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REVIEW PAPER

The Adoption of Circular Business Models in Germany: an Analysis of the DAX40 Companies

Mounir Al-Naami[1] · Kay H. Hofmann[1] · Kai-Michael Griese[1]

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Abstract
In view of the rapid depletion of natural resources and the associated overloading of the biological ecosystem, the concept of circular business models (CBMs) is increasingly discussed in the literature as well as in business practice. CBMs have the potential to significantly reduce the demand for natural resources. Despite their increasing relevance, the diffusion of CBMs in business practice is largely unexplored. Consequently, this article investigates the extent to which CBMs have already been adopted by large German companies. To answer this question, the annual and sustainability reports of the members of the DAX40 are analyzed for the presence of five specific types of CBMs. Data was gathered for the years 2015 and 2020 in order to describe the development over time. The results show an increasing prevalence of CBMs in the DAX companies. In addition, it is noticeable that CBM types that serve to close material cycles are implemented more frequently than those that decelerate material cycles. In particular Sharing Platforms and Product as a Service stand out due to comparatively low adoption. Potential reasons for these findings are discussed and managerial as well as policy implications suggested.

Keywords Circular economy · Business models · Circular business models · DAX40

Introduction

Given its potential to counteract the rapid depletion of natural resources and the generation of waste and emissions, the concept of the circular economy has gained increasing relevance in science and practice in recent years [22]. By helping to decouple economic activities from the extraction of primary raw materials [23], the concept promises a "win–win" situation in which environmental protection is compatible with economic growth [37]. For example, forecasting models indicate that the circular economy has the potential to reduce European consumption of primary raw materials by 32% by 2030 and 53% by 2050 [15].

✉ Kai-Michael Griese
k-m.griese@hs-osnabrueck.de

[1] Faculty of Business Management and Social Sciences, University of Applied Sciences Osnabrück, Caprivistraße 30a, 49076 Osnabrück, Germany

Circular business models (CBM) refer to business models that, through the configuration of their benefit dimensions, help to ensure that products and materials are used for as long as possible, thus reducing the need for primary raw materials [51, 61]. Research investigating the concept of circular business models has gained prominence and momentum in the management literature in recent years [22].

A central research strand represents the classification of different manifestations of CBM [66]. In this regard, several typologies have been developed that classify the different types of circular business models (e.g., [4, 32, 46, 49, 52, 58]. Empirical studies on their implementation are mainly limited to industry-specific case studies (e.g., [5, 12, 28, 59, 62, 68, 74, 76, 77]. Although the widespread adoption of circular business models is considered to be a key driver of the circular transformation [8, 32], the diffusion of the various types of CBM in practice is rarely studied, noteworthy exceptions are Ghisellini and Ulgiati [24] and Bocken et al. [6].

The aim of the paper at hand is to narrow this research gap by investigating the adoption of circular business models among German companies and consequently outlining the proliferation of CBM in Germany. In addition to describing the status quo for the year 2020, the development over the previous 5-year period is analyzed to identify changes and possible trends. Existing case studies show that the development and implementation of circular business models is a demanding and lengthy process [3], which is the reason why an interval of 5 years was chosen. Due to the scale of their economic activities and their impact on the ecological environment, the focus is on large companies [33, 71] (cited in [20], p. 7). More specifically, the members of the German prime stock index DAX40 are analyzed. Accordingly, the paper at hand addresses two research questions. First, which circular business models do DAX40 companies adopt? And second, how has their implementation changed since the year 2015?

Since the prevalence of circular business models is generally still under-investigated and quantitative evidence for Germany is absent, an explorative research approach is used. The annual and sustainability reports of companies included in the DAX40 are examined regarding the mentioning of circular business models by employing a combination of automated and manual content analysis. The results provide a first overview of the adoption of CBM among large German companies and inform a preliminary discussion of the managerial as well as policy implications. The paper closes with a brief conclusion and an outline of its limitations.

Circular Business Models in Theory and Practice

The circular economy describes an economic system in which products and materials are used productively for as long as possible by not disposing of them after a period of use, but reusing them through return mechanisms or cycles such as resale or reprocessing [43]. As depicted in Fig. 1, the circular economy in its mode of operation represents a counter-design to the currently prevailing economic system of the linear economy (i.e., take-make-dispose), in which raw materials are processed into products after they have been extracted and, after a one-time use phase, are usually landfilled or incinerated as waste [17, 46]. According to the principle of the "power of the inner circles" [82], products should be preserved in their original form for as long as possible after their manufacture by choosing the shortest possible cycle for recycling. This is because the shorter the cycle, the more

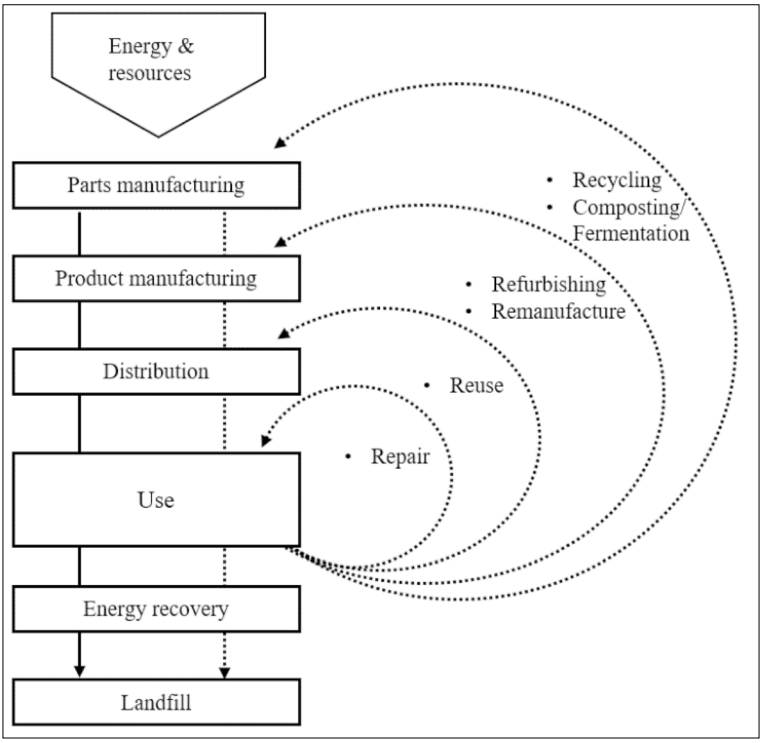

Fig. 1 Resource flows in the linear (left) and circular (right) economy (source: own illustration based on [14, 22, 40])

product value is retained and the less capital (resources, labor, and energy) needs to be expended to make the product or materials usable again [44].

