of that equipment to the End User Customer who uses the product. In some cases the OEM may sell directly to the End user customer as indicated by the dashed line.

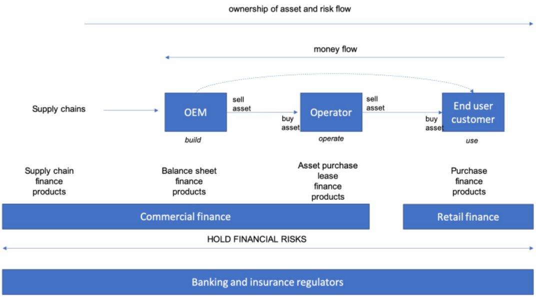

Figure 2: Basic model ("AS IS") of pushing products

The ownership of the asset and the risk flow go throughout the supply chain from the OEM to the end user customer. Insurance tends to be limited to ownership risk with each stakeholder arranging their own insurance. Separate finance products exist depending on the stakeholder and whether they sit in commercial or retail; the institution or organisation that is selling that financial product holds the associated financial risk. Banking and insurance regulators are the main regulatory representatives from the financial services sector.

In a servitization model, instead of selling and financing "products", the financial system will need to provide and finance a "service" within a new set of ongoing relationships between OEM, operator, end consumer and financial services. Although the actors may stay the same, the roles and responsibilities that are assigned to them are likely to change. The traditional goods model, based on capital expenditure, is replaced with a service-orientated model based on operating expenditure (payment through use, not purchase). Figure 3 depicts this transition.

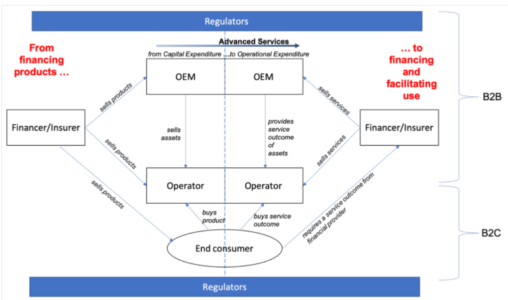

Figure 3: The transition from current model to new financial services ecosystem (Godsiff and Wood, 2020)

Although Figure 3 highlights some of the general key concepts in those transitions, more detail can be given as to what the new ecosystem might look like (i.e., the right-hand side of the figure).

The finance and resource identification should be explicitly considered as part of the ecosystem journey; the inclusion of the financial services sector is crucial. Therefore, in addition to the Original Equipment Manufacturer (OEM), the operator and the end customer, the principal actors should include a wider group of financial solution providers (e.g., banks, asset financers, investors), asset holders, insurers and regulators (see Figure 4). Each of these stakeholders will have their own needs and requirements which will change as servitization in a particular sector develops.

In a servitization business model the focus is on the customer and value from use (e.g., customer oriented pay per use). This must be financed differently to value from exchange because the cash flows and risks are different in terms of amount, timing, location and nature. Instead of a push to sell more products, the ecosystem must focus on getting the most use out of the products. This has an impact for all stakeholders, particularly the financers and insurers.

The majority of the arrows in Figure 4 represent services, expect that in red (i.e., where the OEM sells the asset to the financial solution provider). The stakeholders will see a transfer of risk and changed financial needs. The risk changes from ownership risk to use risk. In the new ecosystem, operational and end-of-life risk must be included in the insurance portfolio. Unlike the “AS IS” model depicted in Figure 2, asset flow will probably stop with the OEM, or the finance company, and will not flow to the operator or end user.

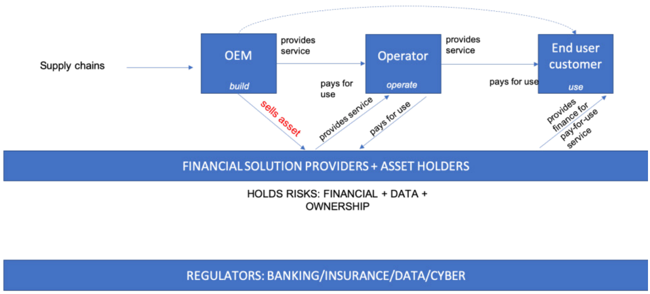

Figure 4: "TO BE" Customers pull and pay for in-use service solutions; operators pull and provide in-use solutions

5. A RESEARCH AGENDA

Further work is needed to fully understand the ecosystem, its stakeholders and how it fits with the wider picture. The following set of research questions have been established to help scope this further work.

What are the implications for digitalisation in the new ecosystem?

Maull et al. (2017) define digital transformation as digitisation (the conversion of analogue to digital), datafication (the collection and analysis of data), and digitalisation (occurs when there is an innovation in an organisation’s business model). Datafication requires digitisation, which drives digitalisation. Digital transformation is happening to servitization (it is not the driver), and it will shape the ecosystem and have implications for each of the stakeholders. Digitalisation can lead to challenges and opportunities (Godsiff and Wood, 2021). It is likely that data will need to be shared between stakeholders, which could lead to new innovative business models and different value propositions (e.g., monetisation of data). Some companies may exist as specific data platforms and others provide specialist data analytics. Understanding the implications of a data-driven approach will include identifying new stakeholders (e.g., FinTech and InsurTech providers), exploring possible data flows and the new innovative business models that may exist within the ecosystem. Each of these research areas will also have implications for regulation and policy.

What are risk flows in the new ecosystem?
The new ecosystem will need to include operational/usage and end-of-life risk in the insurance portfolio. It is important to understand the role of insurance in the new ecosystem and the different risk models that might exist. Research questions will include the evaluation and pricing of risk in usage of an asset instead of risk of ownership , how to visualise the changing flows and nature of risk in the ecosystem (Ziaee Bigdeli et al. 2018) and how these can be funded and potentially pooled.

What are the implications of a customer-centric approach?
Customers are typically the driving force in innovation (Godsiff and Wood, 2021) and, therefore, could determine the offerings of an organisation. Servitization tends to be considered as B2B, however what happens in a B2C environment? In some instances it can be difficult to understand who the end customer is (e.g., insurance supply chains), which can make it difficult to adopt a customer-centric approach (Godsiff and Wood, 2021). Further research is needed to understand the supply and value chain in the B2B and establish if a customer-centric servitization model is possible.

What are the objective functions in the ecosystem and how can/should they be maximised?
There are many stakeholders in the proposed ecosystem, each of which will have their own objective functions. Research is needed to understand those objective functions, how they relate and which ones should be prioritised.

How should the ecosystem be regulated?
The financial services sector is highly regulated, which can result in organisations finding it challenging to embrace the necessary innovations. The new ecosystem includes a complex network of stakeholders with the potential of shared risk and shared data. Some regulators may overlap but there may also be absent regulators (e.g., those relating to emerging stakeholders). Standards are likely to play an important role but who should develop those standards and are there existing bodies to ensure compliance or must new bodies be formed?

How can the ecosystem aid sustainability?
All sectors are being encouraged to play their role in allowing us to move to a more sustainable society. Work has begun in identifying how this might work for the insurance sector by showing how organisations within the sector could embed Circular Economy principles (Godsiff and Wood, 2021). However, the insurance sector is only one industry within the financial services sector. Can the work be applied to other industries within the sector? How can the stakeholders in the new ecosystem help drive sustainability agendas? There is much talk within the finance industry on green finance and investing in green assets, but the construction processes of zero carbon green assets such as wind turbines, nuclear power stations or hydro-storage, and the resulting assets themselves, may not accord with sustainable concepts and philosophies. How will the ecosystem deal with assets that would not be considered green? What are the implications of value in use rather than value from ownership?

What is core to servitization?
From the work of the DEAS Network Plus it has emerged that there is cause to consider whether the principles of Advanced Services and DEAS could be developed to be sector agnostic. Manufacturing could then be considered an exemplar for servitization and advanced services, not the only model that could be followed. Therefore, research must establish what is core to "servitization". Can existing methodologies such as Service-Dominant Logic (Vargo and Lusch, 2016, Vargo and Lusch 2017; Vargo

et al. 2017) help us understand servitization in a sector agnostic way or the transition to the new ecosystem? Can existing research on servitization in manufacturing be applied to other sectors?

How can the ecosystem be implemented in the sector?
It is important that research is relevant to industry and the theory can help inform practise. Research will be needed to help with this transition of knowledge and understand the industry perspective.

6. FUTURE WORK

It is emerging that there may be benefits if the principles of Advanced Services and DEAS could be considered sector agnostic. This conceptual paper has highlighted the need for an ecosystem servitization view that considers a wider group of stakeholders and the importance of the financial services sector. A possible new ecosystem has been proposed and a set of future research questions that will could be used to help inform the future research agenda of the academic community. Consultation will also take place with industry to see how theory could inform practise, how the ecosystem could be established and how they see their roles within it.

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USE-ORIENTED BUSINESS MODEL FOR CONSUMER DURABLES: AN EXPLORATORY CASE STUDY ON BUSINESS MODEL CAPABILITIES

Tara Shahnavaz, Henrik Möller, Wiebke Reim & Vinit Parida

ABSTRACT

Purpose: The purpose of this study is to explore capabilities needed to deploy a use-oriented business model (UOBM) for consumer durables with low utilization rate. The study seeks to uncover activities needed to realize business model capabilities and the impact on business performance.

Design/Methodology/Approach: The study was conducted with an explorative single case study research approach, investigating an incumbent original equipment manufacturing (OEM) firm of consumer durables based in Sweden.

Findings: The study results in a framework which illustrates 13 key capabilities within the three dimensions of the business model (value creation, delivery, and capture) needed to successfully deploy a UOBM in a consumer market.

Originality/Value: The study contributes to the previous research of Product-Service Systems (PSS) in a consumer context through empirically developing the PSS B2C business model research. We have found both organizational-wide prerequisites and business model specific capabilities needed for the provider to undertake to mitigate the challenges, prevent risks, and ensure business performance.

KEYWORDS: Business Model; Product-service systems (PSS); Circular Economy; Consumer Durables

1. INTRODUCTION

Increasingly, firms are choosing to innovate their offerings by focusing on the provision of services and solutions rather than on a single product (Hou & Neely, 2018). The phenomenon is known as Product-service systems (PSS) and can be defined as a marketable set of products and services that are capable of jointly fulfilling customers' needs in an economical and sustainable manner (Reim, Parida & Örtqvist, 2013). Technology advancements and globalization has changed user demand and fostered the new paradigm of PSS, and with that, a new view on business models (Parida et al., 2014).

Previous literature has examined different types of PSS business models (Tukker, 2004) and the capabilities needed to deploy the new business models but in an industrial services context (Parida et al., 2014). One type of PSS business model that has increasingly been adopted by manufacturers of consumer durables is the use-oriented business model (UOBM) where the product is still central to the offering, however, it remains in the ownership of the provider and is made available to customers through for example leasing (Tukker, 2004). UOBM can bring important benefits such as increased financial performance for companies (Parida et al., 2014). In their article, Laukkanen and Tura (2020), recognize that UOBMs in a consumer context have the potential to create sustainable value with respect to both environmental, social, and economic perspectives.

Currently, many studies are discussing the adoption of PSS based business models but in a B2B context (Barquet et al., 2013). One example is Parida et al. (2019) who emphasize developing new capabilities to support organizational changes in value creation, delivery, and capture when adopting a PSS business model. However, a need for exploring UOBMs for consumer goods (Li et al., 2019) and within a B2C context (Mont et al., 2006) is recognized, where potential benefits such as a new revenue stream, customers segments, and increased environmental sustainability is to be realized. This is further supported by Sjödin et al. (2019) who acknowledge that B2C PSS business models vary in their processes, as scale, risk, and complexity are different in a B2C context compared to B2B context.

Even though the shift to PSS business models can lead to increased revenue and profits, it is not without its challenges. Firms have difficulties in realizing PSS, which results in a service paradox where the shift toward revenues generated from services leads to unprofitable business models, which all emphasizes the need for further research. Hence, to overcome these challenges it is of high importance to understand the underlying internal capabilities (Teece, 2007), and a firm's ability to integrate and reconfigure internal and external resources and activities.

To address the practical challenges and identified theoretical gaps, the purpose of this study is to explore capabilities needed to deploy a UOBM for consumer durables with low utilization rate. Therefore, the study seeks to uncover activities needed to realize business model capabilities and the capabilities impact on business performance. The purpose will be answered through a single case study at an incumbent OEM of consumer durables.

2. THEORETICAL BACKGROUND

2.1 Business Model Innovation in UOBM

The business model can be viewed as a conceptual framework that articulates the rationale on how a business creates, captures and delivers value (Teece, 2010), which can be described as a system of interdependent activities that transcends the focal firm and spans its boundaries (Zott & Amit, 2010). Within the PSS literature streams, value creation is characterized by acquiring responsibility from the customer and accomplishing them more effectively (Reim et al., 2017). The value delivery dimension encompasses the activities in which the provider orchestrates the delivery of the service to the customer (Teece, 2010). Value capturing can be defined as all activities an organization performs to absorb created value and splitting the gain with selected partners (Dyer et al., 2018).

Within PSS there are different levels of servitization, where Tukker's (2004) classification model of PSS is the most widely accepted and proposes three types of PSS business models: product-oriented, use-oriented, and result-oriented. The UOBM, is described as a business model where the product remains in the ownership of the manufacturer and then sells the use of the product, where a suitable product category for realizing the business model is consumer durables. Meaning that the product is still central but can be provided through for example leasing, renting, or sharing (Barquet et al., 2013; Tukker, 2004). Therefore, the company becomes motivated to create a PSS to increase and maximize the use of the product, i.e. the utilization rate (Bains et al., 2007). There are several benefits to obtain by switching to a UOBM, mostly discussed in a B2B context. Laukkanen and Tura (2020) have recognized that the UOBM is being utilized for enabling sharing economy principles in a consumer context. One of the most recognized benefits is the potential increase in product use, as assets tend to be underutilized (Baines et al., 2007).

