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En litteraturstudie

Lena E. Bygballe, Hugo Firmo og Ragnhild Kvålshaugen

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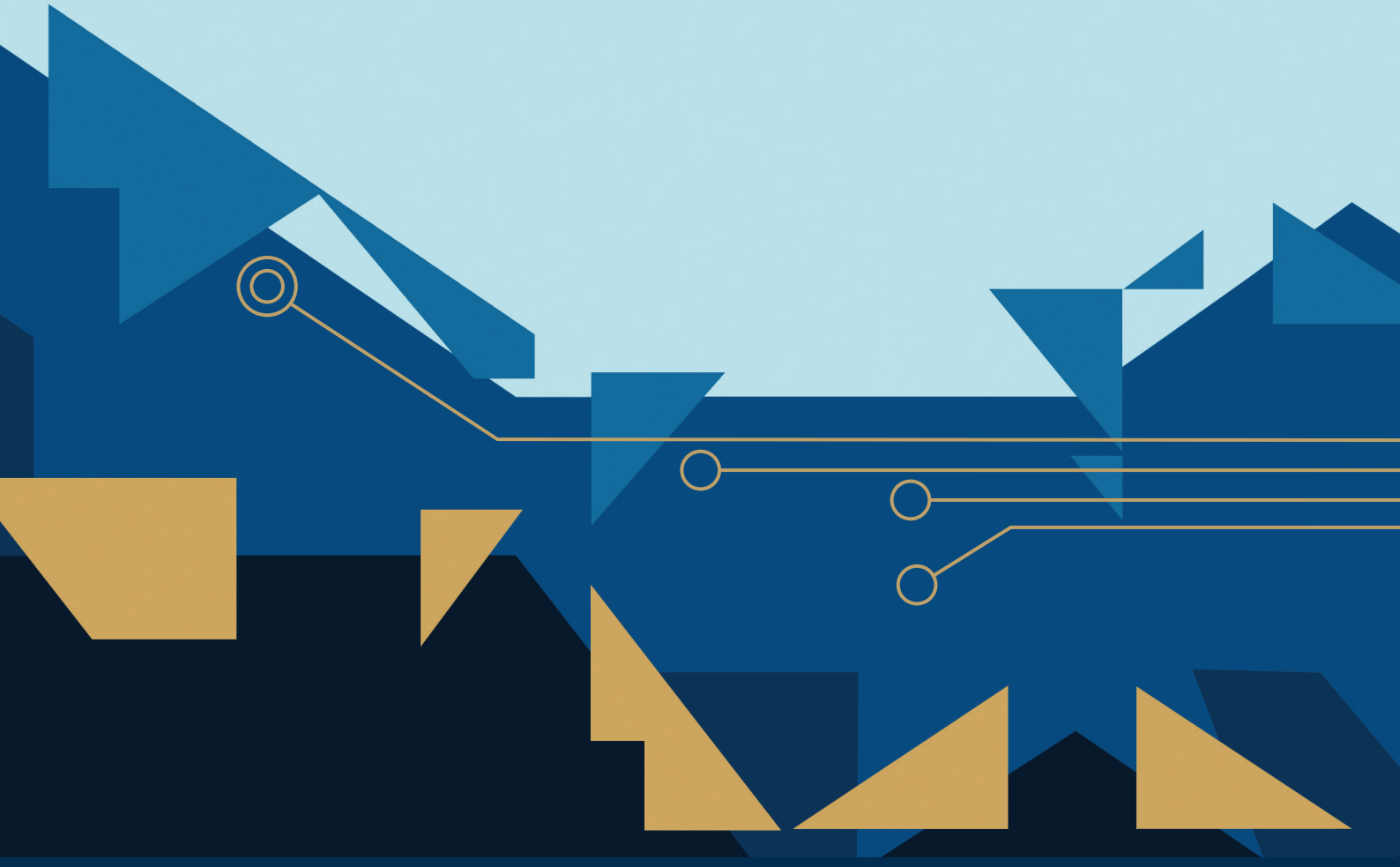

BI Norwegian Business School

Department of Strategy and Entrepreneurship

Lena E. Bygballe, Hugo Firmo og Ragnhild Kvålshaugen

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Forskningsrapport 03/2021

BI Senter for byggenæringen

Handelshøyskolen BI

Forord

Bygg-, anlegg- og eiendomsnæringen (BAE) må bli mer bærekraftig. Et viktig virkemiddel for å oppnå dette er å redusere ressursbruken gjennom å gå fra tradisjonelle lineære til sirkulære materialstrømmer, der gjenbruk/ombruk av byggematerialer og byggeråstoff står sentralt. Sirkulær økonomi handler om at ressurser som forbrukes sirkuleres tilbake i økonomien, og målsetningen er effektiv og redusert ressursbruk. I BAE-næringen drives sirkulær økonomi fram av nye regulativer, krav fra byggherrer og ulike initiativer fra aktører i og utenfor det vi tradisjonelt definerer som BAE-næringen. Veien dit er imidlertid ikke enkel, og sirkulær økonomi krever endring på mange områder.

I denne rapporten adresserer vi problemstillingen med sirkulær økonomi i BAE-næringen gjennom å sette søkelyset på behovet for nye forretningsmodeller i næringen. Forretningsmodeller henviser til hvordan bedrifter skaper, leverer og fanger verdi. Vi har gjennomført en innledende (scoping) litteraturstudie hvor vi har identifisert og analysert internasjonal vitenskapelig litteratur som omhandler sirkulære forretningsmodeller og forretningsmodellinnovasjon. Rapporten presenterer resultatene fra denne studien.

Formålet med studien har vært å identifisere kjennetrekk ved sirkulære forretningsmodeller og på hvilke områder de skapes. Videre identifiserer studien relevante problemstillinger for videre forskning for å bidra til en sirkulær BAE-næring. Dette er i tråd med vår ambisjon ved BI Senter for byggenæringen om å bidra med forskningsbasert kunnskap for en mer bærekraftig næring.

Vi håper rapporten vil skape interesse og danne grunnlag for videre diskusjon og arbeid, både i praksis og forskningsmessig. Denne innledende litteraturstudien har avdekket flere problemstillinger som vi vil følge opp i vår videre forskning, deriblant gjennom to nystartede PhD prosjekter. Det første er ved Hugo Firmo, som har gjennomført selve litteraturstudien som et forarbeid til sitt PhD prosjekt om sirkulær forretningsmodell innovasjon. Det andre er ved Olav B. Soldal og handler om tverrsektorielt samarbeid for sirkulære løsninger. Olav er knyttet til det nye SFI EarthresQue,[1] der BI er akademisk partner.

Oslo, 21. september 2021

Lena E. Bygballe

Senter for byggenæringen ved Handelshøyskolen BI

www.bi.no/bygg

[1] https://www.nmbu.no/tjenester/sentre/earthresque

Innholdsfortegnelse

Sammendrag

Denne rapporten handler om sirkulær økonomi og nye forretningsmodeller i BAE-næringen. Vi har gjennomført en innledende (scoping) litteraturstudie av internasjonal vitenskapelig litteratur på området med utgangspunkt i følgende forskningsspørsmål: *What is the current state of the art of business model innovation within the circular economy?*" Resultatene fra denne gjennomgangen presenteres her i rapporten. Studien har hatt som formål å identifisere interessante aspekter og problemstillinger knyttet til sirkulære forretningsmodeller, og å vise relevansen av disse for det videre arbeidet (både praktisk og forskningsmessig) og diskusjonen som foregår knyttet til å skape en mer sirkulær BAE-næring.

For å forstå essensen i sirkulære forretningsmodeller, og hvordan BAE-næringen kan gå fram i det videre arbeidet, har vi funnet følgende relevante og viktige aspekter:

- Dagens lineære materialstrømmer i BAE-næringen innebærer omfattende ressursbruk, utslipp og avfallsstrømmer, og næringen er et viktig virkemiddel i overgangen til en sirkulær økonomi.
- Sirkulære løsninger krever bl.a. nye forretningsmodeller, som innebærer nye måter for bedrifter å skape, levere og fange opp verdi.
- Litteraturstudien avdekker noen interessante aspekter, som er viktige for BAE-næringen å ta med seg i det videre arbeidet mot sirkulær økonomi:
    - Sirkulær økonomi oppnås i hovedsak gjennom fire strategier: (1) Ombruk/gjenbruk (*cycling)*, (2) forlenget bruk (*extending*), (3) intensivert bruk (*intensfying*), og (4) tjenester fremfor produkter (*dematerializing*).
    - Alle de fire strategiene har konsekvenser for hvordan verdi skapes, leveres og fanges (i.e. forretningsmodellen).
    - Særlig viktige virkemidler for å oppnå sirkulær økonomi og de fire strategiene er: produkt-tjeneste systemer (*product-service systems*) og tjenesteorientering (*servitization*). Videre er samarbeid med kunder, leverandører og andre aktører kritisk for å utvikle sirkulære verdiforslag, som gjør det mulig å koble verdiskaping fra (økt) produksjonsvolum og ressursforbruk.
- Studien avdekker også noen kunnskapshull, og dermed mulige retninger for videre forskning. To relevante spørsmål er:
    - Hvordan kan samarbeid mellom aktører og nye ressursinteraksjoner materialiseres og implementeres i nye sirkulære forretningsmodeller?
    - Hvordan henger sirkulære forretningsmodeller, og innovasjon i slike, sammen med tjenesteorientering (servitization)?

