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Circular Economy in SME – Concept for Initiation and Implementation

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Content

Abstract

This concept paper addresses the following research questions: What challenges and opportunities are associated with initiating and implementing circular economy (CE) approaches in small and medium-sized enterprises (SME)? What support do SME require to adopt circular economic strategies and measures effectively? To this end, potential areas of action, challenges, and opportunities related to CE implementation approaches were analyzed in collaboration with medium-sized enterprises. A structured approach was developed to help companies to identify strategies and solutions, facilitating the transition from linear to circular value creation. The outcome of this work is the CE Potential Check developed by the Prosperkolleg. This four-step approach provides an individualized assessment of circular economy implementation in the respective enterprises and includes the Circularity Matrix - a tool for identifying suitable areas of action within companies.

1 Introduction

Currently, the economy operates predominantly on a 'linear' model, in contrast to a 'circular economy' (CE), which aims to establish closed material cycles as much as possible (for a detailed discussion of the CE concept and its associated strategies, also referred to as circular value creation, cf. Mast and Unruh 2021; Unruh et al. 2021). Large companies have already begun developing strategies and measures for a CE. For example, the confectionery manufacturer Katjes produces vegetarian gummy candies in three German plants, which, according to the company, are carbon-neutral. This is achieved, among other measures, by using 100% recycled materials for cardboard packaging (Umweltdialog 2020). The German solar inverter manufacturer SMA Solar Technology AG supports skilled tradespeople in repairing inverters rather than replacing them outright in the event of a defect. The company also plans to increase the proportion of secondary raw materials used in its production processes by 25% by 2025 (SMA Solar Technology AG 2021, 26). Circularity Germany GmbH i.G. repurposes worn-out bed linens, work trousers, and other textiles to produce yarns for T-shirts using a fully automated spinning machine (Circularity n.d.). Moreover, studies such as the one conducted by the Wuppertal Institute for Climate, Environment, and Energy indicate that CE can make a significant contribution to achieving climate goals (Hennicke 2021).

Small and medium-sized enterprises (SME) often lack clarity on how to navigate the transition to a CE and on the extent to which they can benefit from it. Building on practical insights and theoretical concepts from the literature, the project 'Prosperkolleg – Transformational Research on Circular Value Creation (Prosperkolleg)' employs an action-oriented research approach to develop concepts and tools designed to support SME in North Rhine-Westphalia (NRW) on their path toward a CE. This project, funded by the Ministry of Economic Affairs, Innovation, Digitalization, and Energy of NRW, is being conducted in close collaboration between Ruhr West University of Applied Sciences, Efficiency Agency NRW, the local economic development agency of the City of Bottrop, the regional development agency WiN Emscher-Lippe GmbH, and Prosperkolleg e.V., an association for application-oriented research and the transfer of scientific results into practice.

In NRW, there are approximately 730,600 SME, accounting for 99 % of all businesses in the state and employing around 52 % of the state's workforce subject to social security contributions (Wirtschaft.NRW 2022). Many of these SME act as suppliers within complex global value chains while simultaneously relying on other SME or larger companies in the basic materials industry for their own supplies. This highlights that the full circular potential within value chains can only be realized if SME are actively engaged in the transition.

The starting position of SME differs from that of larger companies due to factors such as a higher number of competitors, greater demand-side uncertainties, occasional cash flow challenges, less standardized business practices, more significant difficulties in finding qualified personnel, and higher employee turnover (Dey et al. 2020).

This paper introduces the 'Circular Economy Potential Check (CE Potential Check)' developed by the project 'Prosperkolleg', a concept designed to support SME on their journey toward adopting a CE. The focus is on SME in the manufacturing sector, which accounted for 16.1% of the gross value added in NRW in 2019, representing approximately 62% of the gross value added of the entire production sector in the region (Wirtschaft.NRW 2022). The paper begins by presenting the findings of a literature review on the situation and experiences of SME regarding CE, highlighting opportunities and challenges as well as barriers and obstacles. Building on these insights, the experiences of the Efficiency Agency NRW are analyzed and complemented with results from the work of the Prosperkolleg project (www.prosperkolleg.de) and a company study conducted in collaboration with the consultants of the company innowise GmbH. Based on these findings, the concept for the CE Potential Check for SME is developed. Finally, the paper concludes with an outlook on the next steps in transformational research on CE in SME within the Prosperkolleg project.

2 Circular Economy in SME

2.1 Opportunities and Challenges

There are several advantages and opportunities for SME to engage with CE practices. These include increased independence from raw material price fluctuations, reduced supply chain disruptions, and mitigation of occasional shortages of critical materials (Irrek et al. 2021; Köllner 2021). Currently, 20 materials are listed as 'critical' due to their high economic importance and significant supply risks (Ellen MacArthur Foundation/McKinsey 2015). RWI (Leibniz Institute for Economic Research) predicts that structural changes will sustain high demand for specialized materials in the long term (Schmidt et al. 2021). Adopting CE can also enhance an SME's reputation by lowering CO_2 emissions and achieving sustainability goals. Additionally, CE offers opportunities for new business models, business growth, cost savings, and productivity increases (Prieto-Sandoval et al. 2018). From 2023 onward, larger SME will also be subject to CSR reporting obligations, including carbon accounting, which, along with market demand, further supports the case for CE adoption.