2.2 The UOBM and its Challenges

As recognized by Teece (2007) to manage the UBOM challenges it is of high importance to understand the underlying internal capabilities. Previous literature has aimed at resolving specific challenges, such as consumer acceptance (Rexfelt & Hiort af Ornäs, 2009), but have not yet provided a consolidated view. When dealing with value creation for PSS in a consumer context, most authors have primarily discussed consumer acceptance related to the loss of ownership, which poses a great barrier to consumers accepting the PSS business model (Akbar & Hoffmann, 2015), which can hamper the value creation. In addition, companies offering PSS perceive that requirements are likely to change rapidly (Sjödin et al., 2019) which stresses the importance of customer-centric value creation (Akbar & Hoffmann, 2018). Parida et al. (2014), recognize that the shift to a service-oriented business model entails a need to acquire new capabilities and processes in how the value is delivered. This emphasizes the importance of understanding the challenges and possible mitigating activities of how value is delivered in PSS business models. One of the most prominent challenges to overcome in the shift to PSS, is to enable the business models through extending the relations with service delivery partners (Parida et al., 2014). In addition, Akbar and Hoffmann (2018) show that the perceived fear of stockout (inability to access the service) increases significantly and can become a barrier for consumers in their transition toward non-ownership. One of the most prominent value capturing challenges is the changing attitude towards the product with a shift in ownership, where consumers tend to be less careful if renting, leasing, or sharing (Tukker, 2004). The tendency for opportunistic behavior originates commonly from lacking incentives to treat the products gently. Several authors have acknowledged the importance of revenue models in order to appropriate the value from customers (Parida et al., 2014; Tukker 2004), but all in a B2B context. Finally, it is also recognized that that revenue sharing models between the provider, partners, and customers in a B2B context can increase the attractiveness for all parties to adopt PSS business models (Parida et al., 2014; Reim et al. 2016).

3. METHODOLOGY

3.1 Research Approach and Strategy

This study has adopted a qualitative research approach, which emphasizes deep validity rather than generalization (David & Sutton, 2011). A qualitative research approach also aligns with the purpose of the study, as the study sought to deepen the understanding of PSS business model design for consumer durables. More specifically, the study has adopted an exploratory case study approach. Exploratory research can be seen as valuable when assessing a phenomenon in a new context, such as exploring a UOBM in a consumer context. In combination with the research strategy, a case study, allowed us to study the phenomenon in a real-life context and thereupon build theory on the subject (Thornhill et al., 2009). The purpose of this study is to explore capabilities needed to deploy a UOBM model, which implies a need for deep analysis of organizational structures, therefore, we designed the study as a single case study. The interviews were performed both at the case organization, as well as from external sources to gather further insight and a broader perspective on the studied case. In total, 34 interviews were performed as (1) exmploratory; (2) semi-structured; (3) confirmative. Additionally, observations and informal meetings proceeded during the study.

The collected data was analyzed with the help of a method referred to as thematic analysis, which is a method for identifying and analyzing patterns from a data set in an iterative process through preparing, linking, and coding (de Casterlé et al., 2012), where the goal of using this method is to generate a set of overarching themes. This was realized in the study by deriving overarching themes (the business model dimensions) from the frame of reference while the first-order codes and categories emerged from the data. With inspiration from de Casterlé et al (2012), we used primarily two phases when analyzing the data: 1) preparation of the coding process, and 2) the actual coding of data and clustering, which resulted in codes, categories, and themes. Each dimension (theme) was represented by business model capabilities (categories) which were built by the business model activities (codes), presented by the respondents' narratives (quotes). A visual scheme of the thematic analysis can be found in Figure 1.

4. RESULTS AND ANALYSIS

The chapter starts with a general description of the changing dynamics as a result of transitioning to a UOBM. The findings are structured accordingly to the presented thematic data map (see Figure 1), where each business model dimension (Themes) is discussed with their corresponding capabilities (Categories) and activities (Codes). Finally, a conceptual framework is presented, describing the capabilities' impact on business performance.

4.1 Value Creation Capabilities

From the empirical data, four prominent capabilities within value creation have emerged. In the coming section, each capability will be discussed and explained with corresponding activities.

The capability *Customer Oriented Product-Service Development* refers to the provider's ability to develop an offering designed for their specific customer segment, which has significant importance to achieve a higher business performance when providing a product-service. To build the capability an important activity conveyed by many respondents is that the product-service should contain elements in which the provider can engage and interact with the customer, which in itself increases the created value but also enables future value appropriation. Furthermore, the respondents express a need to embed technical elements, such as digital sensors, in their product-service to monitor customer data. This to further develop the product-service based on the customer's usage and behavior patterns, but also to cater to a broader set of customer needs which in turn can aid the provider in designing future product-service offerings.

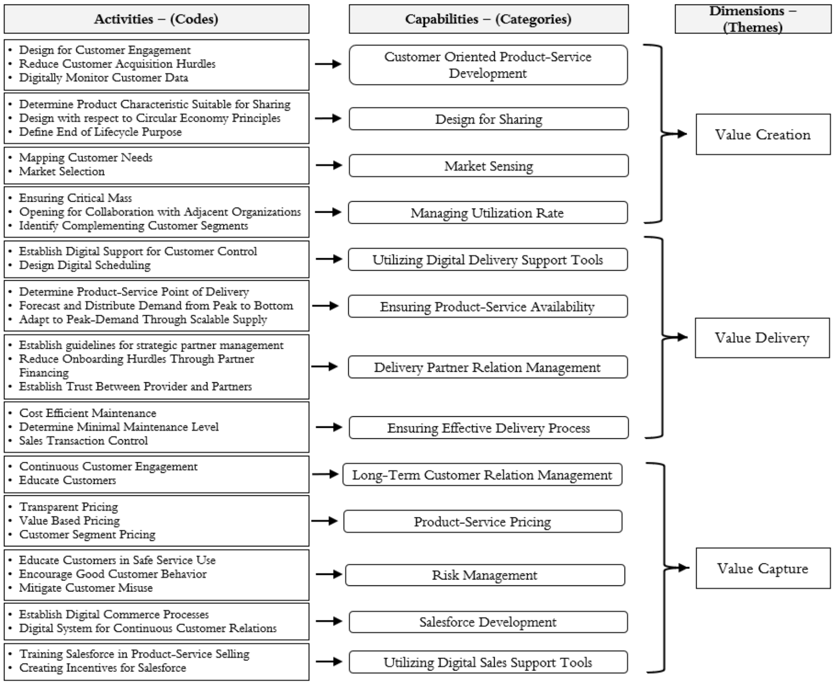

Figure 1 - Thematic data map

The second capability, *Design for Sharing*, is enabling a UOBM as it involves designing the product-service specifically for being used during high utilization and shared among customers. A common message from respondents is that the provider needs to be able to recognize which product characteristics are suitable for the use-oriented offering and at a more mature stage determine what other products can be incorporated into the offering to increase the added value. Furthermore, the activity to design with respect to circular economy principles is essential to handle the increased depletion of the products as a result of the increasing utilization rate and number of users. Even though it can require significant changes in internal processes, several respondents recognize that to define end of lifecycle purpose becomes important when dealing with products employed in a UOBM to achieve higher business performance.

The *market sensing* capability supports the aforementioned value creation capabilities in ensuring decision-making based on appropriate information, hence it should be considered a business-critical capability. The capability is significant since the provider not only needs to understand how to develop their product but also how to construct a service-offering catered to the market's and customer's needs. As both product and service are in focus, mapping customer needs and market selection becomes of importance. Equally important is understanding other market factors such as norms and the maturity of different markets, which stresses the importance of choosing the appropriate market.

Based on input from several respondents', when selling access to a product, reaching a high utilization rate becomes crucial to create value and for future value appropriation. *Realizing a high utilization* rate requires a good understanding of the business model and a mature product-service organization. Based on our respondents, three activities have been recognized. First, ensuring critical mass, meaning that the provider needs to ensure that demand for a specific product in a specific location can yield the sought-after utilization rate. Secondly, opening for collaboration with adjacent organizations, meaning actively staying open to finding partners offering complementary services and/or products that cater to the need of a larger segment of customers and thus creating additional value for the customer base and increased utilization of the delivery infrastructure. Finally, identify complementing customer segments, suggesting that providers should identify customer segments which have different usage patterns to evenly distribute the utilization rate.

4.2 Value Delivery Capabilities

From the empirical data, four significant capabilities emerged. In the coming section, each capability will be discussed and explained with the corresponding activities.

For companies with no prior experience in managing direct contact with the consumers, there is a lack of *Utilizing Digital Delivery Support Tools* to handle customer data, such as product registration and customer information, needed to ensure the accessibility to the product-service. The provider should, therefore, establish digital support for customer control, to manage the large amounts of customers, transactions and increasing number of products owned by the provider. Furthermore, digital support systems are also needed to administrate availability of the product to ensure that the provider can cater to all customers, which is described by design digital scheduling.

When deploying the UOBM the provider retains ownership of the product and the customer, therefore, loses the conveniences of ownership, such as *ensured availability*; hence, the capability is crucial. As the business model changes with the shift in customer behavior patterns, the provider needs to adapt to new means of delivering the product-service, which also entails the critical activity to determine product-service point of delivery. The point of delivery has to both be convenient for the consumer as well as possible for the provider to sustain. The UOBM is based on the foundation of providing access to a product, which sets requirements on the provider to be able to forecast and Distribute demand from Peak to Bottom. Furthermore, by tailoring specific offerings to certain customer segments, the demand can be managed, by moving forecasted peak-demand points to low-demand points. Even though forecasting is important, it is not always accurate which creates a need for the more advanced activity, adapt to peak-demand through scalable supply, which entails the ability to reactively adapt to demand.

The *Delivery Partner Relation Management* capability has emerged as a crucial ability to manage and build as the UOBM changes the provider's relationship with their current or future partners in that the provider overtakes more responsibility from the partners. The respondents stress the importance of their relationship with their delivery partners, and most of the respondents emphasize the strategic partner management as a fundamental activity. When choosing delivery partners, factors such as advantageous location and competence are important to consider, but also the partner’s understanding of the benefits of the new business model. However, the delivery partner's ability to grasp the change is not enough, the provider also needs to reduce onboarding hurdles through partner financing. It should be recognized that delivery partners might not be able to finance the needed operational investment, implying that the provider should consider establishing options for financing.

With the responsibility of the product remaining with the provider and the delivery partners, a need to be able to *Ensure Effective Delivery Processes* is crucial in order to ensure the delivery and functionality of the service effectively. In order to realize the capability cost efficient maintenance ,smart product-and infrastructure design is recognized together with determining minimal maintenance level, the activity to identify product components prone to breakdown and appropriate service intervals. The two activities should also be complemented with an increased sales transaction control, where every sales transaction's profit should be monitored to recognize a decline in delivery process efficiency. The sales transaction is defined as the whole sales cycle including accessing the product, usage, return, and maintenance.

4.3 Value Capture Capabilities

For the provider to ensure that the created value is appropriated and split among selected partners a total of 5 significant capabilities emerged. In the coming section, each capability will be discussed and explained with the corresponding activities.

When shifting from a product-oriented organization toward a UOBM, a need for new capabilities is recognized as a result of changing customer relations where the relation shift from transactional to long-term. As a result, the need for *Long-Term Customer Relation Management* arises to enable value appropriation resulting in higher business performance. The long-term customer relationships entail a need for establishing processes for continuous customer engagement. When the customer relationship becomes long-term, activating the customer to enable re-purchases and up-selling becomes important for enabling value appropriation. In addition, it becomes necessary to educate customers to facilitate the adoption of new services.

To appropriate value, we have found strong support for *Product-Service Pricing* as one of the most important value capturing capabilities. To achieve a strong pricing capability the provider must be able to effectively communicate the final price through transparent pricing, to help the customer arrive at a purchase decision. Additionally, value based pricing, i.e. setting the price closely connected to the perceived customer value, is an important activity. From the empirical data, it is recognized that customer segment pricing is needed to be performed, which is driven by the customers' usage patterns. High-frequency usage customers expect an attractive price, through for example a volume discount, for their specific usage pattern and vice versa.

Based on the empirical data, *Risk Management* is recognized as one of the most important capabilities to enable higher value appropriation. The need for risk management capabilities is driven mainly by the shift of ownership, where the risk remains within service provider's organization together with the ownership of the product. From several respondents, educate customers in safe product-service use is recognized as an important risk management activity where there is a risk for user-injury. The respondents express that if not effectively mitigated there is a risk for damaging the brand reputation if the customers accidentally hurt themselves during usage. Furthermore, we also found the need to actively encourage good customer behavior. An approach discussed among the respondents is the use of kick-back, which could be compared to a form of revenue sharing, where the customer is rewarded if the products are returned in a similar condition as the point of purchase. Driven by the same change in customer interaction, the need for actively engaging in Mitigate Customer Misuse is recognized. When shifting to UOBMs, the provider carries the negative impact of customers using the products in the wrong way which induces unnecessary depletion.

As the dynamics in customer relations change with the shift from product to service selling, *Salesforce development* is recognized to play a significant role in capturing value. Hence,training salesforce in product-service selling becomes an important activity that entails transforming the salesforce's mindset from a product-centric perspective to focus on service selling. To complement the new skills in product-service selling and encourage an increased focus on selling services it is recognized that creating Incentives for salesforce plays an important role. This is also connected to the overall attitude within the company where incentive alignment for product-service selling signals a clear management support which facilitates the business model shift.

The need for *Utilizing Digital Sales Support tools* frequently emerged among the respondents as fundamental and necessary capability to support the increasing complexity driven by the changes in customer relations and sales processes. Firstly, establish digital commerce processes becomes important to manage both the aforementioned complexity in pricing but also to complement the increasing need for digital channels with online-payment solutions. Secondly, implementing digital system for continuous customer relations becomes a fundamental activity to enable long term customer relationship management.

4.4 An Emerging Framework

The 13 identified capabilities are recognized to both answer the purpose of this study, as well as serve as a means to mitigate challenges presented in chapter 2.2, which can be overcome by understanding what capabilities are critical to develop. To better understand the identified capabilities implication on business performance, a framework has been developed based on the analysis, presented in Figure with the capabilities in the respective order: value creation, delivery, and capture. Reading from left to right, the first header in the framework describes, preconditions rather than actual capabilities.

Continuing from the left, the capabilities have been further divided into three categories, Foundational, Intermediate, and Advanced. The preconditions have been recognized from the analysis based on the empirical data collection and during the study, it became obvious that certain preconditions need to be in place before the adoption of the UOBM.

