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Business model development concept for SMEs in the era of twin transition

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Abstract

The urgent need to act against climate change is emphasized in many initiatives, such as the Sustainable Development Goals, the European Green Deal, and the Circular Economy Action Plan. The role of the industrial sector is crucial. Companies, however, have to operate in a very complex environment driven by digitization and are supposed to be more sustainable. This paper explores how companies can implement the ecological transformation, with a focus on the role of digital technologies and data in enabling the twin transition. This paper proposes an approach to support SMEs in the twin transition through a combination of digital and sustainable business model development. The concept includes an interdisciplinary methodology that combines qualitative and quantitative approaches, focusing on the latter. The suggested method collection includes adaptations of the business model canvas, value proposition analysis, data-driven decision-making, and the integration of environmental and economic considerations using the system of environmental-economic accounting. In particular, approaches to define the quantification of economic as well as ecological value will be key levers for sustainable implementation. By leveraging these approaches, SMEs can navigate the challenges of digital transformation and sustainability and contribute to a more sustainable future.

Keywords: quantitative approach; value creation; business model; digitization; sustainability

1. Introduction

The latest World Climate Report [1], like the previous Climate Reports, shows that an immediate trend turnaround is necessary with regard to sustainable action. Significant responsibility is also attributed to companies, but with the challenge that they can only act in an ecologically sustainable manner if economic sustainability is also ensured [2]. The question addressed in this paper is how manufacturing companies can conduct the twin transition, meaning the

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digital and green transition as well [3, 4]. The digital transition plays an essential role, whereby generated data on the one hand, and digital technologies on the other hand are seen as enablers in the context of the twin transition [5] and contribute to reaching the Sustainable Development Goals by 2030 [6].

Large companies usually have their own departments for Industry 4.0 or digitization as well as for sustainability [7]. However, the cross-departmental implementation in terms of the green transition is not targeted due to organizational interfaces. In addition, large companies can allocate far more resources than are available in SMEs, which in turn represents a barrier to a twin transition [8]. In SMEs, these functions are usually defined as additional tasks in existing departments, which means that implementation, particularly with regard to the combination of green transformation and digital transition, cannot take place with the necessary efficiency. Moreover, SMEs are the backbone of the European industry representing 99% of all businesses in the EU. Therefore, special attention must be given to SMEs because they often lack the capacities and knowledge to react to the main streams and therefore need support in the transition process.

Beyond organizational challenges, one of the biggest barriers is the lack of data or a sufficiently precise data basis for a targeted implementation as part of the twin transition - especially true regarding cross-company data. As a result, trade-offs arise between the knowledge of the impacts of technologies and innovation systems and the ability to influence these impacts of development and innovation pathways [9]. The goal here needs to be to use data and appropriate methods (e.g., digitization, AI, etc.) to improve the predictability of impact [8, 5] (see Fig. 1).

A further challenge is that greening does not end at the boundaries of the company and that the main potential of the green transition can be generated across companies or over the entire life cycle, which also ends in the transformation to circular economy [10].

This also means that the aspects of value creation and value proposition, especially with regard to the ecological framework conditions, must be redefined. In other words, *where does economic and ecological (sustainable) added value arise, and who (which stakeholders) in the life cycle benefits from it at what time*? With regard to this question, the paper attempts to explain a concept that allows the twin transition to be realized via new business models. The concept is to show how a combination of digital and sustainable business model development can support SMEs in the twin transition, and how the created value can be quantified. It aims to provide support for SMEs in navigating the complex landscape of digital transformation and sustainability and focusing on the values that can be created with data. By leveraging new digital technologies and incorporating sustainable principles, SMEs should be able to position themselves at the forefront of innovation and contribute significantly to a more sustainable future.