In order to implement the concept of the circular economy at company level, the business model is seen as key leverage [22, 25]. Business models describe the holistic business logic behind companies, business units, or products [69, 80] and define what value is offered to customers ("value proposition"), how this value is created and delivered ("value creation and value delivery"), and how the company ultimately skims off economic value in the form of profits ("value capture") [64]. In contrast, circular business models generate ecological value in addition to economic value by integrating circular economy strategies or principles in their benefit dimensions, thus helping to reduce the overall societal use of primary raw materials and the generation of emissions [7, 48]. Two basic circular strategies or approaches can be distinguished [4]. Closing material loops ("closing resource loops") aims at reusing materials after their end of use, thus closing the gap between post use and production. This is achieved through measures such as recycling or composting. The deceleration of material cycles ("slowing resource loops") is achieved by extending the use phase of products (e.g., through repair services or the reprocessing of products) or intensifying it (e.g., by sharing products between several users). By using products and their components longer or sharing them between multiple users, the need for new products is reduced, which in turn slows down the throughput of raw materials in the economy. Consequently, business models

can be defined as circular if the configuration of their value dimensions helps to close and/or decelerate resource flows [4, 57].

The two circular approaches can manifest in different ways in business models. No generally accepted typology of circular business models has yet been established in the literature [63]. Existing approaches differ, among other things, in the classification criteria used and in their level of detail [49, 57]. In this paper, the typology of Lacy et al. [46] is adopted [47], which is frequently cited in both academic articles (e.g., [17, 54, 78]) and practice-oriented reports (e.g., [60]). Table 1 portraits the five CBM types, including their respective underlying circular approach.

Circular Inputs business models use renewable, recycled, recyclable, or biodegradable inputs to create their service offerings [47]. This includes both physical materials and energy. The idea is to use inputs that do not contribute to the depletion of finite resource stocks on the one hand and to enable recycling into biological and technical material cycles (biodegradable and recycled materials) on the other hand. In this way, the business model contributes to closing material cycles. An example of the CBM type can be found at Adidas, the German sporting goods manufacturer, that has been using yarn made from recycled marine plastic for the production of individual models, thus replacing virgin plastic since 2015 [1].

The business model of sharing platforms makes it possible to optimize the productive use of underutilized products. Digital platforms connect product owners with other consumers or companies interested in using the goods, thereby enabling the sharing of property [46]. Economic value is created by charging a fee for a transaction between product owner and user made through the platform [47]. The collaborative use of products reduces the need for new products and the associated resource input, which contributes to the deceleration of material cycles. Examples include the Cohealo and FLOOW2 platforms. While the former enables the sharing of medical equipment between hospitals, FLOOW2 supports the sharing of machines and office space between companies.

In Product as a Service business models, manufacturers retain ownership of a product and sell only the use or function of the product in the form of a service [46]. Similar to sharing platforms, this increases the utilization of products, which in turn reduces the need for new raw materials [40]. The product function can be made available to customers via pay-per-use, renting or leasing, or performance agreements [47]. For example, tire manufacturer Michelin offers its enterprise customers the option to pay for its tires per mile driven (pay-per-mile). Other examples include renting cars (e.g., Europcar, Sixt), tools (e.g., OBI), electronic devices (e.g., Grover), or clothing (e.g., Leasing for Good).

Product Use Extension business models employ mechanisms that prolong the use period of products and their components [46], thereby lowering the demand for new products and avoiding the use of additional resources [52]. According to OECD [60], these circular business models can be broken down into four subtypes, as shown in Table 2.

Companies employing the Classic Long Life subtype offer high-quality, durable products that are usually combined with additional services (e.g., free repairs or warranties) and are charged at a price premium [4]. Examples include the German household and commercial appliance manufacturer Miele, which markets its products with a service life of 20 years or the Dutch smartphone manufacturer Fairphone. The latter's products are sold with a warranty of up to 5 years and can be repaired by customers themselves. The second subtype, "Maintenance & Repair," may be adopted by manufacturers, retailers, or third party service providers [52]. Examples are car manufacturers such as Mercedes Benz or Tesla, which offer maintenance and repair services in their own workshops. A similar approach is common for electronic devices: the German retail

Table 1 Typology of circular business models

CBM Type	Description	Circular approach
Circular Inputs	Use of renewable, recyclable, and secondary resources to create the service offering	Closing of material cycles
Sharing Platforms	Connecting product users to share products that are already in circulation	Deceleration of material cycles
Product as a Service	Customers are not sold product ownership but access to the product function in the form of services	Deceleration of material cycles
Product Use Extension	Extending the use phase of products and their components through various measures	Deceleration of material cycles
Resource Recovery	Extraction of secondary raw materials and renewable energy from waste streams	Closing of material cycles

Source: own illustration based on Lacy et al. [46], Nußholz [57], and OECD [60]

Table 2 Subtypes of "Product Use Extension"

Subtype	Explanation
Classic Long Life	The expected life of a product is extended through durable product design
Maintenance & Repair	By replacing defective components, the business model enables worn products to reach their full expected life
Direct Reuse	Products that would otherwise be disposed of before reaching their expected end of life are resold without significant reprocessing
Refurbishment & Remanufacturing	Products or product components are given a "new life" by being reprocessed and resold or used in the manufacture of new products

Source: own illustration based on OECD [60]

chain Media-Saturn, for example, offers repair services in its specialist stores. The third subtype comprises the resale of used but still functioning products to new users after the end of a use phase. This offers incremental customers a cost-effective alternative to new goods [52]. Examples are the online fashion retailers Zalando and aboutyou that sell pre-owned, second-hand clothing. The last subtype focuses on remanufacturing of products or components at the end of their service life. This implies processing used goods either to restore functioning (i.e., refurbishment) or create new ones (i.e., remanufacturing). For example, the Dutch medical and household devices manufacturer Philips sells refurbished products such as vacuum cleaners and coffee machines. Another example is Swappie, a Finnish company that is specialized on refurbishing used iPhones. Remanufacturing is usually carried out by original equipment manufacturers because it requires significant technical knowledge of the product [60]. In its "Cat-Reman" program, Caterpillar disassembles used construction equipment, processes the individual parts, and reuses them for new products. Similarly, Renault remanufactures pre-owned car components and incorporates them into the production of new vehicles.

Business models of the resource recovery type recycle a company's own or external waste streams into secondary raw materials [46]. Technical waste is recovered through recycling, while biological waste is processed, for example, through composting or fermentation. The Swiss accessories manufacturer FREITAG represents this business model: the company uses external waste in the form of used truck tarpaulins, seat belts, and bicycle inner tubes to make bags.

The above-mentioned CBM types can be pursued simultaneously and/or may be combined. For example, the Product as a Service model can be an incentive for the parallel introduction of the Product Use Extension model, so that products loaned to customers can generate revenue for as long as possible [75, 78]. The use of recyclable materials in the manufacture of products can also incentivize the simultaneous adoption of end-of-life recycling processes [60]. Dell Technologies is a prime example here because recyclable, recycled, and renewable materials are used in the manufacturing process (i.e., Circular Inputs), and at the end of the use phase, the company collects the devices either for reselling (i.e., Product Life Extension) or recycling (i.e., Resource Recovery) [13]. Finally, an adoption of circular business models or circular approaches besides linear ones within one company is also possible, as the Adidas example from above illustrates.

