Generic Role Model for the Systematic Development of Internal AI-based Services in Manufacturing

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Abstract

Latest research has shown that one challenge for the development and implementation of Industrial AI-based services is uncertainty of roles and responsibilities. To address this challenge, we developed a generic role model for the systematic development of AI-based services in manufacturing. The role model describes which roles are necessary within the development process of an Industrial AI-based service. Thereby, a distinction is made whether the roles are assigned to the "core team", the "extended team" or participate in "supporting roles". Furthermore, the model shows whether the roles are involved in the "Ideation" phase, the "Requirements and design" phase, the "Test" phase or the "Implementation and roll-out" phase. Based on desktop research, semi-structured interviews and expert workshops we identified 22 roles that are relevant to the development and implementation of Industrial AI-based services.

Keywords: Industrial Artificial Intelligence, AI-based Services, Role model, job roles

1. Introduction

Shifting focus from mainly producing and selling physical goods to providing services and solutions has been a popular strategy of manufacturing companies during the last decades (Baines & Lightfoot, 2013). By offering a wide range of value-added services manufacturing firms can provide more customer-centric, individualized solutions, leading to increasing customer satisfaction and resulting in competitive advantages as well as better financial performance (Kowalkowski et al., 2017).

This shift often referred to as servitization, is increasingly being driven by the advancing diffusion of digital technologies, such as the Internet of Things (IoT) and Artificial Intelligence (AI) (Ardolino et al., 2018). Data collected in the IoT allows drawing comprehensive conclusions regarding the condition, usage and application context of physical objects and thus enables adaptation of service offers to specific customer needs in certain situations. AI supports deploying these potentials by, for example, automatically extracting the necessary information for adaptation from large and partly unstructured data sets or by supplementing missing data (Neuhüttler, Fischer, et al., 2020). Moreover, AI applications allow manufacturers to provide their services more automated or even autonomous and thus increase process efficiency and scalability. On the one hand, digital servitization leads to new market offers and service-oriented business models for manufacturing firms (Koldewey et al., 2020). On the other hand, the potentials described can also be used to improve the internal processes of manufacturing companies. By collecting, processing and using data generated during manufacturing, internal AI-based services can be developed and offered that lead to productivity and quality advantages.

AI systems used in manufacturing are summarized under the term Industrial AI (IAI). One popular example is the use of industrial computer vision (ICV) for detecting part or product failures during production automatically. However, since deploying AI is not a mere application of technology but about developing an intangible offer that is directed towards a change in the state of persons, objects, processes or information, we adopt a service systems perspective in our following work (Tombeil et al., 2020). Since in many cases, AI-based services are developed and provided by distinct organizational units to other units within the same company, we consider them as internal AI-based services. Accordingly, internal customer orientation, internal service culture and the provision of high service quality play an important role (Johnston, 2008).

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Companies that want to implement their ideas for AI-based services within the company often face challenges. The development of AI-based services is a relatively new and complex field (Lim et al., 2018). Furthermore, current company structures and processes are often not designed for the efficient and quality-oriented development of new, internal services. In many cases, the difficulties start with the fact that the development processes are not clearly defined. For example, there are no clear descriptions of the tasks, the methods to be used and the necessary roles and personnel requirements (Kutz et al., 2022).

A scientific discipline that aims to support the successful development of new services is service engineering. Service engineering provides suitable processes, methods and tools, and thus enables systematic service development in companies. One of these supporting tools are generic role models. These help companies to facilitate staffing of their development teams (DIN 91364:2018). Against this background, this paper aims to support manufacturing companies in the engineering of internal AI-based services by developing a generic role model.

2. Theoretical Background

2.1 Service Engineering

Service engineering can be understood as a technical discipline that deals with the systematic development and design of services using appropriate process models, methods and tools (Bullinger et al., 2003). By providing a dedicated design methodology, the aim is to enable repeatable and thus efficient development of predominantly intangible and integrative offers (Meyer & Zinke, 2018). Particular importance is attached to the design of high service quality in a resource-efficient development process (Schuh et al., 2016).

At the center of service engineering are reference procedure models that contain detailed documentation of development processes, tasks and responsibilities and thus allow planning and monitoring of developing projects. There are different reference models for the development of new services with different focuses, which are similar in the phases and activities described (cf. Kitsios & Kamariotou, 2019; Witell et al., 2017).