1. Bakgrunn

Sirkulær økonomi er et viktig tema i bygg-, anlegg- og eiendomsnæringen (BAE). Denne næringen skaper store verdier for norsk økonomi, og sto i 2018 for nær 16 % av den totale verdiskapingen i Norge, når vi inkluderer eiendom.[2] Det høye aktivitetsnivået innebærer imidlertid omfattende ressursbruk, klimagassutslipp og avfallsstrømmer. For eksempel, står næringen for 25 % av Norges totale forbruk av råmaterialer og 16 % av Norges totale klimagassutslipp, om vi tar med produksjon og transport av materialer til bruk i BAE-prosjekter.[3] 26 % av alt avfall i Norge kommer fra bygg- og anleggsvirksomhet, men bare 46 % av alt avfall fra byggeaktivitet (i.e. nybygging, rehabilitering og rivning) blir i dag. materialgjenvunnet.[4]

I tillegg kommer avfallsstrømmer knyttet til overskuddsmasser fra BA-prosjekter, og transport av slike masser fra og til prosjekter. Her mangler vi gode virkemidler og tiltak for ressurseffektiv håndtering.[5] Vi mangler også en god oversikt over omfanget av overskuddsmasser, men for å illustrere, ble det bare i Oslo håndtert over 2 millioner m^3 byggeråstoff (e.g. jord, grus, pukk og stein) og overskuddsmasser i 2015, med tilhørende 370000 lastebiltransporter.[6] Dette tallet har sannsynligvis økt og vil fortsette å øke de neste årene, gitt de store utbyggingsprosjektene som for tiden foregår i Oslo og omegn, slik som Fornebubanen, Regjeringskvartalet og nytt vannforsyningsanlegg.[7]

Det er derfor naturlig at BAE-næringen trekkes fram i diskusjoner om hva som skal til for å øke Norges sirkularitet. Beregninger fra Circular Norway viser at ved å øke sirkulariteten i BAE-næringen, kan Norges totale sirkularitet økes fra dagens beskjedne 2,4 % til 7 %.[8] Næringen fremheves også i Regjeringens nye strategi for grønn, sirkulær økonomi, der bygg og byggevare er utpekt som en av sju prioriterte verdikjeder for å gjøre Norge mer sirkulær.[9] Dette må videre sees i lys av EUs mål om 70 % materialgjenvinning av BA-avfall.

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[2] Bygballe, L.E., G. Grimsby, B. Eileen Engebretsen og T. Reve (2019) En verdiskapende bygg-, anlegg- og eiendomsnæring (BAE): Oppdatering 2019. BI-rapport 2/2019. www.bi.no/bygg

[3] Grønn Byggallianse: Klimakur for bygg og eiendom. https://byggalliansen.no/kunnskapssenter/publikasjoner/infopakkeklimakjempen/

[4] SSB 2020. https://www.ssb.no/natur-og-miljo/avfall/statistikk/avfall-fra-byggeaktivitet

[5] Miljødirektoratet: Tverrsektorielt prosjekt om disponering av jord og stein som ikke er forurenset. https://www.miljodirektoratet.no/publikasjoner/2021/september-2021/tverrsektorielt-prosjekt-om--disponering-av-jord-og-stein-som--ikke-er-forurenset/

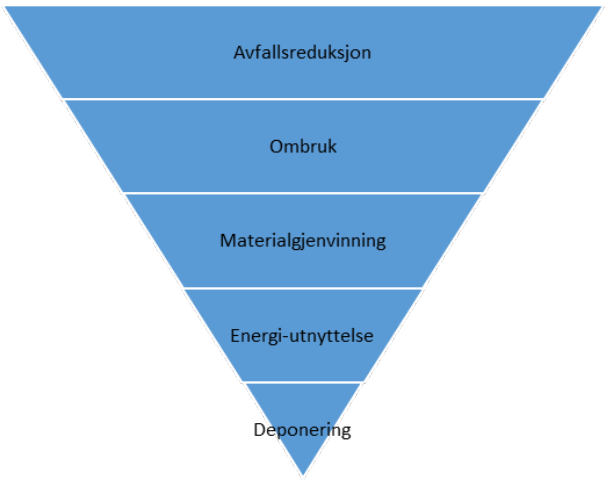
[6] Lundberg, K., M. Johansson, S. Magnusson og A-O. Håøya (2016). Materialhantering vid byggande i Oslo – jämförelse av 2015 och 2030. Sluttrapport. https://www.optimass.se/wp-content/uploads/2019/07/materialhantering-vid-byggande-i-oslo_slutrapport.pdf

[7] Bygballe, L.E., Flygansvær, B.M., Harrison, D. og Soldal, O.B. (2021) Hvordan få til sirkulær massehåndtering for BA-prosjekter i Oslo-området? BI-rapport 2/2021. www.bi.no/bygg

[8] The circularity gap report Norway 2020. https://www.circularnorway.no/gap-report-norway

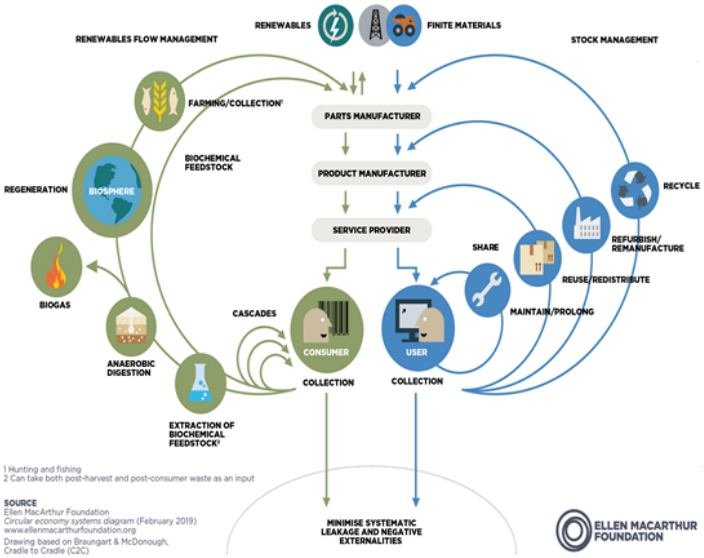
[9] Nasjonal strategi for ein grøn, sirkulær økonomi. https://www.regjeringen.no/no/dokumenter/nasjonal-strategi-for-ein-gron-sirkular-okonomi/id2861253/

Til tross for stor oppmerksomhet, er det mange aspekter ved sirkulær økonomi vi fortsatt vet lite om. Dette gjelder ikke bare i BAE-næringen. Når det snakkes om sirkulær økonomi, viser mange til avfallspyramiden (Figur 1), og at vi må bevege oss oppover fra praksisen med deponering til gjenvinning og ombruk, for til slutt å redusere potensialet for avfall.



Figur 1: Avfallspyramiden

Videre viser mange til «sommerfugl-modellen» (Figur 2) av MacArthur-stiftelsen, som beskriver sirkulær økonomi som en kontinuerlig flyt av biologiske og tekniske materialer gjennom det de refererer til som en verdisirkel (value circle).[10]



Figur 2: Circular economy system diagram

[10] https://ellenmacarthurfoundation.org/circular-economy-diagram

Et viktig aspekt ved sirkulær økonomi, og som vi kan tolke ut av de to figurene, er at det handler om både biologiske og tekniske forhold, så vel som økonomiske, organisatoriske og sosiale forhold. I en interessant kommentar til Regjeringens strategi, argumenterer Soldal m.fl.[11] at det grovt sett finnes tre fortellinger (i.e. narrativer) om hva en sirkulær økonomi skal oppnå: (1) fortellingen om naturmangfold, der planetens tålegrenser og reduksjon av det økologiske fotavtrykket står sentralt, (2) klimafortellingen, der utslippskutt og forpliktelser i henhold til Paris-avtalen er i fokus, og (3) den økonomiske fortellingen, som vektlegger grønn konkurransekraft og mulighetene for næringslivet. Videre hevder forfatterne at selv om Regjeringens strategi omhandler alle disse tre fortellingene, er den økonomiske mest sentral, med trykk på effektivitet, konkurranseevne og lønnsomhet. Hvordan å oppnå det, er foreløpig lite konkretisert i regjeringsstrategien.

Det er klart at skal næringslivet, slik som BAE-næringen, evne å bli mer sirkulær vil det kreves endringer på flere områder. Bedrifter må blant annet tenke nytt om hvordan de skaper, leverer og fanger verdi – de må med andre ord utvikle og implementere nye forretningsmodeller. Dette involverer for det første innovasjon, og for det andre, og sterkt relatert til det første, at bedrifter samarbeider med andre aktører i denne prosessen. Det er godt dokumentert i forskningslitteraturen at komplekse og «wicked» samfunnsutfordringer, slik som overgangen til en mer sirkulær økonomi, krever samarbeid på tvers av organisasjons- og sektorgrenser, og at ingen aktør alene kan løse disse utfordringene (Doh, Tashman, & Benischke, 2019). Sirkulær økonomi og andre sosiale- og miljøproblemer utfordrer altså tradisjonell tankegang rundt forretningsmodeller, som i stor grad har omhandlet hva den enkelte bedrift gjør, i en vertikal (og typisk lineær) verdikjede.

I kapittel 2, gir vi en kort oppsummering av hovedfunnene fra litteraturstudien, før vi presenterer den i sin helhet i kapittel tre. Det kapittelet er på engelsk.

2. Oppsummering av hovedfunn fra litteraturstudien

Litteraturstudien har tatt for seg litteratur innenfor forretningsmodellinnovasjon for sirkulær økonomi, for å besvare følgende forskningsspørsmål: *What is the current state of the art of business model innovation within the circular economy?*

Funnene fra studien indikerer at dette forskningsfeltet er hurtig voksende. For å analysere studier som ble identifisert gjennom litteraturstudien, ble rammeverket av Geissdoerfer et al. (2020) lagt til grunn. Dette rammeverket beskriver fire mulige strategier for sirkulær økonomi: *cycling* (gjenbruk/ombruk), *extending* (forlenget bruk), *intensifying* (intensivert

[11] https://www.bi.no/forskning/business-review/articles/2021/08/hva-regjeringen-snakker-om-nar-den-sier-sirkular-okonomi/

bruk) og *dematerializing* (tjenester fremfor produkter). Litteraturstudien viser at disse strategiene har konsekvenser for de tre elementene i en forretningsmodell: skape, levere og fange verdi.

