Introduction

The working world is currently in a state of upheaval. As a result, many intense debates are being held about the future of work, focusing on the opportunities and implications of new technologies, especially artificial intelligence (AI) (e.g., German government 2018, and Hirsch-Kreinsen and ten Hompel 2017). Thanks to these technologies, new development potentials are opening up for small and medium-sized manufacturing businesses in particular with regard to process innovations (intelligent monitoring, controlling and managing of processes, making them more flexible to lift Industry 4.0 to a new level) and/or product innovations or (service) business models (industrial products with digital services and AI applications, to augment innovative business models). (Federal Government 2018).

The “Industry 4.0” initiative aims to make the entire value-added chain more efficient by way of digitalized and automated or autonomous processing steps (Kagermann et al. 2013). The focus of the initiative is therefore primarily on digital process innovations and their implementation– even due to domain knowledge of production processes of manufacturing enterprises (Obermaier 2019).

Crucial for the competitiveness of small and medium-sized enterprises in global markets is that companies use AI to focus not only on efficiency and thus improving internal processes but also on the effectiveness, i.e., developing (service) business models and thus also considering customer benefits and new products.

In this context, more and more companies are recognizing the potentials of AI; however, they lack the knowledge of how to integrate it into their existing business. There are multiple compositions that praise the high potential of AI, but there have been few realisations that address how exactly companies should effectively and efficiently implement and manage AI in their business and thus also in potential (service) business models. One of the greatest challenge in the coming era of artificial intelligence is reflected in the correct implementation and management of AI, to establish a sustainable business.

Multinational companies have already integrated big data as one of the most important resources in their business models successfully. However, small and medium-sized manufacturing enterprises in particular require suitable concepts and support in the development of AI-based (service) business models. Their competitive advantages exist especially on the basis of their unique technological domain knowledge. However, due to their limited financial and staff/human resources, they seldom avail of further necessary knowledge domains to introduce and operate data- and AI-based (service) business models effectively and efficiently.

In order to systematically support the effective and efficient development of AI-based (service) business models for small and medium-sized enterprises, this article aims to develop a design framework for the implementation of AI-based (service) business models for small and medium-sized manufacturing enterprises.

Theoretical background

The term business model is the subject of various technical disciplines. Besides economics (e.g. in the scope of strategic management), the term business model is discussed predominantly in computer sciences (at the latest with the establishment of e-business) and increasingly in engineering sciences. The business model concept serves the abstract reproduction of companies' business logic. It is applicable to all businesses, regardless of their size or industrial sector and includes facts that are beyond company borders (e.g. suppliers, customers). A business model thus comprises various interdependent components, which vary depending on the model. Yet these models have something in common: they identify the creation of a new value proposition for customers, new revenue streams/value-added finances, new value-added architectures, and new value-added networks (Casadesus-Masanell and Zhu 2013; Andreini and Bettinelli 2017).

There are various concepts and models to develop innovative business models that are meant to provide support in the identification and implementation of new business logic, such as

- Business Model Generation (by Osterwalder and Pigneur 2010)
- St. Gallen Business Model Navigator (according to Gassmann et al. 2020)
- Approach for business model innovation (according to Schallmo 2013)
- Business model engineering (by Doleski 2014)
- Approach for business model innovation (according to Wirtz and Thomas 2014)
- business model engineering for Start-Ups (according to Kandolf 2016)

In practice, two approaches have prevailed – the business model development process developed by (Osterwalder and Pigneur 2010) and the St. Gallen Business Model Navigator developed by (Gassmann et al. 2020).

The Business Model Generation by (Osterwalder and Pigneur 2010) comprises five phases: Mobilise, Understand, Create, Implement and Execute, that are gone through partially in parallel or even iteratively. (Osterwalder and Pigneur 2010) The St. Gallen Business Model Generator differentiates four steps, namely Initiate, Find Idea, Integrate and Implement, which are likewise gone through iteratively (Gassmann et al. 2020). In the centre of this approach is

the “magical triangle” for describing a business model. It comprises the elements: WHO (target customers), WHAT (value proposition), HOW (value-added chain) and VALUE (earnings stream) (Gassmann et al. 2020).

In a digitalised economy, digital technologies, especially based on (big) data and information, are what are (meant) to indeed realise added value. AI technologies do enable the collection and analysis of big data volumes as well as the transformation into information afterwards, which serves as a basis for exploitable insights. Yet AI technologies are always developed by people (AI experts) and implemented for specific company contexts (with experts) and prepare data for information that requires people with the knowledge to be able to act on the basis of this information (service staff/users), especially in an industrial context. For such models to be able to work well, besides customer requirements, all existing, organisational, processual, staff- and work-related resources must be involved (BMBF 2019).