In addition to approaches to developing traditional services, there are also reference models that integrate the use of data and digital elements (cf. Frank et al., 2020; Neuhüttler et al., 2020). Typically, these models include the following six generic development activities, which are combined into phases with varying levels of differentiation. Within "*Ideation*", ideas for a new service are collected and evaluated about criteria such as feasibility, economic viability, customer benefits and market potential. If an idea is selected for further pursuit, technical, organizational and personnel requirements are collected among different internal and external stakeholders during "*Requirement Analyses".* Based on the results a detailed service concept is created during the *"Design"* activities, which includes a description of the service including a system architecture as well as a process and resource model. During the following activity "*Testing*", concepts and prototypes developed so far are evaluated. This includes functional and user testing as well as price and cost simulations. Tests are followed by the "*Implementation*", in which concepts and prototypes that passed the tests are implemented, including organizational measures, regulation of responsibilities and the creation of work instructions and training measures. In the final activity *"Roll-out"*, newly developed services are scaled to all relevant areas and success is monitored closely, for example via feedback questionnaires.

Based on the activities presented, traditional approaches to service engineering often introduce role models that deal with the necessary activities and competences for development at the individual actor level (Schymanietz & Jonas, 2020)

2.2 Service Engineering for internal AI-based Services

In the past decades, service engineering has provided a large body of knowledge that is still considered to be useful and valid today (Marx et al., 2020). However, due to the changed nature of services, a need for further development of service engineering concepts and methods was expressed in scientific literature (Böhmann et al., 2018; Hunke & Schüritz, 2019). This applies in particular to the development of AI-based services, which are characterized by intensive use of data through a high degree of automation up to autonomy in decisions and actions in service delivery.

However, calls for adaptation of service engineering concepts refer not only to the new characteristics of AI-based services but also to their increasingly systemic and collaborative development. Due to the complexity of AI-based services and their impact on internal service systems, different actors with specific competences and resources need to be involved in the development (Neuhüttler, Kett, et al., 2020). On the one hand, this includes technical competences for the collection and preparation of the data basis as well as the development of algorithms and system architectures. On the other hand, due to the high degree of autonomy, there is also a need to involve other actors in the process. Concerning the acceptance of AI-based services, this includes the intensive involvement of users, but also actors who deal with security and questions of safety in the working environment. If stakeholders are not involved throughout the development process, problems arise, such as a lack of resources, commitment and customer focus as well as poor processes, which are regarded as central barriers to internal service quality (Johnston, 2008).

To coordinate and synchronize different actors, competences and tasks during interdisciplinary development projects, role models that describe the tasks and responsibilities of each actor become even more important for the successful engineering of internal AI-based services.

2.3 Definition of role and role model

Due to changes in the working environment, the use of roles and role profiles in organizations is becoming increasingly relevant. In contrast to job descriptions, job roles allow more flexibility. This means that one role can be occupied by multiple people, but also one person can occupy multiple roles. (Grote et al., 2020; Schüller & Steffen, 2021). A role can be defined as a specific function a person or organizational unit fulfills (Broy & Kuhrmann, 2013). Following the definition of social psychology a role is associated with behavioral expectations that are directed at a particular position (Maier). Also, professional roles are associated with specific behavioral expectations (Hinz, 2017). A role profile describes the tasks and responsibilities associated with a role, as well as required competences (Grote et al., 2020).

Several related roles can be combined in a role model. According to Grote et al. (2020) “role models include groups of role profiles specific to the company with clear tasks and competences as well as associated responsibilities and authorities” (p. 1).