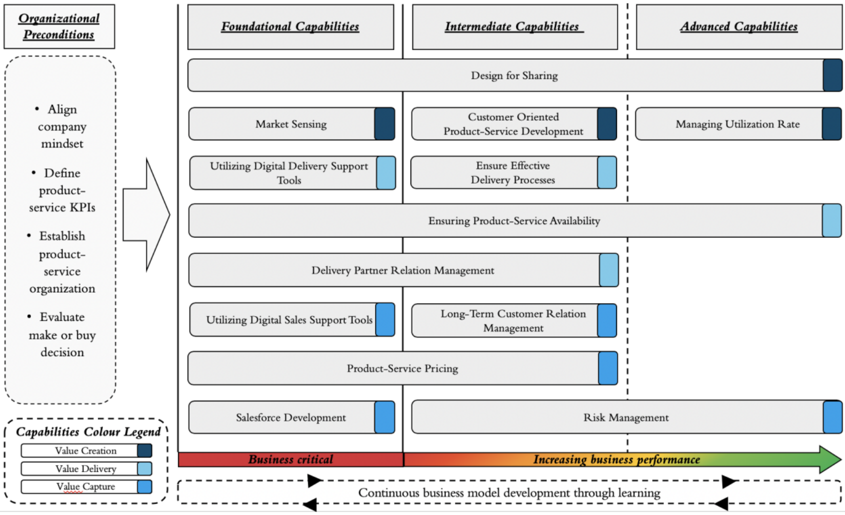

Figure 2 - Capabilities for deploying a UOBM and their impact on business performance

The first precondition, Align Company Mindset, has been frequently emphasized as highly important for succeeding with a shift towards the UOBM. It includes securing support throughout the organization, stretching from top management to both the employees who will implement the changes on an operational level as well as among the employees who will be indirectly affected. Secondly, Define Product-Service KPIs, includes defining KPIs supporting the shift of the company's mindset, meaning that KPIs must be changed to support the development and sales of product-services and thereby important for organizational support. Thirdly, Establish Product-Service Organization is an effective way of aligning the company mindset through concretely showing support for the new business model. But more importantly, it is needed to secure resources for adoption and development of the UOBM, where old structures risk to severely hinder the adoption. Finally, Make or Buy Decision, emphasizes the importance of continuously evaluating what capabilities should be built as an integrated part of the organization or be sourced externally.

Continuing, from left to right, the capabilities have been further divided into three categories, Foundational, Intermediate, and Advanced, which we distinguished from the denotations of the respondents. Each category describes to what degree the capabilities impact business performance, also illustrated by the horizontal axis at the bottom of the figure. Foundational Capabilities are best described as business-critical, meaning that operating the business model without these capabilities would be infeasible and in best case result in very low performance. Once the organization becomes more mature in operating the UOBM, Intermediate and Advanced capabilities should be realized to reach a higher degree of business performance, after the Fundamental capabilities have been established, when resources allow. However, it is important to recognize that a higher degree of organizational maturity is needed to realize these capabilities. In addition, several capabilities also stretch across multiple categories, meaning that these capabilities are composed of activities requiring a varying degree of organizational maturity to be successfully performed.

Several respondents pointed out that the most effective way to continuously develop the business model is to adopt continuous learning through a Trial and Error approach. The approach should include feedback loops to ensure that the capabilities are continuously developed in respect to business performance, which is illustrated at the bottom of the figure by the iterative circle.

5. CONCLUSIONS

This study contributes to previous PSS literature in that the research area is relatively unexplored as not many businesses in the consumer durable sector have begun to adopt the UOBM. In response to gaps in research highlighted by Mont et al. (2006), this study provides an example of the UOBM within a consumer perspective, which also addresses the lack of studies of PSS business models in specific contexts (Li et al., 2019; Rexfelt & Ornäs, 2009). Prior literature from authors such as Rexfelt and Ornäs (2009), Akbar and Hoffmann (2015) have focused on challenges associated with operating the use-oriented and negligibleon how to overcome these challenges, where this study has provided a consolidated view on overcoming the challenges. We have found both organizational-wide prerequisites and business model specific capabilities needed for the provider to undertake to mitigate the challenges, prevent risks, and ensure business performance. Thus, our contribution to previous literature is a structured approach to building business model specific capabilities and evaluating the importance of each capability in regard to business performance.

The study has significant implications for managerial practice as the adoption of PSS-based business models are increasing among manufacturers of consumer durables. In this regard, our study presents essential capabilities and activities within each dimension that providers need to build in order to successfully deploy the UOBM. This to mitigate the potential challenges associated with the adoption of the business model. Another significant implication for managerial practice is the potential of enabling environmental benefits from the capability of Design for sharing. If practitioners are able to Define End of Lifecycle and create a refurbishment for the product, the adoption of the UOBM can result in environmental benefits. Additionally, managing a high utilization rate reduces the need for unnecessary production and ensures that the product stays in full use. Furthermore, practitioners need to understand the overall impact of the shift in customer-provider dynamics has on the provider and customer, as it sets new requirements on the business models.

This study has some limitations and suggestions for possible future research areas. One limitation is that the study was conducted as a single case study which decreases its generalizability, where future research would benefit from a multiple case study. In addition, we see a limitation in that this study has not focused on evaluating how the business model interplays with a company's exciting business models. As employing the UOBM requires large changes within the organization, the consequences of these changes in relation to previous or future business and how they can co-exist, have not yet been uncovered. Therefore, we see the need for future studies to explore the relation between the UOBM and other business models the companies may possess.

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VALUE PROPOSITION PATTERNS OF SMART SERVICES: A DELPHI STUDY

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RESEARCH MOTIVATION

To secure and strengthen their competitive position, manufacturing firms increasingly strive to come up with novel smart service value propositions for their customers (Porter and Heppelmann, 2014). In order to be able to provide such value propositions, they advance their products into so-called smart products by upgrading them with connectivity, sensors, and computational capacity. They connect them to the Internet of things so that they can transmit status and usage data in real-time. The access to this data can yield potentials for value added smart services for customers and even change complete business models (Wünderlich et al., 2015).

For the innovation of such services customer-centric development approaches are recommended that focus on the value proposition as a key element of the desired business models (Neuhüttler et al., 2018). However, identifying a promising value proposition of smart services is seen as one of the main challenges for manufacturing companies (Klein et al., 2018). So far, academia has made a large effort to understand smart service (Dreyer et al., 2019), e.g., by describing how such services can be conceptualized from a (socio-technical) systems perspective (Beverungen et al., 2019; Lim and Maglio, 2018). At the same time, service research in general has been very much concerned on how value is created. Yet, the created value through smart service is still being addressed on an abstract level, e.g., as “removing unpleasant surprises” (Allmendinger and Lombreglia, 2005), or is described by the quite same examples like predictive maintenance over and over again (Beverungen et al., 2019; Dreyer et al., 2019). A comprehensive and empirically grounded overview of potential smart service value propositions and conceptualization of those is still missing. We concur with fellow researchers who state that innovation success is said to depend on the value customers see in the smart service (Wünderlich et al., 2015). Thus, we want to contribute to this important but scarcely researched topic by proposing the following research question: *Which value propositions can be provided through smart service and how can they be conceptualized as patterns?*

CONTRIBUTION TO THEORY AND PRACTICE

This article addresses smart service innovation which represents a highly relevant topic for practitioners and scholars alike that requires research (Dreyer et al., 2019; Zheng et al., 2018). We conducted a Delphi study with 31 experts who are in charge of digitization and innovation projects in manufacturing companies (Skinner et al., 2015). First, we investigated the experts´ understanding of the key characteristics of smart services. The result was following smart service definition: *A smart service is a digitally supported, data-based, and user-oriented service. In order to provide a smart service, data from networked objects (e.g., smart products) is (automatically) collected, provided, processed, analyzed and interpreted into value-added information*. After clarifying the understanding of smart service, the experts were asked to name smart services with a short description. In total, the participants described 116 services. We used the descriptions to find patterns of value proposition for the service recipient by pattern coding (Saldana, 2013). We were able to suggest a set of twelve patterns, which include **Access**, **Analyze**, **Assist**, **Automatize**, **Match**, **Operate**, **Optimize**, **Personalize**, **Predict**, **Recognize**, **Share**, and **Virtualize** (Table 1).

Table 1: Identified Value Proposition Patterns

Pattern	Description
Access	Accessibility to data and information
Analyze	Analysis of data/processes to generate valuable information
Assist	Supporting customers in their value creation
Automatize	Automation of processes and working steps as well as autonomous systems
Match	Matching suppliers and consumers of specific assets or services, for example via a platform
Operate	Operation of an asset/process with payment according to key figures, e.g. availability or output
Optimize	Optimization of assets, processes or workflows
Personalize	Personalization of Services which were adapted to individual needs
Predict	Predictions of future events
Recognize	Identification of objects or patterns in existing processes and/or process data.
Share	Sharing assets among stakeholders so that they no longer have to be procured by everyone.
Virtualize	Virtualization of processes and work stages.

The experts rated provided patterns of value propositions as meaningful (Median = 4.5; APMO = 0.9), useful (Median = 5; APMO = 0.9) and complete (Median = 5; APMO = 0.77).

With our results, we contribute to research and practice. Klein et al. (2018) state that "hazy value propositions and difficulties conveying benefits to customers" are among the major challenges in service innovation. This study addresses this difficulty by identifying existent value propositions of smart services and conceptualizing those as patterns for future smart service innovation activities. Fellow researchers described former patterns as confusingly numerous and difficult to compare (Weking et al., 2018). Thus, in contrast, we consciously focused on the value proposition only. This should make the patterns more applicable and comparable which should directly positively influence their practical applicability.

KEY DISCUSSION POINTS

- We concur with fellow researchers who argue that innovation challenges can be tackled by recombining existing knowledge and patterns (Beverungen et al., 2018; Gassmann et al., 2014). With it the seizing of opportunities for innovations can be systematized and supported
- Our set of patterns can inspire firms in crafting a customer-centric value proposition. They are abstractly labelled in a way that briefly explains what is done for the customer. Keeping them rather abstract was a deliberate choice as the patterns should not be merely copied. The inspiration they provide certainly needs to be transferred to the specific context of the smart service system.
- The practical transfer of our patterns into a smart service innovation process should be a future point of interest. We argue that they present a helpful assistance in the ideation of new ideas of innovative value propositions.
- From a more generic perspective, future research should try to investigate which level of granularity makes sense in which specific situation of innovation initiatives. More precisely, we think that the use of patterns, but also the consideration of different lenses and understandings of patterns requires further research.

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ENABLING SMART SERVICES FOR MANUFACTURING SMEs BY DATA-DRIVEN VALUE CREATION

Jürg Meierhofer, Helen Vogt, Petra Kugler

RESEARCH MOTIVATION

With the transition from products to services, the economy moves from the concept of "Goods-Dominant Logic" to "Service-Dominant Logic" (Vargo & Lusch, 2004). For the development of the service economy, smart information and communications technology have a major impact (Lim et al., 2018), in particular when moving to output-oriented, advanced services (Ulaga & Reinartz, 2011).

Practitioners and scientists agree that the use of data within an ecosystem and sharing the data between the participants in the network has the potential to generating innovative services or products. However, firms within a network are increasingly reluctant to actually share their data with their partners. Although data are available, the potential inherent to these data cannot fully be transferred into value in an ecosystem (Henke et al., 2016; Chin et al., 2017).

Technical implementation is a necessary condition in this process, but not sufficient to trigger cooperation and willingness to share data among SMEs and their partners. Findings from previous work (Meierhofer et al., 2019, Holler et al, 2019) suggest, firstly, that non-technical barriers to data sharing are important but have received less attention so far. Secondly, prior work indicates that data in firms requires a holistic or multi-perspective view for dealing with data (Kugler, 2020). However, prior work could not clearly identify factors that are supporting or hindering in this process.

Therefore, this contribution seeks to describe an initial conceptual approach and a research agenda for SMEs to access data in their ecosystem. It focuses especially on organizational structures and contextual factors of value creation, willingness to share data within an ecosystem, as well as an organization and culture that stresses the importance of data in the context of organizational value creation. The paper aims at discussing the following research question: Which factors support resp. hinder the process of data sharing within a business ecosystem of a manufacturing company? How does trust, organizational culture and mindset, and the value of the data that is transferred between the parties, influence this process? And finally, what are suitable tools in particular for SME's to overcome these hurdles and leverage the potential of data to develop new services and products?

METHOD

The research is exploratory in nature and it is based on a multi-method approach. A review of the literature is followed by a multi-step empirical analysis. In a first step, we lead qualitative interviews with different actors in the described ecosystems that are in volved in the process of data exchange, i.e. manufacturing firms, their customers and IoT-service-providers. The research focuses especially on SME's that are already familiar with the exchange of data in the DACH-region (Germany, Austria, Switzerland). We seek to learn more about the circumstances in which data is shared or not in the ecosystem. To do so, the research focuses on multiple perspectives, a) service value creation in ecosystems b) the willingness to share data / trust c) organisational culture and mindset. Further dimensions of this framework such as legal aspects and IT security are not in the scope of this paper.

Typical situations will be compared and described in case studies. In a second step, selected findings and how these are interrelated will be tested by means of a quantitative online survey that will also be spread in the DACH region. We seek to integrate the findings into a conceptual framework that mirrors a holistic perspective on the supporting and hindering factors of data sharing in an ecosystem.

CONTRIBUTION TO THEORY AND PRACTICE

This study contribution will provide insights in the factors enabling data sharing among SMEs in three dimensions:

a) service value creation in ecosystems. The sharing of data by companies is largely determined by the value it can create for the actors in the ecosystem. If this value is sufficiently high and the actors in the ecosystem can capture enough of it, the willingness to share is positively impacted. Special attention will be paid to the value creation with data when several actors of a service ecosystem share their data for value creation by advanced services. How can the value of data in the ecosystem be quantified as opposed to the case of an individual company? How do these co-creation relationships need to be designed for enabling value capturing and value creation?

b) willingness to share data / trust. Data is already being generated by many products and systems. SMEs rely on this data to improve their products and develop new solutions. However, customers and other participants in the ecosystem are not sufficiently willing to share these data. It is therefore important to understand the drivers to increase this, which includes, besides customer value, the structure of the supply network, the relationship of trust between SMEs and their customers, risk and innovation profile and size of the individual companies, storage, type and amount of data which is being sheared etc. To this end, potential drivers will be identified and evaluated in terms of their importance for different customer segments.

c) organisational culture and mindset. Organizations that use data and data science to add value are exposed to new rules of the game, e.g., network effects or exponential growth rates caused by data-driven value creation on the market. These changes also require a new conceptualization of the organization itself, and preliminary findings indicate the suitability of a data-dominant logic (Kugler, 2020) to reach this goal. It is reflected in its culture, i.e., values, norms, and mindset (e.g., (Schein, 1985)). A data-driven culture must, among other things, reinterpret organizational boundaries and resources to allow data sharing between organizations (Westerman et al., 2019).

The findings of this conceptual work will be integrated to a data sharing framework, which takes into account the specific situation of SMEs. The new concept paves the way for SMEs to share data in order to benefit from advanced industrial services in their ecosystems. Furthermore, the study contributes to research by establishing an agenda for future empirical research towards a comprehensive data sharing framework.