1. Preparing the data set	2. Developing the research tools
- Drawing the sample from the German stock market index DAX40 - Gathering annual and sustainability reports from company websites	- Adopting the category system from theory - Creating the dictionary for automated content analysis - Developing the code book for manual review
3. Testing the research tools	**4. Coding the data set**
- Applying the dictionary and code book to ten reports - Adjusting the dictionary to better represent the categories	- Executing the automated content analysis - Reviewing codings for their validity manually
5. Evaluation Phase	
- Aggregating the findings from document to company level	

Fig. 2 Research process (source: own illustration based on [21])

The academic literature on circular business models is still nascent but has been expanding rapidly since 2016 [18, 70]. Beyond identifying their characteristics and developing typologies as described above, studies are mainly concerned with investigating best practices and drivers as well as barriers for their implementation [5, 62, 65, 68, 76] and devising practical instruments that support decision-making in companies [8, 66]. Of particular interest is the transition from linear to circular business models [17] because many inherent features of the former are at odds with those of the latter [38]. Along these lines, identifying promising industries and types of businesses remains important [19, 56]. Further topics are collaborative approaches [16, 45], business model innovation [63], and the management of resource flows [34]. Although first studies exist that highlight the role of the customer [11, 29, 55], much research continues to fall short of integrating the consumer perspective [16, 18, 79]. Other under-investigated topics include the social implications of the circular transition, the mitigation of possible rebound effects [70], the role of circularity for competitive advantage as well as shareholder value, and the effects of various regulatory interventions [18].

Method

In order to investigate the prevalence of circular business model types in large German companies, a five-step research procedure was implemented, which is depicted in Fig. 2.

First, the sample was defined by narrowing down the members of the German stock market index DAX40 so that the final sample only includes firms relevant to the research question. For this, companies that do neither directly nor indirectly manufacture or distribute physical products or energy were excluded because their comparatively low demand for natural resources offers few possibilities for establishing circular business models (i.e., companies from the banking, software, and insurance industries). In addition, companies headquartered outside of Germany were removed. Lastly, one non-operative holding company was excluded. The final sample comprises 31 companies. The industry break-down is shown in Table 3. Twenty-three of the 31 sample companies (74%) are producers of physical goods; the remaining are service firms. This sample characteristic is relevant because

Table 3 Number of companies per industry

Sector	Amount
Automobile	4
Chemicals	4
Construction	1
Consumer	4
E-Commerce	3
Industrial	4
Pharma and healthcare	5
Real estate	1
Technology	1
Telecommunication	1
Transportation and logistics	1
Utilities	2

Source: own illustration

Table 4 CBM categories and examples of corresponding keywords

ID	Category	Dictionary (examples)
1.0	Circular Inputs	bio based, biodegradable, cradle to cradle, etc
2.0	Sharing Platforms	sharing, pooling, co own, co access, etc
3.0	Product as a Service	as a service, rental, leasing, subscription model, etc
4.0	Product Use Extension	
4.1	Classic Long Life	long life, durable, durability, product longevity, etc
4.2	Maintenance & Repair	maintenance, repair, fix, etc
4.3	Direct Reuse	pre-own, second hand, resell, resale, second life, etc
4.4	Refurbishment & Remanufacturing	refur, reproces, recondition, remanufact, etc
5.0	Resource Recovery	recycl, compost, upcycle, downcycling, etc
6.0	Default	Documents were assigned to this category if they could not be assigned to any CBM type

Source: own illustration

certain CBM types (i.e., Classic Long Life and Remanufacturing) can only be adopted by producers. The annual and, if available, sustainability reports of the 31 companies for the years 2020 and 2015 were collected via the respective company websites. The final data material comprises 100 reports, consisting of 60 annual reports and 40 sustainability reports.

In a second step, the research tools were designed. In line with the typology presented above, the category system consists of five main and four sub-categories as well as one default category. In order to analyze the data material with the help of automated content analysis, a dictionary was created that operationalizes the categories with the help of keywords and search strings, respectively [2]. First, relevant words or word combinations

and their synonyms were derived from the extant literature. This word list was then supplemented by relevant keywords that occurred in the reports but had not been considered. Table 4 lists the categories and sub-categories and provides examples from the dictionary.[1]

Automatic content analysis has the disadvantage that the underlying computer algorithm does not understand the semantic meaning of the text content to be analyzed [9]. In the face of ambiguities of meaning, negations, or rhetorical devices, this lack of linguistic competence can lead to misclassifications, which in turn leads to validity problems [81]. To address this pitfall, a codebook for reviewing the automatically generated codings was created according to manual content analysis guidelines [67]. This should ensure the replicability of the content analysis and thus contribute to the reliability of the entire research procedure [50].

In order to test the dictionary, a pretest was carried out on a sample of ten reports (five business and five sustainability reports). To reduce "false positives" [2], search words were identified that frequently led to erroneous coding and were specified or completely removed from the dictionary. More important for the validity of the study was to identify false negatives and to adjust the dictionary accordingly. For this purpose, the ten documents of the test sample were coded manually using the codebook. Subsequently, it was checked whether automated coding using the dictionary would have produced the same result. Shortcomings in the dictionary were addressed by adding missing keywords.

During the coding process, all 100 documents were automatically coded. Based on the dictionary, the algorithm (MAXQDA-Dictio) marked the search words of the dictionary in the reports and coded them with the ID of the corresponding category. In a next step, the codings were manually reviewed with the help of the codebook. Since it is only of interest which CBM types are addressed in the reports and not how often they are mentioned, not all codings of one CBM type had to be checked manually. As soon as a document was assigned to a CBM category, the remaining codes of the same category were only occasionally checked since the evidence for the occurrence of the corresponding CBM type had already been found. In the event that structural or shareholding links existed between companies in the sample, the manual review helped to avoid duplications. Effectively, all 100 documents were assigned to the categories and sub-categories as shown in Table 4.

Finally, the coded data was processed and analyzed in the evaluation phase. As part of the processing and if applicable, results at document level were aggregated in order to be able to make statements at company level.

Results

Current Use of Circular Business Models

Figure 3 shows the adoption of the different types of CBM in the sample for the year 2020. Due to the fact that companies may employ several types simultaneously, multiple assignments are possible. It is striking that every company uses at least one type of CBM,

[1] The complete dictionary including all keywords and search strings is available from the authors upon request.