2.4 Role models in related disciplines

Previous studies show that the relevance of suitable role models is becoming increasingly important. The development and implementation of AI-based services is still a new application field and accordingly associated with new job roles and competences. Through the growing complexity of data-based services an interdisciplinary team is needed for a successful development process (Anke et al., 2020; Tombeil et al., 2021). According to Kutzias et al. (2021) roles and competences are focused on newer data science process models. For example, the EDDA (Engineering Data Driven- Applications) process model by Hesenius et al. (2019) includes “four roles providing the necessary expertise to develop a data-driven application” (p. 38). The roles are Domain Expert, Data Scientist, Data Domain Expert and Software Engineer. Another model is the Team Data Science Process which includes six roles: Solution Architect, Project Manager, Data Engineer, Data Scientist, Application developer and Project Lead (Microsoft, 2020). There are further studies that deal with roles in data science projects. The study by Crisis et al. (2020) provides a good overview. Based on the analysis of 12 studies in the field of data science, they identified 9 roles that are needed for a data science project. In a qualitative study on smart service innovation, 17 roles were identified. The authors separate Primary roles and Secondary roles in smart service engineering (SSE) projects. Primary roles are (1) project sponsor, (2) digital innovator, (3) system integrator and (4) service operator (Anke et al., 2020).

Besides the establishment of new roles, new approaches to forming project teams are required.

2.5 Summary and research questions

Internal AI-based services represent a new type of development object to which existing concepts and methods of service engineering must adapt. This also includes staffing the development projects with suitable people who have the required skills and competences. Especially in manufacturing, staffing a project team for internal AI-service development is challenging. Development projects often do not take place within the boundaries of one organizational unit, but between different units within a manufacturing company. Besides experts from the IT department, also experts from the production department are needed for successful development and implementation (Kutz et al., 2022). We were not able to find a role model that holistically addresses the development of internal IAI-based services and takes into account all necessary development objects and their specific characteristics (cf. section 2.2). To overcome this challenge the aim of our study is to develop a generic role model for the systematic development of internal AI-based services in manufacturing. Therefore, we address the following research questions:

- RQ1: What job roles are needed to successfully develop and implement internal IAI-based services?
- RQ2: What tasks are assumed by the roles in the internal IAI-based service development process?
- RQ3: During which process phases are the roles involved?

3. Research Design

Our study aims to develop a generic role model for the development of IAI-based services. The model should cover the entire service engineering process, from ideation to roll-out. A 3-stage research design was chosen to develop the role model (cf. table 1).

Table 1. Overview research design

Research Step	Method	Sample
1. Development	Interview	10 AI Expert of a European automotive OEM (Company A)
2. Evaluation	Workshop	1 Product Owner, 1 Project Manager of a European

			automotive OEM (Company A)
3.	Validation	Workshop	2 AI Experts of a German tool manufacturing company (Company B)

Step 1: Development of the role model: First, we conducted semi-structured interviews with 10 AI experts of a European Original Equipment Manufacturer (OEM) from the automotive sector. The interview guideline included questions about the interviewees' roles in the development of AI-based services, related tasks and challenges. Furthermore, questions were asked about additional roles respectively stakeholders which are currently involved or should be involved in future development projects. One interview was about 45 minutes and was conducted virtually via Microsoft Teams. Based on these results, the first version of the role model, consisting of 25 roles, was developed.

Step 2: Evaluation of the role model: During the second step we evaluated the role model in two workshops at the same OEM: In the first workshop the role model was discussed and reviewed with a Product Owner of an IAI-based service in the field of ICV. In the second workshop, the role model was discussed and reviewed with a Project Manager of an IAI-based service in the field of Anomaly Detection. The workshops were conducted virtually and lasted about 60 minutes. We used an online whiteboard for interactive collaboration. In particular, role titles and tasks as well as the allocation to the development phases and levels of the role model were discussed. Reflecting on these results, a second version of the role model was developed.

Step 3: Validation of the role model: Afterwards, the role model was generalized considering the literature and empirical findings. This third version, consisting of 23 roles, was then validated with two AI experts from a German tool manufacturing company. This workshop was conducted virtually along an online whiteboard. The workshop lasted about 60 minutes. Taking these workshop results into account, the final version presented in our paper was created. Based on the results of the workshop, one role was removed, so that the final version contains 22 roles.