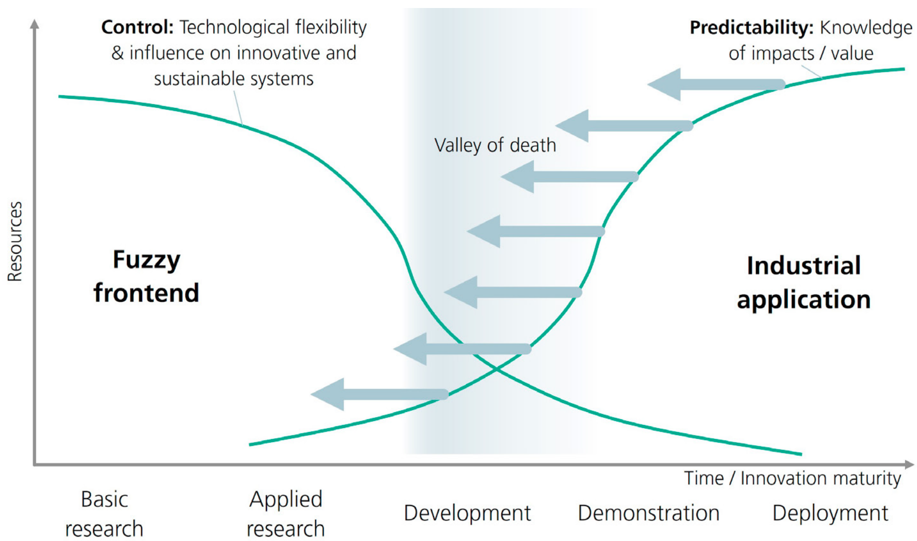
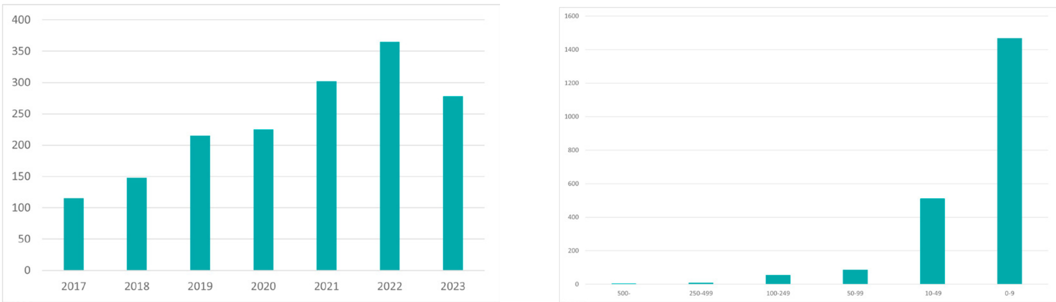


Fig. 1: Collingridge-dilemma (own representation based on [9])

2. Literature review

To get a rough overview of the literature a quantitative literature analysis was conducted in the Scopus database. In the fields “article title”, “abstract”, and “keywords” the following terms were searched: "business model", "sustain*" and "data" without any other filtering. The database query resulted in 2125 papers (conducted on 22.09.2023) with the distribution depicted in Fig.2 and showing on the one hand, that the interest of the research community is continuously increasing in this field and on the other hand the topic is manifold.

Extending the search field with "SMEs" resulted in 48 papers highlighting the limited attention given by researchers dedicated to SMEs. The majority of the papers deal with strategic management topics [11] and innovation [12, 13], and apply qualitative approaches [14]. The aspects used to address the complex topic of sustainability are various: corporate social responsibility [15], economic-ecologic-social pillars of sustainability [16]. Very limited research can be found with quantitative models. In [16] a quantitative approach was applied for the investigation of SME performance in the potato agro-industry. The authors introduced a couple of KPIs for measuring sustainability performance according to the three pillars. Structural equation modeling, as a quantitative approach was applied i) to investigate the external and internal factors influencing the design and implementation of sustainable business models for SMEs [13], and ii) to analyze the value proposition-creation-capture innovation processes in business model innovation and growth of manufacturing SMEs [17]



