

Everything-as-a-service in manufacturing: insights from an expert panel

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Abstract: Nowadays, manufacturing companies have realized that services can be a crucial part of their business: an increasing number of companies is therefore moving from product-centric offerings to services and solutions, in what has been defined as servitization. This transformation radically changes the business models (BM) of manufacturing companies that no longer sells pure products but provides product performance. Over the years, a plethora of different terms has been used to identify these models such as servitized BM, use-oriented BM, and, more recently, Everything-as-a-service (XaaS) and its declination (e.g. Equipment-as-a-service). These models are gaining attention in the managerial community as they can enable the establishment of long-term partnerships with customers by providing solutions on a continuous basis in return for recurring payments. Though the concept itself may not be new, companies still struggle with the adoption of the XaaS paradigms. In fact, if from one side the literature on the topic is very scattered, from the practical side there is still uncertainty on how this concept can be translated into practice. To better define which is the real perception of the applicability of the XaaS model in manufacturing, this paper proposes an empirical analysis involving 20 managers of manufacturing companies. This research, therefore, follows a combined methodology by integrating a literature review with an expert panel. This led researcher to (i) develop a clear and shared vision of the XaaS paradigms, identifying the benefits and the key aspects that characterize this model for manufacturers; (ii) identify the main challenges and barriers perceived from companies in the adoption of the XaaS paradigm.

Keywords: Everything-as-a-Service, Servitization, Business Model

1. INTRODUCTION

Recent research and anecdotal evidence suggest that the manufacturing sector is witnessing a growing interest in adopting more flexible and sustainable business models to face competition. Customers' increased focus on reducing capital expenditure and the new opportunities offered by digitization, artificial intelligence, and automation processes are driving companies to take this route and adopt an as-a-service business model [15]. The shift from one-off sales of capital goods to recurring revenue streams based on the use or production of equipment has been a common practice in some industries for more than a decade. A notable example is Rolls-Royce's well-known 'power-by-the-hour' model [2]. More recently, Schneidereit, a laundry company acquired by the Electrolux Group in 2018, has started offering its customers a contract based on the amount of laundry to be washed, which includes the rental of the equipment and immediate assistance in case of breakdown for a fixed amount for the entire duration of the contract (36 to 120 months). In practice, however, many aspects must be clarified to ensure the effective implementation of this business

model, particularly in the manufacturing sector. For this reason, through a literature review and a panel of experts, this paper aims to develop a clear and shared vision of the XaaS model, identifying the benefits, key aspects as well as the main challenges and barriers that characterize the adoption of this business model for manufacturers.

The structure of the paper is as follows. The next section provides the context of the research and the main gaps highlighted. The methodology of the empirical analysis is presented in the third section. Section four describes the main findings while concluding remarks and directions for future research are in section five.

II. THEORETICAL BACKGROUND

A. Servitization & as-a-service

In recent years companies are moving from product-centric production systems to more service-oriented systems [1], capable of meeting both customer needs and the dynamics of the global market, characterized by strong competition towards dematerialized and digital business models.

Customer demand for deep relationships and a higher degree of customization, as well as the increasing focus on product performance and the advent of digitization and Industry 4.0, have in fact shifted the focus towards a wider product-service combination. More and more companies are therefore embarking on this path, defined as 'servitization' [20], redesigning their business model and changing their structure, culture, and necessary in-house skills accordingly. In this context, the Everything-as-a-service (XaaS) paradigm today represents an example of these service-oriented business models. The term XaaS originated in the information technology field, with the Cloud Computing paradigm, a term introduced in 2007 to denote an IT delivery model based on virtualization in which resources, consisting of infrastructure, applications, and data, are provided as an on-demand service via the Internet [10]. Over the years, various declinations of the concept have emerged, generally linked to the object of sale and the application sector (e.g. software-as-a-Service [13], network-as-a-Service [8], Heat-as-a-Service [4], Mobility-as-a-Service [14] ...). Even with some differences, all concepts are however used to define business models in which digital technologies and the cloud are the enabling factors to make on-demand products-services accessible [10].