KEY DISCUSSION POINTS

- Data are the basis for developing innovative service and products and for the creation of value
- This requires data sharing in manufacturing ecosystems for turning data into value
- Hurdles to sharing data include the lack of information on the value of data, insufficient trust between the network partners and an appropriate data culture

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A SIMULATION-BASED INVESTIGATION OF THE BENEFICIARY OF ADOPTING REMOTE ASSISTED SERVICE PROCESSES FOR THE PROVIDERS OF INDUSTRIAL PRODUCT-SERVICE SYSTEMS

Enes Alp, Michael Herzog & Bernd Kuhlenkötter

RESEARCH MOTIVATION

Servitization describes the process of manufacturing companies transforming their business strategy by adding services to their offerings with the aim of gaining competitive advantages and increasing profits. For the novel value propositions, as the result of the Servitization process, the term *Industrial Product-Service Systems* (IPS^2) has been established. IPS^2 are offered in innovative business models that focus on fulfilling the customers' needs. Hence, the value proposition changes to selling e. g. the availability of a machine instead of selling the machine itself. Consequently, IPS^2-Providers have the responsibility to carry out all activities respectively services to maintain the promised availability. This gives service delivery a crucial role for the success of these business models and creates high requirements for an efficient service delivery. The service delivery is planned in the operative planning by the IPS^2-Dispatcher. His main task is providing the right amount of suitable resources at the right time and place. Due to the changed value propositions in the business models, the IPS^2-Dispatcher has bigger flexibility and solution space when planning the service delivery compared to a classical service provider. This raises the complexity to determine an optimal and efficient plan.

The most important resources to be planned are the technicians who execute the service processes. According to their qualifications and competencies, technicians can be differentiated into unskilled and expert technicians. Unskilled technicians with low qualifications can execute simple processes but are not suitable for complex ones. Expert technicians are experienced employees with high qualifications. They are able to solve new problems and complex tasks. However, they are also hard to find and expensive to employ. Moreover, their willingness to travel decreases over time. Considering pandemics and other catastrophes, traveling is not always possible anyway.

A suggested approach to overcome these problems is the adoption of remote assisted service processes using the technology of augmented reality (AR). AR enables users to enhance reality with additional computer-generated information which can be seen through different devices that have a camera, like e. g. smartphones, tablets, or special glasses. In the context of service delivery, AR can be used to remotely assist lower qualified technicians. These can be equipped with a camera and special glasses on their helmet and get live instructions from experts while executing service processes. The expert can stay at the headquarter and assist the technicians in the field. In this way, the high knowledge and competencies of the expert can be made available for the other technicians. At the same time, the productive working time of experts can be increased by saving traveling times. In the context of IPS^2, another option to use remote assistance by AR could also be supporting the technicians of the customer for the service delivery. In this case, the IPS^2-Provider would save all the traveling costs. While these advantages and possibilities when adopting AR in service delivery are commonly accepted, it is not clear when and under which circumstances the adoption increases efficiency in the service delivery. This contribution aims to investigate the beneficiary of remote assistance via AR for IPS^2-Providers using a simulation-based approach.

CONTRIBUTION TO THEORY AND PRACTICE

For the investigation, the service delivery of an IPS^2-Provider having customers with availability-based business models was modeled based on literature in the software AnyLogic. Furthermore, the results of an interview conducted with a provider of AR-systems for the service delivery were integrated into the model. In the simulation study, the factors *frequency* and *complexity* of the service processes and the *distance* of the customers to the IPS^2-Providers were varied according to the design of experiments (DoE) method. These factors were identified as having the highest impact in a conceptual system dynamics model. Measured the efficiency by the profits over two years, the results show that the factors frequency and complexity of the requested services have the highest effect on the efficiency, whereby the factor distance could be neglected. Therefore, the combination of the factors frequency and complexity was simulated using three different variants: mainly unskilled technicians, mainly expert technicians and mainly unskilled technicians with an expert who remotely assists the others using AR, whereby the number of technicians stayed the same in total.

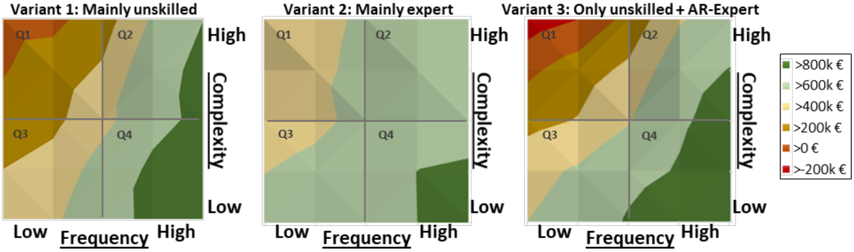

Figure 1 - Exemplary Results of the Simulation Experiments

Based on the results as depicted in figure 1, it can be stated that the beneficiary of remote assistance comes to the fore when the frequency of the service processes is middle to high and the complexity low to middle (quadrant Q4). Compared to variant 1, remote assisted service delivery still achieves higher profits in quadrant Q3 (low to high complexity and low to high frequency). Examining the quadrant Q1, it can be noted that remote assistance can also lead to losses if there is no expert in the field to handle processes with high complexity without mistakes. The missing of an expert in the field can also be noted inspecting quadrant Q2. In variant 1, the high-profit area also covers high complexity areas, whereby in variant 3 the high-profit area goes only until middle-high complexity.

The results of this study could be used by practitioners to have a better decision base for adopting remote assisted service processes. The developed simulation model could be used to give in data from the company and gain more realistic and case-based insights. For theory, this study could lay foundations for a decision support system (DSS) in the operative planning. The complexity an IPS^2-Dispatcher is facing and the concluding need for a DSS is described above. This study could help to understand when to use remote assisted services in the delivery.

KEY DISCUSSION POINTS

- The adoption of remote assisted AR service processes makes sense if the complexity of the requested services processes is middle to high. In other cases, the number of experts in the field should be increased.
- Do the results of this simulation study confirm the experiences and data from the reality?
- How could the model be adjusted to represent reality better?
- The model does not include learning curves for the technicians. How would the results change if the qualifications and competencies were considered dynamically developing over time?

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THE SERVITIZATION ASSIMILATION PARADOX: CONFLICTING LOYALTIES: A SUPPLIER'S EMPLOYEE EMBEDDED IN A CUSTOMER'S ORGANISATION

Scott Wagstaff, Jamie Burton & Judy Zolkiewski

RESEARCH MOTIVATION

Employees are the owners of their knowledge and are therefore amongst the most valuable assets of any organisation (Kot-Radojewska and Timenko, 2018). This knowledge provides a competitive advantage to their organisation (Pedrini, 2007) and the loyalty of these employees is, therefore, important to the success of any business. Servitization is regarded as an opportunity for a business to increase revenue and differentiate themselves from their competition (Lexutt, 2020).

During the servitization process many manufacturers elect to embed their employees into their customers organisation to facilitate closer ties and more effective communication. Generally, this is a mutually beneficial arrangement, however, our research has identified that these employees can assimilate into the host organisation causing a conflict in loyalties for the embedded employee. Hence, the practice of embedding employees is both beneficial and detrimental in developing servitization if the embedded employee works in the interests of their host organisation instead of their employer. In this situation a paradox arises which we have termed the servitization assimilation paradox. This paradox can impede the successful implementation of servitization, resulting in the servitization paradox and is, therefore, of interest to both academics and practitioners.

We selected the oil industry as the field of research as it provides an opportunity to explore independent international and state-owned organisations, each with a diverse pool of employees. If we can show that the servitization paradox can result from a situation where employees can confuse loyalties and assimilate into other organisations, it will allow managers to plan strategies to avoid the servitization assimilation paradox and reduce the risk of the servitization paradox.

CONTRIBUTION TO THEORY AND PRACTICE

Lipka et al. (2014) posit that there are two types of employee loyalty, the first is rational loyalty based upon factors such as who pays an employee's salary and to whom they report. The second, and most important (Kot-Radojewska and Timenko, 2018), is emotional loyalty in which the employee identifies with a company at an emotional level. Noordhoff *et al.* (2011) state that when one company is embedded with another, they are more willing to share knowledge and such interactions can create empathy which develops emotional loyalty (Chun, 2009). Theory derived from other fields of study document a similar effect where exposure to another culture results in a phenomenon known as 'going native' (Jenoff, 2012) and is also observed in ethnographic research (O'Reilly, 2009). These environments encourage a psychological tendency whereby the employee develops an emotional loyalty and conforms to the host organisation's social influence and behaviours (Kleinman, 2012; Myers and DeWall, 2018) and becomes assimilated into the new organisation's culture and practices, sometimes to the detriment of their parent organisation (van Oudenhoven, van der Zee and van Kooten, 2001; Anderson and Jap, 2005).

This research provides new insight by incorporating the previously unrelated theory of employee loyalty into the dark side of servitization. Previous research has shown that tension and territoriality can contribute to the servitization paradox (Wagstaff, Burton and Zolkiewski, 2020). This research has found that the servitization assimilation paradox can create tensions and territoriality and may, therefore, be one precursor of the servitization paradox. This finding adds to the current understanding of servitization theory and the factors which influence its application. This proposed chain of events is summarised below in Figure 1.

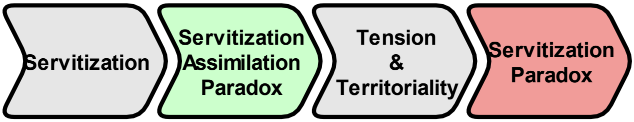

Figure 1: Proposed Servitization Assimilation Paradox Chain of Events

The existence of such assimilation behaviour of the type observed during the research for this paper has little documentation outside the examples provided above, and no research was found in the context of servitization. However, during the research interviews there was widespread tacit acceptance amongst managers that this assimilation behaviour is prevalent. Confirming this observation and exploring the precise nature and consequences of the servitization assimilation paradox will allow managers and other practitioners to make informed decisions on the best strategies to manage it and reduce the risk of the servitization paradox.

KEY DISCUSSION POINTS

- The link between servitization and the assimilation of embedded employees identifies a potential mechanism which could cause the servitization paradox.
- Managers of embedded employees are aware of the assimilation process which initially offers the benefit of increased integration but then may cause loyalty conflicts with the embedded employee.
- No research was found to support the observed servitization assimilation paradox and therefore it remains difficult for practitioners to make informed decisions to prevent or lessen the impact of the servitization assimilation paradox which may cause an increased risk of the servitization paradox.
- The servitization assimilation paradox may be one of many elements which increases the likelihood of the servitization paradox, however, research into this area may reduce the risk of the servitization paradox and may also have applications in other business theory.
- The research took place in the oil industry, because of its existing servitized relationships and diverse geographical and organisational range. However, there is no reason to suspect that the findings are unique to this industry.

SUMMARY

This research used a series of semi-structured interviews undertaken with professionals from several locations and organisations and from both manufacturers and customers within the international oil industry. The results revealed that managers of both manufacturers and customer saw the advantage of embedded employees from the manufacturing company. However, our findings have shown that these advantages fade as the employees assimilate into the customer's culture and become less valuable to their host and parent organisations.

A literature search was undertaken to further understand this phenomenon, but only distantly related information on 'going native' or ethnographic research was found, and it identified an interesting research gap. The potential academic contribution this research makes expands the theory on servitization, specifically, the servitization paradox. This research also has practical applications for managers by providing theoretical and observational confirmation of the servitization assimilation paradox. This knowledge will allow managers to make an informed decision to eliminate or reduce the effects of this paradox and ultimately reduce the risks of servitization failure.

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BUSINESS MODEL INNOVATION AS AN ORGANIZATIONAL LEARNING PROCESS: *EXAMINING THE TRANSITION TO AUTONOMOUS SOLUTIONS*

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RESEARCH MOTIVATION

In the current age of rapid technological development within the industrial sector (e.g. digitalization, electrification, autonomous solutions) firms increasingly recognize the importance of business model innovation (BMI) as a way of unlocking the potential of technology as a source of competitive advantage and strategic renewal (Chesbrough, 2007; Foss & Saebi, 2016; McGrath, 2010; Zott, Amit, & Massa, 2011). Thus, BMI is an essential complement to new product or service development to realize the value of novel technologies (Amit & Zott, 2012; Chesbrough, 2007, 2010; Johnson, Christensen, & Kagermann, 2008) by significantly redefining how firms create, deliver and capture value in relation to their customers (Berends, Smits, Reymen, & Podoynitsyna, 2016; Johnson et al., 2008). Yet, succeeding with BMI for novel technologies is not easy as firms are extending beyond their existing knowledge base which makes the process of BMI uncertain. For example, industrial equipment manufacturers transitioning from the sale of stand-alone industrial vehicles (e.g. a manually operated loader) to the provision of autonomous solutions embedded in customer processes, recognize that the transformation will require a fundamental and challenging reconfiguration of their business model (Thomson, Kamalaldin, Sjödin, & Parida, 2021).

The complexity of developing autonomous solutions, with numerous and constantly changing internal and external factors that affect the innovation processes calls for a dynamic view of business model innovation (Demil & Lecocq, 2010). Indeed, organizational learning has been proposed as a lens capable of helping to increase understanding of how BMI occurs in firms seeking to renew and adapt (Berends et al., 2016; Morris, Schindehutte, & Allen, 2005; Sosna, Trevinyo-Rodríguez, & Velamuri, 2010), as well as being a source of BMI (Foss & Saebi, 2016; Hu, 2014; Ricciardi, Zardini, & Rossignoli, 2016; von Delft, Kortmann, Gelhard, & Pisani, 2019). It is recognized as a key activity for dealing with uncertain and dynamic environmental factors (Karadzic, Antunes, & Grin, 2013; Khanagha, Volberda, & Oshri, 2014; McGrath, 2010; Ricciardi et al., 2016), as is the case with BMI for commercialization of novel technologies. Earlier research has emphasized the importance of incremental trial-and-error experimentation for BMI (Morris et al., 2005; Sosna et al., 2010). Organizational learning therefore presents a promising perspective for increasing understanding of the dynamic and complex processes of innovation for autonomous solutions.

The purpose of the study is to better understand the dynamics behind business model innovation processes of industrial equipment manufacturers engaged in scaling of autonomous solution business models. This led to the research question: *how do industrial equipment manufacturers organize business model innovation of autonomous solution business* models? We build on a multiple case study of Swedish industrial equipment manufacturers, with a total of 33 interviews across three organization who are responsible for the development and implementation of autonomous solution business models.

CONTRIBUTION TO THEORY AND PRACTICE

The study contributes through the development of a framework detailing the *business model search*, *business model experimentation* and business model *institutionalization* activities in which an industrial equipment manufacturer engages for business model innovation, see Figure 1.