4. Findings

4.1 Role model for the development of internal IAI-based services

The role model presented in figure 1 describes which roles are necessary within an internal IAI-based service engineering process. A total of 22 roles could be identified, which were assigned to three levels:

- Core team (5 roles)
- Extended team (8 roles)
- Supporting roles (9 roles)

The roles assigned to the core team are involved throughout the whole development process of an IAI-based service. Roles assigned to the extended team are only temporarily involved to fulfil certain tasks or to contribute their experiences and requirements. Together, these roles form the project team. Further, nine roles are categorized as supporting roles. These roles are only indirectly involved in the development of an IAI-based service. They assume control or advisory function and offer support when necessary. The role model also shows which role should be involved in which process phase of the development of IAI-based services. Process phases used within the role model are based on the process models of service engineering and the development tasks contained therein (Frank et al., 2020; Neuhüttler et al., 2019). Since this study focuses on roles rather than process steps, we have summarized the original six activities into four phases to reduce complexity. In the "Ideation" phase, ideas for solutions to existing challenges are sought and evaluated in terms of technical feasibility, economic viability, customer benefits and market potential (Waidelich et al., 2018). Consequently, it is important to involve customers and end-users from the extended team as well as management in the idea evaluation, in addition to the technical roles, such as software and AI engineers, and omain experts. Once an idea is selected for further pursuit technical, organizational and personnel requirements are collected and defined during the phase "Requirement and design". All stakeholders concerned should be involved in the requirement analysis. In addition to the roles already mentioned, the requirements of maintainers and other important supporting actors, such as IT security, works council and change management, are included and taken into account. Based on the requirements, a concept for the internal IAI-based service is developed and iteratively transferred into functional prototypes. This means the entire service process is described and specified, including a system architecture as well as a process and resource model. Accordingly, additional DevOps experts as well as data engineers and data scientists must be involved during the requirements and design phase. Subsequently, concepts and prototypes developed so far are evaluated. This third phase "Test" includes different functional and validation tests, which require the involvement of the different requirement groups. In the final phase "Implementation and roll-out concepts and prototypes that passed the tests are implemented. This includes the integration of the AI system in the production environment as well as organizational measures, regulation of responsibilities and the creation of work instructions and training measures. After further functional tests in the production environment, the service is then put into operation. At this point, specialists for deployment should be involved in the

