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Circular Solution Canvas:

Background report on the development of a tool for analysing and scaling circular economy impacts

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Neither the canvas nor the company circular economy examples presented for its development and illustration are endorsed by the European Union or by any partners of the EU SWITCH-Asia Policy Support Component, and the publication does not necessarily reflect their views.

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The CE Knowledge Technical Advisory was implemented during May 2024 – May 2025 in consultation with five leading global CE knowledge platforms, respectively: African Circular Economy Network (ACEN); ASEAN Circular Economy Stakeholders Platform (ACESP); Central Asian Climate Information Portal (CACIP); Circular Economy Coalition for Latin America and Caribbean (CEC LAC); and the European Circular Economy Stakeholders Platform (ECESP).

The expert discussions and stakeholders' engagements under this and the other Technical Advisories equally underscored the need for improved curation of experiential, practical CE knowledge as well as informed the development of a canvas for structuring and analysing the implementation of CE relevant activities (in products, services, technologies, processes, value chains and networks). The contributors and participants in the Technical Advisories are therefore acknowledged for their constructive engagements, without which this report would not have been possible. Moreover, this report has benefitted significantly from expert review comments and suggestions from Zinaida Fadeeva, Sara Gabai, Sachin Joshi (SWITCH-Asia PSC) and Cosima Stahr (Adelphi).

The report was produced by Rene Van Berkel (international faculty of School of Global Studies, Thammasat University) and senior expert on Circular Economy for SWITCH-Asia PSC under the guidance and cooperation of Loraine Gatlabayan (key expert on SCP Partnerships), Sara Gabai (communications and knowledge management expert) and Zinaida Fadeeva (team leader), all of the SWITCH-Asia PSC.

1 https://www.switch-asia.eu/our-work/multi-country/accelerating-the-transition-to-a-circular-economy-through-knowledge-generation-management-and-sharing/
2 https://www.switch-asia.eu/our-work/multi-country/asean-circular-economy-pact-acep-mobilizing-business-action-for-circular-economy/
3 https://www.switch-asia.eu/our-work/multi-country/supporting-sustainable-tourism-through-scp-policy-development-and-implementation-in-the-pacific/
4 https://www.switch-asia.eu/our-work/multi-country/circular-economy-policy-dialogues-with-the-parliamentarians-platform-in-central-asia/
5 https://www.switch-asia.eu/our-work/multi-country/strategic-foresight-for-tourism-with-a-food-angle-in-central-asia/

Executive Summary

The Circular Economy (CE) has gained substantial traction globally. CE addresses the urgency of the triple planetary crises of climate change, biodiversity loss, and pollution, and their common root cause in the unsustainable extraction and use of material resources. CE is further supported by its conceptual attractiveness and its convergence with diverse policy and business objectives. Nevertheless, a persistent gap remains between the ambition of closed material cycles and on-the-ground implementation that is largely limited to lower levels of materials recycling and waste-to-energy recovery. Bridging this gap depends on the availability and effective use of actionable CE knowledge, that is grounded in real-world practice.

To address the growing demand for such knowledge, regional and national CE knowledge platforms have been established, of which five were assessed: the African Circular Economy Network (ACEN); the ASEAN Circular Economy Stakeholders Platform (ACESP); the Central Asian Climate Information Portal (CACIP); the Circular Economy Coalition for Latin America and the Caribbean (CEC LAC); and the European Circular Economy Stakeholders Platform (ECESP). This revealed significant shared limitations, that were further validated through a series of four CE knowledge management webinars. **The knowledge management platforms function principally as static document repositories designed with high-definition, top-down information architectures that position users as passive consumers rather than active participants**. Classification and tagging systems are inconsistent, inter-platform interoperability is largely absent, and communication strategies are ad-hoc and under-resourced.

