NordDesign 2022
August 16-19, 2022
Kgs. Lyngby, Denmark

Dashboard-supported approach for feasibility and benefit analysis of Product-Service System-driven business models

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Abstract

Once a company decides to become a Product-Service System (PSS) provider, this inevitably means that the company's business model needs to be transformed. The development of a PSS is thus closely linked to the development of the business model. This transformation is a complex and challenging process, espacially for small and medium-sized entprises (SME). Although these types of companies make up the largest number, they are reluctant to adopt PSS and PSS-driven business models. Especially in SME, this transformation process affects the whole organisaton. A systematic literature review has shown that there is little methodological support in this area, yet. To mitigate the resulting risks and support those responsible for this transformation process, this paper presents a multi-criteria feasibility and benefit analysis for PSS and the resulting business models. Based on initial PSS concepts and business model drafts, the presented approach allows a systematic analysis of the technical and organisational feasibility, the marketability and the monetary and non-monetary benefits of the PSS-driven business model and guides the user trough the whole process of the feasibilty and benefit analysis. The approach was prototypically tested within the scope of a research project in cooperation with a SME.

Keywords: product-service systems (PSS), decision making, uncertainty, feasibility analysis

1 Introduction

The advancement of the 4th industrial revolution offers companies new opportunities for value creation through the development and marketing of downstream services (Kagermann et al., 2013). One of these new forms of value creation is hybrid value creation also known as value creation with Product-Service Systems (PSS). Based on the comparison of common definitions

given in Baines et al. (2007), PSS can be summarised as follows: PSS enable innovative business models that consist of a system of products, services, supporting networks and necessary infrastructure and serve the purpose of increasing competitiveness, better satisfying customer needs and/or reducing environmental impacts compared to traditional offerings.
Adoption of the PSS concept is already taking place in industry (Bahrke & Kempermann, 2015), but mainly in larger companies (Biege et al., 2013).To evolve into a PSS provider, however, it is not enough to just develop a PSS technically. It also means innovating the business model to enable a company to deliver the PSS in an effective and efficient way. Many companies, especially SMEs, have not yet embarked on the path of business model innovation, although this can lead to more sustainable success compared to product innovation (Lindgardt et al., 2013). The transformation into a PSS provider needs, besides PSS development processes, a comprehensive business model innovation process which offers the opportunities mentioned before, but at the same time also requires financial, time and human resources, since these are more limited in SMEs (Lins et al., 2021).
Because the transformation process towards a PSS provider involves many risks, PSS-driven business model innovation projects need support to keep these risks low (Moro et al., 2020). This contribution focuses on the early phase in which the first PSS concepts are available and the decision is pending as to which of the concepts should be pursued further. To support the decision-making process, a multi-criteria feasibility review tailored to PSS is proposed as a solution approach. However, the current literature offers little practical support in this area and especially in the context of PSS development in SMEs. Therefore, this paper describes and tests an approach to answer the following research question:

How can a feasibility study in the context of PSS-driven business model innovation in SMEs be systematically supported?

To answer the question this contribution first introduces the theoretical background of feasibility analysis. Then, the developed approach for feasibility analysis is presented, tested and critically reflected based on a use case. Finally, an outlook on further fields of application and development possibilities for the presented approach is given.

2 Theoretical background and literature review

2.1 Feasibility analysis

Feasibility analysis is an important part of project management to ensure the success of a project (DIN, 2009). It is also referred to in the context of technical development projects or business model innovation (Felkai & Beiderwieden, 2015; Wirtz & Thomas, 2014). Depending on the literature, analysing feasibility involves the investigation of different dimensions of feasibility. (Arvanitis & Estevez, 2018; Felkai & Beiderwieden, 2015; Kuster et al., 2019; Wirtz & Thomas, 2014). According to Arvanitis and Estevez (2018) these dimensions include, for example, technical feasibility, economic feasibility, legal feasibility and organisational feasibility. Within the technical feasibility, it is checked whether the necessary technological elements required for the successful implementation of the project are available and functional. The economic feasibility study examines whether the offer to be developed is cost-efficient and desired by the market. Within legal feasibility, it must be examined whether the offer violates laws or whether there are legal framework conditions that restrict the offer. The organisational feasibility checks whether the current organisational structure of the company is suitable to provide the new offer.