However, there are also significant barriers to implementing CE approaches in SME. These include: lack of financial support, Inadequate information management systems, Insufficient technology, technical and financial resources, A shortage of qualified environmental management professionals, and limited leadership engagement. Other obstacles include low consumer interest in environmental issues and insufficient public sector support (Prieto-Sandoval et al. 2018; Rizos et al. 2016). SME often face constraints due to their budgets, customer pressure, and the demands of policymakers (Ghisetti and Montresor 2020). The benefits of CE investments are frequently unclear to SME, leading to initial resistance. Moreover, standard financial instruments rarely or inadequately address CE measures (Ghisetti and Montresor 2020).

A lack of government support - such as financial assistance, training, effective tax incentives, and legislation at national and European levels (e. g., within the framework of the European CE Action Plan) - is widely recognized as a significant barrier to environmental investments. The absence of legal certainty often discourages SME from considering the integration of environmentally friendly solutions into their operations (Rizos et al. 2021).

Finally, SME are often managed by their owners, who have a significant influence on the strategic direction of the business. While some SME managers are positively inclined toward CE activities, others are less so. Owners and managers also vary in their perceptions of risk. Strong risk aversion among managers can hinder the adoption of CE practices, even when the benefits of implementation are evident (Rizos et al. 2016).

2.2 Supporting Tools and Networks

In recent years, various tools and resources have been developed to support the initiation and implementation of CE approaches in SME. A study by Stiftung Familienunternehmen (2021) identified several CE related tools, as well as companies and organizations offering platforms and web-based applications. These include the Ellen MacArthur Foundation (Material Circularity Index and Circulytics), WBCSD (Circular Transition Indicators), Cradle to Cradle® NGO (certification), R2Pi (a platform with various tools), ResCom (a platform offering eleven tools), TU Delft (courses on Circular Product Design Assessment), the Self-Check for the Circular Readiness Level® of products and product systems, InChainge (The Blue Connection), and the Prosperkolleg project (Stiftung Familienunternehmen 2021).

Joining networks can also be beneficial for companies, as networks are vital for knowledge and experience exchange among stakeholders (Gandenberger 2021). For instance, networks can connect recycling companies with the manufacturing industry. Given their broad spectrum of competences and resources, networks can help SME achieve their CE goals more rapidly and efficiently (Stiftung Familienunternehmen 2021). This has been demonstrated in other sustainability areas, such as energy efficiency (Nestor Coronador Palma 2015; Palm and Backman 2020; Preiß 2021).

Due to the lack of a comprehensive overview of all CE networks, a complete listing is not possible here. However, a selection of resources and points of contact for SME in Germany is provided as examples:

- Umweltcluster Bayern,
- Efficiency Agency of North Rhine-Westphalia (Effizienz-Agentur NRW - EFA),
- ZENIT GmbH, Zentrum für Innovation und Technologie in NRW,
- CirQuality OWL,
- Prosperkolleg project,
- Initiative Kreislaufwirtschaft Deutschland,
- NRW.Energy4Climate (Stiftung Familienunternehmen 2021).

2.3 Experience with SME by Efficiency Agency of North Rhine-Westphalia

One of the key points of contact mentioned is the Efficiency Agency of North Rhine-Westphalia (Effizienz-Agentur NRW - EFA) in Duisburg, Germany. Established in 1998 on the initiative of the Ministry of the Environment of the state of North Rhine-Westphalia, Germany, the agency aims to provide industry and crafts in the state of North Rhine-Westphalia with incentives for resource-efficient economic practices. In collaboration with external consultants, EFA supports manufacturing companies through resource efficiency consulting to optimize their products and processes, thereby reducing costs and environmental impacts. Increasingly, topics such as digitalization, circular design, and the R-strategies of CE are gaining importance in these consulting projects. Additionally, greenhouse gas accounting using the EFA's eco-cockpit tool is a central offering. EFA also provides financing advisory services to assist with securing funding for necessary investments, as well as research and development projects and supports the implementation of measures. Within its 'Development and Cooperation' business area, EFA helps companies, universities, research institutions, and associations to tackle new trends and challenges in cooperative ventures. Through events, training sessions, workshops, and webinars, EFA disseminates information on current developments in the field. Furthermore, it initiates and supports numerous business networks to foster collaboration and exchange among stakeholders.

A significant portion of the companies utilizing EFA's consulting services operate in industries such as metal, wood and paper, food, plastics processing, textiles, chemicals, construction, transportation, electronics, and the service sector. Experience shows that projects are particularly successful when they manage to provide companies with concrete action plans supported by quantifiable benefits. This connection often cannot be achieved through standard in-house procedures. Therefore, external consulting offers new perspectives and complements existing expertise.

Direct personal engagement has proven especially effective when working with SME (LANUV 2020).

2.4 The Prosperkolleg Project Experience with SME

By January 2022, the Prosperkolleg project had contacted more than 800 companies, primarily SME in the manufacturing sector, conducted several initial discussions and workshops with SME, and built a company network where businesses exchange good practice experiences. As part of the company network established within the Prosperkolleg project to further support SME, three meetings took place in January 2022, in which (larger) advanced companies shared their experiences with other larger and smaller companies. However, the motivation and interest of companies to actively participate in such a network has so far been low. One possible explanation for this could be that the field of engagement in CE is relatively new for SME, market pressure is still weak, and regulatory pressure is barely present.