B. XaaS in the manufacturing sector

In the manufacturing sector, one of the most widespread declinations is 'Equipment-as-a-service' (EaaS), in which the manufacturer is responsible for all the activities required for the correct functioning of the equipment [12] and therefore performs all the services required during the product life cycle (e.g. taking care of spare parts, consumables, technician time and recalibration of settings, ...). The concept of EaaS is closely linked to revenue generation mechanisms: it can be offered through different types of contracts, depending on the revenue model established [7]. Thus, two macro-categories can be distinguished: the subscription mode, which provides for the payment of an agreed sum with a certain periodicity, and which represents the step immediately following the one-off sale of a good, and the Pay-per-x category. The latter provides for the receipt of recurring revenue streams based on the actual use of the good by the customer (Pay-per-use), the performance of the machine (Pay-per-performance), or the output produced (Pay-per-outcome) [12, 19]. It is well known and evident that it is exactly this last macro category that can represent the true peculiarity of the XaaS paradigms, where the mechanisms of revenue

generation are overturned and based on specific agreements, often complex, in which both parties must agree on the terms of use, payment, and relative responsibilities.

It is easy to see how the application of the XaaS paradigm can therefore represent an innovative element for providers of manufacturing goods [3], capable of generating new competitive advantages, especially in more traditional sectors. The XaaS model presents advantages for the customer in various forms. In particular, it makes it possible to move from a 'Capex' to an 'Opex' logic, to reduce the total cost of ownership by improving the overall effectiveness of equipment, and to reduce operational and business risks. Moreover, it has a positive impact on the profitability of manufacturing companies by stabilizing their revenues. Companies, however, still struggle to adopt this paradigm [1].

C. Gap

The adoption of the XaaS model, indeed, represents a cultural and organizational challenge for a company as it requires both the full cooperation of the entire management and the involvement of the entire organization [6, 17] and skills and capabilities that are often not present in all companies. Moreover, the presence of significant risks for providers and the challenges to be faced at the technological level represent a relevant obstacle, as well as the difficulty in the implementation due to the difficult scalability of the as-a-service model [5, 19]. From the practical side, thus, there is still uncertainty about how this concept can be translated into practice.

This paper attempts to bridge this gap by investigating the level of paradigm adoption in 20 manufacturing companies by highlighting the most relevant aspects and challenges that companies deciding to embark on this path have to face.

III. METHODOLOGY

In order to answer the research objectives, a combined methodology was used, integrating a literature review and an expert panel. This approach is suitable for collecting opinions on complex and unstructured problems, which allows moving from individual reflection to engagement of the

companies involved. The present research work was carried out in 4 stages, illustrated in Figure 1.

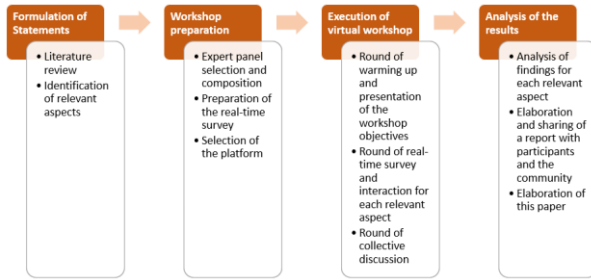


Figure 1: Research methodology (adapted from [16])