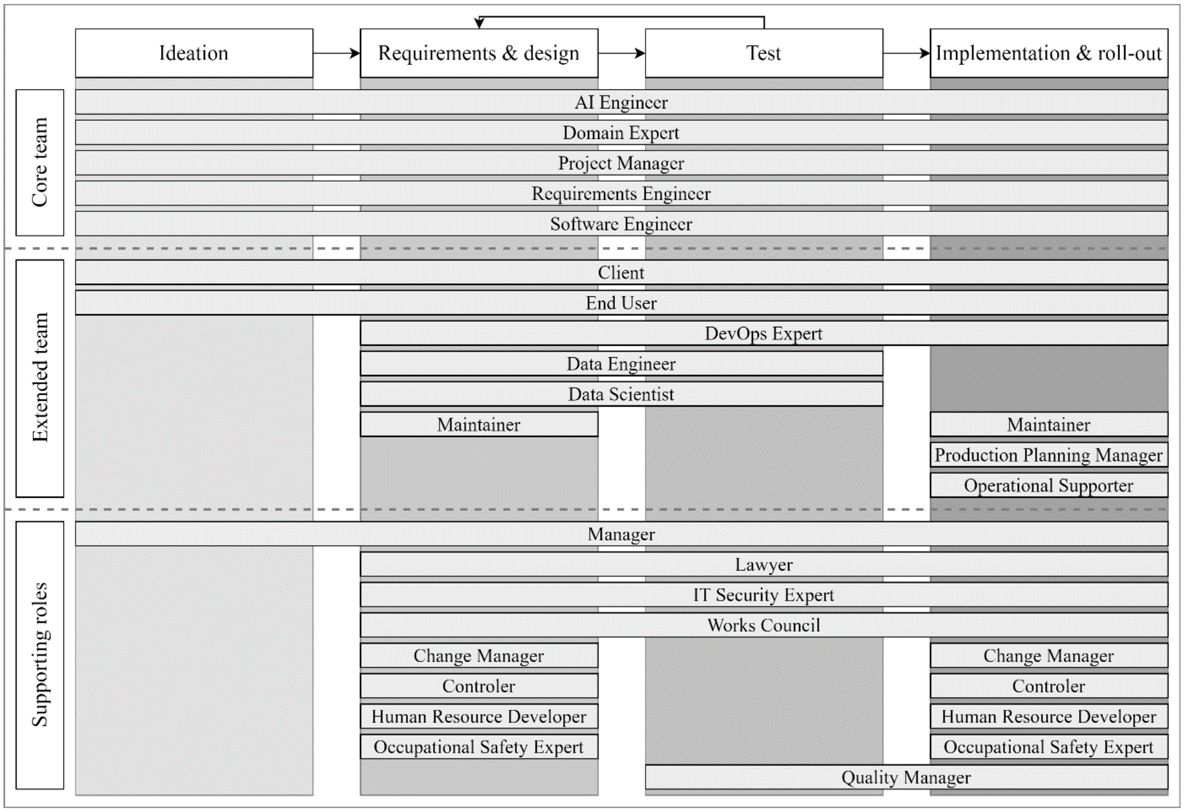

Figure 1. Role model for the systematic development of internal Industrial AI-based services

form of the roles "maintainer", "production planning manager" as well as "operational supporters". As the deployment can lead to changes in existing organizational processes and the need for competences, the roles of "change manager", "controller", "HR developer" and "security experts" should also be included at this point. As already described, the roles are partly involved in the entire development process and partly only in certain development phases. Depending on their functions and tasks, the assignment of roles to the individual process phases was worked out in the workshops (Step 2 and Step 3). Roles of the core team are actively involved in all phases, as they take on active and guiding tasks throughout the whole process. Furthermore, they must be able to keep an overview of the overall process and should be present at all project and status meetings. However, the roles of the extended team do not need to be present at all project meetings, and they only undertake certain tasks. This will be illustrated in the following using the example of end users. In the ideation phase, they can contribute ideas for new AI use cases that have arisen from practical experience. In the second phase, they contribute requirements that relate in particular to the work process, and in the third phase, they test an IAI-based service for its usability. In the last phase, "Implementation and Roll-Out", they have to be involved to acquire the necessary competences for the successful use of the new application.

4.2 Roles descriptions

The following sub-section describes the roles of the core team (table 1) and the extended team (table 2) in more detail. Role descriptions are based on the interviews and workshops, taking into account role descriptions known from literature (Anke et al., 2020; Crisan et al., 2020; Hesenius et al., 2019; Microsoft, 2020). We will refrain from a detailed description of the supporting roles at this point, as their tasks and responsibilities are quite familiar. However, this does not mean that the inclusion of these roles in the development process is less important. According to the interviewees, it is recommended to inform these roles in time about the project progress or to involve them at an early stage, as their areas of responsibility influence the successful implementation of IAI-based services.

Table 2. Role descriptions core team

Role	Description
AI Engineer	Supports the assessment of technical feasibility. Develops, adapts, trains, and validates AI models and provides AI systems for the production environment.
Domain Expert	Contributes expertise from the relevant department to the

	development of IAI-based services. Is responsible for the implementation on the shop floor.
Project Manager	Leads the project from ideation to roll-out. Is responsible for the project organization (e.g., planning of deadlines, documentation of project progress, release processes), project quality and available resources. Reports to the management.
Requirements Engineer	Maintains an overview of the stakeholders to be involved (e.g., production, maintenance, management) and compiles their requirements for the IAI-based service. Introduces requirements into the development process and examines whether these have been fulfilled.
Software Engineer	Develops software solutions that are necessary for the operation of an IAI-based service, such as platforms and user interfaces. Is also responsible for the connection to existing IT systems.

Table 3. Role descriptions extended team

Role	Description
Client	Requests an AI-based service to improve the production process and therefore orders the development of an IAI-based service. Defines requirements for the IAI-based service and checks whether these have been fulfilled.
DevOps Expert	Is responsible for the operation, architecture, and deployment of the required IT systems.
End User	Uses the IAI-based services in daily operations once the service is implemented. Actively supports the development process by contributing information about work processes as well as usability requirements.
Data Engineer	Collects all necessary data, prepares them, and makes data available for the following analysis. Thereby interfaces with all relevant systems are provided or created.
Data Scientist	Identifies and analyses data. Selects or develops models for data analysis. Must implement the requirements of the department and extract findings from the data.
Maintainer	Is responsible for maintenance, repairs and the operational capability of the machinery and equipment. Approves the sensors and systems used within the IAI-based service when the service is implemented.
Production Planning Manager	Reorganizes production processes to suit the IAI-based service. Enables integration into the production and workflow.
Operational Supporter	Supports users using the IAI-based service and provides advice if problems or errors occur. Needs to gain practical knowledge during the last two phases to support users after implementation.