However, cross-cutting CE topics relevant to many SME could be identified, for which supporting tools can be developed, such as in the area of packaging. The Prosperkolleg project was able to learn from the experiences by EFA in designing and implementing such tools. The project developed and tested an approach for evaluating sustainable food packaging through a series of expert workshops in the food industry. Sustainable packaging protects the climate and meets an existing demand: surveys show that 79% of consumers reconsider their purchasing behavior (Effizienz-Agentur NRW 2021).

An evaluation matrix allows a comparison between standard food packaging available in stores and packaging alternatives based on 32 indicators related to product protection, circularity, the environment, plant utilization, and communication. By January 2022, the tool for evaluating food packaging had already been used by 14 companies. Feedback from companies has shown that such cross-cutting tools are particularly helpful for SME (Grundmann and Alscher 2022). Another tool used in initial discussions and workshops with SME is the Circularity Matrix, explained in Chapter 4.1.

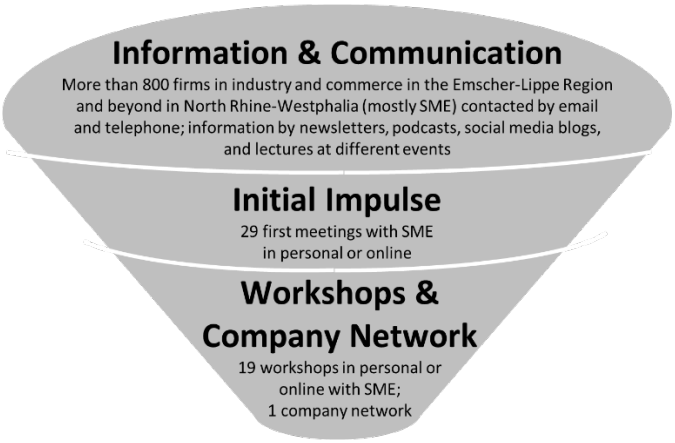


Figure 1 From Diverse Information and Communication to Specific Support Services for Companies in the Prosperkolleg project (March 2022)

The work by the Prosperkolleg project with companies has shown, on the one hand, that the term CE is often associated with very diverse aspects, and on the other hand, that SME usually require a concrete starting point for the topic within their own operations and need assistance in identifying it. The commonly used term 'Kreislaufwirtschaft' in Germany hardly differs in essence from the definition of CE shaped by the European Union or the term 'circular value creation' currently favored by the Ministry of Economic Affairs, Innovation, Digitalization, and Energy of the state of North Rhine-Westphalia (MWIDE.NRW). However, CE practice in Germany, and thus also the perception of CE in companies, primarily focuses on the non-toxic disposal of waste and residual materials (for definitions, see Mast and Unruh 2021). This focus can lead companies to believe that addressing recycling alone would be sufficient, and products might already be considered circular if they are recyclable and their residual materials are separated for recycling within the production process.

Furthermore, there is currently no universally applicable CE implementation model for companies. Therefore, it is important to first establish a shared understanding of CE and provide external feedbacks that guide companies in identifying concrete approaches for implementation. This was highlighted by 26 initial discussions with companies.

To take an initial step towards CE, segmenting the company's operational areas into specific fields where CE activities can tangibly impact the slowing, reducing, and closing of resource and energy flows is helpful (r2pi project 2021). For this purpose, the Prosperkolleg project initially identified five company-internal action fields, which were later focused on four central action fields during the course of the project (see the developed support concept in Chapter 4). These action fields are intended to help companies find initial entry points to CE. The selection of the five initial action fields is based on the works of Konietzko et al. 2020, r2pi project 2021, Evans and Bocken 2014, Vermeulen et al. 2018, Ressourceneffizienz-Zentrum Bayern 2020, Ellen MacArthur Foundation 2015, and Walcher and Leube 2017. The five action fields are as follows:

1) Circular Product Development

2) Circularly Purchased Materials

3) Resource-efficient Production

4) Extension of Product use

5) Product-Service-Systems

2.4.1 Company-Based Case Study: The Potential of a Circular Economy

For the next step, an in-depth study was run under the Prosperkolleg project, looking for how the earlier-mentioned fields of action could be used to identify concrete opportunities in a CE under the chosen SME framework. The consultants of the company innowise GmdH were charged with the implementation of the study. The Prosperkolleg project team was closely working together with them on the analysis and the case studies. Participating companies for the case studies included the SBRS GmbH, the Ventilatorenfabrik Oelde GmbH, the Rattay Group Metallschlauch- u. Kompensatorentechnik GmbH, and the nobilia-Werke J. Stickling GmbH & Co. KG.

2.4.2 Assignment and Goals of the Study

The research plan had five phases: the individual kick-off exchange, the status quo analysis, the first joint information and experience exchange, internal specializations and implementations, and the joint closing exchange:

1) The company-specific kick-off exchange introduced the different participants and the organizational launch of the study. On top of that, the kick-off also served as an introduction

to the study itself, to discuss mutual expectations, to create an understanding of the CE, and to discuss continued cooperation in this research.

