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# Developing a Maturity Model for Digital Servitization in Manufacturing Firms

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**Abstract:** In today's rapidly changing markets, manufacturing firms are increasingly challenged by the convergence of digital technologies and servitization, which is defined as Digital Servitization. Enterprises struggle to grasp this phenomenon's vision, constantly facing pressures to obtain and retain competitive advantage, inventing and reinventing new products and services, reducing costs and time to market, and enhancing quality at the same time. They need to define improvement actions to be taken to navigate through the transformation process and prioritize between different activities. Prior research has highlighted the importance of how to proceed into this transformation, however less emphasis has been put on suggesting suitable activities that fit the organization's current status and future goals. To overcome this challenge, we propose a maturity model for digital servitization that serves as an assessment tool. The design of our maturity model is grounded in literature and expert interviews. During its evolutionary development, we gathered, structured and organized several critical requirements for digital servitization. We could also explore and highlight important attributes that must be examined by companies during the transformational process. We contribute by our proposed maturity model that serves companies not only as a diagnostics tool to assess the current situation, but also as a guideline for continuous improvement.

**Keywords:** Digital servitization, maturity model, digital transformation, manufacturing, assessment

## 1 Introduction

In today's world, the growing digital disruption across industries is blurring boundaries and forcing industrial enterprises to improve their agility and responsiveness to gain ability to manage the whole value-chain. Recent research suggests that the application of digital technologies (DTs) can further advance servitization by enabling sophisticated and novel service offerings (Grubic, 2018; Lerch and Gotsch, 2015). In fact, the adoption of digital technologies such as the Internet of Things (IoT), Data and Analytics, Artificial Intelligence can alter the features of the delivered services significantly (Ardolino et al., 2018; Holler et al., 2017; Rymaszewska et al., 2017) and enable novel business models (Adrodegari et al., 2017), thus, reshaping industry competition (Porter and Heppelmann, 2014). Indeed, DTs shape servitization strategies, structures and activities aiming at increasing the service delivery efficiency and value of service offerings (Lerch and Gotsch, 2015). For instance, KONE, one of the largest global elevator companies, developed, sophisticated condition monitoring and predictive maintenance services together with IBM. Both these services are based on IoT technology and have resulted in lower downtime and speed up equipment restoration (Ardolino et al., 2018).

The convergence of DTs and servitization is called *digital servitization* and refers to the development of new services and/or the improvement of existing ones through the use of DTs by enabling new digital business models, finding ways of co-creating value, generating knowledge from data, improving a firm's operational performance and gaining competitive advantage over rivals (Sklyar et al., 2019a; Vendrell-Herrero et al., 2017) and received lots of attention over the last years from the research community and practitioners. Despite the phenomenon's growing relevance, the issue of defining how digital servitization changes a company's strategy, processes, and culture remains unexplored (Belvedere et al., 2013).

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Evidence shows that organizations often struggle with understanding the impact of digital servitization on their business and industry (Sklyar et al., 2019b). One key barrier is their inability to decide where to begin their own transformation process. To date, to the best of our knowledge, the existing research has not provided tools, such as maturity models for practitioners to master this transformation. Specifically, more attention has to be focused on helping organizations to decide when and why they need to take an action to progress and teaching them which actions should be considered. The introduction of such maturity model in the digital servitization, could therefore allow managers to position and compare their current state to the best-practices in related business fields and map their new strategy accordingly, which will increase the firm's overall performance.

Hence, the aim of our research project is to develop a maturity model (MM) that can ease the decision making, and assess the digital servitization maturity in manufacturing companies based on highly relevant requirements. To achieve our goal, we follow the maturity development process of (Becker et al., 2009a) and aim to answer the following two research questions.

*RQ1*: What are the key requirements for digital servitization in manufacturing?

*RQ2*: What stages can be observed in the process of digital servitization?

In pursuit of answering the two research questions, our paper is structured as follows. Section 2 sets the theoretical background. Section 3 describes the research method, and Section 4 presents the maturity model for digital servitization. Section 5 concludes and suggests avenues for further research.