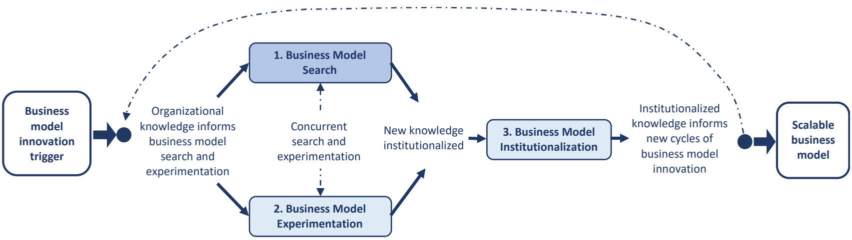

Figure 1: Business Model Innovation as an Organizational Learning Process

We support previous work which finds organizations to be in continuous cycles of conceptualization and experimentation when innovating new business models (Berends et al., 2016); finding that the process is in a constant state of renewal, or "permanently in a state of transitory disequilibrium" (Demil & Lecocq, 2010, p. 240). Secondly, the study contributes to extant business model innovation literature through consideration of the organizationally distributed centers of power and decision making, highlighting the activities in which the front-end and backend organizations engage. Front-end activities are reflective of their customer facing, delivery focused and local orientation; with backend activities characterized by a focus on serving the internal organization, product expertise and a global view of operations. Finally, we find that digitalization is an important enabler of exploration, both with regards to conceptualization and experimentation. Digitalization reduces feedback times, both by enabling accurate predictions and assessments of performance prior to any testing, but also by decreasing the feedback times from experimentation through provision of live data analysis. Industrial equipment manufacturers engaged in the delivery of autonomous solution should accordingly seek to complement efforts to automate with efforts to digitalize.

KEY DISCUSSION POINTS

- Business model innovation can be modelled as an organizational learning process consisting of *business model search*, *business model experimentation* and *business model institutionalization*.
- Business model innovation activities are organizationally and geographically distributed between the front-end and back-end organization.
- Digitalization enhances business model innovation and organizational learning processes through a reduction in feedback times and data insights.

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CHALLENGE THE ENGINEERING MINDSET IN SERVICE INNOVATION

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RESEARCH MOTIVATION

The transformation towards a holistic and customer-oriented solution provider is fueled by digitalization and has accelerated the servitization of manufacturing companies (Coreynen et al., 2017). Increasingly, attempts are being made to exploit the potential in the form of new business models and smart service innovation (Beverungen et al., 2019; Weking et al., 2020). In literature, this transformation is summarized under the term of digital servitization (Paschou et al., 2020), which is challenging and calls existing approaches into question.

Previous research has developed an understanding of hurdles for manufacturing firms to play in this field. It is challenging to overthink strategic directions and, hence, applying a relatively unfamiliar service-dominant mindset that differs from the often deeply rooted product-oriented engineering mindset (Kohtamäki et al., 2020). A whole range of barriers was identified that stand in the way of smart service innovation. One key issue is the translation of technical possibilities into value-generating offerings that match customer needs (Gebauer et al., 2020; Klein et al., 2018). So far, there is little help available addressing these problems.

This work aims to make smart service innovation processes more targeted to customer needs and goals. Recent empirical work on smart service innovation describes the usage of human-centered design to achieve customer orientation (Anke et al., 2020; Neuhüttler et al., 2018). Further, the focus is put on iterative processes and a continuous learning procedure (Sjödin et al., 2020). Service Design has its foundation in design thinking and follows a holistic, human-centered, and iterative approach for service innovation (Patrício et al., 2018). The process is often divided into phases, such as exploration, ideation, prototyping, and implementation, which are iteratively run through and supported by various methods and tools (Stickdorn et al., 2018). Service Design has been used in various fields and has shown the ability to transform mental models (Vink et al., 2019). Even if Service Design seems applicable, current research postulates that Service Design can benefit from more rigorous research methods (Teixeira et al., 2019). To tackle mentioned problems and to answer the research question the Design Science Research (DSR) process (Figure 1), with Service Design as a superficial approach, was used. The process has so far advanced to the phases *Use* and *Eval 4*.

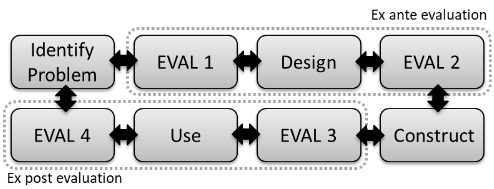

Figure 1*: Design Science Research Process (Sonnenberg & vom Brocke, 2012)*

CONTRIBUTION TO THEORY AND PRACTICE

Initially, this study contributes a new method for **D**esign-**D**riven **S**mart **S**ervice **I**nnovation (DDSSI). The method describes a series of virtual held workshops with different used tools and an individual working phase between the two workshops, where laddering interviews with customers were conducted (Figure 2). Such should challenge existing innovation processes and mental models from participating engineers. The evaluation has shown the potential to change the recent innovation behaviour of participants of the workshops, which was merely technology and opportunity-driven. These findings originate from a first case study with two German manufacturing SMEs. The clear focus on the problem space and mapping out assumptions about their target customer group engaged the attendant organizations to validate their customer profiles and take into question the jobs-to-be-done of their customers. Due to Interviews with the participants after each workshop, a changing mindset regards more custome orientation in smart service innovation could be confirmed.

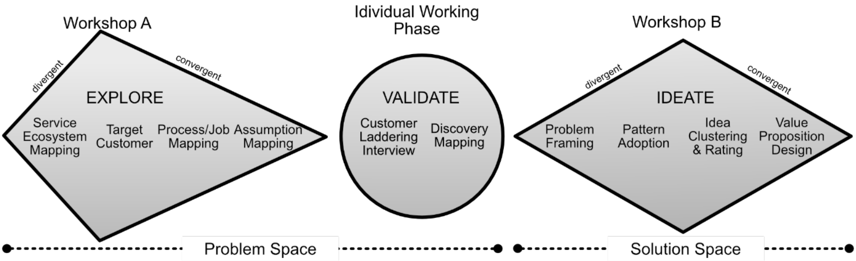

***Figure 2**: Design-Driven Smart Service Innovation-Method*

The findings show the potential of Service Design to solve existing challenges in digital servitization. Even if virtually conducted. Contributions are made to the design knowledge on smart service innovation in digital servitization. Here, the integrability and transferability of methods in other contexts became apparent. On the one hand, it shows that not every method has to be reinvented, but it also shows that individual methods and tools should be meaningfully linked with each other. By focusing strongly on customers' value-in-use, and by mapping solution patterns of smart service value propositions to the tacit needs and goals of customers this study expands existing literature. So far, the method could only be evaluated in a single case study. To further test its usefulness, more runs need to be made in different contexts.

KEY DISCUSSION POINTS

- The Design-Driven Smart Service Innovation (DDSSI)-Method addresses a timely research gap, and it helps manufacturing companies to gain better market fit with smart service innovation
- DDSSI-method assists to overcome known hurdles of digital servitization by focussing on value expectations and jobs-to-be-done by the customer
- Existing methods and approaches do not have to be reinvented but logically linked
- Focus on the Service Design approach and Value Proposition Pattern promotes customer orientation which is mandatory to scale solutions
- The fact that the method can be carried out virtually makes it easier to implement than on-site workshops

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USING A BRICOLAGE STRATEGY TO AUGMENT THE HUMAN TOUCH AND DELIVER DIGITALLY ENHANCED ADVANCED SERVICES IN THE CHARITY AND VOLUNTARY SECTOR: A RESPONSE TO COVID-19

Amir Raki, Ilma Nur Chowdhury, Marzena Nieroda & Judith Zolkiewski

RESEARCH MOTIVATION

Vulnerable groups such as the elderly, homeless people, children from low-income families, and refugees have been disproportionately affected by the outbreak of COVID-19. The Pandemic, with its consequent social distancing measures and large-scale service disruptions, has changed how people access and utilise services. This widespread change in service delivery and consumption has had a severe impact on the instrumental, social, and emotional needs of vulnerable service users with wellbeing consequences due to their unmet needs. Particularly, whilst these groups are reliant on Charity and Voluntary Services (CVSs) to fulfil their multiple needs, the Pandemic-induced digitalisation of services could be detrimental to their wellbeing which needs further investigation.

The ability to deliver person-centred and holistic services is a distinguishing characteristic of many CVSs which is operationalised through the combination of a core service (e.g., education, skills training, money matters, etc.) with complementary peripheral services (e.g., emotional support, social capital, confidence building, etc.). The human-touch element, which is meaningful and sympathetic interpersonal interactions (Solnet et al., 2019), is often perceived as a peripheral service by service providers. Nonetheless, in the Transformative Service Research (TSR) paradigm, these service interactions are recognised as key determinants of the wellbeing outcomes for vulnerable groups (Anderson & Ostrom, 2015). Regardless, the rapid digitalisation of CVSs since the beginning of the Pandemic has been more focused on core services with less attention to the online transitioning of human touch which could harm an individual's sense of social integration (i.e. evaluation of the quality of relationships) and social wellbeing (i.e., the appraisal of one`s circumstances and functioning in society) (Keyes, 1998). Therefore, in the digital transformation of CVSs, the question was how the sector can, with resources they have at hand, transfer human touch online to offer integrative services that transcend instrumental needs and respond to the social needs of service users.

Recently, there has been an increasing interest in expanding the adoption of advanced service (Digitally Enhanced Advanced Service [DEAS] in particular) and servitization principles to sectors outside the manufacturing. Within the area of servitization, advanced services are bundles of offerings that focus on the ongoing outcomes from service consumption, specific to individual service users (Baines & Howard, 2014). This resonates with the holistic and person-centred approach that the charity and voluntary sector maintains. Moreover, the DEAS focus is on the delivery of outcomes to service users and the value of the outputs, and not merely on how the service is delivered and the efficiency of service processes (Ennis & Barnett, 2019). This outcome-centricity makes DEAS apt to offer new solutions to the charity and voluntary sector to sustain their multiplex wellbeing outcomes whilst adopting their service processes to online delivery.

Thus, a three-stage study was undertaken on an education service for refugee learners provided by a charity that had been transitioned online following the start of the Pandemic. The first stage was an exploratory study by conducting 25 interviews and 2 focus groups to understand how human touch is experienced in the context of online CVSs and further ascertain service users' evaluation of their social integration and wellbeing. Furthermore, employing a bricolage strategy (i.e., making do with what is at hand) (Witell et al., 2017), and in consultation with service practitioners, findings from the first phase were used to propose a socially enhanced digital service toolkit, encompassing core and peripheral services, that facilitates the flow of the social resources and encourages positive behaviours and attitudes towards the online service to further meet the multiplex needs of service users. Finally, through a usability study, the proposed intervention was tested with 5 follow-up interviews to ascertain the efficacy of the bricolaged solution in delivering social wellbeing outcomes.

CONTRIBUTION TO THEORY AND PRACTICE

This research responds to the call to study the adoption of servitization and DEAS in non-manufacturing contexts. Exploring the human touch in online CVSs, the findings enhance our understanding of advanced services and their wellbeing outcomes in the charity and voluntary sector. For advanced CVSs, service user value is centred on the multiplex wellbeing outcomes from direct and indirect service interactions rather than the use of core services. The research findings suggest that to create digitally enhanced advanced offerings in the charity and voluntary sector, the quality of interactions, by shaping the flow of social resources, is largely responsible for determining service users behaviours and attitudes towards the service. In other words, a combination of digital enhancement and social enhancement is required to deliver advanced digital CVSs. Moreover, the study's specific consideration of social wellbeing and social integration, as suggested by the TSR paradigm, contributes to the development of a performance measurement tool for advanced services in the charity and voluntary sector to assess the sector's digital transformation.

This research revealed service users' poor appraisal of their social integration and a sense of being socially disadvantaged as potential pitfalls of digital CVSs that can enforce vulnerabilities. By discovering the missing elements of human touch in online CVSs as well as identifying pull factors that can attract service users to the online service and enhance human touch, this study suggests that the sector benefits from optimising their online services not only for direct dialogical interactions through their core service but also for indirect interactions by providing social and emotional resources. This offers new opportunities to the sector to capitalise on the advantages of digitalisation whilst responding to their service users' needs. Also, bricolage has been proved as a promising strategy for the sector to deliver advanced services by implementing innovative yet feasible solutions whilst dealing with restricted resources.

KEY DISCUSSION POINTS

- Servitization and TSR can mutually inform and guide the digitalisation of services in the charity and voluntary sector to deliver holistic and person-centred services.
- The advanced value of charity and voluntary services is in their ability to respond to multiple needs of their service users which is crucial to be sustained in digital services.
- Digital charity and voluntary services ought to be socially enhanced, alongside being digitally enhanced, where the human touch is a key determinant of the wellbeing outcomes.
- Bricolage proves to be promising in the implementation of advanced services in the charity and voluntary sector as they function within the context of resource scarcity.

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INNOVATIVE WORK BEHAVIOURS IN DIGITALLY ENHANCED ADVANCED SERVICES IN FINTECH

Colin Lindsay, Nicola Murray, Patricia Findlay & Matthew Revie

RESEARCH MOTIVATION

This study aims to explore new approaches to research and knowledge exchange on how Fintech SMEs can support workplace and people management solutions that maximise the potential of their employees at all levels to contribute innovation in the development and delivery of Digitally Enhanced Advanced Services (DEAS).

The increasing importance of Fintech organisations to the UK financial services sector and wider economy as whole was highlighted recently in the Kalifa Review of UK FinTech which described the sector as “a permanent, technological revolution, that is changing the way we do finance” (Kalifa 2021: 3). This report emphasises the crucial role the Fintech sector has to play in ensuring the UK maintains its position as a global leader in financial services.

This research focuses on a key element of this agenda; the central role of DEAS in the significant shift in financial services/fintech companies’ business models towards servitisation – i.e. “the transformation from product- to service-based business models” (Garcia Martin et al. 2019: 438). Specifically, this study investigates a crucial area of workplace practice and skills development that is of particular relevance to the shift towards servitisation in line with DEAS – namely, forms of work organisation and workplace learning that support ‘innovative work behaviours’, defined as “employee behaviour directed at the generation, introduction and/or application (within a role, group or organisation) of ideas, processes, products or procedures that significant benefit the relevant unit or organisation” (De Spiegelaere et al. 2014: 126).

The research questions are:

1. What workplace and people management strategies do, and should, Fintech SMEs have in place to ensure that employees have the ability, motivation and opportunity to maximise the impact of servitisation strategies, by providing agility, innovation and responsiveness in co-designing and delivering DEAS?
2. Are there approaches to skills development – and models of work organisation and teamworking – that are more or less likely to support ‘innovative work behaviours’, whereby managers, employees and stakeholders are empowered to collaborate and innovate in co-designing and delivering DEAS?

The research team is working with a small number of case study organisations in the Fintech SME sector to co-create, test out and analyse data from a series of innovative research tools exploring these issues. Mixed methods research combines multi-stakeholder, online focus groups; an online survey plus pulse tracking surveys of frontline employees’ changing perceptions of (factors impacting) their capacity to participate in innovation; and reflexive team job crafting activities to assist the case study organisations and their employees to reflect on ‘what might work’ in facilitating increased innovation and innovative work behaviours in the delivery of DEAS. Following the implementation and analysis of these innovative research tools, we will co-create a toolkit with the case study organisations which can be used by other organisations in the sector to identify and assess their own requirements and necessary partners and, develop confidence that they are ready to start and optimise DEAS implementation, with the necessary skill sets both now and in the future.