2) The content introduction built upon the company-specific status quo analysis. It allows for a qualitative and quantitative evaluation of the current state in different CE activity areas as long as the data allows it. This was done with the help of a maturity model from the methods repertoire of the innowise GmbH, which was adjusted to work with the above-mentioned areas of action. Desired goals and areas of action were then decided on for each company using this information.

3) An event was held to introduce the four participating SME to each other, as well as exchange experiences and information between themselves. The participants discussed what their companies did, their interest points in the project, as well as the conclusions found in the previous research phase.

4) After the individual company introduction meetings, the individual company's specialization, development, and implementation projects took place. Throughout multiple workshops, the prioritized areas of action were identified for potential implementation measures, using suitable instruments from the innowise GmbH.

5) Finally, in a closing workshop, the companies discussed their experiences from the first phase of implementation.

2.4.3 Results from Four Case Studies

Rattay Group Metallschlauch- u. Kompensatorentechnik GmbH

Rattay Metallschlauch—and Kompensatorentechnik GmbH is based in Hünxe-Bucholtwelmen, Germany, and produces stainless steel corrugated hoses and compensators for various industries. Its products mainly focus on customized solutions to specific problems that must meet the highest safety requirements.

For Rattay Metallschlauch- u. Kompensatorentechnik GmbH, the study focused on the development of a recycling system for its products in order to recover individual components from returns, reprocess them and reuse them into the manufacturing process. The aim of the case study was to develop a new business model based on return systems in the B2B sector and test it on a pilot basis. Corrugated stainless steel hoses have a service life of at least 12-36 months, depending on the intended use and industry, or even shorter depending on the application. The stainless steel fittings on the hoses have a potentially much longer service life in most cases due to their nature. Currently, these fittings are disposed of along with the hoses. With the planned recycling system, the hoses will be returned to Rattay Metallschlauch- u. Kompensator Technik GmbH instead of disposed of. There, the stainless steel fitting is dismantled, reconditioned and can be attached to a new hose after a series of tests and documentation processes. The hoses that can no longer be used are recycled. This significantly extends the (partial) use of the product and thus generates added value in terms of a CE.

In summary, the development of a take-back system for corrugated stainless steel hoses in the B2B sector means that 50 to 60 percent of the corrugated stainless steel hoses used by the pilot customer, including stainless steel fittings, can be returned. This corresponds to 1,200 corrugated stainless steel hoses per year in the German chemical industry sector supplied by one customer alone. By reconditioning and reusing the stainless steel fittings, 4.6 tons of stainless steel can be saved per year, which corresponds to a CO_2 equivalent of 20.83 tons per year for this one pilot customer only.

SBRS Schaltbau Refurbishment und Systeme GmbH

The SBRS GmbH is part of the Schaltbau Group. The operations of SBRS GmbH, located in Dinslaken, Germany, are categorized into the business units Rail (refurbishment and systems for rolling stock) and Road (e-mobility, chargers and charging stations). In the Rail unit, SBRS offers detailed refurbishments, significantly increasing the service life of rail vehicles. The Road business unit has set up charging infrastructure for buses in 19 cities. SBRS GmbH is making an important contribution to greater sustainability and circularity in road and rail transport.

Initially, the study focused on circular product development for fast chargers. Due to the results found at SBRS, it was initially determined that there are currently no realistic possibilities for implementation of circular value creation in the areas investigated. Further analyses of dismantling processes and components, on the other hand, drew the conclusions to improve the design of the heat sinks used. SBRS also initiated more in-depth analyses outside of the case study. The results show that when the fast chargers in question are taken back and dismantled, around 25 percent of the components can be reused after cleaning and testing. This corresponds to a new material value of around € 21,000 per fast charger. The current funding model does not allow these components to be installed in new systems, as the implementation of paid/operator models is not possible. The subsidy conditions for chargers would first have to be developed accordingly. Due to the potential savings, however, it seems promising to keep an eye on this possibility.

nobilia-Werke J. Stickling GmbH & Co. KG

The company nobilia-Werke J. Stickling GmbH & Co. KG is Europe's largest kitchen manufacturer. In the past financial year, 753,000 kitchens were produced at the two production sites in Verl, Germany. Environmental protection has always been a central component of the company's philosophy, as sustainability and resource efficiency have also become fundamental beliefs of successful businesses in the kitchen furniture industry. Among other things, nobilia is certified in accordance with ISO 50001 and 14001 and has been awarded the PEFC seal and the 'Blue Angel' eco-label.

For nobilia-Werke J. Stickling GmbH & Co. KG, the focus of the study was on increasing the percentage of recycled raw materials (secondary raw materials) in the end products. The first step towards achieving this was the creation of a comprehensive database. As part of the study, a sample procedure for analyzing the percentage of recycled materials was developed using a sample product component, in the process creating a structure for collecting the required data. This methodology will be continued independently by nobilia after the end of the project. At the same time, selected suppliers of the company were trained on the sustainable and circular use of raw materials. In workshops with them, the use and availability of recycled raw materials as well as the current technology and possible development directions were polled and discussed. This allowed the company to discuss its own vision for the future and future requirements for the suppliers with them. During the workshops, the suppliers signalled that they were prepared to increase the recycling rate of their products in the future.