Videre viser studien at de 10 R-ene: *refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle,* og *recover*, representerer viktige sirkulære aktiviteter som bedrifter kan implementere, i tillegg til «design for X.» Høyere fortjeneste og reduserte kostnader er de finansielle målene for sirkulære forretningsmodeller. Sentrale virkemidler her er «product-service systems» og «servitization.» Mer avanserte nivåer av denne tjenesteorienteringen er spesielt viktig for intensifiering og dematerialisering. Strategier knyttet til utviding og intensifiering er spesielt relatert til delings-modeller, som igjen fremmes av digital teknologi.

Litteraturstudien viser dessuten at sirkulære forretningsmodeller må utvikles i tett samarbeid med kunder og andre aktører. Dette vil igjen påvirke resten av forsyningskjeden og bidra til et verdiforslag som gjør det mulig å skille verdiskaping fra produksjonsvolum og ressursforbruk.

Til tross for noen begrensninger ved en slik type litteraturstudie, mener vi at studien har bidratt med interessante innsikter om sirkulære forretningsmodeller. Ikke minst belyses koblingen mellom de fire typene strategier som kan anvendes, og hvordan de igjen har konsekvenser for hvordan aktører tenker om verdiskaping, leveranse av produkter/tjenester og verdiforslag. Det åpner også videre for flere interessante forskningstemaer. Her vil vi spesielt trekke fram de følgende to:

(1) Forskning viser at samarbeid mellom aktører er avgjørende for å lykkes med å skape sirkulære ressursstrømmer. Det er derfor interessant å se nærmere på hvordan slikt samarbeid, for eksempel mellom kunder og leverandører i forsyningskjeden, mellom konkurrenter og mellom virksomheter i BAE-næringen og aktører fra andre næringer, materialiseres (og implementeres) i nye sirkulære forretningsmodeller.

(2) Forskning viser også at «Servitization», altså et større innslag av tjenesteorientering, er viktig i sirkulære forretningsmodeller. Produkter kan erstattes med tjenester og produkter kan kombineres med tjenester. Digitale løsninger muliggjør overgang fra produkt til tjeneste, men hvordan dette henger sammen og hva mulighetene er for aktørene i BAE-næringen, vet vi foreløpig lite om.

3. Circular economy business model innovation. A scoping review*

**by Hugo Firmo*

3.1. Introduction

The circular economy is presented as a promising approach to achieve sustainable development (Pieroni, McAloone, & Pigosso, 2021a). The concept has been gaining traction among academia, companies, and policymakers (Geissdoerfer, Savaget, Bocken, et al., 2017) and implies modifications in current business models with the goal of decoupling value creation from resource consumption (Pieroni, McAloone, et al., 2021a). Despite its importance and potential, circular economy business model innovation is presently at a conceptualization stage, with limited research explaining how business model design can be adjusted to circular economy principles (Centobelli et al., 2020; Pieroni, McAloone, Borgianni, et al., 2021). As argued by Centobelli et al. (2020), there is a major need for research that links the practices for value creation, value transfer, and value capture to the literature on business model design and innovation.

This scoping review serves as a steppingstone for future studies and systematic literature reviews in the field. The goal of the review is to find and help bridge existing knowledge gaps, map and clarify key concepts, and identify the implications for decision-making and future research (Andrea et al., 2016; Arksey & O'Malley, 2005; Munn et al., 2018). According to Centobelli et al. (2020), breadth is prioritized over depth, focusing on systemic and holistic thinking, rather than isolated choices. This study is guided by the following research question: "What is the current state of the art of business model innovation within the circular economy?".

3.2. Theoretical background

To better understand the issues discussed in this review, a brief theoretical introduction is presented in the following section.

3.2.1. Circular Economy

The Circular Economy (CE) can be defined as "an economic system in which resource input and waste, emission, and energy leakages are minimised by cycling, extending, intensifying, and dematerialising material and energy loops. This can be achieved through digitalisation, servitisation, sharing solutions, long-lasting product design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling" (Geissdoerfer et al., 2020, p. 3). In this system, goods at the end of their service life are turned into resources, closing loops and minimizing waste (Stahel, 2016). According to Bocken and Ritala (2021), the CE aims to break free from the destructive industry practices, still built around the linear model of production and dependent on high sales and fast-paced consumption. The circular model is presented as an environmentally sustainable alternative to the incumbent paradigm, based on linear make-use-

dispose systems (Bocken & Ritala, 2021; Geissdoerfer, Savaget, Bocken, et al., 2017; Ghisellini, Cialani, & Ulgiati, 2016).

3.2.2. Business Model Innovation in the Circular Economy

The transition to a CE requires newly redesigned business models (Pieroni, Pigosso, & McAloone, 2018). Circular business models are an example of business model innovation for sustainability. They contemplate the triple bottom line approach and include a wide range of stakeholder interests (Bocken et al., 2014). Stahel (2016) argues for a circular economy where resources are used for as long as possible, cutting emissions, generating jobs, energy savings, reducing waste and resource consumption. Ultimately, business models that enable a performance economy go one step further by focusing on solutions, rather than products, and selling goods as services.

Business Model Innovation (BMI) is a novel form of organizational innovation that includes theory building, operationalization, and testing, standing as a key source of value creation and competitive advantage (Foss & Saebi, 2016). BMI for sustainability is a new area of interest with a remaining lack of clarity and conceptual consensus (Evans et al., 2017; Geissdoerfer, Savaget, & Evans, 2017). According to Bocken et al. (2014), BMI can be classified as technological, social, and organizational oriented innovations, which can be defined according to three main elements: value proposition, value creation and delivery, and value capture. This is aligned with the general definition by Osterwalder, Pigneur, and Clark (2010, p. 14): "A business model describes the rationale of how an organization creates, delivers, and captures value". For the design of circular business models three strategies are outlined by Bocken et al. (2016): slowing, closing, and narrowing resource loops. Furthermore, Geissdoerfer et al. (2018) identify two additional loops: intensifying and dematerializing loops.

The design of sustainable circular business models can be challenging, especially considering that circularity does not necessarily equate to greater sustainability (Pieroni et al., 2018).

3.2.3. Theoretical framework

The conceptual framework presented by Geissdoerfer et al. (2020) was used as the basis for this scoping review. This framework considers both CE and BMI theory as tools to achieve environmental, economic, and social ambitions. Building on 114 definitions from the literature, the authors (p. 7) define circular business models as:

> *"business models that are cycling, extending, intensifying, and/or dematerialising material and energy loops to reduce the resource inputs into and the waste and emission leakage out of an organisational system. This comprises recycling measures (cycling), use phase extensions (extending), a more intense use phase (intensifying), and the substitution of products by service and software solutions (dematerialising)."*

There are, thus, four generic strategies to be considered: *cycling*, which relates to recycling materials and energy within the system; *extending*, which encompasses the extension of the use phase of the product; *intensifying*, the intensification of use of products; and *dematerializing*, which is the provision of utility without hardware through the substitution of products with services and software solutions. These strategies are summarized in the table below.

Table 1: Summary of circular business model strategies (Geissdoerfer et al., 2020)

Cycling	Reuse, repair, remanufacturing/refurbishing, recycling, design for X/modularity, reverse logistics, incentives to return cores.
Extending	Long-lasting products, upgradability, timeless design, marketing/consumer education encouraging long product life, maintenance/product support.
Intensifying	Sharing models, rental/leasing models, user cooperatives, open elements/creative commons, pooling models.
Dematerializing	Software instead of hardware, service instead of product, consumer education rationalizing demand.

Building on other reference models, such as Bocken et al. (2014) and the business model canvas (Osterwalder et al., 2010), this theoretical framework portrayed in Appendix A, in which each business model strategy is analyzed according to its value proposition, value creation and delivery, and value capture.

3.3. Methods

In this study, a scoping review was carried out. To achieve greater methodological rigor, as recommended by Andrea et al. (2016), this scoping review followed the framework developed by Arksey and O'Malley (2005), which consists of five stages: 1) identify the research question; 2) identify relevant studies; 3) study selection; 4) chart data; and 5) collate, summarize and report the results. This study used a mixed-methods approach, with inductive and deductive methodologies being applied (Bryman & Bell, 2011). The screening and selection of relevant literature were carried out deductively, as well as the subsequent descriptive statistical and quantitative analysis of research results.

The PRISMA framework (Page et al., 2021) was used to identify the most relevant group of articles for the literature review. ABI/INFORM, Business Source Complete, GreenFILE, ScienceDirect, and Scopus were the chosen databases to find relevant literature. The initial

search in the aforementioned databases was carried out on the 7th of June, 2021, and returned a total of 342 records, prior to screening for duplicates (Figure 3).