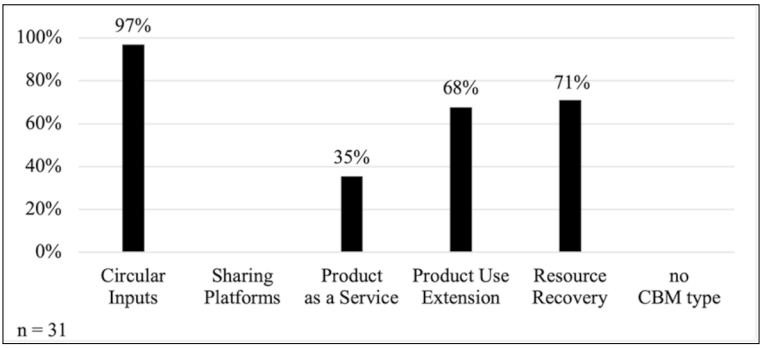

Fig. 3 Proportion of companies per main CBM type in 2020 (source: own illustration)

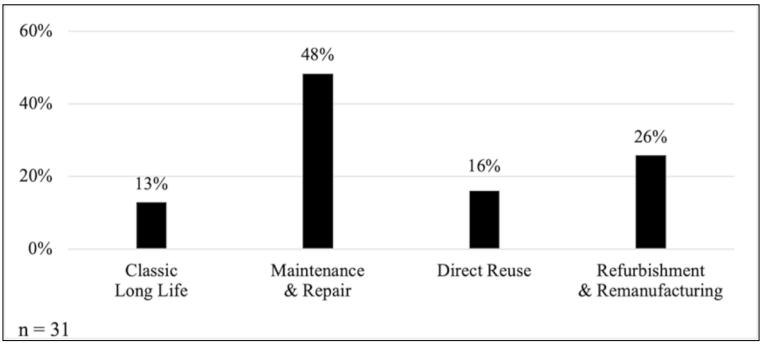

Fig. 4 Proportion of companies adopting a subtype of Product Use Extension in 2020 (source: own illustration)

explaining why the default category "no CBM type" remains empty. With the exception of Sharing Platforms, all CBM types are used among companies in the sample.

The adoption rates of the individual CBM types, however, differ significantly. Circular Inputs and Resource Recovery, both models that aim at closing resource loops, are used most widely. While Product Use Extension, a CBM type that decelerates material cycles, is adopted by approximately two thirds of all companies, Product as a Service clearly falls behind: only 35% of firms have adopted this CBM. Overall, this suggests that closing resource loops models are used somewhat more frequently compared to slowing business models (i.e., Sharing Platforms, Product as a Service, and Product Use Extension). Figure 4 further specifies the adoption of the four subtypes of Product Use Extension. Here, it is striking that Maintenance & Repair stands out with an adoption rate of 48%. The other subtypes have a comparatively low rate of adoption, especially Classic Long Life. Only four DAX40 companies have adopted at least one business model that offers more durable products.

Development of Circular Business Model Adoption Since 2015

In order to ensure a consistent number of companies for the comparison between 2020 and 2015, two companies had to be removed from the sample for two reasons: either they did

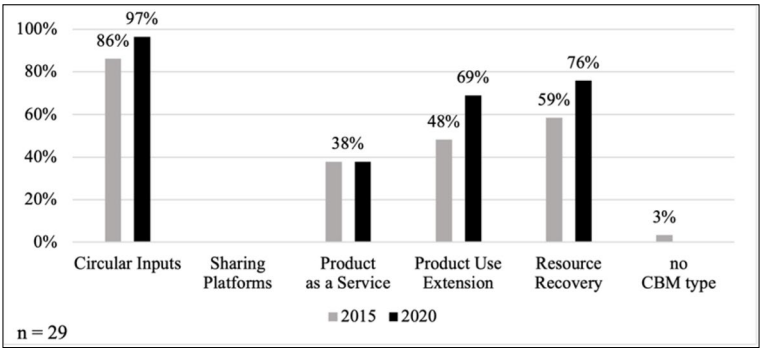

Fig. 5 Development of adoption rate per main CBM type 2015 vs. 2020 (source: own illustration)

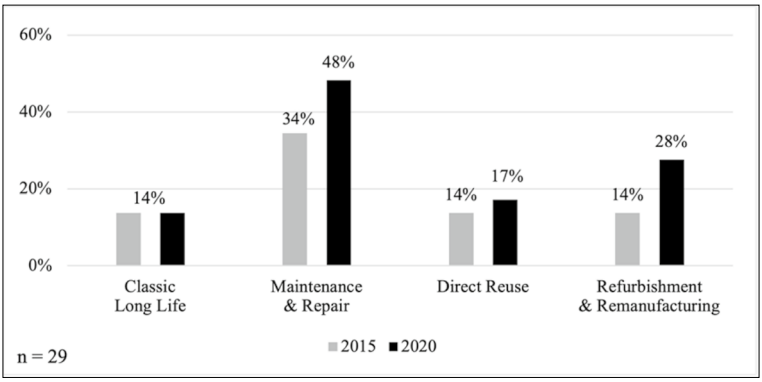

Fig. 6 Proportion of companies adopting a subtype of Product Use Extension 2015 vs. 2020 (source: own illustration)

not exist in 2015 or did not publish the necessary reports. Consequently, the sample for the following analyses consists of 29 companies.

Figures 5 and 6 repeat the analyses from above but visualize the development of adoption over the 5-year period. In general, the results indicate a positive trend for all types, except for Sharing Platforms and Product as a Service—the adoption rates for the latter two remained flat (cf. Figure 5). The one company (3%) with no circular approach in 2015 has implemented at least one CBM in or before the year 2020.

The strongest increase is recorded for the Product Use Extension category. When looking at the corresponding subtypes depicted in Fig. 6, it becomes evident that the positive development is mainly driven by significant adoption increases of Maintenance & Repair as well as Refurbishment & Remanufacturing models. The comparison between models that close versus decelerate resource loops shows that closing models have proliferated more than decelerating ones. The overall positive trend is underlined by an increase of the average number of main CBM types used per company from 2.3 in 2015 to 2.8 in 2020. This development suggests that the largest German companies are underway to explore additional CBM types, hence increasing the variety of circular approaches adopted in practice.

Discussion and Implications

The aim of the previous section was to provide an overview of the prevalence of circular business models among German DAX companies. A significant dysbalance, for example, is noticeable when comparing circular business models that serve to close material cycles and those that decelerate cycles. The former are implemented more frequently by DAX companies than the latter, a finding that is consistent with the observations of Bocken et al. [6], who also diagnosed a focus of large US companies on closing material cycles. In the research at hand, this observation can be explained by the low adoption rates of Sharing Platforms and the CBM type Product as a Service. This may be driven by a low market demand for such business models and their value propositions, at least for some product or service categories. For example, sharing or renting consumer products may be impossible or at least inconvenient. For other durable products such as automobiles, computers, or tools, consumers still prefer owning the goods [73]. Although the technical feasibility for chemical products is somewhat limited, chemical distributor Brenntag offers "performance agreements" under which the company leases the functionality of certain chemicals—customers are billed for the results achieved instead of for the ordered chemicals. This approach reduces the total amount of chemicals, also because certain agents can be re-used. Overall, Product as a Service CBMs tend to be mainly adopted by companies offering technologically complex and hence expensive products, for example, in healthcare (Fresenius and Siemens Healthineers), aero-engineering (MTU Aero Engines), and automobiles (BMW, Daimler, and Volkswagen). Although car sharing offers by automobile manufacturers have become increasingly popular among (younger) consumers, Product as a Service business models seem to be especially appealing in business-to-business contexts. For example, Deutsche Telekom provides and maintains cloud-based IT infrastructure which makes significant investments in hardware redundant for Telekom's clients.