(a) Number of papers per year

(b) Number of papers according to citations

Fig. 2: Paper distribution

3. Conceptual framework for business model development focusing on SMEs

In the paper, a framework is suggested for exploring how the twin transition can be facilitated in manufacturing SMEs. The authors take a mid-and long-term perspective of the digital transition and the green transformation and define a quantitative approach that can be suitable to support the transition of business models towards a more sustainable economy. The overarching research question of the work is:*"How can the twin transition be facilitated in the business model development for SMEs through a quantified value approach?"*. Because of the complexity of the problem an interdisciplinary approach must be taken in order to have a successful twin transition [4]. First, the considered topics and current trends are investigated, then a collection of methods are uniquely combined and presented, and finally, the necessary business model adaptation is derived from different perspectives. Fig. 3 summarizes the research methodology suggested (inspired by [18]).

3.1. Trends and considered topics

According to the authors‘ understanding – who have technological and economic backgrounds – transition is something that happens on its own in the industrial practice because the companies can directly benefit from it, however, it is not necessarily the case when dealing with transformation. Transformation is a more complex change and needs force. This is in line with the European Commission‘s insight defined in a JRC report [4]. Both of them result in a change but they are different in nature and dynamics. Companies apply the achievements of digital technology because their processes will be faster, more effective, and less expensive. The digital transition is in their own interest. That