The literature review aims to an initial conceptualization of the phenomenon in the manufacturing sector in particular and to define a set of guiding questions that were used to guide the expert panel. First, following the methodology suggested by [18], we retrieved articles dealing with the XaaS topic from academic databases such as Scopus. For this purpose, we use some keywords such as "XaaS" OR "as-a-service" OR "EaaS" OR "equipment-as-a-service" OR "pay-per-x" combined with “manufacturing”. Among the selected papers we analyzed the most cited and recent ones in order to understand the most relevant challenges and aspect to investigate. We mention [17], which focused on the Pay-per-X (PPX) revenue model and its implementation in the manufacturing sector, [6], who describe the case of DISTRONIX, an Indian Industrial Internet of Things start-up that implemented an as-a-service offer, while [5] propose a guideline for the adoption of Manufacturing-as-a-Service (MaaS) for small and medium-sized enterprises, analyzing the relevant aspects of large enterprises that have already successfully implemented this paradigm. Thus, we defined the elements useful to assess companies' interest in the XaaS model, such as the motivation of the XaaS paradigm adoption in the industry; the maturity of adoption of XaaS in competitors; the object of the as-a-service offering (*what to sell*); the revenue model (*how to sell*); the key roles within the company for the XaaS transformation and the main barriers. Then, these elements have been operationalized in six specific items and translated into as many guiding questions that were used to guide the expert panel with managers.

The panel of experts was composed of 20 managers of manufacturing companies (Table 1) selected from the ASAP Service Management Forum Community (www.asapsmf.org), an inter-university research center in which scholars and managers collaborate to develop and share knowledge and experience on the servitization of

industrial companies. These experts were chosen based on their experience and expertise in the field of servitization and their interest in collaborating in this research. Most of the manager works in the Household appliances – electronics (HA&EL) sectors and in the Machinery industries (MACH). The few remaining operates in the Material Handling Equipment sector (MHE).

TABLE 1: EXPERT PANEL COMPOSITION

Expert	Function	Sector
1	After Sales Director	MHE
2	3rd Party Network Manager	HA&EL
3	Service & control systems development Manager	HA&EL
4	Sales and Marketing Manager	MHE
5	Service Manager	MACH
6	General Manager	MACH
7	Service Marketing Manager	MACH
8	Service Project Manager	HA&EL
9	Business Development Manager	MACH
10	Marketing Director	MHE
11	Head of Business Unit Customer Services	MACH
12	Senior Marketing Manager	HA&EL
13	Operations & Customer Service Director	HA&EL
14	IPT Customer Support & Service	MACH
15	Customer Care Manager	HA&EL
16	Service Project Manager	HA&EL
17	Machinery Division Director	MACH
18	Sustainability Manager	MHE
19	Business Developer	MHE
20	Head of Field Service	HA&EL

This research adopts the expert panel methodology as it facilitates the development of opinions based on a group of experts in the field. Thus, similarly to other studies (e.g. [9]) expert panel represents an attempt to build a better understanding of the research domain. Following previous research [16], the workshop was conducted online/real-time via MS Teams®, to create an environment for discussion and allow for instant response to any requests for clarification, refute misinterpretations, and encourage dialogue between academic and industry counterparts. After an initial round of warming up and the presentation of participants, the workshop followed a three-step structure for each of the 6 research items identified. First, the guiding question was submitted individually to each

participant. At this stage, each participant provided a real-time quantitative and qualitative answer, using an online form. Then, a team of three researchers analyzed in a few minutes the collected answer to provide a first rationalization. Finally, the researcher presented this rationalization and guide a collective discussion around the specific research item. This procedure was then repeated for each of the 6 research items.

The main evidence collected is presented in the next section.

IV. MAIN FINDINGS

A. Motivations

Concerning the relevance of the XaaS theme in the sector, we asked the participant to assign a score considering a scale from 1 (not relevant) to 5 (very relevant). The results show that for more than half of the respondents, the topic seems to be of interest, with an overall average of 3.3 (Figure 2).

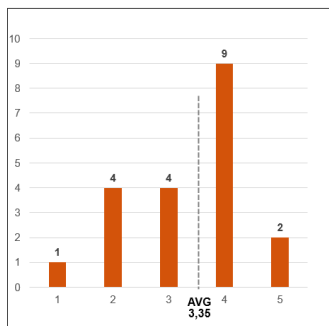


Figure 2: The relevance of the topic

Observing the distribution of responses for the four sectors highlighted above, the topic of XaaS is relevant above all for the appliances and electronics sectors, while the machinery sector shows a discrete variability. What emerges from the discussion confirms the evidence of the reading showing that service models are still underdeveloped in the machinery sector where the product is still central.