Ventilatorenfabrik Oelde GmbH

Innovative aviation technology is the primary expertise of Ventilatorenfabrik Oelde GmbH. At its site in Oelde, Germany, the company develops and produces industrial fans, dedusting and process gas cleaning systems, and ventilation and extraction systems. The company also offers services such as maintenance, servicing and repair services as well as system planning and modernization. In addition to cost-effectiveness, their focus is primarily on efficiency and sustainability. Significant resource efficiency possibilities can often be achieved through new systems, system modernizations or optimized services.

Ventilatorenfabrik Oelde GmbH focused their part of the study on business models for the implementation of circular value creation, taking into account intelligent services and new payment or rental models. Today, Venti Oelde primarily operates as a manufacturer of air technology systems. Usually, access to the systems is removed once they have been sold, unless a service contract has been agreed to saying otherwise. Against this background, the existing business model was questioned as part of the study. The central question was: to what extent can alternative financing and operator models (i. e., a pay-per-performance model or a product-service shift with a focus on intelligent services in predictive maintenance) supplement the existing business model and generate potential for a CE. Two existing business areas, 'dust extraction systems in the furniture industry' and 'fans in the cement industry', were selected for pilot testing. The result was a draft of a yet to be tested pay-per-performance business model, which included service and maintenance contracts for the fans business area in the cement industry.

2.4.4 Qualitative Interviews

Based on what was found in research as well as what was found in a literature review, a guideline was developed for a set of interviews with representatives from the companies of the four case studies explained above. These interviews were used to understand what previous knowledge existed about CE and what opportunities and risks the different companies foresaw in a CE transition. Before the start of the workshops in the case studies, from March 2021 to April 2021 qualitative interviews were carried out with company representatives. After the workshops, from August 2021 to September 2021, the same company representative underwent another round of interviews. In total, eight interviews were held.

The guideline is based on the following research questions:

- Please explain in key terms, what you understand circular value creation to be.
- What importance does CE have to you and your company?
- What are your biggest opportunities regarding CE?
- What are your biggest risks regarding CE?
- Where do you see yourself needing help, in the implementation and future usage of CE?
- Were your expectations for this research project fulfilled?
- What were your results and conclusions from this research project?
- What from this research project are you going to be implementing in your company?

The interview data was saved as audio recordings and later transcribed. The transcribed text files were imported into the MAXQDA 2020 analysis software in order to process the data. A category system was used to analyze the content of the interviews, supported by data reduction, which enabled comparative evaluation of extensive text modules. Individual text passages were summarized in codes, i. e. systematically categorized. The above-mentioned guidelines of the interviews were recorded as the main category. The subcategories and codes used to label individual text passages were derived from the interview material. The results are explained in the following section and illustrated with quotes from the interviews.

In summary, it can be said that the interviewees had different understanding of the term CE. Translated quote from an interview in 2021: 'Circular value creation basically means, trying to avoid wasting materials and keeping products in the cycle; sustainability, reusability, new business models, new incentives to do business.' The interviewees saw the biggest challenges of CE as being the initial investment required, the need to take the customer with them in the transformation, the ability to close loops and the reduction of raw materials and materials. Translated quote from an interview in 2021: 'I believe that we have to make a contribution or become proactive in convincing customers'. Energy savings, resource savings, the innovation of and quality of products, and the stronger cus-

tomer focus of circular approaches were seen as opportunities by interviewees. The necessary assistance should be provided through government financial support, as well as through research and external input that could promote the transition. Translated quote from an interview in 2021: '...because you are simply torn out of your normal way of thinking and get introduced to completely new areas and gain a completely different perspective. Otherwise, you wouldn't see it that way.' Management in the company should be open to CE and the benefits should be visible, so that CE approaches can be developed and implemented.

Even if the number of participating companies and interviews conducted was small, limiting the transferability of the statements, the interviews revealed trends for the further development of support systems for SME. All four companies decided to continue working on the subject, as the possibilities and benefits of CE were clearly seen.

3 Discussion

The analyses show that SME encounter opportunities in the area of CE, but also challenges, barriers and obstacles. SME are often unfamiliar with the concept of CE and the associated opportunities. At the same time, the findings of the study show that CE approaches are diverse and that implementation depends on various factors. What holds potential for one company may be less useful or not possible for another. It is important to take a company-specific approach. The study also made it clear how difficult it is for SME to transition towards CE without prior knowledge. In order to develop starting points for the development and implementation of CE and to identify the benefits for the respective company, they generally require assistance or external push. Guiding offers can provide support. Once this first hurdle has been overcome, companies are usually open to taking further steps.

The experience by EFA and the Prosperkolleg project shows that personal contact and the relationship of trust that builds on it are the basis for successful cooperation with SME.

It therefore appears to be best practice to introduce CE in a face-to-face approach, to analyze individual starting points and enable the SME to take further steps. The development of communication, cooperation and networking approaches, individual support measures, concepts, and instruments are also helpful. It is important to understand the SME, their market, their relationship with their customers, their motivations, challenges, and how to address them personally. CE usually directly affects the company's core business model or even the entire value chain and depends much more on contextual factors and individual approaches, which have already proven to be particularly relevant for the implementation of other sustainability measures, e. g. in the area of energy efficiency (Eymann and Räber 2013; Neri et al. 2021; Hariyani and Mishra 2022; Hrovatin and et al. 2021). Consequently, when developing and implementing CE assistance, the focus should be on encouraging the preparation and ability of SME to change the company's central value creation processes, in fostering cooperation along the entire value chain, and enabling SME to tackle this in their respective context.