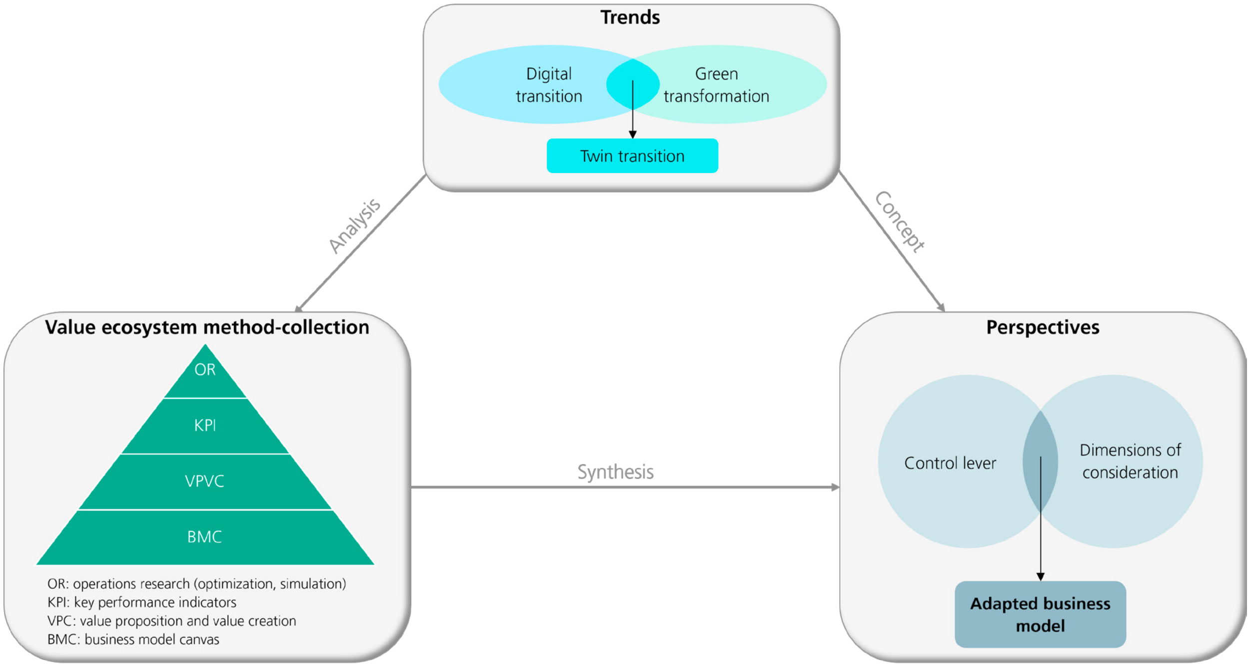


Fig. 3: Suggested research methodology for the concept development

is not definitely aligned with green transformation. More sustainable solutions can increase the company's competitiveness but they are mostly cost-intensive and the benefits can be derived much later after the realization. The green transformation will not happen on its own, if there is no economic benefit or regulatory demand. It needs to be pushed through politics and appropriate regulations. Manufacturing companies after the successful twin transition become not just more efficient (digital) and sustainable (green), but transparent. Internalisation of industrial externalities is already an established regulatory intervention, but definitely must be extended and intensified in the era of twin transition and therefore needs more attention from the research community – with a dedicated focus on SMEs.

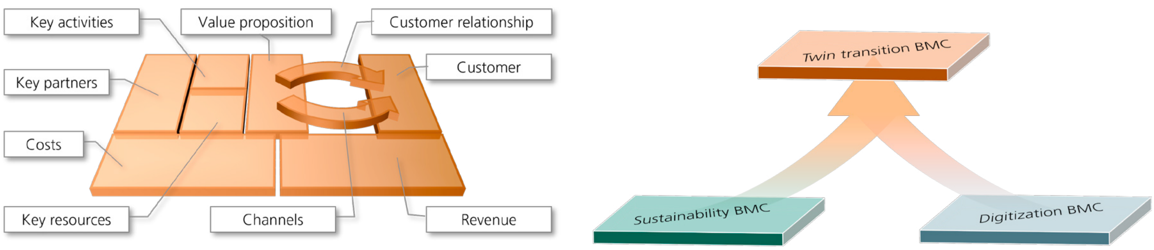
Regarding the green transformation, it must be noted that not just the aim of "becoming more sustainable" is considered. It is also important that digital transformation is carried out in a sustainable manner [19] and supports environmental goals [20]. According to a position paper sustainable digital transformation has three dimensions: i) building on B2B relationships; ii) green(er) technologies, circular economy; iii) and last but not least innovation-enabling policy and regulation [21]. The proposed concept includes all three dimensions.

Considering the present concept it means that politics should be aware of the differences regarding transition and transformation. The green transformation should be facilitated by incentive systems initiated by politics. Moreover, digitization for local purposes should not be any more in the main focus of funding schemes and programs. Financial funds should support more sustainable technologies and contribute to long-term ecological and social objectives. A nice Austrian example of this trade-off is the current financial funding scheme for wind turbines. Because of technological innovation, funding programs facilitate the disassembly and selling of the turbines outside Europe after 20 years of usage – leading to a huge amount of material waste (steel). However, in the long term, it may be more sustainable to reuse parts of a turbine locally.

3.2. Methods

The complexity of the problem implies that there exist no universal solutions. A series of methods should be systematically applied and combined to be able to take up the challenges to SMEs in the twin transition. A method collection is presented in this sub-chapter that can be seen as a building block of the solution for the whole problem. These blocks are methodologies that can contribute partial results to be able to answer our research question and they can be organized in a pyramid with different levels building consecutively on each other.