## 2 Theoretical Background

Although, the phenomenon of digital servitization has been of a great interest for researchers of various disciplines the last years (Paschou *et al.*, 2018), there is a lack of a more interpretative research with the goal of supporting decision-making. Descriptive models (maturity models) for practitioners need to be developed to position companies towards the journey of digital servitization by defining how the adoption of digital technologies changes the whole organization in practice (Belvedere et al., 2013; Ostrom et al., 2015). In particular, to define a digital servitization strategy, managers need to understand the current state of their organization. This transformation is not a linear process, but there are different possible courses of actions. It would be beneficial for managers to know about these difficulties, in order to make an informed decision about prioritizing between different steps and to lay the foundation for successful change. Therefore, we need to know more about how companies actually face such a transformation, what makes them successful, and how organizations approach their transformation. A maturity model provides some guidance in this respect, since it gives an overview of the different areas and maps out typical paths of how organizations go about their digital servitization.

According to (Becker et al., 2009b), maturity models consist of a sequence of maturity levels for a class of objects and represent an anticipated, desired, or typical evolution path of these objects shaped as discrete stages. Their application enables firms to achieve competitive advantages (Wendler, 2012), by generating awareness of the analyzed aspects (their state, importance, potentials, requirements, complexity), and by serving as reference frame to implement a systematic and well-directed approach for improvement, ensuring a certain quality, avoiding errors, and assessing one's own capabilities on a comparable basis. There are several MMs but in this study, we use the Capability Maturity Model, which defines a set of process areas that reflect organizational capabilities which have to be developed to achieve the maturity goal of the service development process.(Paulk and Curtis, 1993), as the main reference due to its wide acceptance in industry.

The development of a MM entails critical requirements that occur throughout the digital servitization process and should be rooted in both scientific grounding and practical relevance. In the case of digital servitization, these critical requirements also impact the manner that a company relates to the other chain elements such as customers, partners, competitors (Baines and Lightfoot, 2014) and internal relationship changes. Hence, this study has identified four main dimensions (strategy, customer experience, business processes, organization and culture) to analyze how they should be considered during the digital servitization process of manufacturers. The four dimensions were defined by using the St.Gallen Business Engineering Map (Leimeister et al., 2014) as a guide to group the critical requirements within the same

type of relationship. The critical requirements for all the dimensions are obtained from the literature and are used to create an initial concept of the maturity model.

### 3 Research Methodology

In this study, to reduce complexity, we decided to apply the development process of (Becker et al., 2009b), one of the most popular models, to develop our MM.

**Table 1** Procedure model

	Problem identification	Comparison of existing MMs	Model development	Model evaluation
Performed activities	Problem identification and motivation	1. Deduction of maturity model requirements 2. Identification and evaluation of existing maturity models	Conceptualization of maturity levels	Evaluation
Used techniques	1. Initial literature review 2. Exploratory expert interviews	In-depth literature review	Model development & expert interviews	Expert interviews