As part of the Prosperkolleg project, a four-step 'CE Potential Check' was developed as a support tool based on the literature research and the findings of the case studies in order to offer other companies the opportunity to identify and develop CE in their companies. This potential check is presented in detail in the following chapter.

4 The Prosperkolleg's Concept for a Transitional Support System for SME: The Circular Economy Potential Check

The Prosperkolleg's CE Potential Check enables companies to take a look at their CE opportunities. Since the first step into the large, often opaque, field of CE usually seems particularly difficult with a multitude of starting points, the approach developed by the Prosperkolleg project focuses on enabling a low-threshold entry and then approaching the identified possibilities step by step. The approach includes (Figure 2):

6) An initial meeting in which both sides get to know each other and discuss expectations and the next steps. Depending on the level of knowledge, a brief explanation on CE can be given here.

7) The use of a 'Circularity Matrix': an Excel tool that identifies and prioritizes the largest possibilities for CE in the company as part of a gap analysis in four fields of action.

8) A 'Circularity Workshop', in which the previously identified possibilities are examined in more detail and solutions are developed.

9) The planning of further collaboration for operational implementation, e. g. with the support of an agency like EFA and its consulting partners or partners from the virtual research network of the Prosperkolleg project.

Starting in spring 2022 until spring 2024, companies from all sectors in North Rhine-Westphalia had the opportunity to carry out the Prosperkolleg Circular Economy Potential Check with the project team. The following chapter explains the two core elements of the Potential Check in more detail: the Circularity Matrix and the Circularity Workshop.

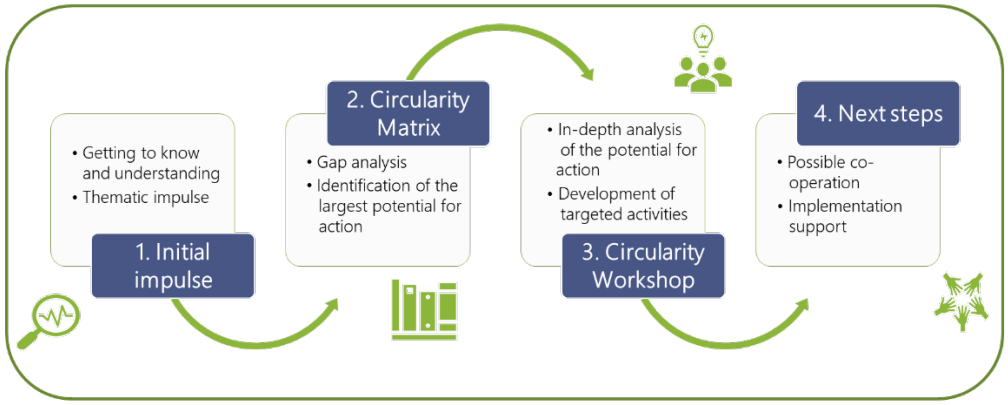


Figure 2 Prosperkolleg Project's Circular Economy Potential Check

4.1 Circularity Matrix

With the Circularity Matrix, companies can approach the topic of CE, regardless of their own level of knowledge, and identify the largest circular action potential in their own company through a gap analysis. The Excel tool developed contains 37 questions (Table 1) relating to the fields of action presented above. To develop the questions, several existing tools were analyzed, including the work of Konietzko et al. 2020, r2pi project 2021, Evans and Bocken 2014, Vermeulen et al. 2018, Ressourceneffizienz-Zentrum Bayern 2020, Ellen MacArthur Foundation 2015, and Walcher and Leube 2017. In developing the matrix, similarities in the questions of different fields of action were identified. This

was in line with the findings of the study and led to the fields of action being revised (see section 2.4). For example, in area 2, 'purchasing of recyclable materials', the supply chain is now considered in addition to the materials. In order to specify the terminology of area 4, 'extending product use', this is now described as 'collection and reprocessing'. In addition, areas 4, 'prolonging product use', and 5, 'product service systems', have been combined to form the area of action 'collection and remanufacturing & product service systems', as the associated sub-topics and issues are closely linked. In conclusion, the Circularity Matrix is now structured into four areas of action, each with eight to ten assigned questions.

These four areas of action are as follows:

1) Circular Product Development,
2) Supply Chain and Procurement of Circular Materials,
3) Resource-Efficient Production,
4) Circularity Aspects in Use Phase and End of Life: Product-Service Systems, Reverse logistics, Reprocessing, Retrieval.

In addition to questions on the products' reparability or durability, a closer look was also taken at resource efficiency in the supply chain and recycling systems. The selected questions enable a low-threshold but holistic view of CE in individual companies. In addition to providing an overview of starting points and measures, the list of questions makes it clear which issues should be considered in the future.