The **business model canvas (BMC)** is a widespread strategic management tool developed by Osterwalder and Pigneur [22] serving as a basis for the suggested method collection. A business model describes the design of value creation, delivery, and capture. The BMC consists of nine building blocks that cover the four main areas of a business: customers (customer relationships, channels, customers), value proposition (value proposition), infrastructure (key partners, key partners, key resources), and financial viability (costs, revenue) (see Fig. 4a). It was argued in the scientific literature that the classical BMC is a general tool that focuses on profit and viability and moreover lacks the ability to sufficiently address new trends such as digital transition or green transformation [23, 24]. Therefore several adaptations of the BMC have emerged. [23] introduced the triple-layered BMC, where the three pillars of sustainability are represented in three layers with vertical and horizontal coherence shifting the focus from profit to sustainability issues. [25] goes beyond sustainability and provides a framework for regenerative business models focusing on planetary health and societal wellbeing. Industrial sector or product-specific adaptions are widespread as well. [24] implemented the BMC in the electrical and electronic manufacturing sector, [26] focused on the wind industry, [27] combined it with the Kano model for the aeronautical and metalworking industry, [28] adjusted the BMC for project-based learning on the management of slurry - to name just a few. Several publications can be found dealing with the BMC adaption focusing on the digital transition as well: [29] dealt with the virtual reality enhanced BMC, [30] studied its application for e-platforms for sailing tourism, a working group investigated different business models in data spaces [31]. However, till now very limited attention was given to research dealing with the BMC adaption for the twin transition or systematical and joint consideration of sustainability and digitization. This is especially true if one would like to focus on SMEs. Therefore it is necessary to increase the research intensity in the field of business models and practical support for SMEs in the twin transition (see Fig. 4b).



(a) The classical BMC with the 9 building blocks (b) BMC adaptation for the twin transition

Fig. 4: The traditional and the adapted business model canvas (BMC)

All of the above-mentioned BMC adaptations have in common the focus on **value proposition and value creation (VPVC)** – representing the next level in our method collection pyramid. The value proposition is one of the nine building blocks that directly relates to value creation, therefore it is a crucial component. Focusing on value proposition gives the possibility for shifting or extending the focus from the classical profit and cost topics to environmental and societal issues [32]. The value proposition describes the unique value that a business can offer to a particular customer or customer segment. Similar to the BMC, the value proposition design (VPD) is a strategic management tool dealing with value creation. The VPD has two sides, namely customer profile focusing on observing the customer or segment (main elements: gains, pains, and customer jobs) and a value map describing the intention to create value for the particular customer (main elements: products and services, gain creators, pain relievers). The main point in value creation is to achieve a fit between the value map (generated value) and customer profile (expected or perceived value) [33]. From a quantitative perspective, it can be modeled with the value hill. Fig. 5 shows the overall correlations of the presented approach from the different levels of the BMC to the sustainable value in the spectrum of the mentioned value hill, which each stakeholder tries to optimize. Each stakeholder would like to maximize the high of their hill [34]. A fit can be realized if a combination of values – both generated and expected – can be found that is suitable for the parties concerned. Becoming more sustainable requires the extension of the trapeze‘s width. With this expansion, value is no longer just for the immediate customer but also for other stakeholders in the product life-cycle entering later on (e.g. repair, recycling). This leads to a stretching of boundaries in business models as well as a shift or expansion of value creation and value proposition. It must be noted here, that value can be defined differently in various branches. In the food sector, local and regional products are valuable. In the textile industry, fair working conditions represent a

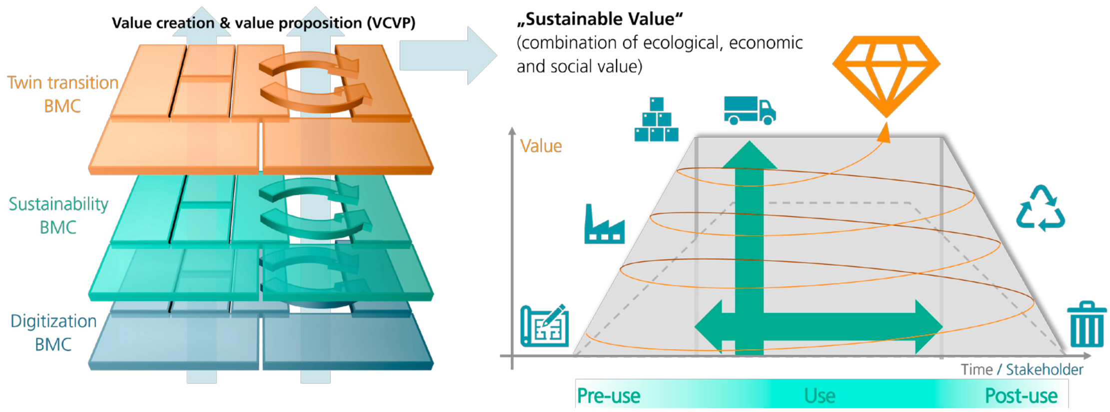


Fig. 5: Approach to sustainable Value in the twin transition

sustainable value, while in the plastic industry the recycling rate - to name just a few. Meaning that the value creation with BMC and VPVC should be addressed sector-specific.