In the first step (*Problem identification*), we specified the research problem and focus of the MM, provided practical relevance and justified the artefact's value based on an initial literature review and exploratory interviews with two experts to get better insights. Based on the problem identification, in the second step (*Comparison of existing MMs*), we gather requirements by conducting a systematic literature search using the Scopus database, which is widely acknowledged as a world leading source and provides the best coverage in this research field (Burnham, 2006). We applied the search combination of servitization ("servitization", "product (-) service system\* (PSS/IPSS)", "integrated solution\*", "service transformation", service infusion") and different terms for digital transformation and technologies ("digital technology/ies", "digitization", "Artificial Intelligence", "Big Data", "Cloud", "Digital Technologies", "digitalization", "Industry 4.0," Internet of Things", etc.). The search, between 2000 and 2019, yielded 86 usable articles. These articles were used to derive an initial list of requirements, which was structured according to the four MM dimensions derived in the theoretical background section. For the coding process the software Atlas.ti was used. Moreover, we operated a second literature review (using keywords such as "digital servitization", "servitization", "business/enterprise/organizational transformation", "digital transformation", "assessment model", "maturity model") to identify any shortcomings or lack of transferability of existing MMs, which are devoted to same or similar domains. In particular, 16 studies emerge from the field of servitization, (Alvarez et al., 2015; Neff et al., 2014) and 11 from digital transformation. Subsequently, we analyzed the MMs according to their domains and functionalities as well as their capability to address the defined research problems. In the third step (*Model development*), we used model adoption mechanisms (Becker et al., 2007) in the rigorous creation of a MM (structure and content). After formulating the model, the study sought expert opinions to confirm support for the model. Emails with a questionnaire to guide open conversations were sent to ten individuals, academics and practitioners involved with digital servitization for over a decade. There were six respondents who provided in-depth feedback through interviews regarding the model, which had a duration of 60-120 minutes each one. The majority of the responses acknowledged the importance of evaluating manufacturers' use of digital servitization and supported the overall structure of the model. Comments included suggestions for definition of stages, notes about wording, suggesting the possibility of needing less stages, need for clarifying requirement description, questions about how the model will be measured and by whom, and proposing extra dimensions/requirements. These opinions were taken into consideration and the model was revised accordingly in order to be more precise and complete. During the last step (*Model evaluation*), we evaluated the comprehensiveness of the model, validity in self-assessment and the capability of supporting the future development of a roadmap with the same experts,

discussing the final version of the MM. Table 1 describes the steps according to the tasks performed and the techniques used achieved in complementing our research.

## 4 Proposed Digital Servitization Maturity Model

The identified requirements both from literature and expert interviews were summarized in four dimensions. For each dimension, corresponding maturity criteria were defined, which describe the fields of action. Activities in these fields show the penetration of digital servitization maturity. Hence, we employed “Strategy”, “Customer Experience”, “Business Processes” and “Organization and Culture” as dimensions that serve not only as a conceptual basis but for collecting the exploratory identified requirements but also as a theoretical lens for the MM (see Table 2).

**Table 2** Identified dimensions and maturity criteria in the individual steps of the study

Dimensions	Requirements	Literature	Expert interviews
<b>Strategy</b>	Strategic orientation	✓	✓
	Business model	✓	(✓)
	Digital service offering	✓	(✓)
<b>Customer Experience</b>	Digital service ecosystem	(✓)	✓
	Customer centricity	✓	✓
	Customer trust	(✓)	✓
<b>Business Processes</b>	Production	✓	✓
	Marketing	(✓)	(✓)
	Human resources	(✓)	✓
<b>Organization and Culture</b>	Digital service business mindset and culture	(✓)	✓
	Governance and leadership	(✓)	✓
	Organization design and talent management	✓	(✓)
	Competences	✓	✓

✓ = frequent mention    (✓) = occasional mention

The **Strategy** of digital servitization is embedded within the overall business strategy and focuses on how the business transforms or operates to increase its competitive advantage through digital initiatives in service. “Strategic Orientation” was identified as an important prerequisite for digital servitization and it refers to the exploitation of the overall growth strategy aiming at developing digital service offerings and innovating the company's portfolio by keeping its heritage (Allmendinger and Lombreglia, 2005; Bustinza et al., 2015). “Business Model”, another critical requirement, refers to the different technology-enabled business models that facilitate firms to achieve a competitive advantage by providing customer knowledge-based digital service offerings during the entire product life cycle (Frank et al., 2019; Kohtamäki et al., 2019). In addition, “Digital Service Offering” applies to the enrichment of the existing but also the creation of totally new service offerings enriched by digital technologies that bring digital and physical systems together creating customer value and revenue streams (Baines and Lightfoot, 2014). The last requirement of this dimension is the “Digital Service Ecosystem” and makes reference to the relationship between the company and business partners (R&D organizations, technology incubators, startups), enabled by platforms, which aims at gaining access to resources such as technology intellectual property, or people to increase the organization's ability to improve, innovate and grow, balancing security and privacy needs with the ability to flex capacity according to business demand (Cenamor et al., 2017; Sklyar et al., 2019a). **Customer Experience** focuses on the necessity of considering customers' needs and interests as the basis for developing digital service offerings. The first requirement, that we identified is the “Customer Centricity” and deals with a set of procedures and practices for assessing closer customers' preferences and continuously evolving needs on digital service offerings, to enhance the competitive position and strengthen customer relationships (Coreynen et al., 2017). Experts stressed the “Customer Trust”, which refers to how the customer's trust is build and how the perceived risks (functional, psychological/safety, privacy) are evaluated by them (Paluch and Wunderlich, 2016). The dimension of **Business Processes** contains the way of executing and evolving a company's operations by