However, besides these dimensions, the mentioned literature only helps through rough guiding questions to be answered in the feasibility study (cf. Arvanitis & Estevez, 2018; Felkai & Beiderwieden, 2015; Kuster et al., 2019; Wirtz & Thomas, 2014).

2.2 Literature review on feasibility analysis in the context of PSS

To identify existing approaches for analysing the feasibility of PSS-driven business models a systematic literature review based on the PRISMA-statement method (Lame, 2019; Moher et al., 2015) was carried out. The databases "Web of Science", "EBSCOhost", "IEEE" and "TEMA" were used with search phrases combined of relevant search strings such as "business model", "business case", "Geschäftsmodell", "produ?t service syste*", "produ?t service", "PSS", "feasibility", "viability", "Feasibility analysis", "Machbarkeit". The search yielded 1300 hits and 1083 were left after duplicates were removed. Publications with inappropriate titles were then removed, after which the abstracts were read and titles with inappropriate abstracts were excluded. Finally, 13 full texts were read, and 7 publications were found whose contents fit the topic of feasibility analysis. Criteria for the removal of records were language, only English or German publications were considered, and the context of the publications, only publications dealing with feasibility studies in the development of PSS were considered. The procedure is shown in Figure 1.

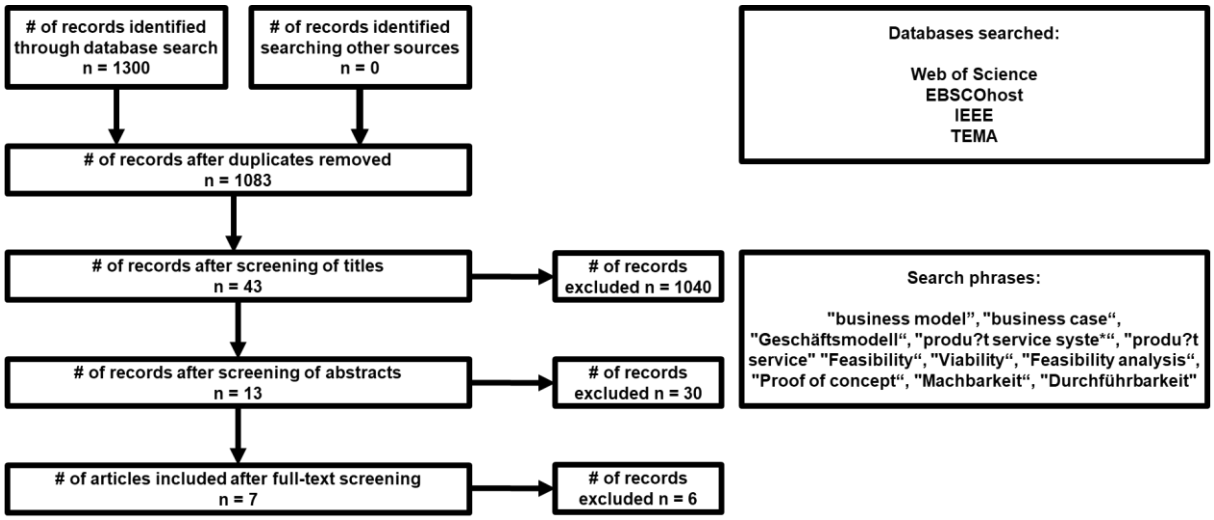

Figure 1. PRISMA statement of literature review

Van Ostaeyen et al. (2013) analyse the economic feasibility of a PSS business model using a Monte Carlo simulation as well as different scenarios and compare the results with the current business model. Frost et al. (2020) combine different methods such as prototyping, PESTEL, system dynamics, decision trees, life cycle assessment and techno-economic assessment to test the feasibility of different circular business models. D'Souza et al. (2015) present a business model design framework for viability that combines different business model ontologies, design principles and evaluation criteria for business model design. Feng and Hong-dan (2010) use the e^3-value model to test the feasibility of e-business models in a network context. Guyandi et al. (2017) check the feasibility of a bike sharing business model by using Business Model Canvas, prototyping, user surveys and SWOT analysis. Zsifkovits et al. (2016) use System Dynamics to simulate a sustainable business model to test its feasibility. Kim et al. (2007) present a

business model feasibility analysis framework for ubiquitous technology environments that examines the feasibility of business models in the areas of technology, strategy and market.
All seven publications describe different approaches to analysing the feasibility of new business models, but only one has a clear link to PSS. However, each approach only analyses parts of a business model. From a scientific point of view, all the approaches mentioned appear to be interesting and helpful, but it is doubtful whether these approaches can be used in an SME context without further ado. Together with the companies involved in the research project, the following requirements for a solution approach were defined:

- The approach has to be applicable with limited time, financial and human resources.
- The approach has to have a well-structured and easily understandable procedure with clear decision criteria.