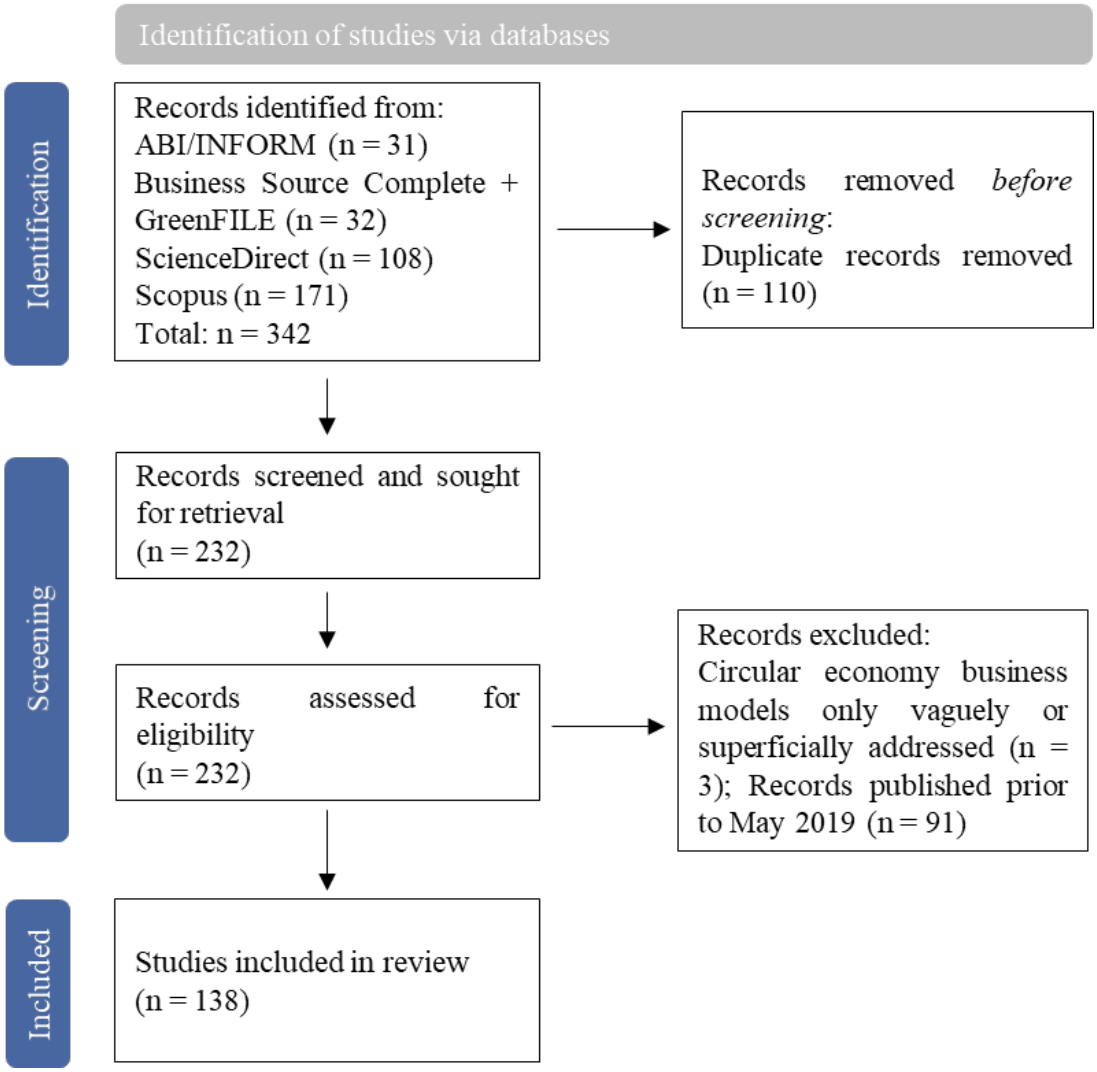


Figure 3: PRISMA framework

The articles included in this study were peer-reviewed and published between 2015 and 2021. Publications not written in English were excluded. The following research queries were used in their respective databases:

- ABI/INFORM
    - "business model innovation" AND ab(("business model" OR "business modeling" OR "business models")) AND ab(circular);
- Business Source Complete + GreenFile

    - "business model innovation" AND AB "business model*" AND AB "circular economy";
- ScienceDirect
    - Find articles with these terms: "business model innovation"
    - Title, abstract or author-specified keywords: ("business model" OR "business models") AND "circular economy";
- Scopus
    - ALL ("business model innovation") AND ABS ("circular economy" , "business model*") AND KEY ("Circular Economy" , "Business Model*") AND (LIMIT-TO (LANGUAGE , "English")).

The framework developed by Geissdoerfer et al. (2020) was used as the basis for a content analysis of the selected articles. Because this review was published in 2020, the final selection corresponds to the latest literature to date and that was not analyzed by Geissdoerfer et al. (2020), that is, articles published between May 2019 and June 2021. Three records in which CE business models were only vaguely or superficially addressed were also excluded, leading to a final selection of 138 articles. Furthermore, a snowball sampling technique (Bryman & Bell, 2011) was used in the theoretical framework section. Previous research was analyzed through cross-reference, using the final selection of articles.

A content analysis (Bryman & Bell, 2011) was carried out using as a coding scheme the strategies and respective descriptions in the framework by Geissdoerfer et al. (2020), presented in Appendix A. The articles were then coded using ATLAS.ti.

In the discussion and conclusions sections, theory was generated inductively, proceeding from this particular selection of articles to a generalization (Alvesson & Sköldberg, 2009), that aims to portray a picture of the current state of the art of this field of research.

3.4. Results

In this section, a descriptive statistical analysis of the research results will be presented. This will be followed by a summary of the findings from the content analysis, in accordance with the structure of the framework by Geissdoerfer et al. (2020).

3.4.1. Descriptive analysis

The initial identification of records consisted of 342 publications, as displayed in Figure 3. Out of these, half were retrieved from Scopus, 32% from ScienceDirect, 9% from ABI/INFORM and also 9% from Business Source Complete and GreenFILE. To get a clearer view of how research has been evolving in this field, the following descriptive analysis concerns the final selection of records including the records published prior to May 2019, i.e., a sample of 229 records.

The topic of BMI within the CE has been growing rapidly, as shown in Figure 4, below. More than a ten-fold increase in yearly publications can be observed since 2016, with the linear regression function showing a positive slope of approximately 11.4, revealing the rapid growth of this field.

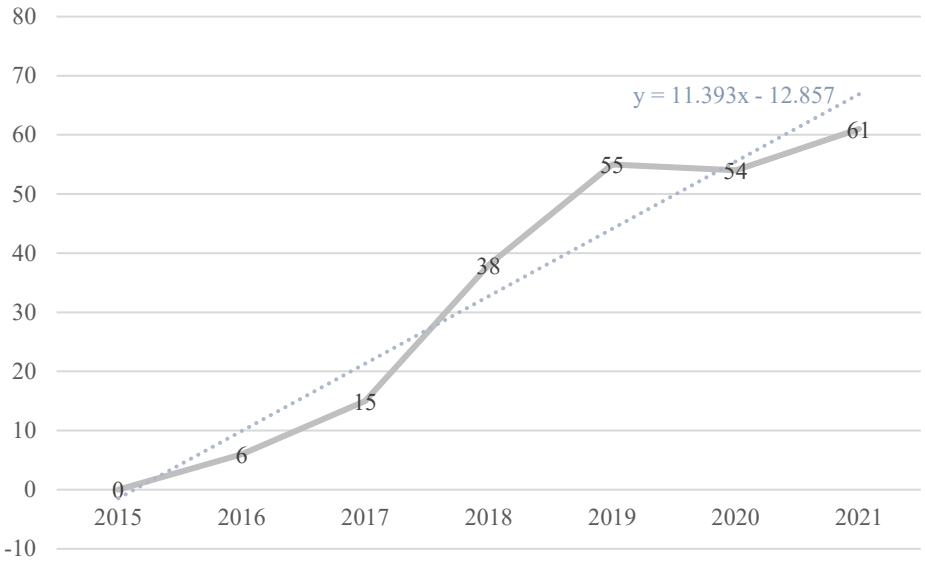


Figure 4: Publications per year

The Journal of Cleaner Production is responsible for 28% of the studies and is the greatest contributor in this review (Figure 5).

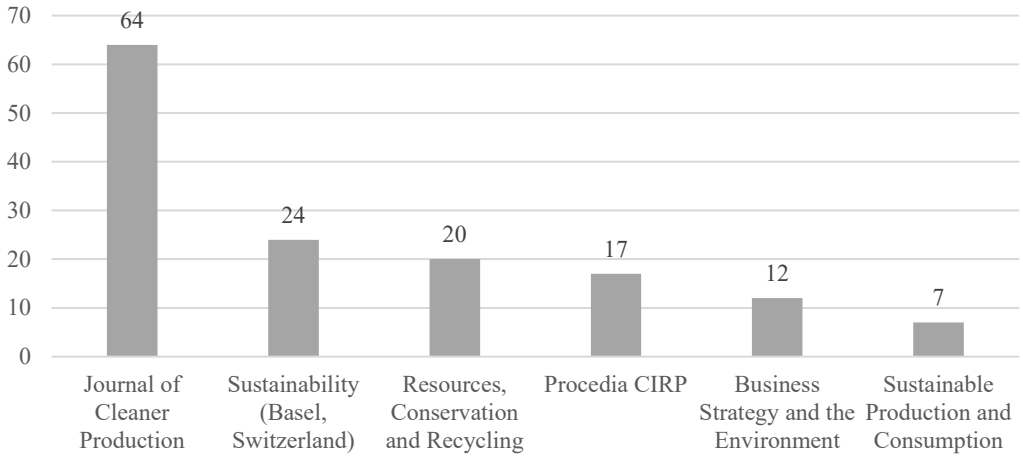


Figure 5: Publications per journal

The most represented authors are Nancy Bocken, Daniela Pigosso, Tim McAloone, and Marina Pieroni, contributing with over 10 articles each. Bocken, in particular, was responsible for almost 11% of publications in the field, since 2015, totaling 25 articles (Figure 6).