A business can make data-driven decisions and optimize its offerings for maximum value by using a quantitative approach to measure and analyze value creation. For data-driven decision support data and **key performance indicators (KPIs)** are essential – the third level in the method pyramid depicted in Fig. 3. There are several quantitative approaches in the scientific literature that can be useful to address different aspects of the twin transition. Cost-benefit analysis (CBA) compares the costs of a project or investment with the benefits it will generate. Life cycle costing (LCC) extends the scope of CBA and covers time periods before or after the project or investment duration. LCC takes a broader perspective and can consider different stakeholders and their needs including the society as well. Similar to LCC, customer lifetime value (CLV) deals with the long-term financial performance of a product or a service, but LCC focuses on the total costs of ownership and CLV on revenue generated during the entire lifetime of a product or service. Product-service systems are seen as one of the most effective instruments for moving society towards a resource-efficient and circular economy [35]. In a recent review on the topic, value creation considering the interests and benefits of different actors and risk- and revenue-sharing models are on the future research agenda [36]. [37] considers the customer journey and defines different service strategies optimal not just from producer and customer perspectives but with minimal ecological effects as well. The uniqueness of this approach is the application of mathematical models. However, this research focuses always on the direct business relationship of the producer and the customer. For a general business model development a much higher level approach is necessary – aggregating views from different SMEs in a particular industrial sector. The application of quantitative models is not typical in the business model development context and was identified as one of the main future research topics [38].

All of these methods have a micro-economic view and deal with one or more stakeholders directly. Supporting the SMEs, however, needs a higher level of consideration. The authors think that a joint top-down bottom-up methodology collection is necessary to overcome the challenges of the twin transition. The system of environmental-economic accounting (SEEA) can be an appropriate method with a macro-economic view for integrating environmental and economic considerations into decision-making processes. SEEA is a system of integrated and internally consistent series of accounts that aims to systematically record data on the stocks and flows related to ecosystems. It provides a quantitative framework for measuring (including accounting in physical and monetary terms) ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets, and linking this information to other measures of economic and human activity. The system is consistent with the international statistical standard for measuring the economy, meaning, that it is possible to integrate environmental and economic data to make environmental data more useful for economic decision-making, and economic data more useful in environmental decision-making [39].

One of the additional potential methods for bringing together the micro- and macro perspectives may be the consideration of opportunity cost. It can help assess trade-offs during decision-making. Given the sustainability topic, rather long-term related decision alternatives are meant. For example, a product design decision between a product with classical properties and a sustainable product with increased repairability can be facilitated with opportunity costs. Selecting the classical product is a cost-based decision aligned with linear production. The possibility of refurbishing and remanufacturing on the product reaching end-of-life may not be the best alternative at first sight. But sooner or later it can become a priority because of the scarcity of the resources (and the resulting cost increases) or the more sustainable expectations of the customers or reinforcement from politics. This potential value derived from the possibility of applying any of the R-strategies has a direct connection with the sustainable value that is difficult to measure and changes over time [40].

If a business can be described with different KPIs – integrating different micro- and macro-economic aspects – it can be optimized. **Operations research (OR)** dealing with quantitative model development can be useful to support decision-making in the twin transition. OR has several sub-disciplines and methods that can be useful in the support of business model development, such as mathematical programming, simulation, forecasting, heuristics, and metaheuristics, etc. Finding the Pareto front with multi-objective programming considering the partly contrary aims of various stakeholders; carrying out a systemic sensitivity analysis of a product life cycle simulation or LCA/LCC model parameter; or automated and artificial intelligence-supported decision-making concerning the most suitable R-strategy can examples where OR can help to identify tradeoffs.