This assessment pointed to two specific action areas for CE knowledge generation and management: a **CE knowledge management taxonomy** to improve the classification and discoverability of existing knowledge products; and a **CE solution ontology** to enable the structured analysis and curation of experiential CE knowledge from practice. The Green Growth Knowledge Partnership (GGKP) has been developing a dynamic taxonomy with Artificial Intelligence (AI)-enabled classification capabilities. This report focuses on the development and illustration of a CE solution ontology operationalised as the Circular Solution Canvas.

The Circular Solution Canvas is grounded in an analysis of the current CE-practice and its supporting conceptual and methodological constructs, focused on the CE idea, its objects of change and its intended impacts. The CE idea is captured as an open-ended innovation space driving towards circular value chains, guided by three resource strategies: circularity; efficiency; and substitution. The objects of change can be five-fold, respectively: product; business process; business model; value network; and ecosystem, amongst which change at the level of product and/or business process is necessary to achieve circularity impact. Such circularity impact can cut across business, environment and society domains, having intermediate results (or midpoints), under the control of the implementing organisation, and final impacts (or endpoints), beyond its control, yet contributing to broader economic and sustainable development objectives.

The Circular Solution Canvas is structured around three main elements, mirroring the CE deployment pathway from idea to objects to impacts. The **Circular Value *Proposition*** describes how a circular solution improves resource circularity, resource efficiency, and/or resource substitution. The **Circular Value *Creation*** identifies which products, services, and/or business processes have been innovated, and at which stages of the circular value chain. The **Circular Value *Capture*** articulates the benefits achieved, for business, environment, and society. Each element has sub-elements and potential subject categories, providing a structured but flexible approach for canvassing any circular solution.

The Circular Solution Canvas has been illustrated with single-firm CE cases from Southeast Asia, covering community-based plastics recycling (Precious Plastics, Philippines), sustainable fashion redesign (Thai Wacoal, Thailand), mycelium-based materials production (Mycotech Lab, Indonesia), and organic pepper cultivation (Fair Farms, Cambodia). It has also been applied for an illustrative mapping of 16 purposively-sampled Indonesian CE business cases. Moreover, initial trials in training and stakeholder engagement settings in Thailand, Indonesia, and the Philippines have further shown practical utility.

Scaling CE impact requires moving beyond one-size-fits-all approaches. **The Circular Solution Canvas is positioned as an instrument for developing context-*specific* understanding of existing CE solutions to design and implement context-*effective* scaling approaches, and help bridge the gap between knowledge of CE examples and their widespread replication, deepening and widening.**

Moving forward the Circular Solution Canvas is foreseen to serve two complementary applications. Used retrospectively, it enables the **structured analysis and learning from operational circular solutions,** generating evidence-based insights that can inform the design of CE scaling strategies. Used prospectively, it provides a **framework for value-engineering conceptual circularity ideas into practical, value-adding and investable, circular solutions**.

In conclusion, this report makes two principal contributions. First, informed by the practices of CE knowledge management and CE implementation, it offers a **framework for structuring CE implementation from the core CE idea, to its objects of change and its intended impacts**. Second, it introduces and illustrates the **Circular Solution Canvas as a practical tool for analysing, curating, and designing circular solutions**. Together, these contributions support the broader objective of scaling up CE and its impacts, and the effective use of knowledge therein, as a means to close the persistent gap between what is expected from the Circular Economy and what is currently being done for its realisation.

Contents

Abbreviations

ACEBA	ASEAN Circular Economy Business Alliance
ACEN	African Circular Economy Network
ACESP	ASEAN Circular Economy Stakeholders Platform
ASEAN	Association of South East Asian Nations
CACIP	Central Asian Climate Information Portal
CEC LAC	Circular Economy Coalition for Latin America and Caribbean
ECESP	European Circular Economy Stakeholders Platform
EU	European Union
EMF	Ellen MacArthur Foundation
GCP	Global Circularity Protocol (for business)
GGKP	Green Growth Knowledge Partnership
ISO	International Organisation for Standardisation
OPN	One Planet Network
PSC	Policy Support Component (of the EU SWITCH-Asia Programme)
STEP	Sustainable Tourism Enhancement in the Pacific
UNGC	United Nations Global Compact
WBCSD	World Business Council for Sustainable Development