In this context, AI-based (service) business models are socio-technical systems and the result of the interaction between individuals or groups and systems based on their unique data, information and knowledge domains (North and Varvakis 2016). Besides (big) data and information flows, in order to develop and implement (service) business models, and to prevail in competition shaped by digitalisation, companies must thus integrate various knowledge domains beyond the limitations of traditional functional areas and IT-supported business processes (Koch and Windsperger 2017). Technological, organisational and staff knowledge domains are thus to be identified, networked, and created so that a contemplated value proposition or unique customer value is created (Hamel and Prahalad 1994; Teece 2009).

Various methods and tools can work as “enablers” to systematically structure and use data, information and knowledge domains and flows (Mertins & Seidel 2016 for the differentiation of data and knowledge) under a sociotechnical perspective (i.e. under due consideration of technological, organisational and staff design options) for developing AI-based (service) business models.

Such knowledge management must serve in a digital and, at the same time, agile and volatile environment as dynamic and stabilising force (North and Maier 2018). On the one hand, knowledge management must support the development of (dynamic) resources and capabilities of organisations to reconfigure, realign and integrate core competences with the aid of external resources and abilities. On the other hand, knowledge management as a stabiliser, must make the right knowledge available in the right place at the right time to support the employees of an organisation as well as the relevant stakeholders in the organisation’s environment in day-to-day business. (North and Maier 2018).

There are various digital tools and technologies to create such a balance and to enable a knowledge-based value creation (see Figure 1). These can be differentiated in relation to both their support on a technological, organisational/work-related level and/or staff-rleated level as well in relation to the object of creation regarding data, information and knowledge domains and flows.

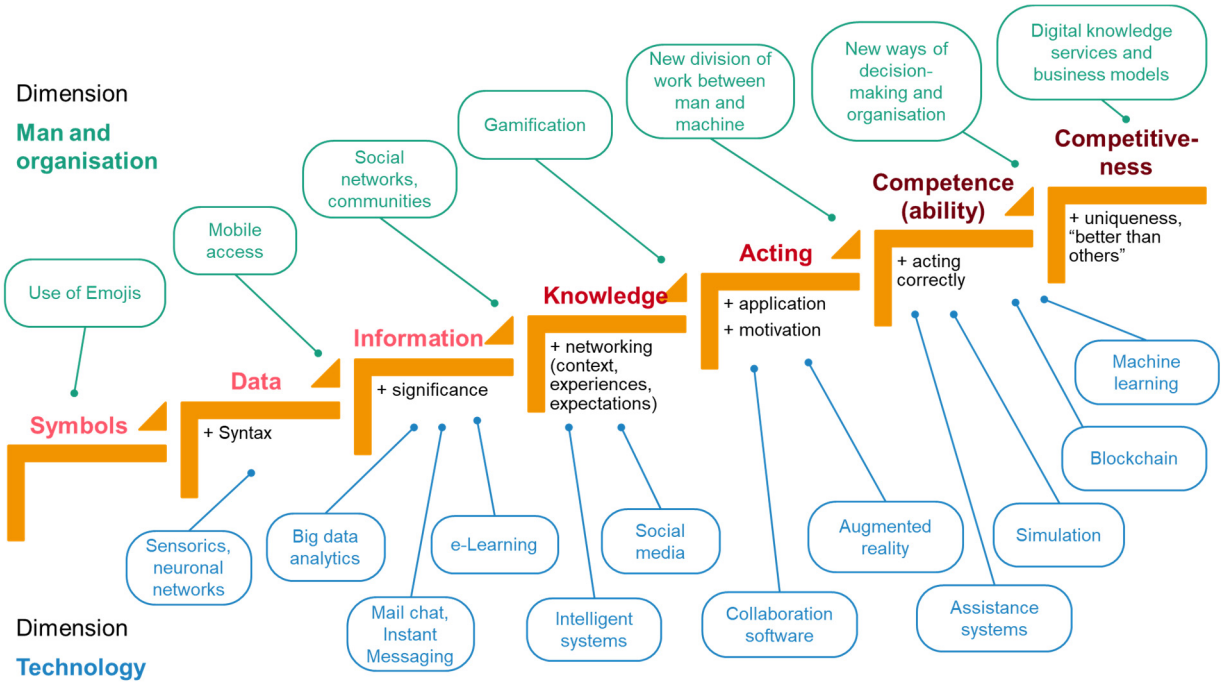

Figure 1: Examples of digital methods and tools for structuring (data, information &) knowledge (North and Maier 2018)