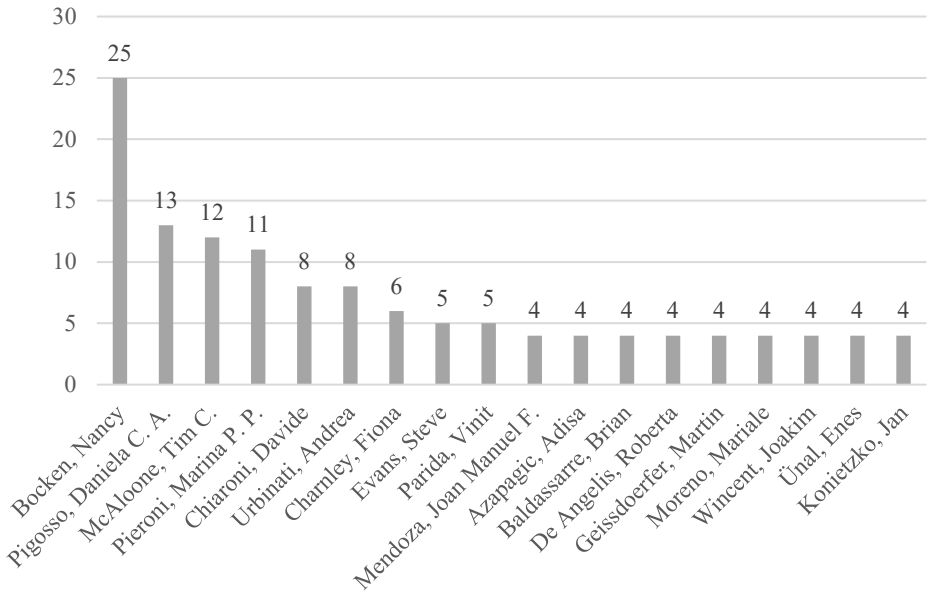


Figure 6: Top contributing authors

The most frequent keywords are shown in Figure 7. This comes as the result of a keyword refinement in which spelling differences such as plurals or orthography differences were eliminated. “Circular economy”, “sustainable development”, “sustainability”, “business model”, and “circular business models” were the most common keywords.

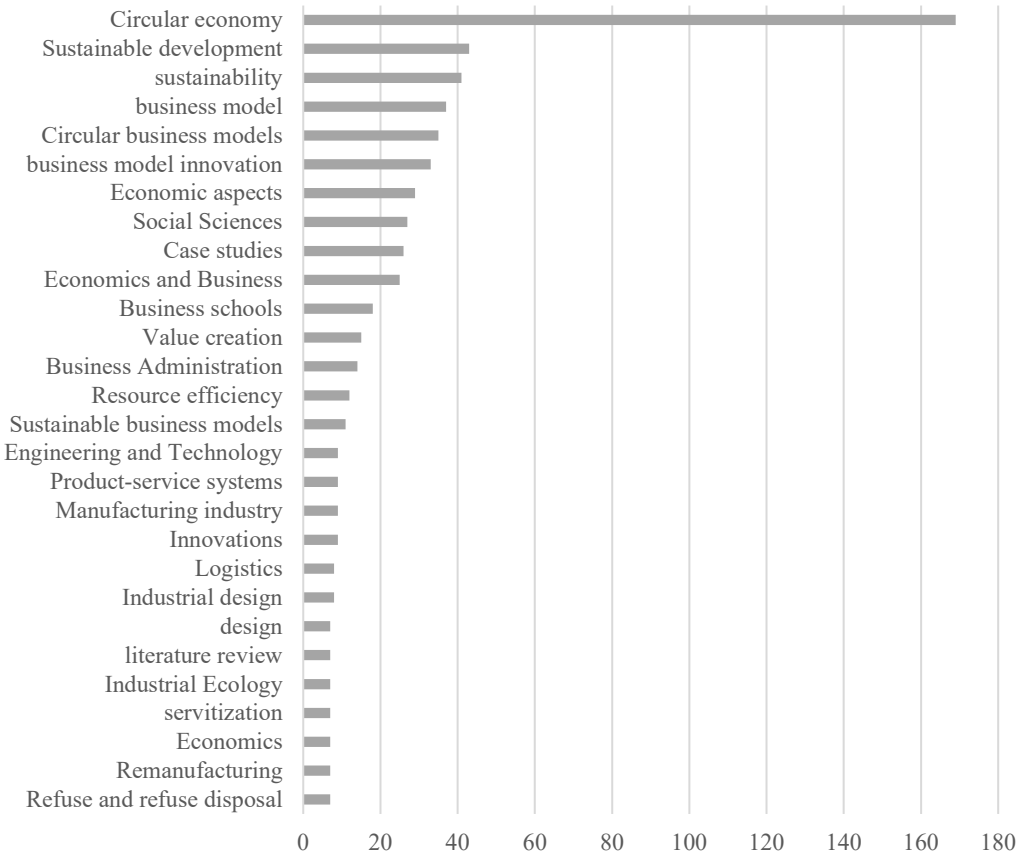


Figure 7: Most frequent keywords after keyword refinement

Figure 8 illustrates the origin of the publications, based on author affiliation. Sweden, the Netherlands, and the UK stand out as the greatest contributors worldwide. Finally, 84% of publication affiliations were European.

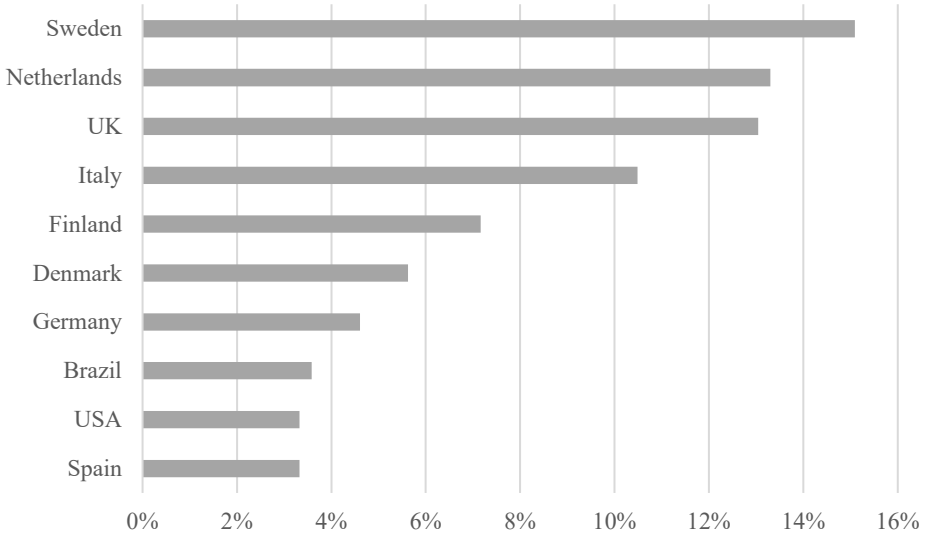


Figure 8: Top countries based on author affiliation

3.4.2. Findings

In this subsection, the main findings will be presented, applying the aforementioned framework by Geissdoerfer et al. (2020).

3.4.2.1. Cycling

The first strategy identified by Geissdoerfer et al. (2020, p. 10) is cycling:

> *Cycling entails the implementation of a number of end-of-use strategies, such as reuse, repair and remanufacturing. From a value proposition perspective, take-back is a key element of the value proposition, which is enabled by collaborations in the value chain and effective reverse manufacturing processes (such as repair, remanufacture, refurbish and recycling).*

Value proposition

The 3Rs (reduce, reuse and recycle) (Garcia et al., 2019; Inigo & Blok, 2019; Khan, Ahmad, & Majava, 2021), 6Rs (reduce, recover, reuse, recycle, redesign, and remanufacture) (Bjørnbet et al., 2021; Khan et al., 2021), and 10Rs (refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover) (Antwi-Afari, Ng, & Hossain, 2021; van Boerdonk, Krikke, & Lambrechts, 2021) are often mentioned in the literature and associated with the idea of looping resources, which is also considered economically advantageous (Mhatre et al., 2021). When cycling, customers can buy remanufactured goods at a lower cost and lower environmental impact (Khan et al., 2021; Okorie et al., 2021; Ranta, Aarikka-Stenroos, & Väisänen, 2021). This can be done while maintaining quality, performance, and reliability (Shao et al., 2019).

Reverse logistics and take-back schemes are considered key elements of the value proposition (Ertz et al., 2019; Geissdoerfer et al., 2020; Pieroni, McAloone, & Pigosso, 2019b; Shao et al., 2019; Ville-Veikko, Kaisa, & Eeva, 2020). Closing loops can be referred to as recycling. Downcycling consists of using discarded materials of lower quality for lower value purposes or to generate energy. Upcycling refers to when higher quality products are created (Bocken & Ritala, 2021). This can be a way to incorporate a product's post-consumer value in the value proposition (Kant Hvass & Pedersen, 2019).

Greater supply chain resiliency is expected through recycling and resource management (Rosa, Sassanelli, & Terzi, 2019). Products should be restorative by design or intention (Han, Heshmati, & Rashidghalam, 2020). Design for X practices (e.g. design for recycling, design for remanufacturing and reuse, design for disassembly, and design for environment) is commonly mentioned as a part of the value proposition (Guzzo et al., 2019; Urbinati, Chiaroni, & Toletti, 2019), as it increases durability and repairability for customers, empowers users to self-learn, reuse and repair, and prevents waste (Franco, 2019; Guerra & Leite, 2021; Han et al., 2020; Real, Lizarralde, & Tyl, 2020; Rossi et al., 2020). Job creation

from activities such as maintenance, reverse logistics, refurbishment and recycling can also be expected (Haines-Gadd & Charnley, 2019; Rossi et al., 2020).

Customers are increasingly seeking long-lasting design and sustainable products for economic, ecological and ethical reasons (de Kwant, Rahi, & Laurenti, 2021; Pal, Shen, & Sandberg, 2019; Urbinati et al., 2019; van Boerdonk et al., 2021). These activities can result in improved reputation and long-lasting customer relations originated from maintenance and repair services, for example (Cullen & De Angelis, 2021). Customers may also benefit from reward points for recycling or engaging in other environmentally benign activities (Pieroni, McAloone, & Pigosso, 2020).