using digital technologies aiming at driving strategic management and enhancing service business efficiency and effectiveness. The first requirement is “Production” and indicates the way processes are executed, monitored and managed. It consists of internal processes (the way inputs are transformed to outputs, products and services are integrated through digital technologies to create value for the customers and end users), supply chain orchestration (the way the firm employs digital technologies to manage the value network of all actors and individuals that interact to deploy resources and applied competences in order to create value) and digital innovation (practices based on digital technologies that support research, design, and development of new product-service offerings) (Belvedere et al., 2013; Vendrell-Herrero et al., 2017). “Marketing” requirement include the pricing, the process whereby a business sets the price at which it will sell its digital service offerings and value co-creation, which occurs through interactions among providers and customers by integrating resources and applying competences (Bonfanti et al., 2018; Valencia et al., 2015). “Human Resources” requirement depicts to services provided by an HR department to business operations. HR operations include administrative services, recruitment, job analysis, and employee relationship management (Bustinza et al., 2018). **Organization and Culture** dimension defines and develops an organizational culture with governance and talent processes to support progress along the digital servitization maturity curve, and the flexibly to achieve growth and innovation objectives. “Digital Service Business Mindset and Culture” describes the diffusion within the companies of a mental model that is oriented towards digital service culture: the company needs to change mental model to view digital service offering as a business logic and perspective on value creation (Uhlmann and Geisert, 2017). Furthermore, “Governance and Leadership” refers to the efficient and effective decision making processes which define the expectations, systems and management of projects related to digital servitization (Vendrell-Herrero et al., 2017). Another significant requirement is the “Organization Design and Talent Management” and cites the transformation of the internal organizational structures by establishing dedicated team/roles/persons for the development of digital service offerings in light of new competitive pressures (Baines et al., 2013). The final requirement is the “Competences”, which treats higher and diversified competences that employees need to develop by acquiring new knowledge and ways of working to encounter increasingly interactive tasks, take data-driven decisions, understand customer's problem and interpret its real needs (Paschou *et al.*, 2018).

To define the digital servitization MM phases we used as main reference the MM processes of (Paulk and Curtis, 1993). For simplicity in this study, we use three maturity stages (see Table 3).

**Level 1:** Beginner is a maturity level where a company has some pilot strategy initiatives and offers base services. The usage level of digital technologies in business processes (production, marketing, HR) is low. Flexibility, integration and collaboration with partners are at low level as well. The customer interaction is distant, while there is a low attitude towards digital servitization. The organization structure and people are not prepared enough for this transformation.

**Level 2:** Experienced is a maturity level where a company is implementing digital servitization and offers intermediate services. Digital technologies are used in a moderate level in the different business processes. The ecosystem is getting digitized while the collaboration is becoming closer. The customer is integrated in the design phase already and the general attitude is encouraged towards the new transformation. The organization structure is suitable for initial projects and people for specific units that have digital servitization projects have the necessary competences.

**Level 3:** Leader is a maturity level where a company has implemented digital servitization, has a comprehensive vision and offers advanced services. The usage level of digital technologies is high both in the business processes and business models. There is a fully digitized, integrated partner ecosystem built on a flexible and integrity architecture. There is an intimate relationship and personalized communication with the customer while the attitude is comprehensive and promotes digital servitization. The organization structure is well structured and digital competences are prevalent in the whole company.