Chapter 1: Introduction

1.1 Background

The Circular Economy (CE) has witnessed a surge in interest particularly since the mid 2010's, equally in public policy (e.g., [1], [2], and [3]), business and civil society (e.g., [4], [5], and [6]), and scholarly research (e.g., [7], [8], [9], [10]) and [11]. In turn, the demand for ***actionable*** CE knowledge and insights is on the rise among business, policy makers and other stakeholders. Such actionable CE knowledge, may be as diverse as: specific CE product, technology and business model solutions; relevant and robust CE relevant data on materials use and waste generation; and effective policy instruments and enabling frameworks to create and transform markets, including through the mobilisation of financing, technology and innovation [12]. In response, CE knowledge and stakeholder engagement platforms have been created, at regional and national levels, in e.g., Africa[6], Southeast Asia[7], Central Asia[8], Latin America and Caribbean[9], Europe[10], Nordic Countries[11], Australia[12], Japan[13], South Africa[14], Taiwan[15] and elsewhere.

Recognising both the opportunities and challenges posed by these and other CE knowledge platforms operating in parallel, the EU SWITCH-Asia Policy Support Component (PSC)[16] and the Green Growth Knowledge Partnership (GGKP)[17] started a joint Technical Advisory (TA) to contribute to improving the generation, management and sharing of CE knowledge[18]. This TA was initiated with the ambition to support the development and acceptance of a common knowledge management taxonomy specific to CE, i.e., a standard way to classify CE knowledge product. Such taxonomy had been expected to improve both the ***impact*** and ***efficiency*** of knowledge management – in terms of reaching end-users and them acting on the CE knowledge provided - and ***expand*** and ***deepen*** the knowledge management through improved interoperability between knowledge platforms. Such interoperability allows knowledge platforms to extract and process knowledge stored in other platforms, without the need to duplicate the upload and classification of the knowledge products. Thereby, inter-platform knowledge sharing allows each participating platform to better serve the knowledge needs of its specific target groups and end users.

This CE knowledge TA started with an in-depth assessment of five leading regional CE knowledge platforms, collectively considered illustrative for the global status quo in open access, publicly-funded CE knowledge management, respectively: African Circular Economy Network (ACEN); ASEAN Circular Economy Stakeholders Platform (ACESP); Central Asian Climate Information Portal (CACIP); Circular Economy Coalition for Latin America and Caribbean (CEC LAC); and the European Circular Economy Stakeholders Platform (ECESP). This assessment considered the contents (i.e., the library of knowledge products stored and disseminated), the categories and procedures for classification (or '*tagging*') of these knowledge products, and the communication and other knowledge sharing functions. This TA also organised and hosted a series of four interactive, global CE knowledge management webinars (16 October 2024[19], 28 November 2024[20], 27 February 2025[21] and 6 May 2025[22]), to explore the perspectives of knowledge managers and CE practitioners (policy makers, businesses and experts' community).

6 https://acen.africa/ and https://www.aceaafrica.org/
7 https://ce.acsdsd.org/
8 https://centralasiaclimateportal.org/aboutus/
9 https://coalicioneconomiacircular.org/
10 https://circulareconomy.europa.eu/platform/en
11 https://nordiccircularhotspot.org/
12 https://circularaustralia.com.au/
13 https://www.ce-association.org/en/, https://harch.jp/en/media/cehub, and https://j4ce.env.go.jp/en/
14 https://circularsouthafrica.co.za/
15 https://circular-taiwan.org/en/
16 https://www.switch-asia.eu/
17 https://www.greengrowthknowledge.org/
18 See: https://www.switch-asia.eu/our-work/multi-country/accelerating-the-transition-to-a-circular-economy-through-knowledge-generation-management-and-sharing/
19 https://www.youtube.com/watch?v=rmd69aY21Qw
20 https://www.youtube.com/watch?v=SkpyjlEJ2jo&feature=youtu.be
21 https://youtu.be/yW8JCfpuhDs
22 https://youtu.be/iFRci3j4q0U