4.3 Application of the model

The presented role model can be understood as a tool to support the systematic development of IAI-based services in manufacturing companies. Once a company decides to develop such services for internal application, the role model provides information about who should be involved in the development process. According to the study participants, a major added value of the role model developed here is the interdisciplinary team composition. Nevertheless, the cooperation between IT and manufacturing was also described as a challenge by the interviewees. For example, the AI experts explained that it is often difficult for them to gain access to production stuff. The role model presented here can help overcome this challenge by involving people from all relevant areas in development from the very beginning. At the beginning of a development process, it should be determined which person or respectively persons occupy one or more roles. The model and the detailed description of the roles help to communicate the requirements and necessary tasks for each person involved clearly.

Furthermore, it is possible to work with external partners if not all roles can be filled by internal employees. If roles cannot be filled internally, transparency is created about missing competences in the company. It is possible to train employees accordingly or to hire new people with the appropriate competences.

In addition, during the development process, the role model can be used by the core team to ensure that all relevant stakeholders are involved. Parallel roles and the tasks, responsibilities and competences associated with them should be described in more detail.

5. Discussion and Conclusion

Industrial AI-based services have several advantages for manufacturing companies. For example, they strengthen resilience, improve work processes, and increase product quality. To reach their full potential, the successful development and implementation of IAI-based services are crucial. Service engineering provides guidance to do so, in form of formalized process models, methods and tools. However, traditional service engineering approaches do not take into account specific features and circumstances of developing internal AI-based services (cf. 2.2).

Among other things, companies need support in defining roles to be included in an internal IAI-based service development process. No role model tailored to this field of application could be found in the literature. To support companies, our paper presents a generic role model developed based on qualitative research. Some of the roles known from the literature (Hesenius et al., 2019; Microsoft, 2020) for the implementation of data-driven services can also be found in our model (e.g., data engineer, data scientist or project manager). What is unique about our model is the extensive addition of roles from other disciplines. Roles of the production department, such as domain expert, end user and maintenance, have been integrated. Other important business areas are integrated through supporting roles such as human resources manager, change manager or the works council. As described by Anke et al. (2020) and Tombeil et al. (2021) before, our role model confirms that interdisciplinary teams, in our case, mainly consisting of roles from the areas of the production department and IT department, are needed for a successful development process. According to the interviewees, however, this is one of the biggest challenges that must be overcome. Measures to strengthen interdisciplinary collaboration should be addressed in future research.

The role model presented can support the development of internal IAI-based services in companies in various ways. First, it can serve as a basis for staffing internal development projects with the necessary people. Based on the role descriptions, suitable persons can be identified. In addition, they can be used to identify competence gaps from which personnel development measures can be derived.

The role model can also make an important contribution to the communication of expectations and tasks to the persons involved in development projects. The systematic preparation and presentation of activities and required components can improve transparency within the teams.

In addition, the representation of the required roles prevents necessary actors from being left out of the development process. Although not every role needs to be involved to the same extent for every project, a systematic selection helps to ensure systematic development and to make decisions transparent and traceable.

As our model is mainly based on the experiences of AI experts working in the manufacturing industry, we expect it to have high usability for practitioners. Furthermore, this role model can also be applied by human resource management and organizational development for an "AI-oriented personnel and resource management" (Ganz et al., 2021, p. 46). It should also be noted that, depending on the size of the development project, it may be useful to divide some of the defined roles into sub-roles. Moreover, it is possible to adapt the model to the company's internal requirements, for example by adding company-specific roles. However, a more detailed differentiation would have gone beyond the purpose addressed in this paper.

The results presented are subject to limitations and need to be further validated, because the generic role model was developed based on the expertise of AI experts from two companies from the automotive and manufacturing sectors. To validate our results, a larger number of companies with different types of AI-based services should be considered.

Validation should be conducted with the involvement of employees occupying one of the defined roles working in additional companies or other service development projects. In addition, the role model should be piloted in development projects and evaluated.