## 5 Concluding remarks

Although, evidence show that manufacturing companies struggle with comprehending the impact of digital servitization and how to master it, little attention has been devoted so far in developing a tool that

Dimension	Requirement	Level 1 - Beginner	Level 2 – Experienced	Level 3 - Leader
Strategy	Strategic orientation	Limited vision of digital servitization, no documented implementation target. Strategy initiated and developed. Low investment.	Incremental vision of digital servitization, not fully defined implementation target. Strategy implemented and occasionally reviewed. Investment and Innovation management established in multiple areas.	Transformational vision, clearly defined implementation target. Strategy implemented and regularly reviewed. Enterprise-wide Investment and Innovation management established.
	Business model	Add-on business models use DTs (ICT, IoT) to enable additional functions or adding personalized services to the existing physical products or service to facilitate service provision.	Usage-based business models use DTs (IoT, cloud computing, big data) to measure the amount of product usage and allow customers to pay for or subscribe to the plan, based on their actual usage and needs (pay-per-use).	Solution-oriented business models use DTs (IoT, artificial intelligence) to enable the provision of solutions to customers. With the aid of IoT technology, providers are able to offer integrated solutions to customers' needs (subscription availability).
	Digital service offering	Low usage level of DTs is used to provide obligatory product-related services (base services), such as installation or maintenance and repair.	Moderate usage level of DTs (IoT, Cloud computing, Big data, Advanced manufacturing Solutions) is used to provide intermediate services (e.g. remote monitoring)	High usage level of DTs (IoT, Big data, Advanced manufacturing solutions, Artificial Intelligence) provides value for both customer and the companies' internal processes creating novel services (advanced services).
	Digital service ecosystem	Company has partnerships with a few stakeholders; low level collaboration. No flexibility, no additional integration; limited understanding today, no future shared view.	Company has partnerships with some of stakeholders; medium level of collaboration. A moderate level of flexibility, integration and understanding.	Fully digitized, integrated partner ecosystem; open system built on a flexible and integrity architecture; clear shared view, today and in the future.
Customer Experience	Customer centricity	None customer preferences and needs are collected. Interaction between customer and company is not existent/distant. No feedbacks from the customer are collected. Impersonal customer communication.	No standard approach of preferences/needs collection. The customer is integrated in the early design process in order to align the product to the customers' needs. Formal feedback is collected after technical assistance interventions.	Formal procedures and rules drive customer preferences and needs, used for future strategic decision. Customer and interaction data collected through different channels. Feedbacks are discussed with the client and are explicitly considered in the continuous improvement process by creating common platforms. Intimate relationship.
	Customer trust	No documentation; customer does not know when/how the service provider access the equipment; uncertain about which activities are performed on the machine. Service technician can access private/confidential information beyond the service agreement; no control.	Some documentation; customer does not know when/how the service provider access the equipment; certain about which activities are performed on the machine. Service technician can access some private/confidential information beyond the service agreement; little control.	Documentation; customer knows when/how the service provider access the equipment; certain about which activities are performed on the machine. Service technician cannot access private/confidential information beyond the service agreement; control.
Business Processes	Production	Operation process traceability is provided partially; low level end-to-end visibility and production customization. Standard agile methods in project execution (e.g. Scrum); no clear integration and standardization. Integrated supply chain processes between company, suppliers and customers in terms of basic data sharing and communication; few software systems in use and production systems are partially automated. No activities supporting the digital service innovation, apart from observations. Data usage in service innovation is at low level.	Operation process traceability is provided at production line level; medium level end-to-end visibility and production customization; integration and standardization are at a medium level. Integrated supply chain processes between company, and key strategic suppliers/customers in terms of data transfer; some software systems in use and production systems are automated at production line level. Systematic approach for digital service innovation; company is aware of the process but some activities are still incomplete or inconsistent. Data usage in service innovation is at medium level.	Operation process traceability is provided at factory level; high level end-to-end visibility and production customization; high level of process standardization. Supply chain systems are fully integrated between company, suppliers and customers which provide real-time planning; lots of software systems in use and production systems are automated in factory level. Quality management and continuous improvement activities are formalized in the procedure. Data usage in service innovation is at high level.
	Marketing	A few analytics studies are conducted and data obtained from environment is not used in product pricing and dynamic pricing. The customer has little control over the contribution process and the provider offers the digital services that chooses.	Analytics studies are conducted and data obtained from environment is used in product pricing and dynamic pricing. The customer has some control over the contribution process and the provider offers the digital services that customer also needs.	Analytics studies are conducted and data obtained from environment is used in product pricing and dynamic pricing. The customers are tightly integrated and engaged with the provider's processes and resources. They are jointly able to discover opportunities for value creation.
	Human resources	Data is used in a few areas, but company does not share real-time data with field workers. Traditional recruitment and training, e-learning is not an option.	Data is used in some areas; company shares real-time data with field workers. Traditional/Digital recruitment, e-learning is an option.	Data is used in lots of areas; company shares real-time data with field workers. Special training (mixed reality, internal academy) for re-qualification of the employees. Digital recruiting.
Organization & Culture	Digital service mindset & culture	Low attitude towards digital servitization. Mistakes and lessons from failed projects not secretive, digital competences are not critical, the development of new digital service offerings by customers is not actively promoted. Low level of knowledge sharing and no/in limited area collaboration across company. Home office for employees for whom it makes sense.	Promote attitude towards digital servitization in a medium level. Evaluate errors, identify the importance of digital competences, the development of new digital service offerings is promoted. Encouragement of knowledge sharing and structured and consistently performed cross-functional collaboration.	Promote digital servitization vision. Evaluate errors to improve processes, digital competences are critical, customers suggest systematically improvements for the digital service offerings. High level of knowledge sharing and sophisticated forms of cross-company collaboration in value creation networks. Great experience on mobile working and little regulations are needed.
	Governance and leadership	De-centralize decision making process. Low quality/transparency/availability and accuracy of data used for decision- making processes.	Promote central decision making process. Medium quality/transparency/availability and accuracy of data used for decision- making processes.	Re-centralize decision making process. High quality/transparency/availability and accuracy of data for decision- making processes.