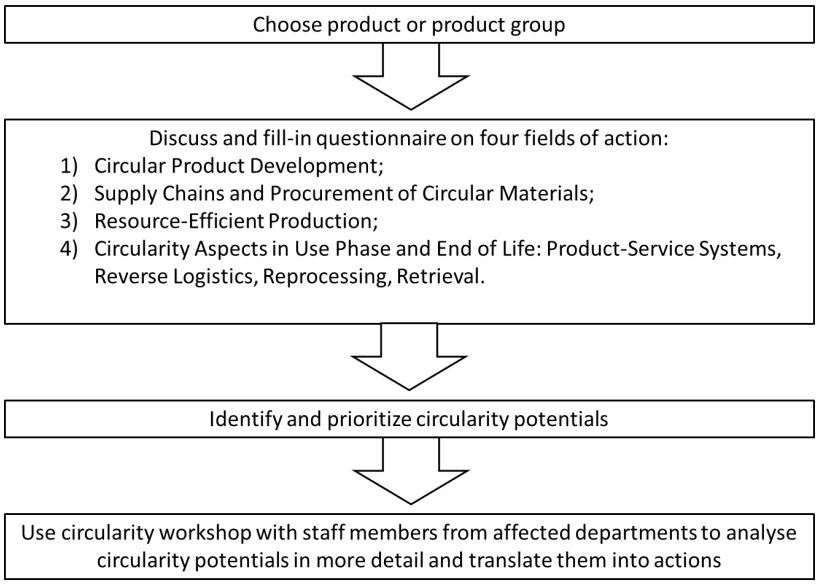


Figure 3: Process of Applying the Circularity Matrix

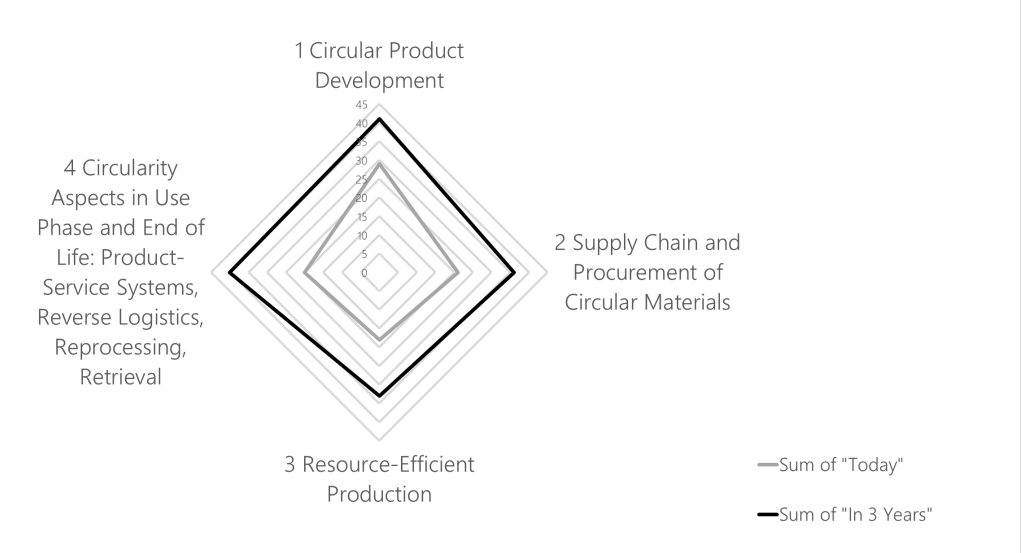
The Prosperkolleg project team applied the matrix with companies in a one to two hours session (the process is visualised in Figure 3). Companies with several products must first decide on a product, e. g. the one with the highest turnover, or a product area. The matrix can be repeated for other products. Each question requires one of the following responses: not at all, rather not, partly, mostly, completely, no answer. The assessment assesses for an ACTUAL state at the starting point and a desirable TARGET state in three years' time. The answers are translated so that a numerical value is stored for each question and a difference can be calculated. By looking at the gap between the current state of development and the desired target in three years, the starting points with the largest potential can be identified in accordance with the company's goals and motivation.