CONTRIBUTION TO THEORY AND PRACTICE

This research connects literature and theory on servitisation, workplace innovation and innovative work behaviours. It explores how ability-motivation-opportunity (AMO) approaches can help us to understand the potential (and limitations) of people management strategies in contributing to the impact of servitisation strategies, by providing agility, innovation and responsiveness in co-designing and delivering DEAS.

This research will have academic impact through delivering new insights on how workplace and people management practices can support innovative work behaviours, agility and responsiveness in engaging with customers and stakeholders, and improved productivity for Fintech and finance sector organisations delivering DEAS. It will have practical impact by providing evidence on the efficacy of potential workplace and people management practices. The process of engaging in intensive workplace research with managers and employees in the case study organisation is necessarily co-created, given the need to ensure that the research process aligns with other business demands. Crucially, the research gives much needed voice to Fintech SME employees on issues of work organisation, skills development opportunities and facilitators of/barriers to innovative work behaviours. Survey findings will complement focus group discussions to provide rich and dynamic data that business leaders and line managers within the case study organisation can reflect upon to inform action and investment in workplace and people management practices. Our online job crafting exercises will empower teams across the organisation to reflect on how workplace practice, team dynamics and people management support innovation within a DEAS context; we will facilitate action-focused discussions on crafting job roles and workplace practices to maximise all participating employees' opportunities to engage in innovation.

KEY DISCUSSION POINTS

- This research explores the under-researched issue of the contribution of people management strategies and workplace practices in supporting the skills and behaviours that are likely to be important if servitisation strategies are to be realised effectively by FinTech SMEs.
- As importantly, and more specifically, the research will provide insights into the potential importance of innovative work behaviours among FinTech professionals; how these behaviours inter-connect with servitisation skills and approaches; and the workplace practices that both support and constrain DEAS in FinTech.
- The research will report on the process of co-creating research instruments and problem-solving tools with FinTech SMEs, providing insights on the extent to which key themes in the extant servitisation and workplace innovation literatures connect with the challenges and opportunities reported by organisations seeking to develop DEAS.

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SHAPING SERVITIZATION IN SMES RELATED RESEARCH
A SYSTEMATIC LITERATURE REVIEW AND FUTURE RESEARCH DIRECTIONS

Davide Gamba, Tommaso Minola & Matteo Kalchschmidt

RESEARCH MOTIVATION

This paper aims to address the current body of literature on servitization in SMEs and to identify future research directions on this topic.

The 4th industrial revolution is based on the introduction of the servitization concept into manufacturing companies (Thoben et al., 2017), which refers to the transition in enterprise's business model from products to product-service systems to generate higher use-value, pricing is based on value, and capabilities support customer-dominant orientation (Lightfoot et al., 2013).

Despite SMEs are the most ubiquitous form of business organization in the world, current servitization literature did not investigate too much SMEs that attempt to servitize (Adrodegari et al., 2020), mainly focusing on large multinational firms (Kowalkowski et al., 2018). This makes difficult transfer findings to SMEs (Baines et al., 2017). Compared to large manufacturing companies, SMEs lack internal resources and skilled personnel (Kowalkowski, 2013), are more vulnerable to competition (Rapaccini et al., 2019), have a simpler organizational structure that enables organizational changes over time (Valtakoski & Witell, 2018), and have limited access to their installed base (Gebauer, 2010) because of distributors and resellers usage. In addition, the limited number of contributions related to the topic is composed mostly by technical conference papers that had not yet become well cited enough in comparison to other research papers based on large manufacturers (Clegg et al., 2017).
Due to these considerations, the following research questions will guide this literature review:

1. What are the features of the current body of literature on servitization in SMEs?
2. What are the limitations within the literature on servitization in SMEs that could inspire future research directions?

A systematic literature review from of the available scientific literature was organized capturing the state of the art of the area, represented by 44 articles. Review process was readapted from Thomé et al. (2016), opportunely rearranged in a five steps iterative workflow, and established on Scopus database. Data gathering and quality evaluation were based on PRISMA process (Paschou et al., 2020). Results presentation was grounded on textual narrative synthesis approach that allow to organize selected papers in homogenous subgroups based on data extracted from them (Xiao & Watson, 2017).

CONTRIBUTION TO THEORY AND PRACTICE

First, this study organized existing knowledge summarizing results through descriptive and thematic analyses. Eight propositions were stated pointing out findings.

In specific, descriptive analysis highlights (i) distribution of the selected articles final sample along time, research fields, geography, and (ii) methodological approaches applied. Results highlight that servitization in SMEs is still a recent topic in which existing contributions – especially from European authors – are fragmented among different fields, and it is developed mainly through empirical qualitative studies, mostly based on multiple case studies.

On the other side, thematic analysis outlines literature's features about (iii) PSS business model, design, and development adopted by SMEs, (iv) drivers to servitization and faced barriers to its progress, (v) analyses of servitized SMEs' financial and non-financial performances, (vi) territorial servitization and policy making, as well as (vii) decision-making systems, and production systems for PSS. Propositions allowed to identify gaps in the body of knowledge that led to the definition of 45 future research directions for scholars, which constituted the second output of this article.

In addition, the work represents a time-saving tool for practitioners. Shading light on the different dimensions in SMEs, this paper aimed to summarize available state-of-art knowledge providing a guide for entrepreneurs and managers from small and medium companies during servitization journey. Digitalization is acknowledged as key-driver to PSS design and development for new smart services, granting collaboration among suppliers, customers, and KIBS along supply chain to enhance SMEs' financial and non-financial performance growth.

The approach embraced during this literature review has been characterized by some personal author's choices that constitute limitations to research. Future studies should include conference papers to expand the source of potential findings. Furthermore, the Scopus' query designed potentially exclude papers related to the same topic but labelled with keywords not used. Last, thematic analysis clustering should benefit from quantitative techniques to prevent subjective bias, such as the LDA (Latent Dirichlet Allocation) modelling (Pirola et al., 2020).

KEY DISCUSSION POINTS

- Despite SMEs represents the ubiquitous form of business organization, literature on servitization in SMEs is scarce and fragmentated: a review to "make order" is needed.
- The selection process generated a final sample of 44 articles, which were clustered in six thematic groups.
- Eight propositions were stated: two from descriptive analysis to quantitatively describe the sample, and six from the thematic one to illustrate each group of papers.
- Propositions allowed to identify gaps in the body of knowledge that led to the definition of 45 future research directions for scholars.

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DIGITAL SERVICE CO-CREATION PROCESSES IN TEXTILE ECOSYSTEMS

Olga Sironi, Jonathan Rösler, Thomas Friedli

RESEARCH MOTIVATION

The processes of digitalization and servitization increasingly offer manufacturers new potential for innovation (Baines, 2015; Frank et al., 2019; Paiola & Gebauer, 2020; Roos, 2015) and challenge organisations' traditional mechanisms for value creation and appropriation (Porter and Heppelmann, 2014). In this context, customers assume a more active role in the supplier-buyer relationship, becoming an integral aspect of organisations' servitization trajectories. This tight form of collaboration, together with its consequent relationship, is known as 'co-creation', and has recently garnered attention in servitization literature (Carlborg et al., 2018; Hein et al., 2019; Kohtamäki & Rajala, 2016; Lenka et al., 2017; Ruiz-Alba et al., 2019; Sjödin et al., 2020; Vargo & Lusch, 2004). Customers play a key role in the development of digital service value propositions in the process of co-creation, contributing to the value prioritization of the offering and subsequent stages of service development (Sjödin et al., 2020).

While customers assume a prominent role in the transition from product to service provision, broader ecosystem actors, such as intermediaries, service partners and distributors, also emerge as formative in the process (Bustinza et al., 2019; Hullova et al., 2019; Paiola and Gebauer, 2020; Reim et al., 2019; Sjödin et al., 2020; Skylar et al., 2019a; Skylar et al., 2019b). Based on this finding, academics have called for further studies which seek to shed light on the complex relationships between actors. Particularly of relevance is how organisations can best manage the ecosystem of actors (Kohtamäki et al., 2019; Paiola & Gebauer, 2020), and how appropriate adaptations to the context specific (Lenkenhoff et al., 2018) and local conditions of the network can be made (Reim et al., 2019). It is evident that each service ecosystem presents specific and unique challenges, and organizations' diverse strategic choices in their servitization processes are made according to the particular individual situations and conditions (Reim et al., 2019). Actors need to further continuously re-create and re-balance their position in the system with consideration of these contingencies, in order to achieve progressive mutual value creation (Tronvoll et al., 2020). Thus, the fundamental question as to the role of industry-specific characteristics and settings in shaping multi-actor digital service co-creation processes remains unanswered.

Addressing the identified gap relating to the importance of co-creation trajectories in digital servitization, this ongoing research aims to shed light on the role of customers and intermediaries in the European textile manufacturing ecosystem. This industry is a suitable context for this analysis due to its disintermediated supply chain (Gimet e al., 2010; Padovani et al., 2017) and exposure to global competitive pressure, in which players are embarking on innovation trajectories (Ahmad et al., 2020; Bontoux et al., 2017; Ellen MacArthur Foundation, 2017; European Technology Platform, 2016; Ricchiardi & Bugnotto, 2019) and focusing on the continuous improvement of quality and processes (Dotti et al., 2013). Despite the strong interest in servitization in the sector evidenced by the European Textile Services Association and continuous innovations presented at the ITMA (the world's largest international textile and garment technology exhibition), the industry has a low percentage of servitized organisations (Mastrogiacomo et al. 2019), thus presenting an intriguing setting for the investigation.

CONTRIBUTION TO THEORY AND PRACTICE

Findings draw on a multiple case study approach (Yin, 2009) and, following a multi-actor perspective, our sample consists of in-progress semi-structured interviews (20-30) with managers and practitioners in the European textile manufacturing industry. Service providers and customers (15-20), intermediaries (5-10), such as distributors and solution providers along the value chain, and experts (5-10) are interviewed in detail. This enables an examination of the entire ecosystem from multiple perspectives, and allows the question as to how actors mutually interact to be addressed.

This research seeks to contribute theoretically to existing academic literature, and practically to provide managers and practitioners actionable suggestions and directions. Overall, the interviews provide evidence that ecosystem characteristics are key variables in the digital service transformation. According to our study, textile market disintermediation appears to lead to a decentralization of decision-making processes around services. Thus, it is important that digital service implementation should be conceived not as an isolated process within organisational boundaries, but as a collaborative path with further actors in the ecosystem (Kohtamäki et al., 2019; Skylar et al., 2019b). This is reflected firstly in the tight collaboration with customers, which results in an increased responsiveness and the joint exploration of service benefits. Secondly, it is reflected in wider actions that include the involvement of intermediaries who take charge of localizing and adapting the offering to local and individual conditions. By acknowledging the central position of customers and their increasing digital service demand, it is evident that each service provider aims to offer a personalized and tailored solution, resulting in fierce, global competition around digital services. However, adding to this complex panorama, we observe both a range of different attitudes towards digitalization and services, and varied levels of organisations' technological maturity and respective readiness. By examining 'attitudes' we understand not only the organisational culture and its heritage, but also the mindset towards the service and the price sensitivity.

This paper seeks to promote the conception of co-creation processes not only on the basis of inter- and intra-organisation relationships, but also in the context of industry-specific characteristics. Rather than viewing the organisational strategic implementation as limited by collaboration (Kohtamäki et al., 2019), we attempt to emphasize the capacity of broader ecosystem actors and variables to impact the process, and therefore promote the consideration of these factors within digital service developments.

KEY DISCUSSION POINTS

- Despite increasing academic interest focused on digital service co-creation processes, less is known on the role of further ecosystem actors, such as distributors and intermediaries, and analysis on context-specific situations and contingencies is demanded.
- Research at the industry-specific level highlights the existence of market variables that can act as antecedents, mediators, and moderators in digital service development.
- Defining organisational boundaries is key to understand these phenomena and specifying individual tasks and responsibilities could help to match digital service co-creation processes with respective strategies and capabilities.

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SERVITIZATION OF BUSINESS IN HEAVY EQUIPMENT INDUSTRY

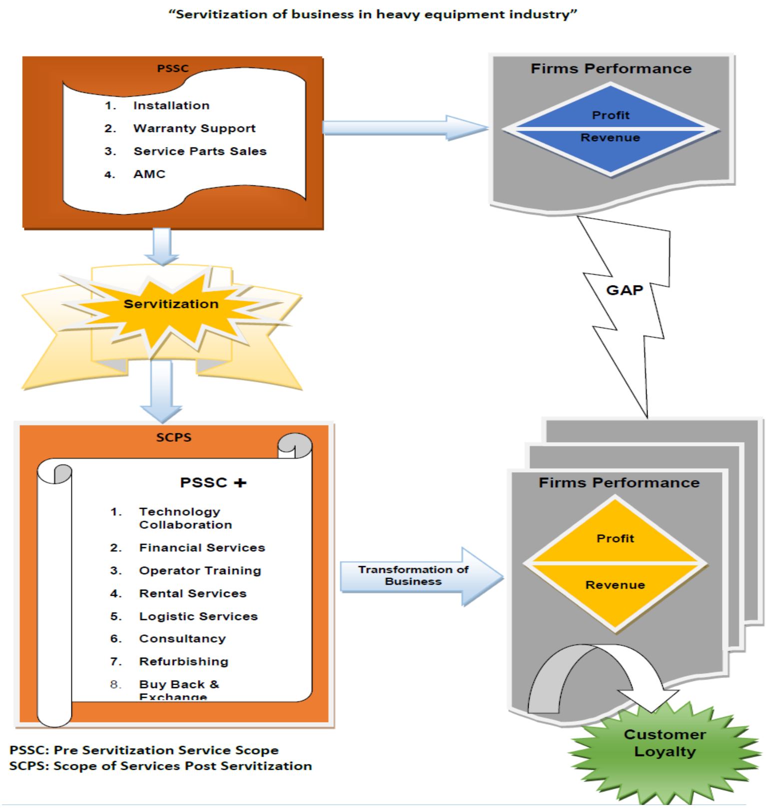
Shovan Bhattacharya ,Dr.R.P.Sharma

RESEARCH MOTIVATION

There is a growing need to understand the impacts of servitization strategy on firm performance in the manufacturing sector.Most of the heavy equipment manufacturers in India have transformed their businesses to compete through services, giving special attention to the more advanced services. The relationship between servitization and firm performance has significant differences in results, contexts and methods under internal-external factors, both moderating and mediating variables.Further there are various local manufacturer complementor networks to unravel localised economies of scale across different structural boundaries. Past empirical studies have claimed that additional services will have both positive & negative marginal effect on the firm's overall profits.There are also predominant implications of servitization adoption for buyer-supplier relationships. Hence In light of the above research gaps, there is a growing need to understand the impacts of servitization strategy on firm performance in the manufacturing sector. Heavy equipment manufacturers like JCB India, BEML,Caterpillar(India),L&T (Komatsu),Volvo,Liebherr India etc have transformed their businesses to compete through services, giving special attention to the more advanced services. Present study focuses on measuring the performance gap of heavy equipment manufacturing firms to understand their adoption of servitization process in Indian scenario & their customer loyalty.