These webinars revealed two, interrelated challenges for improving the impact and efficiency of CE knowledge management [12]:

- The first challenge is related to the consistency of classification and/or tagging of the knowledge products. This improves the discoverability of the available knowledge products, and – vice versa – the relevance of the returned search results to the end-user. This is the traditional role of the Knowledge Management Expert, making sure that users find knowledge that best meets their specific knowledge needs. It requires a ***knowledge management taxonomy*** that considers key features of the knowledge products, e.g., its sectoral, geographical or other scope, its intended application (for e.g., policy making, analysis and research, implementation by business), its knowledge type (e.g., manual, case study, technical report) and a broad classification of its specific knowledge contents (or in other words, the CE topics covered in detail). Typically, the knowledge taxonomy would be hierarchical, having different layers with subcategories (e.g., going from region to country to locality, or from sector, to subsector and unit operations).
- The second challenge concerns the analysis and organisation (or '*curation*') of the knowledge contained in any individual knowledge product. This involves the structuring of the contained knowledge by observable features of and characteristics in the CE subject area. These could be the types and/or scales of environmental, business and/or other impacts achieved and/or risks incurred, the circularity strategy deployed, the object changed by the CE practice (e.g., a product, packaging, business process, or otherwise), etc. This knowledge curation focuses on features and characteristics of the CE solution(s) contained in the knowledge product, using an agreed set of key subjects that are not necessarily hierarchical, or a ***subject ontology***. An ontology is of particular relevance for analysis of experiential, or practice-derived, knowledge, for example a specific CE product or policy instrument (regardless of it being considered a success or failure). It allows for articulating, debating and understanding the essence of the example or case study, which can support meaningful learning (leading to knowledge creation) about its origin, enabling factors and replicability, both within apparently similar applications (e.g., in the same sector or region) or outside thereof (through application of its abstractions in other application contexts). Particularly given that CE adoption and implementation are still in an early stage, curating and structured learning from practical examples has great potential to scale-up and accelerate the impactful implementation of CE.

Both these challenges are subject-related, or CE specific. They are, however, moderated by platform design, in particular the way each platform allows its users (both the traditional categories of knowledge suppliers and knowledge users, as well as knowledge intermediators, beneficiaries and others) to interact, learn and problem-solve, and in the process co-create and curate further knowledge. This may be captured as the media environment [13]. Existing knowledge platforms create '*hot*' media environments, characterised by high-definition, polished information that requires minimal user participation, and thereby positioning users as passive consumers and instilling authority in the knowledge suppliers and platform managers – reinforcing one-way, top-down dissemination that leaves little room for feedback, reinterpretation, or collaborative meaning-making. In contrast, '*cool*' media environments involve systems with strategic incompleteness that invite users' participation, co-creation and contextual interpretation. Given the rapidly evolving theory, methodology, policy and practice of CE, incompleteness is inherent to the CE domain. Cool knowledge platform designs create space for navigating this inherent incompleteness, understanding local meaning and co-curating knowledge that is relevant to the problems and knowledge needs of different types of platform users.

This report though zooms in on the CE subject ontology particularly for practical circular solutions that businesses and other organisations implement to advance circularity. In parallel, GGKP has been developing and implementing an improved CE knowledge management taxonomy, as a subdomain of its green growth taxonomy, which is driving the green policy platform[23], the green industry platform[24] and the green finance platform[25]. This is operationalised with an automatic classification engine, federated search infrastructure and quality assurance mechanisms to benefit from developments in Artificial Intelligence (AI) [13]. This

23 https://www.greenpolicyplatform.org/
24 https://www.greenindustryplatform.org/
25 https://www.greenfinanceplatform.org/

provides a dynamic taxonomy that can automatically classify and re-classify knowledge products against a taxonomy that evolves and improves over time. The development of this knowledge management taxonomy is not further elaborated upon in this report.