Creating the design framework

Artificial intelligence is attributed the potential of fundamentally changing entire markets, sectors and general business activities (Pfau and Rimpp, 2021). The combination of innovative technologies (with the) appropriate (corresponding) evaluation logic, business model innovations can be created for new customer-oriented solutions (Nagele 2016). The innovation of data-driven (service) business models can influence various business elements and is associated with various challenges. While multinational enterprises are already constantly storing and processing using data in order to accelerate increases in efficiency and intensify unique selling points, many SMEs still lack the domain and method knowledge to generate tangible value for customers. Especially for small and medium-sized companies , it is highly important to network heterogenous knowledge domains in order to develop AI-based (service) business models.

In order to effectively strengthen and promote the innovation potential of SMEs, a process of the competence of the actors involved must be present. A design framework can help to create the possibility of providing starting points for the respective actors in the SME. In all relevant

questions about the identification, design and implementation of a new business logic and contribution with socio-technical knowledge and competencies for the development of new value propositions for customers, new earning/income streams/value creation finances, new value-added architectures and value-added networks. In practice, especially for SME's, questions seem to be in the foreground, in the field of/ in the area of

- The value proposition for customers in identifying relevant AI areas of application as well as data quality (sensorics amongst other things) and data security,
- New earnings streams/value-added finances to determine user-based customers' readiness to pay,
- New value-added architectures regarding the acceptance as well as necessary qualification (digital competences) of the staff, and
- New value-added networks in determining an active or passive use of AI technologies.

Summarising the challenges and insights a development model for the implementation of AI-based (service) business models for SME's can be summarized. (see Figure 2)

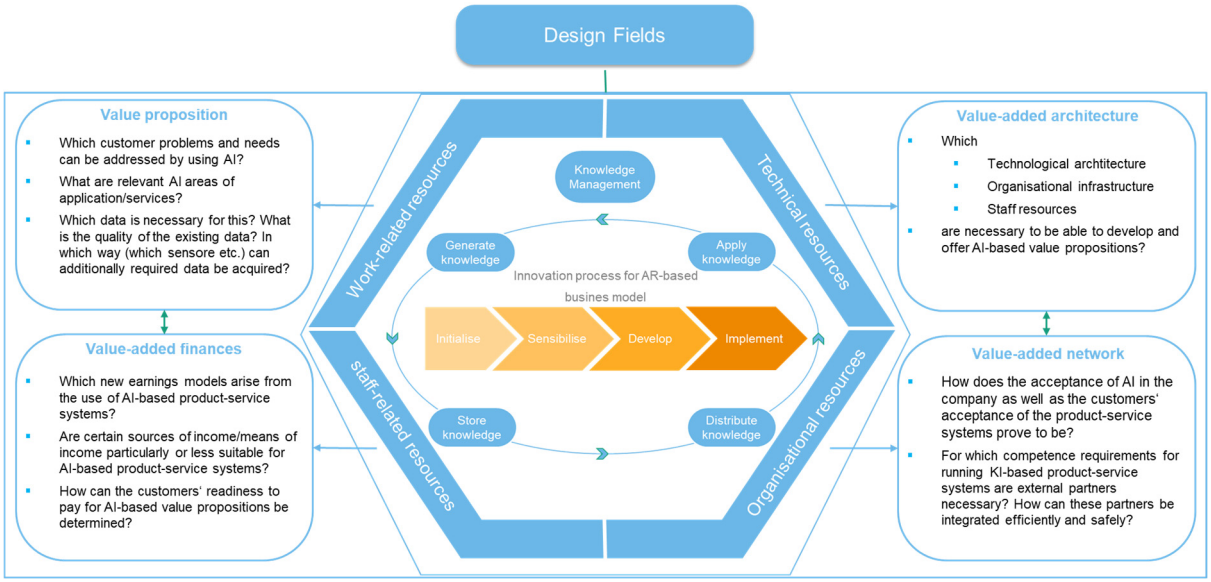

Figure 2: Design model for the implementation of AI-based (service) business models for SMEs

If the operationalization of this design framework succeeds as a support system suitable for the actors, the effectiveness, i.e. the development of (service) business models for SMEs and the benefit for the customer will be into focus.

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