CONTRIBUTION TO THEORY & PRACTICE

The findings include a comparative study of the revenue generated by each services offerings post servitization,with the goal to link financial performance of the firm along with the customer loyalty, characterized by more advanced services offerings .At first this study supports the data from various complementors, present in heavy equipment manufacturers' supply chains and other external partner organisations (Baines .et.al 2021) in the context of platform ecosystems,in Indian scenario.Secondly it focusses on both product and service differentiation advantage (Silveria 2020) which will lead to advanced services offerings in emerging market like india. Thirdly it will also stand for a positive servitization performance relationship as per Wang et.al (2018).Moreover the customer loyalty outcome of the proposed framework reveals that the adoption of servitization strategies provides manufacturers with better information about customers' needs, as per Visnjic & Van Looy, 2013. Lastly from the concept of a solution providers, the heavy equipment manufacturers in India, needs to develop competitive capabilities associated with the development and delivery of modular solution offerings as per Davies and Brady, 2000.



KEY DISCUSSION POINTS

1. The above study gives an understanding of the influence of degree of servitization on heavy equipment firm's business performance in Indian scenario & their overall services growth**.**
2. Additional services like financing of equipment, operators training, rental services, consultancy services, logistics services, opportunities of buy back/exchange sales & refurbishment, technology collaboration can help a heavy equipment manufacturing firm to gain customer loyalty in Indian market segment.

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DEVELOPMENT AND PRELIMINARY EVALUATION OF A SERIOUS GAME TO COMMUNICATE A DIGITALLY ENHANCED ADVANCE SERVICE (DEAS) OFFER

Mohammed Soheeb Khan 1, Vassilis Charissis 2 & David Harrison 3

RESEARCH MOTIVATION

DEAS are a cluster of high-value business models that focus on the delivery of outcomes rather than products to customers (DEAS NetworkPlus, 2020). Advance Service offers can be challenging to communicate and limit businesses understanding of the value and benefits. This can be costly both for customers and service providers. This has initiated researchers to explore innovative digital technologies to enhance the communication, education and engagement of customers about DEAS offers (DEAS NetworkPlus, 2019). This work employed Serious Games as an innovative technology to research if DEAS offers can be communicated to current and future customers, whilst engaging and educating them about the DEAS benefits. Thus, this project was developed in collaboration with the Howden Group which are a global engineering business that focuses on providing their clients with industrial air and gas handling assets (Howden Group, 2021). Howden provided their DEAS “service agreement” offer, as an industry example. This offer was split into services and benefits, recommended to the player as controls, perks and upgrades in the game. The game simulation challenges the users with random equipment malfunctions, forcing them to select appropriate DEAS solutions and learn in a chaos-based scenario.

CONTRIBUTION TO THEORY AND PRACTICE

Current literature identifies a limited number of research projects that employed Video Game-Based learning techniques to convey the concept of servitization (Petridis, Baines and Shi, 2014; Andrews and Baines, 2017; Andrews et al., 2017; Guang et al., 2017; García-Magro et al., 2019). The work carried out in these studies seen some success in communicating the benefits of servitization to manufacturers through adopting game-based learning. However, the methodologies adopted have been predominantly gamification of content rather than creating a serious game. Although gamification is a powerful model it has some limitations with the gaming aspect of the final output. Gamification is restricted to the pre-existing content and material to be gamified, rather than a game specifically built for play and learning. The play element of the game can be seen as a superficial add-on. Alternatively, studies that utilised the Serious Game approach attempted to convey the concept of Servitization to manufacturers (Petridis et al., 2014; Uren and Petridis, 2015). However, the approach adopted was unsuccessful in teaching the intended learning points. The systems presented in these papers focus more on educating/conveying the overall Servitization concept rather than a specific offer for a business. Furthermore, most of the previous work has attempted roleplaying simulation experiences, which can be complex to learn and play. Additionally, such simulation games can be lengthy to play which can limit players’ engagement.

RESEARCH METHODOLOGY

The proposed work adopted the serious game model over gamification, making it possible for the game to be developed with a unique play experience centred on Howdens DEAS offer. The game design enforces the players to learn through experience and highlights the practical use of servitization offered by Howden. Whilst learning about these benefits and using them effectively the player can improve their score as they progress in the game. Moreover, this allowed experimentation with the dissemination of the content to be communicated and develop a well-suited game for the intended target audience (Howden Employees and Customers). The design and development of the game resulted in the alignment of the Howden DEAS offer to be mapped into the game. An educational/ simulative value was given to each of the main actions and goals the player has complete. Furthermore, it was difficult and ineffective to feature every benefit of the DEAS offer into the game. This was due to several of the upgrades/ perks becoming too similar and not providing significant improvements to the player's progression. Additionally, this was needlessly extending the game length and providing too much information for the player to remember, the number of upgrades was reduced to six upgrades. These were designed by combining multiple services, and benefits into key game upgrades. Alignment of Howdens DEAS offer with the Learning Outcome and Game Upgrades is demonstrated in Figure 1. This research employed an iterative game design methodology to research, design, develop and test the game. This allowed the level to be developed in incremental phases which enabled constant improvement and necessary changes by gathering feedback from playtests throughout the development of the game. Quantitative means were used to establish the effectiveness of the prototype.

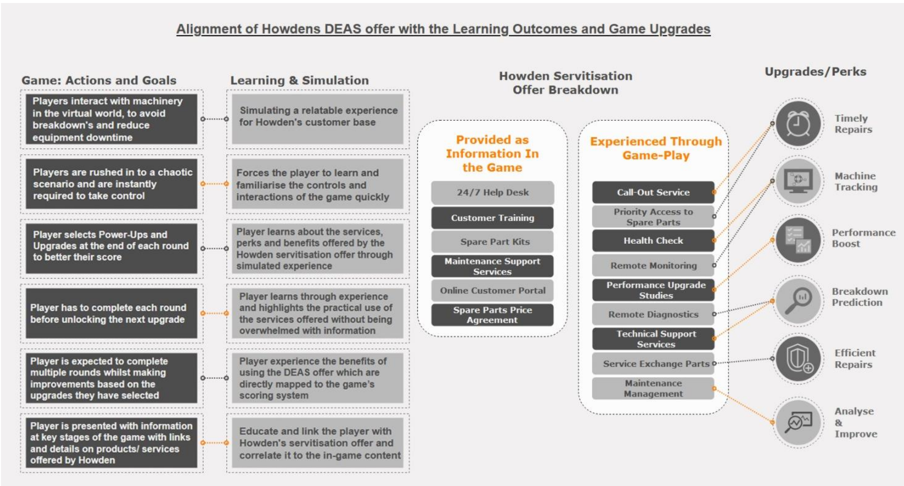

Figure 1: Alignment of Howdens DEAS offer with the Learning Outcome and Game Upgrades

KEY DISCUSSION POINTS

- How can Serious Games be used in order to communicate, engage and educate customers about DEAS offers?
- What are the considerations to take in to account whilst designing a game to promote/ educate DEAS offers?
- Can a serious game be effective in communicating a DEAS offer?
- How applicable is the design/development of the Howden DEAS game to other companies/ organisations and other sectors?

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FUTURE TRENDS ON ELECTRICAL VEHICLES SERVITIZATION DRIVEN BY THE DIGITAL REVOLUTION

Luís Serrano, Marcelo Gaspar, Ricardo Ribeiro & Jorge Julião

RESEARCH MOTIVATION

Servitization in the automotive industry has focused mainly on after-sales servicing to create and capture value. Conversely, car manufacturers refer to servitization as a powerful way to generate revenue by differentiating their products and improving customer loyalty based on after-sales services (Genzlinger et al., 2020; Verstrepen et al., 1999). The current transition towards a more sustainable mobility paradigm allows for discussing new and greener mobility solutions (Fernando et al., 2020). One way to improve such sustainability is by the use of Electric Vehicles (EVs) as a personal mobility system (Faria et al., 2012). Thus, the combined effect of EV mobility and the undergoing digital transformation allows foreseeing new and improved services and related business models for the automotive sector at a scale that transcends the current after-sales automotive servitization model.

The ongoing digital transformation can be considered a key trigger for new servitization business models. Given the relevance of after-sales servicing for the undergoing value proposal related to automotive servitization, alternative services have to be designed to face the impacts and challenges resulting from the undergoing transition to an electric mobility paradigm. These arise mainly because EVs require significantly less maintenance when compared with alternative internal combustion vehicles. Thus, the current digital transformation will promote new and improved servitization business models (Kohtamäki et al., 2019). Considering the relevance of servitization for the automotive sector, and addressing the opportunities that may arise from the digital transformation in the automotive industry (Llopis-Albert et al., 2021), current research focuses on identifying and discussing the future trends envisaged mainly for the EVs servitization driven by the current digital revolution.

CONTRIBUTION TO THEORY AND PRACTICE

In this research, a dedicated prospective conceptual framework is developed and presented. The proposed conceptual framework discussion and validation are supported by empirical data collected based on a dedicated exploratory survey. This survey comprised a set of semi-structured interviews carried out with representatives of manufacturers, companies and organizations that are related to the mobility of people and goods. These interviewees have tackled the main impacts and challenges they perceive and foresee related to the use of EVs and the related services towards the undergoing transition to a new electric mobility paradigm.

The main goals of the proposed framework are centred on identifying and discussing the future trends in EV servitization. According to this framework, these services are foreseen and discussed based on four main categories, namely the experience and use of EVs, their management, the servicing and their end-of-life. As a result, the main trends related to the future EV servitization driven by the digital revolution were based on a new type of after-sales servicing centred on digital connectivity and online consulting. This type of seamless connectivity allows not only for over the air software updates but also for both the user and the servicing company to monitor and process real-time data related to the actual and foreseen use of the EVs. New types of mobility, like micromobility, shared mobility and autonomous driving were also addressed. Finally, a new type of use of public transportation was addressed and discussed based on the integration of multi-modal mobility services.

KEY DISCUSSION POINTS

- Impact of the widespread use of Electric Vehicles on automotive servicing.
- Challenges and opportunities that arise from the reduced servicing needs of Electric Vehicles.
- New services related to the use and the end-of-life of Electric Vehicles.
- New type of after-sales servicing centred on digital connectivity and online consulting.
- New trends of mobility, like micromobility, shared mobility and autonomous driving.
- New type of use of public transportation based on the integration of multi-modal mobility services.

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CONSIDERING A TAXONOMY FOR ADVANCED SERVICES

Phil Godsiff, Zena Wood

RESEARCH MOTIVATION

The Digitally Enhanced Advanced Services (DEAS) Network Plus focuses on research into how products or services are used, rather than how they are produced, and the resulting opportunity for innovative new business models that exploit digital innovations to create Digitally Enhanced Advanced Services.

Working with academics from computer science, engineering and business, and industry representatives from three sectors (manufacturing, transport, and finance services), the EPSRC funded DEAS Network Plus has produced three research agendas[1], with a fourth in production (charity/voluntary), that highlights the research priorities for each of the relevant sectors. Each research agenda: is broad enough to cover a wide range of related areas; inclusive to look at challenges from multiple disciplines; balanced in order to be guided by theory; exploratory to be aligned with the overall objectives of DEAS project; and, relevant to lead to impact on business and make a contribution to knowledge.

Based on the research agendas, thirteen associated collaborative research projects between industry and academia have been funded. The research agendas, and review of these projects, have allowed learnings from new sectors (charity/voluntary sector), and established sectors (i.e., manufacturing), producing a two-way exchange between those sectors where servitization is established and those where it is not (e.g., transportation and financial services). This exchange has allowed us to identify commonalities that are important for those who wish to make the servitization journey. These commonalities can form the basis of a taxonomy that allows the servitization process to be explored and understood for all industries and sectors. This paper presents a taxonomical base, based on the work of the DEAS Network to date, that allows the servitization process to be explored and understood for all industries and sectors (i.e., is sector agnostic). Future work will see the completion of the taxonomy and review by our industry partners. In the development of the taxonomy, an ontology of servitization will also be explored.

CONTRIBUTION TO THEORY AND PRACTICE

Many existing methods that characterise or classify the servitization process provide a framework or model that focuses on the manufacturing sector. We wish to create a taxonomy that is sector agnostic. A taxonomy is a way of classifying entities and the relationships between them. From an ontological point of view, it is ‘a hierarchy consisting of terms denoting types linked by subtype relations’ where types are based on common features (Arp et al 2015). The initial step in developing a taxonomy is to identify these common features.

The theoretical contribution of this work is the taxonomical base to explore and understand the servitization process independent of industry or sector. The practical contribution is the consideration of different sectors in its development and helping sectors outside manufacturing understand how they can transition to a servitization business model.

KEY DISCUSSION POINTS

- A review of the DEAS Network’s work-to-date has identified three top-level features that could form the basis of a taxonomy: concepts, issues and sector organisational qualities.
- Concepts represent the sector agnostic features that must be considered within a servitization business model. Here we consider concepts as ‘a unit of thought that can be constituted through abstraction on the basis of characteristics common to a set of objects’ (ISO, 2000).

[1] www.deas.ac.uk/outputs

Concepts that have currently been identified include *service, '"everything" as a service', outcome, customer, innovation, business model, Capex to Opex, consumption-in-use, digital, viewpoint, system, circularity, pay-per-use, advanced services* and *sustainability.*

- Issues represent problems that will need to be overcome and currently include: *pricing, communication, risk, financing, regulation, insurance, data collection, data quality, data sharing, partnerships* and *relationships.*
- Organisational qualities refer to features that might allow an organisation to be classified; further exploration is needed to identify the relationship between organisational qualities and issues. The features identified under this category include *length of supply chain, type (industry, government, non-profit), product/service, size mix of industry* and *regulator.*
- What are the principles that are core to servitization? Which principles are dependent on sector?
- In developing the ontology of servitization, different sectors will be considered. Further research will identify how such an ontology might help organisations outside of manufacturing transition to servitization business model.
- How can an ontology of servitization help develop a transformation map that can be applied to a supply chain or the wider ecosystem?

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HOW COMMUNITY BUSINESSES (CB) SERVITIZED THEIR BUSINESS MODELS DURING THE COVID CRISIS TO CREATE BOTH FINANCIAL AND SOCIAL VALUE.