One of the biggest barriers in circular economy regarding data-driven optimization is missing data and data exchange along the supply chain. Several initiatives force to overcome this barrier such as the digital product passport (DPP) – seen as an enabler of the circular economy. The DPP will be developed industry specifically (such as the first two levels of the pyramid) and should contain all relevant data a product can generate during the whole life-cycle beginning in the mines of primary raw materials through production of logistics till recycling and end-of-life phase. It will facilitate the KPI generation and optimization foreseen at the upper two levels of the pyramid. But the DPP must be realized in a sustainable way as well – which is a huge research topic right now.

3.3. Perspectives

Different perspectives may be required in the synthesis of the analysis results. The dimension of consideration and the control lever are mainly involved at this stage of the concept development.

Various **dimensions of consideration** can be taken into account. Both the micro- and macro-economic aspects are addressed in the method collection. The micro-economic issues are modeled where either the unique stakeholders (BMC) or the business relationships between the actors are studied (VPVC). The macroeconomic aspects can be addressed with methods such as the SEEA. Another dimension can be the pillars of sustainability. Efficiency is a basic requirement for company competitiveness, therefore, the economic pillar is ensured. The digital transition facilitates the implementation of this pillar. The social and ecological pillars (and values), however, must be guaranteed by politics (green transformation). All of the considered dimensions influence the problem to be tackled. In a quantitative optimization problem, these dimensions are identical to the restrictions or constraints describing the optimization space and objective function formulating the aim of the optimization.

The **control levers** have a direct connection with the dimensions discussed. On the micro level, a company in a supply chain can choose a more sustainable supplier if sustainable value optimization can be achieved with this preference change. On the macro level, politics have to ensure that the not-so-attractive possible solutions (mainly because of cost issues) become more attractive and should be considered as preferred operating points by the stakeholders. This can be achieved by appropriate incentive systems that can help SMEs overcome the financial burdens faced in the twin transition. This can be realized by industry sector-specific and/or regional regulations, directives, and laws [41]. It must be noted, that because of the dependencies of the pillars (economics influence policy and vice versa), this kind of optimization problem can be a very challenging one. Moreover, different regional, national, and international objectives are not always aligned with each other.

4. Validation and application

The proposed concept includes both analysis and synthesis (see Fig. 3). The considered topics have to be broken apart and the individual parts have to be investigated with selected methods from different perspectives. However, the complexity of the problem requires putting the knowledge and information gained together to see an overall pattern of how things come together. In this sense, the following points are listed on the authors' research agenda:

- focusing on at least 3 relevant industrial sectors;
- involvement of different stakeholders and perspectives depending on the industrial sector;

- conducting interviews to have a better understanding of the sector in focus and companies involved, applying the qualitative methods of the method-collection pyramid;
- deep dive into KPIs and optimization, analyzing sector-specific problems;
- synthesizing the sector-specific results and contribution to policy and regulation activities.

The validation of the proposed concept and the analysis has already been started in the frame of the Austrian-German joint-funded research project champI4.0ns focusing on the wood industry, which is an important economic sector in both countries. On the one hand, wood is a sustainable and future-oriented material; on the other hand, the processing of the raw material is very machine and energy-intensive. The particularly high degree of individualization expected for the end products and the large difference among companies in terms of their I4.0 maturity level makes this sector very promising from a research perspective – especially considering the focus topic of the current paper.

One use case deals with the traceability issue of wood and its end product furniture. Material tracking from a tree to a piece of furniture will be realized to be able to inform buyers of furniture that the wood used comes from sustainable forestry. The developed method supports companies in their efforts to fully demonstrate the sustainability and rationality (with GPS data) of their products and to pass on this important information to their end customers. The value of the local, renewable resource wood is significantly increased. It can lead to increased competitiveness in the short term and changes in the classical business models in the long term.