As these criteria were only insufficiently fulfilled, the need arose to develop a suitable tool for the feasibility analysis of PSS concepts.

3 Feasibility & benefit analysis for PSS-driven business model concepts

To meet the above requirements for a feasibility analysis of PSS concepts and the resulting business models, the required analysis dimensions including possible tools were identified, a process was defined and a dashboard was designed to support the process and decision-making.

3.1 Elements of a feasibility analysis for PSS

Table 1. Selected tools for feasibility analysis (excerpt)

	Prototype test	SWOT	Expert advice	FMEA	Trends / competition	PESTEL	TRL	Stakeholder analysis	Lead User	Conjoint analysis	Customer survey	Capacity analysis	Activity structure	Value stream	Employee survey
Technical feasiblity	X	X	X	X	X	(X)	X								
Marketability	X	X	X		X	(X)	(X)	X	X	X	X				
Organisational feasibility	X	X	X	X		X		X	(X)			X	X	X	X
Monetary benefit										(X)		(X)	(X)	(X)	
Non-monetary benefit			X			X			X		(X)		X	(X)	(X)

X = applicable; (X) = partly applicable

As there is no consensus in the literature on the elements of a feasibility analysis in general and especially in the context of PSS, these need to be defined first. Therefore, six risk dimensions of the transformation into a PSS-driven business model were initially identified in the course of the project (technical, economic, political, legal, organizational and resource-related risks). In an iterative development process theses six risk dimensions were transformed into four elements of the feasibility analysis: technical and organizational feasibility, marketability and

benefit. Last one again is subdivided into monetary and non-monetary benefit. *Technical feasibility* describes whether the know-how to implement the technologies and processes for the technical implementation of the PSS is available in the company. This includes also the interoperability between product and service components. *Marketability* analyzes whether the value proposition of the PSS is desired by the customer, meets customer demands and can be legally marketed, i.e., compliance with regard to laws, patents, licenses, trademark law, data protection and contracts is given. Furthermore, willingness to pay for the PSS and its fit to current socio-political conditions are checked. *Organizational feasibility* analysis availability and capability of human, financial, time and technical resources as well as the current organizational, process and partner structure needed to provide the PSS. Furthermore, internal political influences are taken into account, e.g., business model strategy fit or employee acceptance of the new business model. *Monetary benefit* checks the economic feasibility of the PSS-driven business model by analyzing the expected cost in comparison to the expected revenue scenarios. *Non-monetary benefits* are an essential aspect of every PSS business model, but these are individual and differ from PSS to PSS and from company to company. Non-monetary benefits describe all benefits that are not of a monetary nature, e.g., improved customer loyalty or customer satisfaction, greater transparency in processes.
To perform a feasibility analysis in the described categories supportive tools are needed. During the development and testing of the approach several tools showed to be helpful. These are listed and assigned to the appropriate feasibility element in Table 1 by the authors. In addition, section 3.4 explains a method for evaluating the monetary and non-monetary benefits.

3.2 Procedure

This section describes how to perform a feasibility analysis for PSS-driven business model concepts. It is proposed that this task will be carried out by an interdisciplinary development team in several workshops. The specific detailed analyses should take place outside these workshops.
To start the process each a description of the current and the new business model is needed. In the following it is always referred to Business Model Canvas (Osterwalder et al., 2010), because its nine building blocks describe the relevant categories for PSS business models. In the first step, the current Business Model Canvas (BMC) is compared to that of the target business model. Because, the current BMC is assumed to be feasible, only the differences, changes or new elements of the target state compared to the baseline state need to be considered for the feasibility analysis. These deviations are highlighted and assigned to the respective feasibility element. Possible mappings based on the building blocks of the BMC are shown in Table 2.
For example, new key resources such as new hardware (machines, equipment, etc.), software or infrastructure can be assigned to the technical feasibility area, as various aspects need to be checked, e.g., the availability or technical ability of appropriate resources or the manufacturability of a PSS component. In addition, or alternatively, they could be assigned to the area of organizational feasibility, since it must be checked whether the resources can be financed or whether there are suitable partners to supply them. So, there is a variety of possible assignments for the upper building blocks of the BMC (Key Partners, Key Activities, Key Resources, Value Proposition, Channels, Customer Relationships, Customer Segments).
Based on this mapping, the project team determines which detailed analyses are necessary and documents them in the dashboard (see Figure 2). To support this, there is a list of topics within the dashboard, which, however, must always be individualized and supplemented. After the identification of relevant criteria to be checked for feasibility, the following steps shall be carried out:

1. Mark all elements in the dashboard with a blue rating (not checked & unknown).

2. Perform the feasibility check for the selected elements using appropriate tools from the tool kit (Table 1). Start with the most critical elements.
3. Transfer the results into the dashboard using the appropriate traffic light.
4. Repeat steps 2 and 3 if needed
5. Execute the monetary and non-monetary benefit evaluation.

After all the assessments have been completed, the result is displayed in the dashboard. The well-known traffic light logic serves as an indicator for the implementation risk: If all elements light green, the implementation of the new business model is assumed to be feasible at a low risk and should deliver a financial benefit for the company. If yellow lights are visible, the implementation of the new business model is assumed to be more medium risky. Not all evidence could be provided to full satisfaction or there are too many assumptions or ambiguities. In this case, it is advisable either to conduct the review in greater depth or to revise the target state in an iteration loop on the basis of the insights gained and then initiate a new review. In case of a red light, the implementation of the new business model is associated with a high risk. Therefore, in this case, the target state should be revised and a new review initiated or the concept should be discarded.

Table 2. Mapping BMC to feasibility categories

	BMC building blocks								
	Key Partners	**Key Activites**	**Value Proposition**	**Customer Relationships**	**Customer Segments**	**Key Resources**	**Channels**	**Cost Structure**	**Revenue Stream**
technical feasibility	X	X				X	X		
organizational feasibility	X	X		X	X	X			
marketability	X		X	X	X		X		
benefit							X	X	X

3.3 Dashboard

It is advantageous to support early phases of the development process of PSS with tools that enable intuitive visualization or real-time decision support (Kuhlenkötter et al., 2017). Therefore, the dashboard represents a solution approach. It fulfils three main functions: first, it provides an overview of the aspects that need to be analysed. Second, it documents the results and the reliability of the assessment. Thus, third, it is a decision support tool that illustrates the remaining implementation risk with the help of traffic lights. In its presentation (see Figure 2) it is divided into two sections to illustrate the feasibility (top) and the benefit analysis (bottom). The feasibility analysis section is subdivided into three parts each representing one sub-analysis: technical feasibility, marketability and organisational feasibility. Whereas the benefit analysis section consists of two parts: assessment of non-monetary benefits and monetary benefits.

The dashboard is designed in such a way that each assessment category receives appropriate assessment criteria for the PSS development use case. These can be selected from a list of

criteria appropriate for the particular use case. Each evaluation criterion has its own status display based on the logic of a traffic light (see Table 3). Likewise, the entire rating area has its own traffic light. This shows a red light if at least one partial evaluation is marked red and a yellow light if no red but at least one yellow light is set.

Table 3. Traffic light criteria

	Feasibility	**Benefit**
Red	verified & not feasible or verified & not yet assessable/needs to be developed	no or negative non-monetary benefit & negative monetary benefit
Yellow	assessed as feasible or reviewed & only feasible with great effort	positive non-monetary benefit & no/negative monetary benefit
Green	verified & feasible	positive monetary benefit & positive non-monetary benefit
Blue	not verified & unknown	not verified & unknown