B. Current situation

To better understand the state of the art, together with the participants we then explored whether and how companies have already started to approach the XaaS paradigm. By rationalizing the answers provided, companies were classified into three categories, with their relative distribution in the sample:

- the “steady”, i.e. those who are not interested (0%) or have not yet approached the 'as-a-service' paradigm (10%)
- "departing", i.e. those companies that have already started a pilot project to test the "as-

a-service" model on their products and/or services (20%) or have started to talk about it (35%)

- 'on the road', i.e. those who already offer their products (21%) or services (14%) in 'as-a-service' mode.

It emerges, therefore, that more than half of the sample is about to embark on this path, while one-third of the companies interviewed already state that they offer an as-a-service offer, even if only to a limited extent, as explained in the remainder of the paper.

C. Offering

Participants were asked about what they are offering today or plan to provide in the near future in as-a-service mode. Five main categories were proposed to the respondents: (i) services, (ii) software, (iii) spare parts and/or consumables, (iv) product/machine/system, and (v) solutions, i.e. the sale in 'as-a-service' mode of all or some of the components mentioned above in an integrated manner. For this purpose, we used the scale 1-5 as previously. Analyzing the average of the answers for each category and grouping the votes into "Very likely" (scores 4 and 5), "likely" (score 3), and "not very likely" (scores 1 and 2), it can be seen that the service area is the one with the greatest interest for companies today. Offering the product in an "as-a-service" mode, on the other hand, still seems difficult for companies nowadays: almost half of the respondents, in fact, declare as "not likely" the adoption of such a mode of offering in the short term (Figure 3).

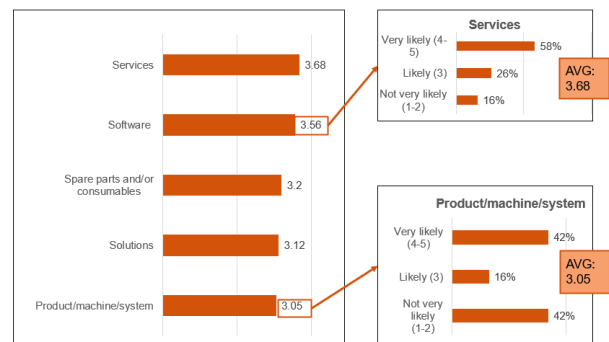


Figure 3: What to sell

The discussion revealed that this representation is coherent with the sample composition, which is mainly formed of manufacturing companies where product sales still represent the most relevant business. Furthermore, managers state that the complexity of products, in terms of technological content, customization, and cost, is another important barrier to the adoption of 'as-a-service'. Indeed, the standardization aspect is a major

problem, especially for those companies that operate on a made-to-order basis, and thus seek to standardize wherever possible.

D. Revenue models

The participants then explored a key issue for the adoption of the XaaS paradigm, namely the revenue model. Four different modes were submitted to the interviewed companies: (i) subscription, (ii) pay-per-use, (iii) pay-per-performance, and (iv) pay-per-outcome. The answers show a (very likely) propensity for companies to go for the pay-per-use mode, followed by subscription, a mode already adopted by some of the companies surveyed. On the other hand, interest in more advanced models seems to be less probable due to the difficulties associated with risk management and data collection, although the literature in this area is accelerating (Figure 4).

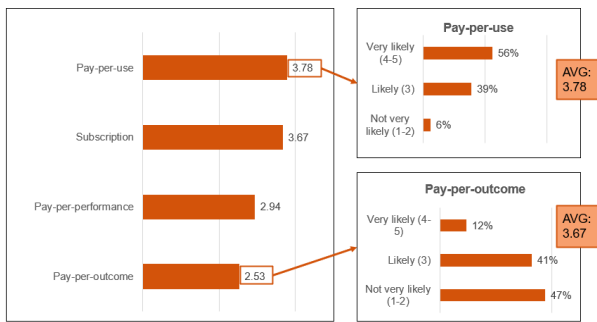


Figure 4: How to sell

The discussion revealed that the difficulty in moving to a Pay-per-X revenue model is linked to the need to collect data and information when the product/service is used. Therefore, it becomes necessary for companies to equip products with sensors capable of transmitting information, starting with the product's design. To this end, Industry 4.0 technologies become an important lever for this transition. In addition, companies must equip themselves with skills and personnel trained in this regard, defining a path that evolves from rental to pay-per-x.