Focus Area	Questions	Today	In 3 Years
1 Circular Product Development	Do you use qualified indicators to estimate enviromental impacts already during product development?		
	Is your product systematically designed to save ressources in production and requires as little material as possible?		
	Have the optimisation measures applied during product development already utilised a large part of the potentials?		
	Is your product designed to be most durable?		
	Is your product designed to be repairable?		
	Is your product designed to be upgradeable?		
	Is your product designed to ease recycling of materials after various life cycles?		
	Do you analyse the possible use of alternative materials like bio-based or biological degradable materials or recyclates?		
	Do you consider the product's use phase during product development like operating costs or use of ressources?		
2 Supply Chain and Procurement of Circular Materials	Do you have sufficient knowledge about the whole supply chain including procurement and sales?		
	Do you avoid the use of critical ressources?		
	Do you track and evaluate the threat by using critical ressources in procurement, e.g. by criticality analysis?		
	Do you systematically consider regional procurement and import independence, as far as technically and economically possible?		
	Do you avoid the use of hazardous, toxic oder unhealthy ressources in your product?		
	Do you avoid the use of socially critical ressources in your product?		
	Do you systematically find out about ecological aspects when purchasing materials, components or products?		
	To which extent do you use recyclates?		
	Do you use recyclable materials?		
3 Ressource-Efficient Production	Have you analysed your production process with regard to resource efficency potentials and avoidance of waste?		
	Have you integrated a continous improvement process to increase resource efficency of production?		
	Dou you use renewable energy in production?		
	Do you use by-products of production processes as internal ressources, e.g. waste or rejects?		
	Do you sort and recycle by-products which cannot be used any further?		
	Do you know the type and amount of production waste or rejects?		
	Do you have a greenhouse gas emissions balance for your product?		
	Do you co-operate with external people like customers and suppliers to minimise ressource use and maximise use of reusable systems in production and logistics?		
4 Circularity Aspects in Use Phase and End of Life: Product-Service Systems, Reverse Logistics, Reprocessing, Retrieval	Do you know what happens with your product between first time use and end of life, e.g. with regard to repair, refurbishment or reuse?		
	Do you have (internal or external) service agreements for your product, e.g. aiming at extending life cycle and recovering materials?		
	Do you have (internal or external) repair services for your product?		
	Are there spare parts available for your product, internally or externally?		
	Do you refurbish your product to a certain level of quality after the use phase?		
	Do you have a take-back system for your product, with functioning reverse logistics?		
	Is there a second-hand market for your product?		
	Do you provide services like product leasing, sharing, pooling, pay-per-use or pay-per-service unit besides selling to your customers?		
	Do you provide consulting to your customers on how to use your product as long as possible?		
	Do you provide consulting to your customers on how to repair the product by themselves?		

Table 1 Circularity Matrix

The largest possibilities result from the largest difference between the actual and target status for the respective selected product or product area. The questions are not prioritized yet in terms of the largest ecological, economic or social effects. Such an evaluation will be possible in a subsequent Circularity Workshop.

The results of the matrix are presented in a detailed, structured overview. A radar chart (Figure 4) shows how much the current state differs from the future state for each area of action, so that the largest possibilities for action become visible. Questions with the highest potential are also listed separately. A closer look at the results and the development of solutions for the priority area are part of the Circularity Workshop following the application of the Circularity Matrix.



Prioritised Field of Action in Example (largest gap between actual and target state): '4 Circularity Aspects in Use Phase and End of Life'.

Questions with High Potential in Example:

- *Field of Action '1 Circular Product Development': Is your product systematically designed to save ressources in production and requires as little material as possible?*
- *Field of Action '3 Resource-Efficient Production': Do you use renewable energy in production?*

Figure 4 Example of a radar chart for illustration of the results of the circularity matrix

4.2 Circularity Workshop

After applying the Circularity Matrix, a statement can be made about the field of action with the largest potential. Individual starting points for a CE can also be created by looking at questions with the highest gap between the current situation and the company's target in three years. The largest possibilities should be examined in more detail in an in-depth circularity workshop. The aim of the workshop is to translate these findings into recommendations for concrete action and solution steps. Based on the findings of the workshops with the companies as well as the experience gained from company workshops conducted by EFA in other projects, a four-hour course was prepared for the next step after the application of the Circularity Matrix in order to generalise the findings. The workshop comprises the following steps:

1) Introductions & feedback,

2) Determine goals,

3) Develop project measures,

4) Conclusion & next steps.

As part of the first step, an external expert feedback is given in accordance with the prioritized field of action. This is in addition to analysis from the circularity matrix. As an example, company-individual feedbacks were prepared by the Prosperkolleg project as part of the study, which should enable a deeper examination of the chosen field of action. In step two, a 3-year target is defined for this field.

This is critically examined in the third step and fist solution steps are brainstormed using various methods. At the end of the workshop, the company receives a table of measures with short, medium and long-term recommendations for action.

It has been shown that the methods used are best carried out with a group of less than ten people of each company. Depending on the prioritized field of action, people from different departments of the company should participate in the workshop, ideally including relevant commercial or technical management positions. The Prosperkolleg project team is responsible for moderating and documenting the workshops, which is then sent to the company following the workshop. Additionally, the Prosperkolleg project team can establish suitable collaborations to implement the agreed upon possibilities. For example, EFA can provide support with its advisory services or the associated network. On the research side, cooperation with the Circular Digital Economy Lab (CDEL) at the Hochschule Ruhr West University of Applied Sciences or in the Prosperkolleg research network is a possibility. EFA can also help with the acquisition of funding.

5 Conclusion and Outlook

The work of the Prosperkolleg project has shown that the term CE is perceived differently by different companies and that there is no universal implementation model or solution that is suitable for all companies. There are, however, companies that have identified suitable solutions for themselves and can serve as examples of good practice.

It is important to take the first steps to experiment without fear and rethink your own business processes. As the results of the literature research and the findings of the study show, it can be worthwhile for SME to develop durable products, save resources, develop business models that are compatible with the competitive conditions of a climate- and resource-friendly economy in the long term, and put users at the forefront. If SME have already recognized the added value of CE, or if they are forced, for example through legal or customer requirements, to deal with CE, it is important to overcome the barriers of entry into the topic. Assistance such as the Prosperkolleg project's four-step CE Potential Check with its Circularity Matrix and Circularity Workshop offer a suitable approach for this. They create an understanding and offer assistance by offering courses of action and providing initial instructive recommendations for action.

Figures

Tables

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