Nevertheless, concerns about cannibalization effects could prevent a more widespread use of the two types of CBM. Sharing platforms and Product as a Service models reduce, at least theoretically, the need for ownership by selling idle capacities or usage rights for these products. In contrast to the other CBM types, the two CBMs that decelerate resource loops thus break with the classic, linear logic of value creation, which aims at maximizing product sales [40]. Since the core business of most companies in the sample is built on precisely this value creation logic, the two CBM types consequently pose a potential threat to the main purpose of public corporations. Finally, it is also conceivable that DAX companies are generally open to the adoption of sharing platforms and Product as a Service business models, but do not have the necessary innovative strength or dynamic capabilities to implement them. Large incumbent companies tend to maintain the status quo or optimize it with the help of incremental innovations [39]. Radical innovations, such as sharing platforms and Product as a Service models, often encounter institutional, cultural, and administrative barriers, which impede their successful implementation [32, 72]. Unlike the other CBM types, they do not necessarily build on the existing value creation logic (i.e., maximizing product sales), but require the creation of completely new value propositions and economic value creation patterns. While this may exceed the innovation capacity of many DAX companies, smaller organizations and especially start-ups may find it easier to implement CBMs that decelerate economic activity, despite significant resource constraints within these firms [35].

The third most frequently implemented CBM type in the sample is Product Use Extension. Within this category, the strongest subtype is Maintenance & Repair, which is a

promising result because it leverages the power of the inner circles. The adoption of the other subtypes is relatively low. The organization of economically viable take-back systems for the collection and return of used products may be one possible barrier [53, 78]. Another obstacle may be the risk of cannibalization: if a company expands its range to include cheaper recycled product variants (i.e., Direct Reuse, Refurbishment & Remanufacturing) or long-lasting expensive alternatives (i.e., Classic Long Life), it will create additional competition for its existing product portfolio, potentially lowering sales of product variants with higher margins. The two fast moving consumer goods companies Henkel and Beiersdorf, however, have implemented a noteworthy business model that enables consumers in selected retail outlets to refill products such as shampoos or laundry detergent. Although this approach does only extend the lifecycle of the packaging, it is likely to create value for the seller and buyer.

With regard to the second part of the research question, the analysis shows that the use of circular business models in DAX companies has increased since 2015. In line with the relevant literature, this indicates that circular business models gain popularity in practice. Based on the assumption that public companies only pursue business models if they promise economic success [26], the growth also suggests that the majority of circular business models have become more attractive from an economic perspective. This may be related to new technologies, legislation, or increasing demand [60]. Despite the overall positive trend, the penetration of Sharing Platforms, Product as a Service, and Classic Long Life CBMs has not increased since 2015 and remains on a comparatively low level. This result suggests that fundamental hurdles exist that restrain DAX companies from slowing down resource loops in Germany.

Managerial Implications

The identified gaps in the proliferation of various CBM types represent business opportunities to capture both ecological and economic values. In order to seize these opportunities, DAX companies could especially explore the technological and economic feasibility of Sharing Platforms and Product as a Service models as part of innovation projects. For this purpose, it may be advisable to cooperate with companies within and across their respective industries [41]. Advantages of innovation partnerships include but may not be limited to bundling complementary competencies and sharing investment expenditure as well as risks [10, 27, 31]. An example of this is the car sharing company SHARE NOW, which is a joint venture of the automobile companies BMW and Mercedes Benz Group. In this context, joint ventures may represent a good governance mode to advance business models that would encounter institutional or cultural barriers in their parent companies or conflict with prevailing linear business models.

Policy Implications

Since the prospect of economic value creation is the most important driver for companies to revise existing business models and implement circular ones [23, 26], policy makers should use regulatory instruments that make the use of decelerating CBMs economically more attractive. These include, for example, extending or lengthening legally mandated product warranties [41] to encourage the production of long-lasting products. Another possibility is to expand extended producer responsibilities (EPR) to further product categories in order to incentivize companies to reuse products at the end of their use phases. At the

same time, the tax system could be adapted by shifting the comparatively high taxation of labor to the use of private raw materials [36]. On the one hand, this contributes to the internalization of environmental externalities, and on the other hand, it reduces the costs of labor-intensive CBM types, such as Maintenance & Repair or Refurbishment & Remanufacturing, thus creating financial incentives for their implementation. Kirchherr et al. [42] were able to show through surveys and expert interviews with European companies and policymakers that a lack of consumer interest and awareness of circular products is a significant barrier to the circular transformation in the EU. Consequently, to stimulate demand for circular business models or their service offerings in the B2C sector, consumer education campaigns should be used in collaboration with NGOs and companies [30].

Conclusion

The paper at hand examines the proliferation of circular business models in large German companies and shows how the development has been since 2015. The results show that, with the exception of the sharing platform business model type, all CBM types are used in the sample companies. Business models that serve to close material cycles are used more frequently than those that decelerate material cycles, a result which is somewhat disappointing due to the potentially higher societal impact of the latter business models. The three CBM types Circular Inputs, Resource Recovery, and Product Use Extension are used by more than two thirds of the companies. Sharing Platforms and Product as a Service models have a comparatively low prevalence. This may be due to the fact that they are at odds with the classic, linear logic of value creation, which aims at maximizing product sales. Especially, the latter can be reasonably expected to be inherent in the missions of most public corporations. Consequently, this stark contrast to the currently prevailing economic approach curtails the adoption of decelerating circular business models in practice. Based on the assumption that all CBM types are relevant for the sustainable transformation of society, deficits and imbalances thus point to untapped potential.

With regard to the second part of research question, an overall increase in the use of circular business models can be observed. This underscores the increasing relevance of circular business models in the German economy. Sharing Platforms and Product as a Service models stand out negatively in the longitudinal comparison. Together with the Classic Long Life subtype, their rates of adoption have only stagnated. The findings are consistent with previous, albeit very limited research on circular practices in large companies. For Germany, the research at hand provides the first systematic investigation into the proliferation of circular business models. Methodologically, the work represents a further development of previous research approaches. Automated content analysis was combined with classical, manual content analysis to increase the validity of the results. This approach proved to be a suitable tool for identifying circular business models in text materials.