In another use case, the traceability focus is extended with production planning and control and with quality assurance. The variable natural raw material and the complexity of manufacturing need optimized model-based process control and quality prediction. Materials and products are tracked throughout the value chain and a carbon footprint is assigned to products ensuring full transparency in the supply chain and increased competitiveness for the actors.

The sustainable value in the use cases is determined by the additional data available about the product and the transparency of the production process beginning with harvesting through the components (not just wood, but the glue applied as well, which can be a hazardous material requiring special attention regarding tracking and information content) till the end product. Gathering and maintaining the data requires extra effort and cost from the companies. If there are already customers on the market who are ready to pay the increased price of this product, sustainable business models may be derived. If this is not the case, incentives can facilitate the twin transition because they have the ability to create value. However, the research community points out, that there is often no clear incentive for information sharing [42], especially the SMEs lack relevant experiences. [41] In both use cases data spaces will be developed and the main aim is to show the benefits for each actor (data provider, service provider, data consumer) that can be realized.

Business model development may be realized in two ways. First, in the short term, existing roles can be slightly changed, e.g.taking the role from the previous or next actor in the supply chain – such as in product-service systems, where the ownership stays at the manufacturer. Later on, new business models can emerge and old ones can disappear, meaning not just the shifting of value creation roles, but realizing the value creation with a new stakeholder structure.

5. Conclusion and future research agenda

The twin transition or transformation has two parts: the digital transition happening on its own and the green transformation needing to be pushed. In the ideal case, they should reinforce each other. Definitely, an interdisciplinary approach and integrated management will be needed.

The twin transition presents an enormous challenge, characterized by a complex transformation process [10]. This transition involves the green transformation of industries, facilitated by the integration of digital technologies and big data. It signifies a departure from the traditional model of "produce a product and sell" towards a more comprehensive product-service system, where value creation and value propositions occur at different stages both of the product life cycle and among various stakeholders.

Realizing this transition requires the development and creation of sustainable business models, accompanied by the challenge of determining sustainable value in terms of economic and ecological sustainability. In the long term, considerations of value creation and value proposition stakeholders need to be incorporated into the quantitative value assessment and optimization across the nine building blocks of the Business Model Canvas.

The digital transition in pursuit of economic efficiency is primarily driven by companies themselves. However, green transformation is often initiated and implemented through regulations or incentive systems that emphasize the value of ecological sustainability. These regulatory frameworks or incentives act as catalysts, encouraging businesses to align their practices with sustainable principles. The next step in this process besides academic research in defining and assessing the ecologic value involves practical validating the described use cases [43] to further refine the value assessment and allocate value generation and value propositions to different phases of the product life cycle and the relevant stakeholders.

Future research should focus on expanding the definition of ecological value beyond just CO_2 emissions [37], considering factors such as repairability and the use of secondary raw materials. Similarly, KPIs for social sustainability should be developed based on the same methodology, taking into account specific industry branches, such as textiles or primary raw material mining, where an ecological impact is potentially very high.

Furthermore, it is essential to explore the influence of the digital product passport (DPP) [44] on sustainable business models. Many sustainable business models are subject to regulatory requirements related to data privacy, environmental standards, and ethical practices. This investigation should consider effective security measures to help ensure compliance with these obligations, reducing legal risks and associated costs [45], as well as incentive systems in shaping and extending the business model's stakeholders, ensuring a holistic and integrated approach to sustainability.

In conclusion, the twin transition represents a substantial challenge that necessitates a complex transformation process. By leveraging digital technologies and big data, businesses can drive green transformation and create value through innovative business models. Future research should focus on expanding the definition of ecological value and developing KPIs for social sustainability. Additionally, understanding the influence of regulations, incentive systems, and DPPs on sustainable business models will contribute to the successful realization of the twin transition and the creation of a more sustainable future.

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