1.2 Overview

This report covers the development and illustration of a proposal for a practical ontology for curating experiential CE knowledge. In analogy to the widely-used operationalisation of the ontology for business models into the business model canvas [14], the CE ontology is proposed here in the form of a ***Circular Solution Canvas***. Where the business model canvas has proven its usefulness for analysing and improving revenue generation by firms, it is aimed that the Circular Solution Canvas will support and improve the creation of circularity value, both for the firms or other organisations developing and implementing the circular solution, and for planet (contributions to mitigation of the climate, nature and pollution crises) and society (keeping communities healthy and safe and supporting them to develop and prosper). The Circular Solution Canvas is foreseen to be used ***prospectively*** to support development of practical circular solutions (i.e., finding ways to maximise the benefits of circular ideas or boundary concepts) as well as ***retrospectively*** to analyse – relative – success or failure of specific circular solutions (i.e., analysing the circularity benefits created by a specific circular solution and the ways these are being achieved).

The Circular Solution Canvas drives CE knowledge generation based on experiential, practical or '*lived*' evidence. Experiential knowledge is used here as a short-hand for action-grounded, practice-derived knowledge about context-specific CE-relevant solutions, as developed, trialled and adopted by businesses, farmers, foresters, communities and/or other stakeholders and policy makers. As a stage setter, Chapter 2 provides a snapshot of current CE knowledge management globally, based on the activities of five public regional CE knowledge management initiatives and the CE knowledge management webinar series, co-convened by the EU SWITCH-Asia PSC and GGKP.

At its core, ontology concerns '*knowing, perceiving and interpreting*' phenomena in the world (in this case the adoption of CE by businesses and other organisations) by providing a set of concepts and categories in a subject area or domain that shows the properties of the phenomena studied and the relations between them. In practical terms, an ontology provides the relevant features of the subject area, hence of the Circular Economy. This is lacking for CE, as CE has started to mean different things to different organisations, businesses, policy makers, scholars and consumers (e.g., [8] and [9]). This equally presents a challenge for the development of a Circular Solution Canvas as well as underscores the necessity of a such canvas. Chapter 3 therefore delves into key current operationalisations and concepts of the CE, to propose a pragmatic operationalisation for an ambitious CE, in terms of its idea, its objects and its impacts, suited to guide the development of the circular solution canvas.

Chapter 4 covers the development of the Circular Solution Canvas. This includes operational descriptions for the key features, elements and subject categories used in the canvas. Moreover, the canvas is illustrated with its application for a set of practical CE business cases from different sectors in Southeast Asia.

Chapter 5 summarises and reflects upon the analysis and development and suggests avenues for further piloting and development of the Circular Solution Canvas.

Chapter 2: Circular Economy Knowledge Management in Practice

2.1 Introduction

As interest in and commitment for the CE expanded significantly since the mid 2010's, the demand for actionable CE knowledge has increased. To meet this emerging demand for CE knowledge a diversity of open-access knowledge and stakeholder engagement platforms have been set up at national, regional and sectoral levels, with support from national governments, development partners, business, professional and academic communities. These operate with diverse organisational and functional mandates, typically with a variable balance between advocacy and awareness creation, knowledge management, stakeholders' engagement, training and/or policy and technical advisory services.

In order to understand the practical opportunities and challenges in communicating and localising CE knowledge in different socio-cultural, economic and industry-sector contexts, the EU SWITCH-Asia PSC and the GGKP engaged in a constructive assessment and dialogue with five leading, publicly-funded, open-access CE knowledge management initiatives. This covered analysis of their respective knowledge management platforms from three complementary perspectives, respectively: organisation and governance; contents (the CE knowledge products made available); and communication and engagement activities.