3.4 Benefit assessment

The benefit assessment is based on the findings of the previously conducted analyses and is split into two parts: The non-quantifiable benefit and quantifiable benefit (Burianek et al., 2008). In the dashboard, the non-monetary and monetary benefits are considered.
If a company decides to offer a new service bundle, it can first be estimated for whom a non-monetary benefit will arise. Based on the marketing triangle (Kleinaltenkamp & Saab, 2021), a benefit can arise either for the offering enterprise itself or for the customer by using the PSS. Furthermore, competitive advantages can result for the company. In addition to considering advantages on the provider side and the customer side, the competitive perspective can also be taken into account. It is possible that the new PSS offering could create a competitive advantage because it makes the overall offering unique on the current or future market (Diehl et al., 2009).
In the monetary view, it is assessed whether the offering is economically profitable. For this purpose, the implementation costs and the costs for ongoing operation are estimated. This is contrasted with the estimation of one-time revenues, ongoing revenues and cost savings. With the help of the estimated values for cost and revenues, a return-on-investment calculation can be carried out.
Ultimately, the decision of the benefit lies with the management. Even if the result of the monetary benefit is negative, the company may see a point in introducing the product anyway due to its non-monetary benefit, e.g., because it expects a unique selling proposition on the market and thus competitive advantages.

4 Use Case

The presented tool was tested in the context of a state-funded joint research project with the aim of enabling SMEs to provide product service systems.

4.1 Case Company

The project partner with whom the approach was tested is a SME which offers the anodizing of aluminium components to regional customers. In recent years, the company experienced more and more problems in the anodizing business. One problem is that the value contribution of anodizing to the total value of a component in the value chain is very low, while the value of

the components is increasing. This means an ever-increasing risk for the company if, for example, components are damaged in the anodizing process. Furthermore, the components are becoming more and more complex, making the anodizing process more complex and expensive, while customers do not want to pay higher prices for it. In addition, the company does not have the necessary negotiation power to enforce higher prices. As a result, the company wants to find new ways to create value for its customers and grow its own offering range to support its core offering.
As part of the project, various ideas for new PSS offerings were developed together with the company and the decision was finally made to implement a concept whose prospects for success were rated the best. For the selected idea, a detailed concept and a target state in the form of a Business Model Canvas were developed using various methods. The concept for the new PSS offering is based on the introduction of new ERP software to support all company processes. With the new software, a customer portal will be set up that will allow customers to track orders and view their status. In addition, customers can use this portal to convert orders that have already been placed into rush orders for a fee, so that the lead time for the processing of the goods in the case company can be greatly reduced. To ensure that the concept is feasible and beneficial, the developed approach described in section 3 was used.

4.2 Application of the approach

To assess the feasibility, first the target state business model was elaborated and the main differences between the old and the new business model were analysed. In addition to the expanded value proposition and the associated new revenue streams, significant changes arose in the following building blocks:

- Key partners, as the existing value network must be expanded to include comprehensive IT partners.
- Key resources, as this solution is only possible in combination with an improved production planning and control software.
- Cost structure, as a special software solution is necessary to enable the service
- Customer relationships, as the company expects improved customer service and greater transparency from the new solution.
- Channels, as the order portal adds a new channel for the customer.
- Customer segments, as the new service opens up a customer segment with a need for fast deliveries.

Based on these changes, the developers then assessed how feasibility can be estimated with regard to the dimensions of technical and organisational feasibility, marketability and monetary as well as non-monetary benefits. In terms of technical feasibility, it was generally assumed that there are already similar solutions on the market, but that these do not necessarily fit the industry. For this reason, the target process was first detailed and validated using FMEA. On the basis of these results, it was possible to create a specification sheet, which was used to conduct concrete discussions with implementation experts to assess whether and with what technical risk the concept could be technically implemented. The integration into the new production planning and control system was seen as a sticking point. However, one of the IT companies approached was confident that it could be implemented. In the area of marketability, the acceptance and willingness to pay of the target customers was seen as critical. For this reason, a first prototype of the order portal with its core functions was created as a digital mock-up and tested with various customers in the sense of the lead user method. In these customer meetings, the solution received positive feedback. Several possibilities for improvement were identified. On the organisational side, resistance was initially expected in the order processing

department, which is why the PSS concept was then presented to the stakeholders and their feedback as well as ideas for improvement were solicited.
Based on the previous findings, customer feedback and initial estimates of the expected costs and service revenues, a first assessment of the monetary benefits could be made. It turned out to be acceptable under the assumptions made. In parallel, it was also possible to identify aspects that indicate the existence of a non-monetary benefit. Consequently, there was no longer a red light in the dashboard, which is why the management decided to go ahead with the implementation of the product service system based on this feasibility analysis.