Mandy Gardner 1, Dr Peter Bradley 2 & Prof. Glenn Parry 3

RESEARCH MOTIVATION

The estimated 11,300 CBs in England (Higton et al., 2021) form a distinct group of social enterprises. CBs differ from other social enterprises by being place-based, geographically embedded within the community that they service, utilising the social capital within the community, as staff, volunteers, and customers to generate social value and positive outcomes for that community. CBs all share a common purpose, to produce positive outcomes for their community through trading, these impacts can be economic, social and/or political (Diochon and Anderson, 2011; Pearce, 2003; Ratten and Welpe, 2011). The symbiotic relationship that CBs have with their communities lead (Johnstone and Lionais, 2004) to conclude that community is the 'location' (the place), 'the tool' (the facilitator) and the 'goal' (the positive outcomes) of a community business.

The COVID 19 lockdowns and social distancing restrictions presented unprecedented challenges to CBs forcing them to rapidly innovate and adapt their business models towards digitalised services (Kowalkowski *et al.*, 2017), to ensure financial survival and to continue to provide essential services to their communities. The appeal of digital servitization was that it could be undertaken by a business at a relatively low cost, delivered concurrently with the existing business model and generate new business and new customers (Vendrell-Herrero *et al.*, 2017). Therefore, for CBs with often limited resources (Bailey, 2012), this provided a route for creating additional financial value for themselves as a business and social value for their communities.

Whilst the Business Model Canvas, (Osterwalder et al.,2010) with its focus on the needs of the customer, provides a good starting point from which to analyse CB business models and how CBs changed to digital services during the pandemic, its definition of value capture lacks the subtlety required to define the different layers of value that are created and captured by a CB. CBs are not seeking to capture or create value to solely to sustain themselves, they are also seeking to generate positive social outcomes for their communities and trading enables them to fulfil this purpose. In a review exploring the applicability of a variety of business models frameworks to address sustainable development, (Bradley et al., 2020),the limitations of the concept of value capture within the Business Model Canvas and particularly the definition of 'revenue streams' was highlighted. Bradley et al., (2020), put forward a more nuanced understanding of value capture and revenue streams that explores value creation through the lenses of the different stakeholders within the business model: value for the individuals that are employed by the business, value for the organisation, value for society and use of the value proposition in context. The work builds on the Osterwalder et al., (2010) Business Model Canvas and provides a valuable conceptualisation from which to explore the aspect of social sustainability within a CB business model.

Existing servitization literature has largely focused on how manufacturing firms have transitioned from providing goods to creating additional value through offering services to their customers (Dmitrijeva *et al.*, 2020). However, the application of the concept of servitization, as a means of creating additional value through offering more personalised services to their customers (Vandermerwe and Rada, 1988), is also applicable to businesses that seek to generate not only financial but also social value to their customers. Servitization is therefore a valuable lens from which to explore how CBs can create additional value for themselves and their communities through offering digitalised services. This research seeks to fill the gap in the existing servitization literature and business model theory through exploring the adoption of digital services by socially trading community businesses during the COVID 19 pandemic.

CONTRIBUTION TO THEORY AND PRACTICE

Much of the existing servitization literature has focused on how manufacturing businesses have created additional value through adapting their business model to encompass digital services and the stages that they employed to enable these changes (Baines *et al.*, 2020). Building on both servitization and business models for sustainable development theory, this study explores the rapid adoption of digital services within the context of CBs and the initial COVID 19 lockdown which forced CBs to evaluate and adapt their existing business models to ensure financial survival and meet the needs of their communities. The value generated by CBs by utilising digital services is explored through the 'business model for sustainability' Bradley et al., (2020) lenses of value: for individuals within the CB, for the CB, and wider social value, adding the dimension of context and social value creation to existing servitization theory.

The findings of this study have been used to write a report for the Power to Change Trust, an organisation that provides support to CBs and policy makers to develop the CB sector within England. CBs within the study faced several obstacles with this switch to digital services. Firstly, CBs needed to access new funding streams or utilise limited reserves to be able to pay for these services, with 80% of CBs in the Community Business Market Survey (CBMS) reporting that they had received some financial support during the pandemic (Higton et al.,2020). Secondly, the pandemic heightened the need to close the digital divide within communities as often the most isolated and vulnerable members of their communities were not able to access these digital services due to lack of equipment, low-cost Wi-Fi or digital illiteracy (Kaye and Morgan, 2021). Finally, the internal capacity of the CB to be able to adapt their business to digital services was dependent on having the right infrastructure and knowledge available to them to make those changes. The CBMS reports that 40% of respondents identified the need for advice and support with adapting their business model (Higton et al.,2020).

Digitalised services offer CBs low cost solutions to delivering services and produce positive social outcomes for the community. However, there needs to be investment made to support CBs in making the changes that they need, supporting them with staff training, providing access to expertise, supporting digital infrastructure growth and sharing good practice. Digital servitization could provide CBs with one of the many tools that they will need to enable them to continue to support their communities, grow their businesses by reaching new customers, enhancing their reputation and remaining financially sustainable post pandemic.

KEY DISCUSSION POINTS

- Digital services during the Covid 19 restrictions were enabled by the flexibility and support of funders. How can digital services be monetised by CBs, post-COVID, to support the long-term sustainability of CBs and to enable them to meet the needs of vulnerable members of their communities?
- Does the move to digitalised services widen the digital divide? Is this a good business model to create positive social value?

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SERVITIZATION MODEL IN ENERGY EFFICIENT EQUIPMENT: IMPLEMENTATION STUDY IN THE NETHERLANDS, BELGIUM AND SPAIN

Mira Tayah (Agoria), Javier Pamplona (ANESE), Arno Nijrolder (InnoEnergy NL), Christophe Rynikiewicz (Stiftung BASE).

RESEARCH MOTIVATION

Although energy efficient technologies are available, interviews and research carried out in Belgium, Spain and the Netherlands thanks to the EaaS H2020 EU funded project[1] have confirmed several barriers that prevent them from being deployed at full potential. Barriers identified include SMEs' focus on core business activities and other priority investments,, high up-front costs, higher-risks perception and lack of trust, uncertain returns, lack of maintenance skills, technological complexity and limited financing options.

Servitisation represents an effective way to increase investments in energy efficiency needed for the economic recovery after COVID-19 and to deliver the EU targets, the Paris Agreement goals and achieve a low-carbon and circular economy. The servitisation business model will be tested with stakeholders in the three countries as a solution to barriers as the SMEs no longer need to set out capital expenditures to adopt the energy efficient technology.

CONTRIBUTION TO THEORY AND PRACTICE

Efficiency as a Service is a strategic partnership between end-users, technology and service providers and investors. The project implementation enables to study the respective roles of actors along the servitisation journey. One particular issue are the conditions of a strengthened relationship between the supply chain and the service end-user to incentivise the enhancement of circularity.

SME Energy efficiency projects might be small and can be complex to underwrite, and the transactional costs can be high compared to the size of the deals. Aggregation is envisaged as a strategy to group small individual projects together to make the task of evaluating the transaction and documenting the deals cost-effective. This facilitates more efficient financing deals with larger institutional investors. EaaS providers or SPVs (Special purpose vehicle) have the ability to aggregate energy efficiency projects to reach a scale where they are attractive for sale to large investors, for securitization or access to competitive financing. To implement aggregation, phased approaches for building the required volumes have been explored.

Contribution to standardised tools

The EaaS project contributes to standardising the financing structure(s) that allows the technology providers to capitalise and access competitive financing and reduce their investment risks.

Activities of the project enable to co-create with stakeholders the tools and guidelines that are necessary to lift some of the identified barriers to the servitisation business model, namely:

- A standardised servitisation contract
- A financing structure for recapitalisation
- Guidelines on the accounting and fiscal implications of the servitisation business model
- Eligibility criteria for efficient technologies
- Economic and pricing modelling tool
- Capacity building sessions and awareness raising tools

[1] The project started in June 2020 and has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 892499.

KEY DISCUSSION POINTS

- Market assessment

Barriers analysis in Belgium, Spain and the Netherlands showed that SMEs require very small projects, and with low energy prices, the payback time can be long. Furthermore, the lack of knowledge of the servitisation model and its perceived complexity require specific awareness raising and capacity building activities. For prioritisation, the following evaluation factors were used: payback time, incentives or supporting policies, GHG emissions reduction potential, simplicity of implementation, evidence of successful projects, operational and maintenance cost.
The following sectors and priority technologies have been identified:

	Belgium	Netherlands	Spain
Service	Food retail	Building related consumption	Hotels, Private hospitals
Industry	Food, chemical and plastic	Industry, Fishing	Agriculture, Food, drink and tobacco

The identified priority technologies are:

Sector	Belgium	Netherlands	Spain
Services	LED, Cooling equipment	Heating, Cooling	Solar PV, LED
Industrial	LED, Cooling equipment, Compressed air equipment	Heating, Cooling, Compressed air	Industrial Cold, Water Pumps

- Standardised contract

Successful adoption is simpler when there is a simple and understandable servitisation contract. Standardised contracts have been developed in each country by legal firms and will be tested with stakeholders to see how the complexities of servitisation can be accounted for.

- Financing structure:

The technology provider can recapitalise through innovative mechanisms such as sale and leaseback, SPV (special purpose vehicle) or the securitisation of cash flows. A payment guarantee can be established to reduce the risk of default from the end- client, which can be endorsed to the banks to reduce their exposure to payment default by technology providers seeking the use of the above-mentioned financing mechanisms.

- Pilot projects and investment pipelines:

Transitioning from sales model to as-a-service model has financial and operational implications. Stakeholders in each country are co-developing the tools and energy efficient investment pilot projects. The groups are comprised of early adopters, interested firms and financial institutions (banks, leasing companies, ESCOs etc), large size SMEs looking for ways to reduce their energy bills and SMEs open to innovation and technology provider companies that have already established EaaS (pilot) projects.

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PATTERNS FOR PLATFORM-BASED BUSINESS MODEL INNOVATION - EVIDENCE FROM THE RENEWABLE ENERGY SECTOR

Alexander Arzt, Heiko Gebauer & Sebastian Haugk

RESEARCH MOTIVATION

Green hydrogen has become a major strategic cornerstone of the European Union to combat climate change and to comply with the 1.5 °C goal of the Paris Agreement. In that context, companies invest heavily into green hydrogen, supported by governments, in order to build a lead market and to become a global leader in hydrogen technology. However, considering that value creation in most industries increasingly shifts from the physical world into the digital world, it is essential to take into account the importance of data-driven value creation and the role of digital platforms in the green hydrogen economy. Therefore, we developed a conceptual value creation model for the green hydrogen economy, accounting for a horizontal dimension (from renewable energy production to utilization of green hydrogen in various application domains), a vertical dimension (from individual components to whole systems), and a digital dimension (from data and connectivity to data-driven and platform-based business models). Our research focuses on the digital dimension, analyzing how companies in the renewable energy sector leverage data and platforms for data-driven business models and, as a next step, deriving future opportunities and strategic priorities for data-driven value creation in the green hydrogen economy.

The paper relies on recent literature on digital servitization, business model innovation, and platforms. Digital servitization highlights the convergence of servitization and digitalization literature and refers to the utilization of digital technologies for advanced service offerings based on the transition to product-service-software systems (Kohtamäki et al., 2020; Tronvoll et al., 2020; Coreynen et al., 2017). In that context, digital platforms are a key element to leverage the value of digital and information technologies, and to facilitate value co-creation (Cusumano et al, 2019; Cenamor et al., 2017). Evans and Gawer (2016) differentiate four types of platforms: transaction platforms, innovation platforms, investment platforms, and integrated platforms. However, there is a need for research from a business model perspective to understand the relevant implications of digital servitization and the emergence of platforms and their business model configuration (Paschou et al., 2020; Sjödin et al., 2020; Kohtamäki et al., 2019; Gebauer et al., 2020). Systematic research on platform business model characteristics and underlying patterns in the business model components that drive business model innovation is still sparse. This paper contributes to closing this gap by analysing 150 platform solutions in the renewable energy sector.

We apply an iterative procedure, using a conceptual-to-empirical and empirical-to-conceptual approach. Our research consists of three studies. Study I is a literature review to conceptualize value creation in the energy sector with a focus on the green hydrogen context and to identify key components of platform business models. Study II is an exploratory study based on desk research and additional interviews on 150 platform solutions in the renewable energy sector to describe and to justify platform business model components. Study III is an in-depth study to identify and explain dominant patterns for innovation in these business model components.

RESULTS AND CONTRIBUTION TO THEORY AND PRACTICE

The paper provides insights into companies in the renewable energy sector that explore data-driven business opportunities and increasingly incorporate a platform logic into their business models. Such companies include for example manufacturers of wind turbines and photovoltaic systems, component manufacturers, grid operators, energy and heat suppliers, providers of smart home and e-mobility solutions, and providers of financial services. They utilize digital platforms for example to connect

interdependent systems to optimize process coordination, to enhance customer value of own products and services, to optimize service activities, or to increase energy efficiency and sustainability.

First, the paper contributes to understanding the holistic value creation logic in the green hydrogen economy, by developing a conceptual value creation model consisting of a horizontal, a vertical, and a digital dimension along specific value creation steps. We emphasize why the digital dimension has to be taken into account from political decision-makers and company managers as a key element in order to build competitive advantages to become a global leader for green hydrogen.

Second, as a tool for platform analysis, the paper relies on the following identified key components of platform business models: interaction enabled by the platform, value proposition towards platform users, value proposition towards partners, scaling strategy, monetization approach, and network effects.

Third, we analysed 150 platform solutions in the renewable energy sector and systematically aggregated information concerning their business model in form of a platform catalogue. We assigned these platforms to the platform types identified by Evans and Gawer (2016) and we positioned these platforms in the value creation steps of the green hydrogen economy. Transaction platforms dominate energy trading and become increasingly important for power supply. Innovation platforms, especially IoT platforms, already exist in almost all sectors related to the renewable energy sector, e.g. in energy production, power transmission, electrolysis, energy-intensive plants, heat supply, and smart city solutions. Integrated platforms were identified for example in the area of electromobility. Furthermore, we further analysed respective platform characteristics by examining the identified key components of platform business models.

Fourth and finally, we derived dominant patterns in the business model components that companies in the renewable energy sector pursue. For example in the value proposition we identified three dominant patterns, that is improving asset availability and performance, optimizing energy efficiency, and matching supply and demand (e.g. brokering energy products and services, or balancing energy surplus and energy demand). We illustrate these patterns through company examples in the renewable energy sector. These patterns can be of value for further research on platform business models, for example to study the correlation between certain business model components or between components and the platform ecosystem context. Managers can use these patterns to evaluate business model configuration when establishing or modifying platform business models.

KEY DISCUSSION POINTS

- Platform business models can be broken down into specific patterns in the business model components of which some patterns dominate.
- Patterns in the business model components correlate with each other and depend on the specific platform ecosystem context.
- Some combinations of patterns are more suitable than others for the platform’s respective application context and the overall business strategy of the company.

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