E. Key roles

Investigating among the respondents the roles most affected by the adoption of the model, companies report greater involvement in after-sales and marketing & sales (23% and 21% of responses), while management registers a percentage of 14%. On the other hand, the most internal activities occupy the last places in the ranking: administration, finance and control, project

manager and logistics (all at 5%), and quality (4%) (Figure 5).



Figure 5: key roles for the transformation

During the discussion, it emerged, however, that the score given by management was influenced by taking the importance of this figure for granted. In fact, the respondents emphasized the value of top management defining a clear strategy, tasks, and roles to adopt an as-a-service business model.

F. Main barriers

The responses concerning the challenges were classified into six main categories: customer culture and relationship, IT/digital technologies, contracting/pricing/risks, business model, corporate culture, and financing. The difficulty in interacting with the customer, obtaining the necessary data, and ensuring privacy (category customer culture and relationship) are the challenges most feared by companies, while the financing aspect is considered, at first analysis, the least problematic. Customer reaction is seen as the biggest obstacle as some managers observe some difficulty and reluctance in customers to pay for innovative services. In fact, interest in an as-a-service model often arises in those "small" customers who do not have the resources to develop advanced services in-house but who also represent the most financially risky customers for the company. Investigating, moreover, the financial aspect, in the course of the discussion it emerged how risk mitigation represents a challenge for companies seeking to undertake this path, with the consequent need to rely on a financial partner and to be able to target the offer correctly, i.e. to customers with good creditworthiness. The respondents revealed that most of their companies have product control systems spread over the entire fleet, collect data in real time, and have developed platforms for analysis for their customers. However, they claim, that they

have difficulty in guaranteeing a secure connection, managing a large amount of data of different types, and ensuring integration of platforms with the realities already present at the customer's site. The issue related to information integration between different systems (company-customer-supplier) is furthermore a significant challenge, which implies not only the definition of a perimeter of applicability (end-user only or involvement of the entire network as well?) but also the management of organizational and management problems. Companies with a large presence of intermediaries also say that the most impactful challenge is to explain to the various actors in the chain that they are trying to offer broader value to all joint customers, and not just for the benefit of the individual company. The challenges therefore concern not only the external aspect, i.e. supplier involvement and customer relations, but also internally there is a need to redefine objectives and incentives at the commercial level between services and sales.

V. CONCLUSION

The results of this research show that most of the companies are planning to implement the XaaS paradigm within the next few years, and some have already launched pilot studies offering specific services with subscription business models. To this end, new digital technologies (IoT, embedded intelligence, control and fleet management systems, ...) represent an essential tool to collect data and provide valuable information to customers and service partners (e.g. for maintenance needs and cost estimation). However, the integration of machine data with ERP and business systems as well as the ability to communicate the value proposition to the customer represent an obstacle for the majority of the interviewed sample. Indeed, while companies have experienced that rental or subscription models can be particularly attractive to financially challenged customers, who would not approach traditional 'capex' offerings, they show difficulties in engaging their customers and creating a solid foundation to justify the investment in adopting an as-a-service business model.

Future developments in the research include the possibility of exploring, through practical case studies, some of these aspects to try to provide useful guidelines for companies in overcoming the main challenges, and to implement a possible reference framework for manufacturing companies that want to adopt the XaaS paradigm. In particular, the research will focus on customer culture, to discover the barriers and attitudes that lead

customers to reject this model, and the cost of the paradigm adoption for companies, especially from the perspective of the technology needed.

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