The explorative nature of the study results in a number of limitations that offer starting points for future research. In order to clarify the status quo of CBMs in large German companies, a heterogeneous sample was necessary. Since the companies differ in their industries, service offerings, strategic positionings, and target groups, only limited general conclusions can be drawn. Hence, future studies should apply the research design of this paper to a more homogeneous sample in order to expand the scope for interpretation. The second limitation results from the data collection methodology. While the combination of automated and manual content analysis proved valuable (i.e., the manual review allowed to

correct erroneous classifications and exclude false positives), only sections in the analyzed reports that were flagged in the automated coding were manually reviewed. Thus, there is a possibility that relevant sections were missed (i.e., false negatives) due to unknown and omitted keywords in the dictionary. For example, the keywords "waste based" and "recirculation" were initially not considered in the deductively derived dictionary but were identified through inductive keyword derivation and added to the dictionary later. While "waste based" led to the identification of companies that use waste to create new products (i.e., Circular Inputs), "recirculation" describes practices that reuse waste water (i.e., Resource Recovery). These two examples illustrate the importance of inductive keyword derivation. Since it cannot be ruled out, however, that additional relevant keywords remained undetected, a small residual risk of false negatives remains as a limitation of the chosen method. Consequently, future research could extend the dictionary used here. Furthermore, additional documents such as press releases, press reports, or website content could be included for the analysis. Third, the research approach used here is unable to shed light on the extent of adoption. Companies that are identified as employing circular approaches may do so to much varying degrees and with fundamentally different underlying motivations (e.g., greenwashing versus advancing a sustainable business transformation). Such a study requires a more fine-grained view into the companies and probably insider information; automated content analysis of publicly available documents does not suffice. Finally and related to the previous limitation is the fact that the underlying reasons for differences in the adoption rates and for the observed trends remain unexplored. Again, deeper insights into the decision-making processes and a different methodology would be required.

Despite these limitations, the study at hand offers promising starting points for quantitative research that should, among other things, examine the underrepresented CBM types to shed light on the reasons for their comparatively low adoption in practice. At the same time, methodological adjustments can be made to increase the interpretability of future studies. Overall, the study does not only provide valuable insights into the proliferations of circular business models in German DAX companies, but also underlines the urgency of further research.

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References

1. Adidas (2019). Adidas schließt den Produktlebenszyklus mit Futurecradt.Loop: Ein Performance-Laufschuh geschaffen für ein neues Leben, https://www.adidas-group.com/de/medien/newsarchiv/pressemitteilungen/2019/adidas-schliesst-den-produktlebenszyklus-mit-futurecraftloop/ [14.01.2022]
2. Belderbos R, Grabowska M, Leten B, Kelchtermans S, Ugur N (2017) On the use of computer-aided text analysis in international business research. Glob Strateg J 7(3):312–331. https://doi.org/10.1002/gsj.1162
3. Bjørnbet MM, Skaar C, Fet AM, Schulte KØ (2021) Circular economy in manufacturing companies: a review of case study literature. J Clean Prod 294:126268. https://doi.org/10.1016/j.jclepro.2021.126268
4. Bocken NMP, de Pauw I, Bakker C, van der Grinten B (2016) Product design and business model strategies for a circular economy. J Ind Prod Eng 33(5):308–320. https://doi.org/10.1080/21681015.2016.1172124
5. Bocken NMP, Harsch A, Weissbrod I (2022) Circular business models for the fastmoving consumer goods industry: desirability, feasibility, and viability'. Sustain Prod Consum 30:799–814. https://doi.org/10.1016/j.spc.2022.01.012
6. Bocken NMP, Ritala P, Huotari P (2017) The circular economy: exploring the introduction of the concept among S&P 500 firms. J Ind Ecol 21(3):487–490. https://doi.org/10.1111/jiec.12605
7. Bocken NMP, Short SW, Rana P, Evans S (2014) A literature and practice review to develop sustainable business model archetypes. J Clean Prod 65:42–56. https://doi.org/10.1016/j.jclepro.2013.11.039
8. Bocken NMP, Strupeit L, Whalen K, Nußholz J (2019) A Review and Evaluation of Circular Business Model Innovation Tools. Sustainability 11(8):2210. https://doi.org/10.3390/su11082210
9. Brosius H-B, Haas A, Koschel F (2016) Methoden der empirischen Kommunikationsforschung: Eine Einführung, 7. Auflage, Springer VS, Wiesbaden
10. Buckley PJ, Casson MC (1998) Models of the multinational enterprise. J Int Bus Stud 29:21–44. https://doi.org/10.1057/palgrave.jibs.8490023
11. Camacho-Otero J, Boks C, Pettersen IN (2018) Consumption in the circular economy: a literature review. Sustainability 10:2758. https://doi.org/10.3390/su10082758
12. de Jong AM, Mellquist A-C (2021) The potential of plastic reuse for manufacturing: a case study into circular business models for an on-line marketplace. Sustainability 13(4):2007. https://doi.org/10.3390/su13042007
13. Dell Technologies (2022) Sustainable products and services: delivering more, depleting less, https://www.dell.com/en-us/dt/corporate/social-impact/advancing-sustainability/sustainable-products-and-services.htm [06.02.2022]
14. Ellen MacArthur Foundation (2015) Towards a circular economy: business rationale for an accelerated transition, https://ellenmacarthurfoundation.org/towards-a-circular-economy-business-rationale-for-an-accelerated-transition. Accessed 05.01.2022
15. Ellen MacArthur Foundation, McKinsey Center for Business and Environment, and Stiftungsfonds für Umweltökonomie (2015) Growth within: a circular economy vision for a competitive europe. https://ellenmacarthurfoundation.org/growth-within-a-circular-economy-vision-for-a-competitive-europe. Accessed 05.01.2022
16. Ertz M, Leblanc-Proulx S, Sarigollu E, Morin V (2019) Made to break? A taxonomy of business models on product lifetime extension. J Clean Prod 234:867–880. https://doi.org/10.1016/j.jclepro.2019.06.264
17. Esposito M, Tse T, Soufani K (2018) Introducing a circular economy: new thinking with new managerial and policy implications. Calif Manag Rev 60(3):5–19. https://doi.org/10.1177/0008125618764691
18. Ferasso M, Beliaeva T, Kraus S, Clauss T, Ribeiro-Soriano D (2020) Circular economy business models: the state of research and avenues ahead. Bus Strateg Environ 29:3006–3024. https://doi.org/10.1002/bse.2554
19. Florido C, Jacob M, Payeras M (2019) How to carry out the trinsition towards and more cicular tourist activitiy in the hotel sector. The Role of Innovation. Adm Sci 9(2):47. https://doi.org/10.3390/admsci9020047
20. Frishammar J, Parida V (2019) Circular business model transformation: a roadmap for incumbent firms. Calif Manag Rev 16(2):5–29. https://doi.org/10.1177/0008125618811926
21. Früh W (2017) Inhaltsanalyse, 9. Auflage, UVK Verlag, Konstanz/München
22. Geissdoerfer M, Pieroni MPP, Pigosso DCA, Soufani K (2020) Circular business models: a review. J Clean Prod 277:123741. https://doi.org/10.1016/j.jclepro.2020.123741

