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Essential Areas of Action for the Smartification of Traditional Products and Services Considering the Capabilities of SMEs

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ABSTRACT

One way for small and medium sized (SMEs) enterprises developing traditional physical products to follow the digital transformation is to smartify their products and develop smart services according to business or customer needs. The process to set up a smartification strategy for the first time covers many different organizational, human, technical and business process related aspects. With our research we provide a decision framework to support CEOs in identifying, which areas of action should be focused upon and enterprise-specifically further developed for the smartification of selected products. This paper derives the areas of action, which build the base for the decision framework's underlying capability and maturity model.

Keywords: Smartification, Smart product, Smart service, Strategic decision making, Capability, Maturity, Resilience, Digital transformation

INTRODUCTION AND CHALLENGES

Digital transformation, nowadays, is a very broad subject and surely discussed in each small and medium sized (SMEs) enterprise developing and possibly manufacturing traditional physical products. Their relevant success and competitive factors – like cost efficiency and effectiveness through process optimization, adaption to the market through reaction to customer needs, as well as having skilled and motivated employees (Schmidt and Tritschler 2021) – do not really differ from those of large companies. Nevertheless, the ability to participate in the digital transformation may be very different due to aspects like company budget, length of the decision paths and the fact that SMEs often are stronger niche experts with only little competences in complementary areas of expertise such as digitalization (Lindner and Leyh 2019). Especially this last characteristic and the high potential for improving the internal process to plan and build smart products makes the research on SMEs developing and selling a traditional physical product lacking smart attributes like data processing in the Cloud, automation, autonomy, self-learning, or the like, very interesting.

Usually, the SME's ultimate aim is to develop and sell competitive products. But over time every product looses its competitiveness (Engeln 2020). The

SME could create more value and make the product physically "smart(er)" thus being able to add a more attractive, as well as more viable product. By doing so, it could add smart services to the company's offer (Porter and Heppelmann 2014).

However, the question, which digitalization path is the most promising and should be taken, can keep the SME in a state of "smart product paralysis" (sirris 2021). One of the reasons is the uncertainty by the SME's top management about the strategic digitalization decisions in general before going into detail about the smart product and service design and implementation. Therefore, preparation for digitalization turns out difficult and lengthy in the jungle of a great variety of different options.

Those options are not only comprised of purely technical aspects of digital transformation. More than that, many aspects on different levels of the SME need to be taken into account. This covers vision/mission development, strategy/goals development, change/innovation management, needs-definition, cost-benefit analysis, requirements-definition, smart product/smart service (re)design, data management/ architecture, business model, IT-architecture/system-landscape, IT-security and legal aspects, to name the most important ones (see the references in the next chapter).

To help SMEs out of this smart product paralysis state, our research work proposes an approach, which covers the early strategic planning phases of smartifying a traditional physical product, including delivering a product-service-offer and not just to transform a product. In previous work (Frings and Kett 2021) we outlined the methodical framework for this approach. In this paper, we cover the essential areas of action as base for the underlying capability and maturity model.

METHODICAL APPROACH AND RELATED WORK

Crucial competencies of a CEO are being a visionary and having the ability to think competitively, to translate customer's need and make appropriate decisions (Barton et al. 2018). These factors are essential in constantly searching for new ways to keep or make the SME more successful especially during digital transformation. Generally, once a vision is stated, the logical next steps would be to define goals, to detail the vision, to prepare a strategy, how to reach the defined goals and then to plan activities within this strategy to be able to help the vision come to life (Timinger and Seel 2018). But since the topic of smartification may be very new for the CEO, the exact strategy and the associated tasks are not yet clear in detail.