This started with a broad mapping of international CE knowledge platforms (during 2nd Quarter of 2024), defined by them having at least an open-access, active searchable database of CE-relevant – digital - knowledge products (blogs, reports, business cases, audio-visuals, policy documents, manuals, etc.). This yielded an initial long list of 38 '*platforms*', many of which were connected in informal and semi-formal ways to other platforms, showing early signs of organic and loosely-facilitated collaboration into a *'network of knowledge platforms'*. Following further desk reviews (during 3rd quarter of 2024), five regional platforms were selected, based on: perceived reputation; established partnerships; expected influence potential; CE relevance of the platform's contents; alignment with global CE principles, practices and criteria; and willingness to engage with the GGKP and the EU SWITCH-Asia PSC. Next, these five selected CE knowledge platforms were further assessed and opportunities and challenges discussed and refined in dialogue with the management of the respective platforms (during 4th quarter of 2024).

The key insights are summarised in the following section 2.2. Although these only represent a timebound snapshot of the respective platforms' achievements in the second half of 2024, the key opportunities, issues and challenges have turned out more generally relevant and applicable, as evidenced during the deliberations of the knowledge management webinar series held during October 2024 – May 2025 with the selected knowledge platforms as well as other CE stakeholders globally [12], as summarised in section 2.3.

2.2 Current Initiatives

African Circular Economy Network (ACEN)

The ACEN[26] was established in 2016 and has since expanded into a pan-African network of over 1,100 CE professionals, businesses and other organisations representing 42 African countries, whilst establishing strong institutional partnerships with e.g., World Economic Forum (WEF), United Nations Environment Programme (UNEP), African Development Bank (AFD) and the African Union (AU). ACEN envisions to build a restorative African economy that generates well-being and prosperity, inclusive of all its people.

ACEN operates with a three-pronged strategy: (1) *connect* – build and strengthen Africa's most comprehensive network of CE practitioners; (2) *empower* – equip stakeholders with knowledge, skills and tools to become effective CE champions and implementers; and (3) *transform* – deliver impactful programmes and projects that translate CE principles into tangible business models, policy frameworks and systematic changes

26 https://acen.africa/

across African communities and economies. Through its projects and through its membership, ACEN continues to play a key role in pan-African CE initiatives, including the African Circular Economy Alliance (ACEA)[27], a coalition of African governments committed to develop and implement national CE roadmaps[28] that focuses on the five African CE bets (food systems; packaging; electronics; fashion and textiles; and built environment)[29], supported by the African Development Bank, and the development and launch of the Continental Circular Economy Action Plan for Africa 2024-2034[30], by the African Union.

ACEN operates an informative website that serves as knowledge platform. The knowledge resources are structured in four sections; publications; case studies; webinars (recordings of key ACEN online and offline events); and training (links to external online training offerings). The publications section is a searchable document repository covering key ACEN and ACEN-partner initiatives, categorised in: plastic; food systems; e-waste; national policy/strategy; continental initiatives; just transition; and external sources. The case studies section provides an interactive map of documented CE-relevant community and business initiatives around Africa.

ACEN maintains an active communications strategy with its members and general public through monthly newsletters and social media coverage. Moreover, ACEN leverages partnership opportunities to contribute to projects and programmes, including delivery of African-centric CE training and policy advisory.

European Circular Economy Stakeholders Platform (ECESP)

The ECESP[31] was jointly launched by the European Commission (EC) and the European Economic and Social Committee (EESC) in 2017. ECESP brings together stakeholders active in the broad field of the CE in Europe. ECESP provides a meeting place where stakeholders can share and scale-up effective solutions and address specific challenges. The ECESP thereby bridges local, regional and national level initiatives that support and facilitate the implementation of the CE. ECESP is governed by a Steering Committee comprising representatives of founding organisations (EC and EESC) and the two co-chairs of the Coordination Group. This Coordination Group is responsible for planning and is comprised of elected representatives of 24 participating organisations in the ECESP participants' base, serving two-year terms, supported by the ECESP Secretariat.