It also requires further research to analyze whether the role model is transferable to other industries, or the development of AI-based services manufacturers are providing to their customers.

6. References

Anke, J., Poeppelbuss, J., & Alt, R. (2020). It Takes More than Two to Tango: Identifying Roles and Patterns in Multi-Actor Smart Service Innovation. *Schmalenbach Business Review*, *72*(4), 599–634.

Ardolino, M., Rapaccini, M., Saccani, N., Gaiardelli, P., Crespi, G., & Ruggeri, C. (2018). The role of digital technologies for the service transformation of industrial companies. *International Journal of Production Research*, *56*(6), 2116–2132.

Baines, T., & W. Lightfoot, H. (2013). Servitization of the manufacturing firm. *International Journal of Operations & Production Management*, *34*(1), 2–35.

Böhmann, T., Leimeister, J. M., & Möslein, K. (2018). The New Fontiers of Service Systems Engineering. *Business & Information Systems Engineering*, *60*(5), 373–375.

Broy, M., & Kuhrmann, M. (2013). *Projektorganisation und Management im Software Engineering*. *Xpert.press*. Springer Berlin Heidelberg.

Bullinger, H.-J., Fähnrich, K.-P., & Meiren, T [Thomas] (2003). Service engineering—methodical development of new service products. *International Journal of Production Economics*, *85*(3), 275–287.

Crisan, A., Fiore-Gartland, B., & Tory, M. (2020). Passing the Data Baton: A Retrospective Analysis on Data Science Work and Workers. In *2020 Visualization in Data Science (VDS)*.

Deutsches Institut für Normung e.V. (2018). *91364:2018 Leitfaden für die Entwicklung neuer Dienstleistungen zur Elektromobilität.* Beuth Verlag GmbH.

Frank, M., Gausemeier, J., Hennig-Cardinal von Widdern, N., Koldewey, C., Menzefricke, J. S., & Reinhold, J. (2020). A reference process for the Smart Service business: development and practical implications. In Proceedings of the ISPIM connects. International Society for Professional Innovation Management (ISPIM).

Ganz, W., Friedrich, M., Hornung, T., Schneider, B., & Tombeil, A.-S. (2021). *Arbeiten mit Künstlicher Intelligenz: Fallbeispiele aus Produktion, Sacharbeit und Dienstleistungen*. Fraunhofer IAO.

Grote, E.-M., Pfeifer, S. A., Roltgen, D., Kuhn, A., & Dumitrescu, R. (2020). Towards Defining Role Models in Advanced Systems Engineering. In *2020 IEEE International Symposium on Systems Engineering (ISSE)* 1–7. IEEE.

Hesenius, M., Schwenzfeier, N., Meyer, O., Koop, W., & Gruhn, V. (2019). Towards a Software Engineering Process for Developing Data-Driven Applications. In *2019 IEEE/ACM 7th International Workshop on Realizing Artificial Intelligence Synergies in Software Engineering (RAISE)* (pp. 35–41). IEEE.

Hinz, O. (2017). *Segeln auf Sicht: Das Führungshandbuch für ungewisse Zeiten* (1. Auflage 2017). Springer Fachmedien Wiesbaden.

Hunke, F., & Schüritz, R. (2019). Smartere Produkte durch analysebasierte Dienstleistungen – Ein methodisches Werkzeug zur strukturierten Entwicklung. *HMD Praxis Der Wirtschaftsinformatik*, *56*(3), 514–529.

Johnston, R. (2008). Internal service – barriers, flows and assessment. *International Journal of Service Industry Management*, *19*(2), 210–231.

Kitsios, F., & Kamariotou, M. (2020). Mapping new service development: a review and synthesis of the literature. The Service Industries Journal, 40(9-10), 682–704. https://doi.org/10.1080/02642069.2018.1561876

Koldewey, C., Meyer, M., Stockbrügger, P., Dumitrescu, R., & Gausemeier, J. (2020). Framework and Functionality Patterns for Smart Service Innovation. *Procedia CIRP*, *91*, 851–857.

Kowalkowski, C., Gebauer, H., Kamp, B., & Parry, G. (2017). Servitization and deservitization: Overview, concepts, and definitions. *Industrial Marketing Management*, *60*, 4–10.