Value creation and delivery

Regarding value creation and delivery, different versions of the 10Rs are put forward as key competencies and capabilities for cycling, such as reduce, reuse, recycle, recover, regenerate, remanufacture, repackage, recondition, and refurbish (Braun, Schöllhammer, & Rosenkranz, 2021; Ertz et al., 2019; Halonen, Majuri, & Lanz, 2019; Henry et al., 2020; Pieroni, McAloone, & Pigosso, 2019a). Design for X, such as maintenance and repair, creates value by enabling and incentivizing users to maintain and repair their products (Heesbeen & Prieto Hoces, 2020; Konietzko, Bocken, & Hultink, 2020; Kristensen, Mosgaard, & Remmen, 2021).

Modularity, reducing process complexity (Albertsen et al., 2021; Huerta Morales, 2020; Rosa et al., 2019), partnerships with upstream and downstream stakeholders, inter-organizational collaboration, such as with research institutions, and the development of value networks are considered important aspects of this strategy (Centobelli et al., 2020; Daniela & Alex, 2020; De Angelis, 2021; Pal et al., 2019; Patwa et al., 2021; Shao et al., 2019; Upadhyay, Kumar, & Akter, 2021). Companies should seek industrial symbiosis, identify key partners to leverage on existing capabilities (such as reverse logistics) and provide guidelines and training (Albertsen et al., 2021; Guzzo et al., 2019; Hossain et al., 2020; Kant Hvass & Pedersen, 2019; Pieroni et al., 2019b; Rovanto & Bask, 2021). Collaborating with customers can be a way to share risks and initial investments (Pieroni et al., 2019b). Centobelli et al. (2020) explain that within the company, managerial commitment is necessary to spread circular competencies and capabilities across the organization. This is particularly relevant considering that path dependency and lock-in can hinder CE innovation breakthroughs. Internal factors, including strategic management, can help unlock innovation capabilities (Lehtimäki, Piispanen, & Henttonen, 2020). Furthermore, a market for secondary products and materials has to be created (Huerta Morales, 2020).

The use of digital technologies and the Internet of Things (IoT) can positively impact the business model (Haines-Gadd & Charnley, 2019; Ranta et al., 2021). New technologies enable the resource recovery model, which aims to recover almost any type of resource output using industrial symbiosis, closed loops recycling and cradle-to-cradle designs (Daniela &

Silvio, 2020). The usage of service-based models is suggested by some authors, in which value is created through refurbishment, remanufacturing or recycling services (Gusmerotti et al., 2019; Henry et al., 2021; Pieroni et al., 2020; van Keulen & Kirchherr, 2021).

Finally, Hopkinson, De Angelis, and Zils (2020) and Pigosso and McAloone (2021) point to the possibility of influencing legislation, taxation and subsidies, while exploring the market for second-hand products.

Value capture

In terms of the way companies capture value, several authors point to the possibility of leveraging on novel policies on waste management, subsidies, and other taxation instruments that incentivize recycling and facilitate circularity (Daniela & Alex, 2020; Konietzko et al., 2020; Mhatre et al., 2021; Pieroni et al., 2019a; Shao et al., 2019; Upadhyay et al., 2021; Urbinati, Franzò, & Chiaroni, 2021). Second-hand marketplaces and reselling can be a source of revenue (Ertz et al., 2019; Guzzo et al., 2020; Pieroni et al., 2019b).

Obtaining additional revenue from services using business models such as Product-Service Systems (PSS) is regularly mentioned in the literature. Companies can offer reuse, recycling, repair and maintenance services as add-ons to their products (Cullen & De Angelis, 2021; Han et al., 2020; Kristensen et al., 2021). Services that involve an ownership transfer, such as leasing, renting, or Product-as-a-Service (PaaS) are another possibility (Albertsen et al., 2021; Bakker et al., 2021; Pal et al., 2019; Santa-Maria, Vermeulen, & Baumgartner, 2021).

Cost reductions are also mentioned. Savings can result from capturing the residual value of products and materials, better maintenance, and increased energy and resource efficiency (De Angelis, 2021; Khan et al., 2021; Kristensen et al., 2021; Ranta et al., 2021). Remanufacturing can also come at a lower cost compared to newly manufactured products (Okorie et al., 2021). Energy generation is a way to valorize waste (Fernandez de Arroyabe, 2021; Hankammer et al., 2019). These strategies allow the capture of the residual value of products and materials. Take-back systems, reverse logistics and buy-back programs can be a way to realize untapped value at the end of a product's lifecycle (Guzzo et al., 2019; Hansen & Revellio, 2020).

3.4.2.2. Extending

The second strategy is extending, which Geissdoerfer et al. (2020, p. 12) define as follows:

> *Extending aims at keeping the product in use to the highest extent possible, being mainly enabled by design and operation practices. Long-life products (value proposition) that are serviced during its lifetime can create a long-term customer relationship (value creation & delivery), and create new revenue streams during the use phase of the products through service*

packages or tailored contracts. The implementation of this strategy lead to reduced need for producing new products.

Value proposition

Extended producer responsibility, through prolonged warranty or maintenance programs, can create value for the customer (Ertz et al., 2019; Maffei, Grahn, & Nuur, 2019), particularly using predictive, preventive and reparative services (Guzzo et al., 2020). In turn, this can enhance long-term relationships with users and improve reputation (Cullen & De Angelis, 2021; Urbinati et al., 2020). Having long-lasting products with low maintenance needs is another advantage (Colucci & Vecchi, 2021; Guzzo et al., 2019). The usage of PSS to extend product life is associated with superior customer value (Pieroni et al., 2019b).

Value creation and delivery

Providing repair and maintenance services is often mentioned in the literature to extend product value and life (Di Biccari et al., 2019; Mhatre et al., 2021).

Sharing platforms are believed to contribute to this strategy, allowing for remote monitoring and predictive maintenance (Daniela & Alex, 2020; de Kwant et al., 2021; Guzzo et al., 2019; Mhatre et al., 2021; Patwa et al., 2021). Asset sharing can be PSS-based and involve a transfer of ownership (Chiappetta Jabbour et al., 2020). The IoT and other technologies enable the use of instruments like smart maintenance to extend product life (Bigliardi & Filippelli, 2021; Han et al., 2020; Ingemarsdotter, Jamsin, & Balkenende, 2020; Ranta et al., 2021). Extension can also be achieved using high quality and durable materials, creating long-lasting products and decreasing maintenance needs (Antwi-Afari et al., 2021; Daniela & Alex, 2020; Guzzo et al., 2019; Mhatre et al., 2021; Mostaghel & Chirumalla, 2021).

Product value can be extended with design for X principles (e.g. design for maintenance, repairability, interchangeability, upgradability, durability, behavior change, and long life) (Franco, 2019; Heesbeen & Prieto Hoces, 2020; Henry et al., 2020; Konietzko et al., 2020; Rovanto & Bask, 2021). Offering product warrantees and a life-extending program represent other alternatives (Mwesiumo, Kvadsheim, & Nujen, 2020; Salvador et al., 2020; Santa-Maria et al., 2021). Changing customer behavior through remarketing activities and increased public awareness and education is another resource to prolonging product life (Daniela & Silvio, 2020; Hansen & Revellio, 2020; Hoffmann, de Simone Morais, & Teodoro, 2020). Products can also be upgraded aesthetically to counteract the perceived loss of value (Huerta Morales, 2020).

Value capture

Value is captured from additional revenue streams from maintenance, repair and remanufacturing services (Cullen & De Angelis, 2021; Ranta et al., 2021). These services can be a part of a PSS with revenue mechanisms that include renting, leasing, pay-per-use and maintenance services (Florido, Jacob, & Payeras, 2019; Franco, 2019; Hopkinson et al., 2020;

Mostaghel & Chirumalla, 2021; Pieroni, McAloone, & Pigosso, 2021b; Sigüenza, Cucurachi, & Tukker, 2021). Bocken and Ritala (2021) add that a price premium can be put in place when achieving quality leadership and customer loyalty. Moreover, extending the life of a product means that value can be extracted multiple times. An increase in resource efficiency is also noted in the literature (Okorie et al., 2021).

3.4.2.3. Intensifying

According to Geissdoerfer et al. (2020, p. 12) the third strategy is intensifying:

> *Intensifying leads to the implementation of new value propositions around sharing models, being enabled by capacity management, digital capabilities and customer relationship management. Intensifying enables new business models with stronger servitisation elements, such as PSS, which results in recurrent revenue streams. The main environmental benefits of this strategy are reduced idle time or structural waste (disposal of product before specification lifetime), leading to reduced need for producing new products and reduced waste output.*

Value proposition

Value propositions built around sharing models (Al-Saidi, Das, & Saadaoui, 2021; Geissdoerfer et al., 2020) maximize the utilization of products through peer-to-peer sharing, leasing, renting, pay-per-use, PaaS and other PSS-based models (Alastair et al., 2020; Mhatre et al., 2021; Pieroni, McAloone, et al., 2021b; Salvador et al., 2020). With servitization and, in particular, PSS, customer demand is fulfilled by providing the use or functionality of the products, rather than simply the products themselves (Hankammer et al., 2019; van Boerdonk et al., 2021). This is done while providing a better solution (Baldassarre et al., 2020; Guzzo et al., 2019; Tunn et al., 2020) and creating new relationships with customers (Han et al., 2020). Chiappetta Jabbour et al. (2020) consider that consumer preferences have changed, favoring access to services over asset ownership.