23. Ghisellini P, Cialani C, Ulgiati S (2016) A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J Clean Prod 114:11–32. https://doi.org/10.1016/j.jclepro.2015.09.007
24. Ghisellini P, Ulgiati S (2020) Circular economy transition in Italy. Achievements, perspectives and constraints. J Clean Prod 243:118360. https://doi.org/10.1016/j.jclepro.2019.118360
25. Guldmann E, Huulgaard RD (2020) Barriers to circular business model innovation: a multiple-case study. J Clean Prod 243:1–13. https://doi.org/10.1016/j.jclepro.2019.118160
26. Gusmerotti NM, Testa F, Corsini F, Pretner G, Iraldo F (2019) Drivers and approaches to the circular economy in manufacturing firms. J Clean Prod 230:314–327. https://doi.org/10.1016/j.jclepro.2019.05.044
27. Hamel G (1991) Competition for competence and inter-partner learning within international strategic alliances. Strateg Manag J 12:83–103 (https://www.jstor.org/stable/2486643)
28. Han J, Heshmati A, Rashidghalam M (2020) Circular economy business models with a focus on servitization. Sustainability 12(21):8799. https://doi.org/10.3390/su12218799
29. Hankammer S, Brenk S, Fabry H, Nordemann A, Piller FT (2019) Towards circular business models: identifying consumer needs based on the jobs-to-be-done theory. J Clean Prod 231:341–358. https://doi.org/10.1016/j.jclepro.2019.05.165
30. Hansen E, Wiedemann P, Fichter K, Lüdeke-Freund F, Jaeger-Erben M, Schomerus T, Alcayaga A, Blomsma F, Tischner U, Ahle U, Büchle D, Denker A, Fiolka K, Fröhling M, Häge A, Hoffmann V, Kohl H, Nitz T, Schiller C, Tauer R, Vollkommer D, Wilhelm D, Zefferer H, Akinci S, Hofmann F, Kobus J, Kuhl P, Lettgen J, Rakowski M, von Wittken R, Kadner S (2021) Zirkuläre Geschäftsmodelle: Barrieren überwinden, Potenziale freisetzen, acatech/Circular Economy Initiative Deutschland/SYSTEMIQ. https://www.acatech.de/publikation/zirkulaere-geschaeftsmodelle-barrieren-ueberwinden-potenziale-freisetzen/. Accessed 15.02.2022
31. Hennart J-F (1988) A transaction costs theory of equity joint ventures. Strateg Manag J 9(4):361–374 (https://www.jstor.org/stable/2486271)
32. Henry M, Bauwens T, Hekkert M, Kirchherr J (2020) A typology of circular start-ups: an Analysis of 128 circular business models. J Clean Prod 245:1–19. https://doi.org/10.1016/j.jclepro.2019.118528
33. Hockerts K, Wüstenhagen R (2010) Greening Goliaths versus emerging Davids - Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. J Bus Ventur 25(5):481–492. https://doi.org/10.1016/j.jbusvent.2009.07.005
34. Hofmann F (2019) Circular business models: business approach as driver or obstructer of sustainability transitions? J Clean Prod 224:361–374. https://doi.org/10.1016/j.jclepro.2019.03.115
35. Hofmann KH, Jacob A, Pizzingrilli M (2022) Overcoming growth challenges of sustainable ventures in the fashion industry: a multinational exploration. Sustainability 14(16):10275. https://doi.org/10.3390/su141610275
36. Holtmann T, Schlaak T, Börsch A, Neuhuber L, Koring E-C (2021) Zirkuläre Wirtschaft: Herausforderungen und Chancen für den Industriestandort Deutschland, Deloitte/BDI. https://www2.deloitte.com/content/dam/Deloitte/de/Documents/risk/Zirkuläre%20Wirtschaft%20Studie_Deloitte%20und%20BDI.pdf. Accessed 01.03.2022
37. Homrich AS, Galvão G, Abadia LG, Carvalho MM (2018) The circular economy umbrella: trends and gaps on integrating pathways. J Clean Prod 175:525–543. https://doi.org/10.1016/j.jclepro.2017.11.064
38. Hopkinson P, Zils M, Hawkins P, Roper S (2018) Managing a complex global circular economy business model: opportunities and challenges. Calif Manag Rev 60(3):71–94. https://doi.org/10.1177/0008125618764692
39. Inigo EA, Albareda L, Ritala P (2017) Business model innovation for sustainability: exploring evolutionary and radical approaches through dynamic capabilities. Ind Innov 24(5):515–542. https://doi.org/10.1080/13662716.2017.1310034
40. Jaeger-Erben M, Hofmann F (2019) Kreislaufwirtschaft – Ein Ausweg aus der sozial-ökologischen Krise?, Hessische Landeszentrale für politische Bildung, Wiesbaden
41. Kadner S, Kobus J, Hansen E, Akinci S, Elsner P, Hagelüken C, Jaeger-Erben M, Kick M, Kwade A, Kühl C, Müller-Kirschbaum T, Obeth D, Schweitzer K, Stuchtey M, Vahle T, Weber T, Wiedemann P, Wilts H, von Wittken R (2021) Circular Economy Roadmap für Deutschland, acatech, Circular Economy Initiative Deutschland/SYSTEMIQ. https://doi.org/10.48669/ceid_2021-3
42. Kirchherr J, Piscicelli L, Bour R, Kostense-Smit E, Muller J, Huibrechtse-Truijens A, Hekkert M (2018) Barriers to the circular economy: evidence from the European Union (EU). Ecol Econ 150:264–272. https://doi.org/10.1016/j.ecolecon.2018.04.028
43. Korhonen J, Honkasalo A, Seppälä J (2018) Circular economy: the concept and its limitations. Ecol Econ 143:37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