Kutz, J., Neuhüttler, J., Spilski, J., & Lachmann, T. (2022). Implementation of AI Technologies in manufacturing - success factors and challenges. In C. Leitner, W. Ganz, C. Bassano, & D. Satterfield (Eds.), AHFE International, The Human Side of Service Engineering. AHFE International. https://doi.org/10.54941/ahfe1002565

Lim, C., Kim, M.-J., Kim, K.-H., Kim, K.-J., & Maglio, P. P. (2018). Using data to advance service: managerial issues and theoretical implications from action research. *Journal of Service Theory and Practice*, *28*(1), 99–128.

Maier, G. *Rolle.* Springer Fachmedien Wiesbaden GmbH.

Marx, E., Pauli, T., Matzner, M., & Fielt, E. (2020). From Services to Smart Services: Can Service Engineering Methods get Smarter as well? In N. Gronau, M. Heine, K. Poustcchi, & H. Krasnova (Eds.), *WI2020 Zentrale Tracks* (pp. 1067–1083). GITO Verlag.

Meyer, K., & Zinke, C. (2018). Service Engineering – eine Standortbestimmung. In K. Meyer, S. Klingner, & C. Zinke (Eds.), *Service Engineering*. Pp. 3–17. Springer Fachmedien Wiesbaden.

Microsoft. (2020). *Team Data Science Process Documentation: What is the Team Data Science Process?*

Neuhüttler, J., Fischer, R., Ganz, W., & Urmetzer, F. (2020). Perceived Quality of Artificial Intelligence in Smart Service Systems: A Structured Approach. In M. Shepperd, F. et al. (Eds.), *Communications in Computer and Information Science. Quality of Information and Communications Technology* Vol. 1266, pp. 3–16). Springer International Publishing.

Neuhüttler, J, Ganz, W., & Spath, D. (2019). An Integrative Quality Framework for Developing Industrial Smart Services. *Service Science*, *11*(3), 157–171.

Neuhüttler, J, Kett, H., Frings, S., Falkner, J., Ganz, W., & Urmetzer, F. (2020). Artificial Intelligence as Driver for Business Model Innovation in Smart Service Systems. In J. Spohrer & C. Leitner (Eds.), *Advances in Intelligent Systems and Computing. Advances in the Human Side of Service Engineering* (Vol. 1208, pp. 212–219). Springer International Publishing.

Schymanietz, M., & Jonas, J. M. (2020). The Roles of Individual Actors in Data-driven Service Innovation – A Dynamic Capabilities Perspective to Explore its Microfoundations. In T. Bui (Ed.), Proceedings of the 53rd Annual Hawaii International Conference on System Sciences. Hawaii International Conference on System Sciences. https://doi.org/10.24251/HICSS.2020.142

Schuh, G., Gudergan, G., & Kampker, A. (2016). *Management industrieller Dienstleistungen*. *VDI-Buch*. Springer.

Schüller, A. M., & Steffen, A. T. (2021). *Die Orbit-Organisation: In 9 Schritten zum Unternehmensmodell für die digitale Zukunft* (3., aktualisierte Auflage). GABAL.

Tombeil, A.-S., Dukino, C., Zaiser, H., & Ganz, W. (2021). *KI-Ambition als Treiber für die Realisierung von Digitalisierung: Wann ist weniger mehr? Automatisierung und Unterstützung in der Sachbearbeitung mit Künstlicher Intelligenz: Vol. 8*. Fraunhofer Verlag.

Tombeil, A.-S., Kremer, D., Neuhüttler, J, Dukino, C., & Ganz, W. (2020). Potenziale von Künstlicher Intelligenz in der Dienstleistungsarbeit. In M. Bruhn & K. Hadwich (Eds.), *Automatisierung und Personalisierung von Dienstleistungen*. 135–154) Springer Fachmedien Wiesbaden.

Waidelich, L., Richter, A., Kölmel, B., & Bulander, R. (2018). Design thinking process model review. In *2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)*. Symposium conducted at the meeting of IEEE.

Witell, L., Gebauer, H., Jaakkola, E., Hammedi, W., Patricio, L., & Perks, H. (2017). A bricolage perspective on service innovation. Journal of Business Research, 79, 290–298. https://doi.org/10.1016/j.jbusres.2017.03.021