Value creation and delivery

The development of a PSS, and associated sharing platforms, is often mentioned in the literature as an important driver (Han et al., 2020; Heesbeen & Prieto Hoces, 2020; Henry et al., 2021; Salvador et al., 2020; Sigüenza et al., 2021). This is associated with the replacement of capital ownership with the use or shared access to services (Franco, 2019; Henry et al., 2020; Pollard et al., 2021). Providing repair and maintenance services can help intensify use and slow the loop (Albertsen et al., 2021). The integration of digital capabilities can further enable this strategy (Pieroni et al., 2019b; Tunn et al., 2020). Structural flexibility and close supply chain collaboration are also relevant elements (Ferasso et al., 2020).

Value capture

Leasing, renting, peer-to-peer renting, sharing, mutualizing, pay-per-use, pay-per-performance, pay-per-service, subscription-based business models, repair services, and after-sales services are the proposed revenue mechanisms in the analyzed publications (Albertsen et al., 2021; Cantú, Aguiñaga, & Scheel, 2021; Ertz et al., 2019; Fehrer & Wieland, 2021; Ferasso et al., 2020; Franco, 2019; Henry et al., 2020; Hoffmann et al., 2020; Kant Hvass & Pedersen, 2019; Okorie et al., 2021; Pollard et al., 2021; Urbinati et al., 2020). These are usually presented in the context of PSS solutions and servitization (Centobelli et al., 2020; Hankammer et al., 2019; Maffei et al., 2019; Okorie et al., 2021; Salvador et al., 2020).

3.4.2.4. Dematerializing

The final strategy identified by Geissdoerfer et al. (2020, p. 12) is dematerializing:

> *Dematerialising decreases the use of physical resources by enhancing the value created by intangible solutions, such as services and software. Value creation & delivery is ensured though [*sic*] slow and close the loop capabilities and collaborations. Recurrent revenues, increased profit margins and new pricing mechanisms are key elements for value capture*.

Value proposition

Companies can use services and software solutions to decrease the use of physical resources, virtualizing and dematerializing their businesses (Geissdoerfer et al., 2020; Mhatre et al., 2021). PSS business models emphasize the sale of use over the sale of products (Okorie et al., 2021). The principle behind sustainable PSS is that the same function can be fulfilled, simultaneously reducing the number of products that are used and enhancing customer experience (Geissdoerfer et al., 2020). Furthermore, in the case of result-oriented services, the PSS provider has an incentive to optimize the use of materials and energy while providing the results to customers (Guzzo et al., 2019). One caveat pointed out in the literature concerns the potential of rebound effects that these solutions might generate, as a consequence of increased consumption and less conscientious behavior of customers (Geissdoerfer et al., 2020; Guzzo et al., 2019). Nonetheless, some studies show significant environmental benefits resulting from the adoption of PSS (Sigüenza et al., 2021). The value propositions emerging from these business models have the potential to decouple profit from production volume, leading to a reduction in resource use and waste, while delivering superior customer value (Ingemarsdotter et al., 2020; Long et al., 2020; Pieroni et al., 2019b; van Boerdonk et al., 2021). Consumer needs are at the center of PSS-based value propositions (Hankammer et al., 2019), although a broad range of stakeholders should be considered (Fernandes et al., 2020)

IoT and Industry 4.0 technologies are associated with positive effects in circularity and enable PSS (Chauhan, 2021). Big data, automation and remote sensing are a few examples of

technologies that companies use to improve the performance and efficiency of their products (Alastair et al., 2020).

Value creation and delivery

Value creation and delivery in a dematerialization strategy are connected to a PSS design (Fehrer & Wieland, 2021; Geissdoerfer et al., 2020; Heesbeen & Prieto Hoces, 2020; Ingemarsdotter et al., 2020; Long et al., 2020). Long et al. (2020) state that properly designed PSS solutions can dematerialize consumption, intensify use and increase resource efficiency. Circularity and resource efficiency have to be explicitly addressed in the design of the new PSS (Werning & Spinler, 2020). Early customer involvement is a critical step in the design of this business model. Establishing the right indicators and maintaining a continuous feedback loop with customers are common barriers to establishing performance-based PSS. The ownership transfer from customers to producers and asset sharing are key characteristics of PSS (Henry et al., 2020; Palmié et al., 2021). Customer involvement in the value creation process means that they become co-producers (Salvador et al., 2020). Being able to provide superior customer value is considered a success factor of PSS (Pieroni et al., 2019b). Customer education and changing user behavior are necessary to achieve circularity (Galvão et al., 2020; Hankammer et al., 2019; Inigo & Blok, 2019).

IoT technologies and digitalization are central to dematerialization. IoT supports circular strategies and business models, particularly PSS (Chiaroni et al., 2021; Han et al., 2020; Ingemarsdotter et al., 2020; Maffei et al., 2019; Ranta et al., 2021; Tunn et al., 2020). Software-as-a-Service (SaaS), Product-as-a-Service (PaaS), and access-based product-service systems (AB-PSS) are examples of variants of PSS enabled by digital technologies (Okorie et al., 2021). These technologies allow for different forms of collaborative innovation in the supply chain (Garcia et al., 2019). The network of stakeholders that create and deliver value to consumers is central is PSS design, according to Baldassarre et al. (2020).

Value capture

The publications analyzed in this review point to a few ways to capture value from dematerialization. Renting, leasing, sharing, pay-per-use, pay-per-service, power by the hour, fee-based contracts, advice and consultancy, after-sales services, and subscriptions are presented as mechanisms to capture value in PSS business models (Fehrer & Wieland, 2021; Franco, 2019; Guzzo et al., 2020; Maffei et al., 2019; Pieroni et al., 2019b; Pieroni et al., 2020; Tunn et al., 2020; Ville-Veikko et al., 2020; Werning & Spinler, 2020). Servitized business models are associated with high initial investments for the service provider and postponed revenue streams with longer payback times (Urbinati et al., 2021). Thus, while representing a source of prolonged revenue (Öhgren et al., 2019), these business models can also increase cash-flow pressure due to diluted revenue (Ghisetti & Montresor, 2020).

3.5. Discussion

A reflection on the results of this research is here presented. First, a discussion on the statistical research data is provided, followed by an interpretation of the findings from the content analysis, according to the framework by Geissdoerfer et al. (2020).

Out of the databases that were used in this review, Scopus was the most complete one, representing 50% of the records initially identified. The field of BMI in the CE is a recent topic that has been growing rapidly. If this trend is to continue, significantly more research in the field can be expected in the upcoming years. The Journal of Cleaner Production has been publishing most of the literature in the field, followed by Sustainability, and Resources, Conservation and Recycling. Bocken, N., Pigosso, D., McAloone, T., and Pieroni, M. are not only responsible for a large amount of studies in the field (almost 11% of the publications retrieved in this review), but are also frequently cited in other articles. Besides the most frequent keywords, presented in Figure 5, it is worth mentioning "sustainable business models", "value creation", "product-service systems", and "servitization" as frequent keywords. Sustainable business models can be seen as an umbrella term that includes circular business models (Bigliardi & Filippelli, 2021). PSS models enable circularity and are often used in combination with cycling, extending, intensifying and dematerializing strategies. This is consistent with the emergence of PSS and servitization as common keywords in the literature. Research on circular BMI stems mostly from Europe, in particular from Sweden, the Netherlands and the UK.

3.5.1. Cycling

The 10Rs are the most comprehensive list of circular activities presented in the literature. They are the following: refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover (Antwi-Afari et al., 2021; van Boerdonk et al., 2021). Design for X includes design for recycling, design for remanufacture and reuse, and design for disassembly (Guzzo et al., 2019; Urbinati et al., 2019). As a part of the value proposition, design for X is connected to an increase in quality, durability and repairability. By extension, users are empowered to self-learn, reuse and repair their products, reducing waste (Franco, 2019; Guerra & Leite, 2021; Han et al., 2020; Real et al., 2020; Rossi et al., 2020). One could hypothesize a link between user empowerment and the development of long-lasting customer relations as enablers of a change in user mindset. The existence of this causal relationship is, however, not clear in the analyzed literature. Jobs created from maintenance activities, refurbishment and recycling (Haines-Gadd & Charnley, 2019) and influencing legislation (Hopkinson et al., 2020; Pigosso & McAloone, 2021) could contribute positively to creating a market for secondary products and materials (Huerta Morales, 2020). This has also not been explicitly addressed.

Creating partnerships with other stakeholders in the value chain, inter-organizational collaboration and industrial symbiosis are important resources and capabilities (Albertsen et al., 2021; Centobelli et al., 2020; De Angelis, 2021; Guzzo et al., 2019). Managerial commitment is necessary to implement this strategy across the organization (Lehtimäki et al., 2020).

IoT and digital technology enable not only the resource recovery model (Daniela & Silvio, 2020), but also other strategies within circular business models (Bigliardi & Filippelli, 2021; Chauhan, 2021; Haines-Gadd & Charnley, 2019; Tunn et al., 2020).

Value is captured from increased revenue and reduced costs. Additional revenue can be obtained from PSS, including add-on services, such as repair and maintenance, and advanced servitization in the form of leasing, renting or PaaS (Albertsen et al., 2021; Bakker et al., 2021; Cullen & De Angelis, 2021; Kristensen et al., 2021; Pal et al., 2019; Santa-Maria et al., 2021). Cost reductions result from a residual value from products, better maintenance, energy generation and greater resource efficiency (De Angelis, 2021; Fernandez de Arroyabe, 2021; Khan et al., 2021; Ranta et al., 2021).

3.5.2. Extending

Providing long-lasting products with low maintenance needs, combined with design improvements, prolonged warranties and maintenance services are the pillars of this value proposition (Antwi-Afari et al., 2021; Colucci & Vecchi, 2021; Ertz et al., 2019; Franco, 2019; Guzzo et al., 2019; Heesbeen & Prieto Hoces, 2020; Maffei et al., 2019).