The ECESP website is an open resource: stakeholders can consult it and contribute contents (subject to clearance by the Secretariat's editorial team). There are four main and 11 sub-categories of knowledge items: (1) Events (events and news); (2) Knowledge Hub (covering: Good Practices (mostly businesses); Strategies (published by governments); Knowledge (reports, studies, etc.); (3) Commitments (by companies); and (4) Pledges (relating to the European Strategy for Plastics in the Circular Economy)), Moreover, the Toolbox (see Box 1) covers: Financing (information on financing mechanisms); Education and training (details of circular courses); Measuring the circular economy; and Toolkits and Guidelines); and CE Networks and Platforms.

27 https://www.aceaafrica.org/
28 https://www.aceaafrica.org/country-roadmaps
29 https://www.aceaafrica.org/5-circular-bets
30 https://au.int/sites/default/files/documents/45336-doc-GIZ-AU_Continental_Circular_Action_V11.pdf
31 https://circulareconomy.europa.eu/platform/en

Box 1: The ECESP Toolbox

The Toolkit is organised through combination of the 'opportunity', 'target group', 'format' and 'country'. The Knowledge Hub is solely organised on subject matter, across the following categories:

- 'type': fact sheet, position paper, presentation, report, study or other;
- 'key area': production, consumption, waste management, secondary raw materials, and innovation and investment;
- 'country';
- 'scope': cities/municipalities, regional, rural, cooperation and development, national, international, global and EU; and
- 'sectors' (widely interpreted and further subdivided into: agriculture, fertilisers and forestry; awareness raising; B2B services; behavioural incentives; bio-economy and biomimicry; business incubators and start-ups; cement, steel and chemicals; ceramics and glass; circular action for climate neutrality; clothing and fashion; construction, buildings and infrastructure; corporate procurement; culture, sports and leisure; economic instruments; education and skills; electronics and ICT; empowering consumers; energy and waste-to-energy; food, water and nutrients; furniture; governance; health and healthcare; housing and urban development; industrial symbiosis; industrial techniques; innovation and investment; machinery and equipment; measuring circularity; mining, metals and minerals; mobility and transport; other; personal and household goods; personal and household services; plastics, polymers and rubber; power and utilities; product as a service; public procurement, public services; pulp and paper industry; recover and regenerative economy; recycling; refineries; refuse, rethink and reduce; repair, refurbishment, remanufacture and repurpose; research; retail; reuse; social enterprise; social impact; soils, soil improvement and restoration; textiles, apparel and leather; waste management and secondary materials; and water).

Across its diverse categories, it was found that the ECESP Knowledge Hub has a strong focus on end-of-life, post-consumer, waste elimination and materials circulation. It also has an active feed of news and events. The contents display unequal distribution, leaving multiple categories with just a couple of entries, and these most often as the secondary or tertiary tagging, rather than the primary. The 53 subcategories for 'sectors' cover both economic sectors (ceramics & glass, cement, steel & chemicals, etc.), as well as policy instruments (e.g., awareness raising, behavioural incentives, economic instruments, government procurement, etc.), circular business models (e.g., product as a service, industrial symbiosis, etc.) and circularity practices (refurbishment, remanufacturing, reuse etc.). Moreover, several sectors appear to overlap (e.g., 'clothing and fashion' overlaps with 'textile, apparel and leather', and 'construction, building and infrastructure' overlaps with 'housing and urban development').

The ECESP combines the knowledge hub with a range of communication and convening activities in both English and French. These include e.g., monthly newsletter (with digest of key new knowledge resources), social media, annual conference, CE podcasts and EU Circular Talks. Opportunities exist for further targeting and expanding communication activities and creating mechanisms for user feedback, co-creation, and participatory engagement. These are moving the platform toward a *'cooler'* media environment that supports dialogue, interpretation, and situated knowledge use rather than one-way dissemination.