Starting with our methodical framework (Frings and Kett 2021) and existing maturity models, as well as systematic literature reviews on those models (Software Engineering Institute 2010; Becker et al. 2019; Röglinger et al. 2012; Berger et al. 2020; de Bruin and Rosemann 2005; Dymond 2002; Frings and Kett 2021; Gollhardt et al; Achi et al. 2016; Adrodegari and Saccani 2020; Angreani et al. 2020; Katuu 2021; Ochoa-Urrego and Peña-Reyes 2021; Sadiq et al. 2021; Santos-Neto and Costa 2019; Schallmo et al. 2021; Williams and Lang 2019), we dove deeper into the necessary subject areas from the strategic viewpoint of a CEO leading a SME, which

develops traditional physical products like for example a walker for people having walking disability. Based on our literature reviews and the experience we already have on the smartification topic, we identified the following six necessary steps the SME's CEO needs to go through to be able to make appropriate strategic decisions: 1) Determination of the strategic importance of smartification; 2) definition of relevant use case(s) for the smart product and product-specific smart service-bundles; 3) identification of characteristics for the future smart product and identification of relevant smart services; 4) rough determination of available capabilities for the smartification; 5) rough comparison of target and current capabilities; 6) rough estimation of cost and benefit through smartification. These steps could be combined with methods like the Business Canvas Model (Osterwalder and Pigneur 2010) or other business model analysis methods to cover the topics defined there within and to get a broader view. In our research we focus on very specific smartification questions, which will be further detailed in future publications.

Our hypothesis is, that once theses steps are taken, the CEOs have a better understanding of, which challenges are waiting for them as well as, which benefits they will profit from. Our literature review's result is that none of the publicly available solutions, approaches, or scientific work covers all these necessary steps within one framework for the smartification of traditional products. Therefore, we decided to pick relevant areas of action from divers existing models, concepts and approaches (see the most relevant literature references in Table 1) and structured our framework and the underlying maturity and capability model accordingly.

AREAS OF ACTION FOR SMARTIFICATION

Within our framework, the underlying capability and maturity model covers all relevant areas of action for smartification. As described above, there could be different goals within a vision. For this paper, we use the vision "Smartification of a traditional physical product" and the associated concrete goal "Functional expansion of an existing well established traditional, physical product with intelligent components and services (new smart product-service offers)".

To make it more plausible, we selected the following realistic example: A traditional, non-smart walker is to be made smart for people having full control of their vision and being mentally healthy, but lacking confidence in walking without aid. Previous work (Merlet 2010; Wachaja et al. 2017; Alves et al. 2018; Aristizabal-Aristizabal et al. 2022) focusses on unhealthy elderly having different impairments, which calls for other functions to be provided by a smart walker. Our example fulfills the vision and goal stated above. For a minimal functional expansion, a simple GPS tracker and an emergency button would be sufficient to fulfill a subgoal of being able to track the person using the smart walker in case the emergency button is pushed. For an extensive functional expansion, the following possibilities are realistic: Addition of information sources like weather and radio, medically relevant functions like heart rate or blood pressure monitoring, further emergency

Table 1. Areas of action.