44. Korhonen J, Nuur C, Feldmann A, Birkie SE (2018) Circular economy as an essentially contested concept. J Clean Prod 175:544–552. https://doi.org/10.1016/j.jclepro.2017.12.111
45. Lacy P, Keeble J, McNamara R, Rutqvist J, Haglund T, Cui M, Cooper A, Pettersson C, Kevin E, Buddemeier P (2014) Circular advantage: innovative business models and technologies to create value in a world without limits to growth. Accenture, Chicago
46. Lacy P, Long J, Spindler W (2020) The circular economy handbook: realizing the circular advantage. Palgrave Macmillan, London
47. Lacy P, Rutqvist J (2015) Waste to wealth: the circular economy advantage. Palgrave Macmillan, London
48. Lahti T, Wincent J, Parida V (2018) A definition and theoretical review of the circular economy, value creation, and sustainable business models: where are we now and where should research move in the future? Sustainability 10(8):2799. https://doi.org/10.3390/su10082799
49. Lewandowski M (2016) Designing the business models for circular economy - towards the conceptual framework. Sustainability 8(1):43. https://doi.org/10.3390/su8010043
50. Lewis SC, Zamith R, Hermida A (2013) Content analysis in an era of big data: a hybrid approach to computational and manual methods. J Broadcast Electron Media 57(1):34–52. https://doi.org/10.1080/08838151.2012.761702
51. Linder M, Williander M (2017) Circular business model innovation: inherent uncertainties. Bus Strateg Environ 26(2):182–196. https://doi.org/10.1002/bse.1906
52. Lüdeke-Freund F, Gold S, Bocken NMP (2019) A review and typology of circular economy business model patterns. J Ind Ecol 23(1):36–61. https://doi.org/10.1111/jiec.12763
53. Mollenkopf DA, Frankel R, Russo I (2011) Creating value through returns management: exploring the marketing-operations interface. J Oper Manag 29(5):391–403. https://doi.org/10.1016/j.jom.2010.11.004
54. Moreno M, De los Rios C, Rowe Z, Charnley F (2016) A conceptual framework for circular design. Sustainability 8(9):937. https://doi.org/10.3390/su8090937
55. Mostaghel R, Chirumalla K (2021) Role of customers in circular business models. J Bus Res 127:35–44. https://doi.org/10.1016/j.jbusres.2020.12.053
56. Núnez-Cacho P, Molina-Moreno V, Corpas-Iglesias F, Cortés-García F (2018) Family businesses transitioning to a circular economy model: the case of "Mercadona." Sustainability 10(2):538. https://doi.org/10.3390/su10020538
57. Nußholz JLK (2017) Circular business models: defining a concept and framing an emerging research field. Sustainability 9(10):1810. https://doi.org/10.3390/su9101810
58. Nußholz JLK (2018) A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops. J Clean Prod 197:185–194. https://doi.org/10.1016/j.jclepro.2018.06.112
59. Nußholz JLK, Rasmussen FN, Whalen K, Plepys A (2020) Material reuse in buildings: implications of a circular business model for sustainable value creation. J Clean Prod 245:118546. https://doi.org/10.1016/j.jclepro.2019.118546
60. OECD (2019) Business models for the circular economy: opportunities and challenges for policy. https://www.oecd.org/environment/business-models-for-the-circular-economy-g2g9dd62-en.htm. Accessed 22.01.2022
61. Oghazi P, Mostaghel R (2018) Circular business model challenges and lessons learned - an industrial perspective. Sustainability 10(3):739. https://doi.org/10.3390/su10030739
62. Okorie O, Charnley F, Russell J, Tiwari A, Moreno M (2021) Circular business models in high value manufacturing: five industry cases to bridge theory and practice. Bus Strateg Environ 30(4):1780–1802. https://doi.org/10.1002/bse.2715
63. Pieroni MPP, McAloone TC, Pigosso DCA (2019) Business model innovation for circular economy and sustainability: a review of approaches. J Clean Prod 215:198–216. https://doi.org/10.1016/j.jclepro.2019.01.036
64. Richardson J (2008) The business model: an integrative framework for strategy execution. Strateg Chang 17(5–6):133–144. https://doi.org/10.1002/jsc.821
65. Rizos V, Behrens A, Van der Gaast W, Hofman E, Ioannou A, Kafyeke T, Flamos A, Rinaldi R, Papadelis S, Hirschnitz-Garbers M, Topi C (2016) Implementation of circular economy business models by small and medium-sized enterprises (SMEs): barriers and enablers. Sustainability 8:1212. https://doi.org/10.3390/su8111212
66. Rosa P, Sassanelli C, Terzi S (2019) Towards circular business models: a systematic literature review on classification frameworks and archetypes. J Clean Prod 236:117696. https://doi.org/10.1016/j.jclepro.2019.117696

67. Rössler P, Geise S (2013) Standardisierte Inhaltsanalyse: Grundprinzipien, Einsatz und Anwendung, in Möhring, W. and Schlütz, D. (Hrsg.) Handbuch standardisierte Erhebungsverfahren in der Kommunikationswissenschaft. Springer VS, Hannover, pp 269–288
68. Rovanto IK, Bask A (2021) Systemic circular business model application at the company, supply chain and society levels—a view into circular economy native and adopter companies. Bus Strateg Environ 30(2):1153–1173. https://doi.org/10.1002/bse.2677
69. Sabatier V, Mangematin V, Rousselle T (2010) From recipe to dinner: business model portfolios in the European Biopharmaceutical Industry. Long Range Plan 43(2–3):431–447. https://doi.org/10.1016/j.lrp.2010.02.001
70. Salvador R, Vetroni Barros M, Mendes da Luz L, Piekarski CM, de Francisco AC (2020) Circular business models: current aspects that influence implementation and unaddressed subjects. J Clean Prod 250:119555. https://doi.org/10.1016/j.jclepro.2019.119555
71. Schaltegger S, Lüdeke-Freund F, Hansen EG (2012) Business cases for sustainability: the role of business model innovation for corporate sustainability. Int J Innov Sustain Dev 6(2):95–119. https://doi.org/10.1504/IJISD.2012.046944
72. Stringer R (2000) How to manage radical innovation. Calif Manag Rev 42(4):70–88. https://doi.org/10.2307/41166054
73. Tukker A (2015) Product services for a resource-efficient and circular economy - a review. J Clean Prod 97:76–91. https://doi.org/10.1016/j.jclepro.2013.11.049
74. Ünal E, Urbinati A, Chiaroni D, Manzini R (2019) Value Creation in Circular Business Models: The case of a US small medium enterprise in the building sector. Resour Conserv Recycl 146:291–307. https://doi.org/10.1016/j.resconrec.2018.12.034
75. Urbinati A, Chiaroni D, Chiesa V (2017) Towards a new taxonomy of circular economy business models. J Clean Prod 168:487–498. https://doi.org/10.1016/j.jclepro.2017.09.047
76. van Boerdonk PJM, Krikke HR, Lambrechts W (2021) New business models in circular economy: a multiple case study into touch points creating customer values in health care. J Clea Prod 282:125375. https://doi.org/10.1016/j.jclepro.2020.125375
77. van Loon P, Van Wassenhove LN (2020) Transition to the circular economy: the story of four case companies. Int J Prod Res 58(11):3415–3422. https://doi.org/10.1080/00207543.2020.1748907
78. Vermunt DA, Negro SO, Verweij PA, Kuppens DV, Hekkert MP (2019) Exploring barriers to implementing different circular business models. J Clean Prod 222:891–902. https://doi.org/10.1016/j.jclepro.2019.03.052
79. Wastling T, Charnley F, Moreno M (2018) Design for circular behaviour: considering users in a circular economy. Sustainability 10:1743. https://doi.org/10.3390/su10061743
80. Wirtz BW (2011) Business Model Management: Design - Instruments - Success Factors. Gabler, Wiesbaden
81. Wolf M, Horn AB, Mehl MR, Haug S, Pennebaker JW, Kordy H (2008) Computergestützte quantitative Textanalyse: Äquivalenz und Robustheit der deutschen Version des Linguistic Inquiry and Word Count. Diagnostica 54(2):85–98. https://doi.org/10.1026/0012-1924.54.2.85
82. World Economic Forum, Ellen McArthur Foundation and McKinsey & Company (2014) Towards the circular economy: accelerating the scale-up across global supply chains. https://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf. Accessed 22.01.2022