Organization design & talent mgmt.	Organization structure is not suitable for transformation. No formal or informal roles are created. Limited interaction between departments.	Organization structure is suitable for initial projects. Some roles are being created. Departments are open to cross-company collaboration.	Well-structured for transformation. Formal roles responsible for strategic planning, which are well connected within business units. Departments are open to cross-company collaboration to drive improvements.
Competences	Only technology focused areas has employees with digital skills that are not allocated to specific digital servitization projects.	In most areas of the business digital skills have been well developed that are allocated to specific digital servitization projects in different units.	All across the business, cutting edge digital and analytical skills are prevalent and allocated to specific digital servitization projects in same units.

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can be used from practitioners. This study presents the development of a new maturity model, that based on specific requirements identified in digital servitization literature and expert interviews, can be used as a management instrument to analyze the current set-up, by assessing the maturity level of strategy, business processes, customer experience, organization and culture. Three levels of maturity have been outlined, and the model constitutes the main contribution of our research, since, to the best of our knowledge, no such kind or model exists for digital servitization in manufacturing.

Coping with the challenges of digital servitization is of considerable interest to both researchers and practitioners. In particular, developing a maturity model for digital servitization 1) contributes to the body of knowledge on enterprise transformation processes, which entail unplanned and radical organizational changes, and 2) represents a practical way of operationalizing the digital servitization process. For practitioners, the results may help managers to assess the status quo of their organization and identify possible new courses of action. This understanding can contribute to more systematic and strategic change processes, as opposed to intuitive reactions to external turbulence. Furthermore, even though a maturity model suggests that a more advanced stage produces better performance, this correlation is not proven and even may not exist at all. The maturity model in this study is simply used for mapping out the typical stages, but every company needs to decide whether the activities in each stage are appropriate, feasible, and relevant for the specific industry, business model, and the competitive context.

Although this paper produced some interesting and useful finding, we would like to point some limitations that need to be considered when interpreting the results. First of all, the development of the model is based exclusively on literature and a number of expert interviews, which makes it conceptual. For that reason, further research could involve more experts, divided into academics and practitioners, aiming at completing the requirement list considering different perspectives. Moreover, we also acknowledge that even though the maturity stages have been carefully developed, based on literature and interviews, a testing and final evaluation of the tool with cases has not yet been conducted.

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