Value is created and delivered by providing services, such as maintenance and repair (Di Biccari et al., 2019). Sharing platforms are enablers of this strategy (Daniela & Alex, 2020; de Kwant et al., 2021). An ownership transfer can be expected from asset sharing (Chiappetta Jabbour et al., 2020), furthering producer responsibility and control. Much like in the cycling strategy, changes in customer behavior are also mentioned and can be achieved with remarketing activities, increased public awareness, and product upgrades (Daniela & Silvio, 2020; Hansen & Revellio, 2020; Hoffmann et al., 2020; Huerta Morales, 2020).

Value can be captured from the additional revenue streams including maintenance and repair services (Cullen & De Angelis, 2021; Ranta et al., 2021). With greater customer value, quality leadership and increased customer value, a price premium may be introduced (Bocken & Ritala, 2021) further increasing revenue.

3.5.3. Intensifying

Research links the value proposition of intensifying with sharing models (Al-Saidi et al., 2021; Geissdoerfer et al., 2020). The use of products is intensified when access to services is

offered rather than asset ownership in use- or result-oriented business models. This can be done as an adaptation to new customer preferences (Chiappetta Jabbour et al., 2020) or through the creation of new relationships with customers, in which a better solution is provided (Baldassarre et al., 2020; Han et al., 2020). How these new relationships should be built, within sharing business models, is not the focus of the reviewed literature. As with other circular strategies, digital capabilities are enablers of intensification. Value capture results from leasing, renting, sharing, pay-per-use, subscriptions (Albertsen et al., 2021; Cantú et al., 2021; Ertz et al., 2019; Fehrer & Wieland, 2021; Ferasso et al., 2020) and other well-known mechanisms from servitization and PSS literature. Advanced forms of servitization focusing on functionality are often presented in the context of intensifying.

3.5.4. Dematerializing

Dematerializing deals with the reduction of physical resources creating value through intangible solutions, virtualizing and dematerializing businesses (Geissdoerfer et al., 2020; Mhatre et al., 2021). When services or intangible solutions substitute physical assets, value can be created while avoiding the use of materials and, particularly, virgin materials, and reducing waste. Delivering customer value is thus decoupled from production volume (Ingemarsdotter et al., 2020). Rebound effects are a potential concern (Geissdoerfer et al., 2020; Guzzo et al., 2019). This highlights the need to explicitly address sustainability in the BMI processes. Digital technologies are central to dematerialization and enable service-centric models (Chauhan, 2021; Chiaroni et al., 2021; Ingemarsdotter et al., 2020).

PSS solutions dematerialize consumption and contribute to intensifying, extending and cycling strategies, as previously explained. Early customer involvement is critical in the design of PSS models (Henry et al., 2020), which could represent an opportunity to develop better value propositions that generate a mindset change and encourage sustainable customer behavior. Besides customers, other stakeholders should also be involved (Baldassarre et al., 2020) in the creation of a circular supply chain.

PSS value capture mechanisms are also used in dematerialization. Businesses must be prepared for the possibility of high initial investments when implementing their servitized models, postponed revenue streams and longer payback times (Urbinati et al., 2021). Previous servitization literature identifies this financial performance issue, as well (e.g. Fang, Palmatier, and Steenkamp (2008) and Suarez, Cusumano, and Kahl (2013)). Adequate business model design should contemplate this potential challenge and balance the long-term financial and environmental benefits with the potential short-term losses and cash-flow pressure.

3.6. Conclusion

This scoping review explored the body of literature in the field of BMI in the CE. The framework developed by Geissdoerfer et al. (2020) was used to analyze the selected studies and answer the following research question: "What is the current state of the art of business model innovation within the circular economy?".

The findings indicate that this field is growing rapidly and significantly more research can be expected in the future. Scholars like Bocken, N., Pigosso, D., McAloone, T., and Pieroni, M. are responsible for various relevant publications and are frequently cited in other studies.

Cycling, extending, intensifying, and dematerializing are four possible strategies for the CE. To some extent, these strategies overlap in terms of their value proposition, value creation and delivery, and value capture. The 10Rs (refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover) are relevant circular activities that companies can incorporate in their business, as well as design for X. User empowerment to self-learn, reuse and repair enable circular strategies. Increased revenue and reduced costs are the financial goals of circular business models. This is achieved through PSS and different levels of servitization, from having add-on services to having use- and result-oriented models. Some of the revenue mechanisms include maintenance and repair services, leasing, renting, pay-per-use, and subscriptions. More advanced levels of servitization are suggested in the context of intensifying and dematerializing. Extending and, especially, intensifying are linked to sharing models. These can leverage on digital technologies and are focused on functionality. Transferring ownership from customers to the service providers increases companies' responsibility and control and has implications for customer behavior. As customers demand more sustainable practices and begin to embrace servitized models, a shift in their preferences can favor the circular models presented in this review. Circular business models should be developed in close contact with customers and other stakeholders, positively influencing the rest of the supply chain and creating a superior value proposition that allows value creation to be decoupled from production volume and resource consumption.

The biggest limitation of this study is the fact that breadth was prioritized over depth, which is a limitation of scoping reviews. In addition, the quality of the reviewed publications was only superficially assessed. Lastly, contextual factors were not addressed, such as market specificities, country, social and organizational contexts.

Several research avenues can be identified. Firstly, the existence of a causal relationship between user empowerment and the development of long-lasting customer relations is not clear in the studies that were reviewed. The possibility that job creation resulting from circular models, such as maintenance and repair jobs, could foster the creation of a market for secondary products and materials is also not addressed. Moreover, given the importance of having close and long-term customer relationships, future studies should address how these could be materialized in circular models. Finally, the characteristics of the four strategies analyzed in this study seem to suggest a

continuous increase in servitization, that is, these strategies go from being product- to being increasingly service-centric, from cycling, extending, intensifying, to dematerializing. Future studies investigating this hypothesis could help clarify these concepts.

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Appendix A

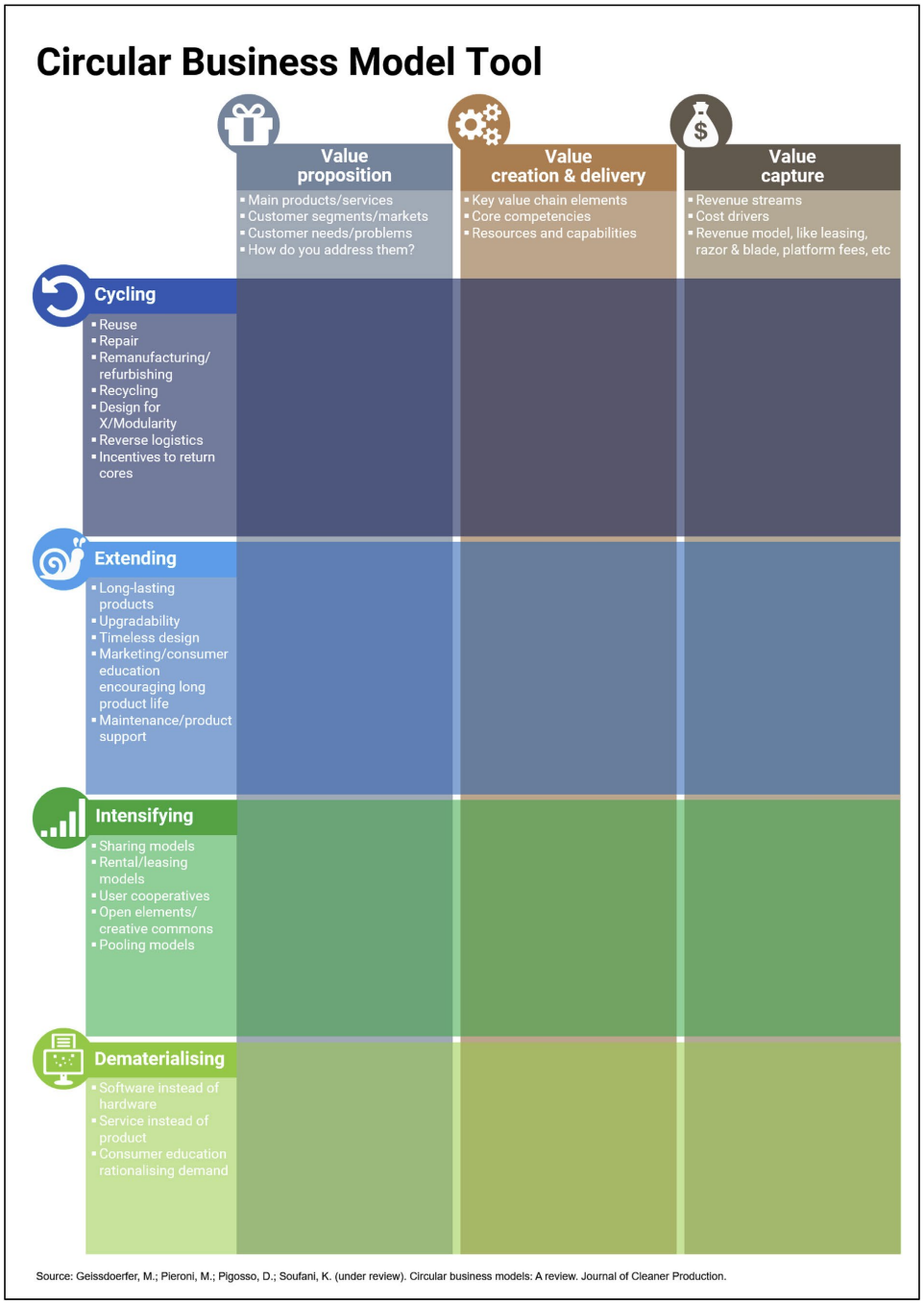

Figure 9: Framework presented by Geissdoerfer et al. (2020)

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