Area of action	Relevant questions and references
Strategy	What is the maturity of relevant strategies (e.g. enterprise/digitalization/ IoT/data/smartification strategy)? Which strategic drivers influence the smartification vision and thus strategy the most (e.g. product/services drivers, technical drivers (e.g. artificial intelligence, data processing, process automation), market drivers, customer drivers)? (Henderson 1989; Software Engineering Institute 2010; Koldewey et al. 2019b; Pierenkemper and Gausemeier 2021; Yu 2021; Gausemeier and Plass 2014)
Smart Service	On which feature related characteristics (e.g. monitoring, control, optimization, prediction, automation, autonomy, criticality/product as a safety device) and, which context related characteristics (e.g. data processing, communication, mobility, data security, sustainability, location) should the focus of the new services be put? (Porter and Heppelmann 2014; Westermann 2017; Strobel et al. 2019; Britze and et al 2020; Falkner 2020; Winkler 2020; Neuhüttler et al. 2020; Frank et al. 2020; Kett et al. 2021; Freitag and Wiesner 2018; Grohmann et al. 2021))
Smart Product	Which device related characteristics (e.g. sensors, actuators, communication, connectivity, scalability, data storage, security, information sources, integrated business systems, human computer interaction) are relevant within the planned smart services and where should the focus be put? (Porter and Heppelmann 2014; Porter and Heppelmann 2015; Westermann 2017; Strobel et al. 2019; Britze and et al 2020; Falkner 2020; Winkler 2020; Neuhüttler et al. 2020; Frank et al. 2020; Kett et al. 2021)
Stakeholder	Which stakeholders with respect to the new smart services and smartified product are mostly relevant to which degree and why? (e.g. customer, dealer, development partners, supplier, ecosystem participants) (Gausemeier and Plass 2014; Falkner 2020; Neuhüttler et al. 2020; Frings et al. 2021)
Data	Which key data-related issues are needed to be able to deliver the intended smart services (e.g. data acquisition/collection/generation, data analysis, data aggregation, data integration, data transmission, data storage, data security, data sources, data architecture, data quality)? (Software Engineering Institute 2010; Porter and Heppelmann 2014; Bernerstätter 2020; Kutzias et al. 2019)
Business model	What is relevant regarding the new/adapted business model (e.g. product as a service, shared usage model, product driven, system solution driven, service driven, value driven, data driven, stakeholder driven); which business model pattern may be relevant (e.g. addon, direct selling, flat rate, freemium, pay per use, subscription, two sided market)? (Koldewey et al. 2019a; Gassmann et al. 2021; Nagl and Bozem; Osterwalder and Pigneur 2010; Müller et al. 2020)

Continued.

Table 1. Continued.

Area of action	Relevant questions and references
IT	Which key information technology related issues are to be dealt with to realize the intended smart product/service bundle (e.g. infrastructure (IoT platform, ecosystem platform), connection, network, communication, product cloud, architecture, integration with business systems/external sources, IT security, technological trends (e.g. artificial intelligence, machine learning, block chain, virtual/augmented reality)? (Software Engineering Institute 2010; Porter and Heppelmann 2014; Kutzias et al. 2019)
Development	Which key development related issues are to be dealt with during strategic decision making to realize the intended smart product/service-bundle (e.g. within product development, service development, software development)? (Software Engineering Institute 2010; Lindemann 2016; Engeln 2020)
Operation	Which key operational issues are to be included in the strategic decision making when operating the smart product/service-bundle (e.g. ordering, helpdesk/ customer service, billing/invoicing, maintenance, infrastructure)? (Software Engineering Institute 2010; Gausemeier and Plass 2014; Yu 2021)
Organization	Which key issues are relevant from an organizational point of view when developing the smart product/service-bundle (e.g. innovation management, change management, collaboration, cooperation with relevant business departments, culture, leadership, responsibilities, compliance and governance, quality management, documentation, business processes definition)? (Software Engineering Institute 2010; Gausemeier and Plass 2014; Frank et al. 2020)
Project management	Which project management specific factors are relevant to be able to realize the intended smartification (e.g. project management method/approach, project initiation, planning, execution, documentation, project monitoring and controlling, closing)? (Software Engineering Institute 2010; Ziółkowski and Deręgowski 2014; Kuster et al. 2018; Timinger and Seel 2018)

functions like tilt or acceleration sensors, socializing functions like find and meet other persons. Nowadays, this list is nearly endless.

The above mentioned capability and maturity model of our decision framework is made up of eleven "areas of action", which are listed in Table 1 including the most relevant references. They cover questions, as well as aspects and drivers, which are generally relevant to be dealt with for setting up a smartification strategy.

Upcoming publications will cover details of the six steps of our framework mentioned in the previous chapter, all of which fall back on the underlying

capability and maturity model, which builds upon those eleven areas of action.

SUMMARY AND CONCLUSION

The set of identified areas of action relevant for the smartification of traditional physical products builds the basis for an evaluation method, which supports not only the identification of the essential aspects, which need to be further developed in a SME, but provides the different degrees of effort for advancing these aspects. Our work will support SMEs during their strategical efforts to design future service business, with this being able to use the advantages of digitalization, taking necessary steps towards sustainability and thus strengthening its resilience to competitors.

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