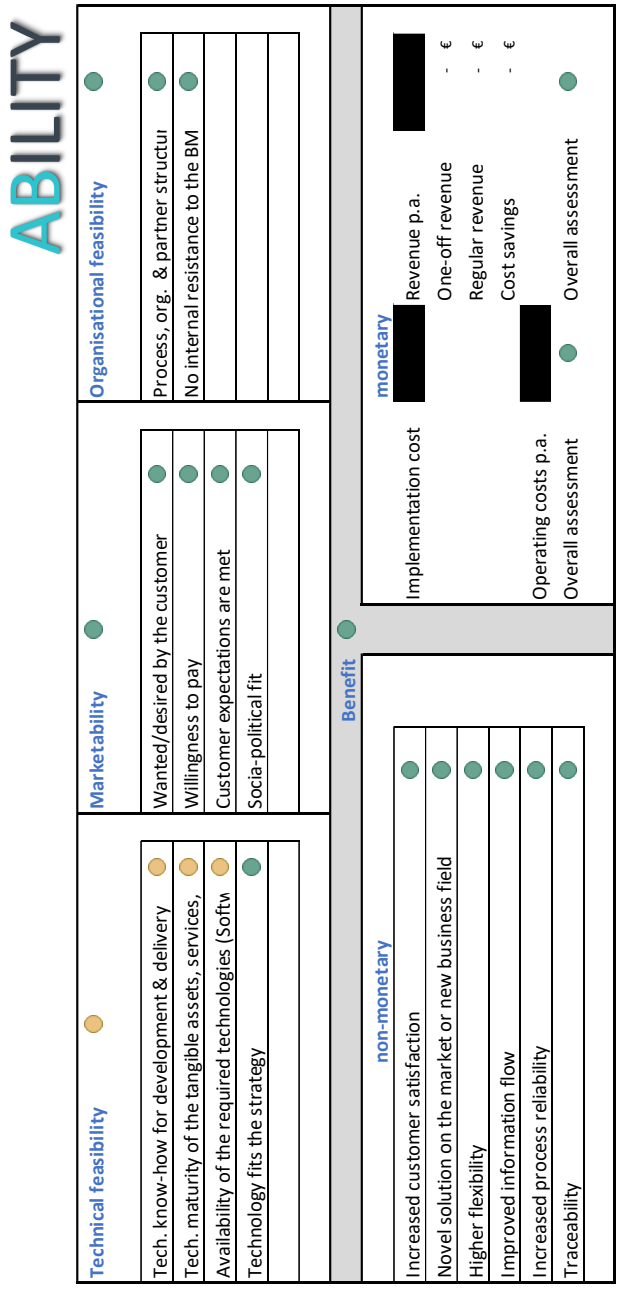

Figure 2. Feasibility dashboard (example)

5 Conclusion & Outlook

This contribution introduces an approach to perform a feasibility analysis during the conceptualisation of a PSS-driven business model. It integrates the technical and organisational perspective with economic aspects such as marketability, monetary and non-monetary benefits. Thus, it supports the multidimensional decision-making process in the complex context of PSS development. The approach was tested in a case study at a SME and there proved to be a helpful tool. Consequently, this contribution helps to fill the gap identified in the literature review in the field of feasibility analysis, especially in the context of PSS.
However, the approach presented in this publication has so far only been tested in the context of the state-funded research project. Therefore, further tests are needed to collect more experiences in other scenarios, to validate and to improve the approach. Moreover, it is planned to extend the approach with a flexible simulation scenario using System Dynamics in order to obtain more precise assessment results and to analyse potential interdependencies. In addition, the approach described was developed in a funded project in the context of digitization and SMEs and without a direct focus on sustainability issues. Due to the major ecological challenges the world is facing, it also makes sense to transfer the approach to the context of circular business models based on PSS. For this reason, the approach presented here will be further developed and supplemented by a sustainability dimension to address these challenges.
In conclusion, no method can cover all risks or make them visible. There will always remain a residual risk, which can at least be reduced by an interdisciplinary composition of the development team and a systematic methodological approach. Aspects such as customer or price acceptance, however, remain verifiable only to a limited extent.

Acknowledgement

The project ABILITY is financed with funding provided by the German Federal Ministry of Education and Research and the European Social Fund under the "Future of work" programme (FKZ 02L17B020 - 02L17B026).

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