ECESP is building on its unique composition as a pan-European and globally connected network of networks to also develop and curate knowledge, brought to the fore by its participants base and integrated through the work of its Coordination Group and the Secretariat. Five areas are being targeted for knowledge curation, leading to the production of ECESP branded knowledge products[32], namely:

32 E.g. *Extended Producer Responsibility: current state and recommendations for improvement* (2025) (https://circulareconomy.europa.eu/platform/en/about/cg-activities-documents/epr-schemes-current-state-and-recommendations-improvement); *Introduction to Economic Incentives* (video) (2025) https://circulareconomy.europa.eu/platform/en/about/cg-activities-documents/introduction-economic-incentives) ; and *Circular Economy Joint Declaration* (2024). (https://circulareconomy.europa.eu/platform/sites/default/files/2024-05/Circular%20Economy%20Joint%20Declaration.pdf)

1. Transitioning to circular value chains;
2. Advancing an integrated circular bioeconomy;
3. Enabling an inclusive circular society;
4. Economic and financing instruments for the circular transition; and
5. Increasing demand for European circular solutions.

Central Asia Climate Information Portal (CACIP)

The development of CACIP[33] was commissioned by the Central Asian Regional Environment Centre (CAREC), an intergovernmental organisation of the five Central Asian countries, in 2019 ahead of its official release in May 2021 during the Central Asia Climate Change Conference (CACCC). CACIP was initiated to assist countries with climate change adaptation strategies through access to geodata, maps, and information for the region. The Platform was developed in partnership with the International Center for Agricultural Research in the Dry Areas (ICARDA) and with the financial support from the World Bank. It has become a core activity of CAREC and hence become subject to its intergovernmental governance arrangements. CACIP hosts an extensive knowledge management portal, as summarised in Box 2.

Box 2: The CACIP knowledge platform

CACIP operates an online, searchable digital repository of technical, policy and other relevant documents[34]. Uploaded documents are keyword searchable, and have been classified as follows:

- 'country' – any of the Central Asian countries or immediate neighbour country that shares relevant natural asset with Central Asia;
- 'topics' – adaptation; agriculture and rural development; air quality; biodiversity; CACCC; climate change; desertification and dust storms; (official) documents; drought; ecosystem and ecology; education, knowledge and training; emergency, risk and disaster reduction; finance and insurance; flood; food security; forest; green technology and nature based solutions; greenhouse gas; interview; land degradation; landscape; mountains; mudflows and landslides; pastures; policy and regulation; resilient land (RESILAND); snow and ice; soil; tourism and recreation; trade and markets; transport; waste and recycling; water resources; and youth and local communities;
- 'tags' - Asian Development Bank (ADB); CAREC; Circular Economy; ClimateCA (Central Asia); climate change; climate finance; climate resilience; energy resilience; Food and Agriculture Organisation (FAO); landscape restoration; Nationally Determined Contribution (NDC); Resilient Land (RESILAND), United Nations Economic Commission for Europe (UNECE); United Nations Children's Fund (UNICEF); World Health Organisation (WHO); and World Meteorological Organisation (WMO); and
- 'categories'– analytics and analysis; best practices; case studies; conference materials and proceedings; expert opinions and interviews; forecasts and scenario assessments; links to resources; materials from pilot and demonstration sites; media articles; multimedia resources; photo materials and photo reports; policy briefs; presentations; press releases; project reports; reports of international organisations; results of expert examinations, evaluations and audits; review; scientific articles and abstracts; standards and technical regulations; statistical data; technical documents, manuals and instructions; textbooks and study guides; training courses and modules; transcripts of meetings and sessions; video materials; and webinars and seminars.

The knowledge management taxonomy operates with categories that are unclear and overlapping. The 'topics' for example include several (economic) sectors (e.g., agriculture, forestry, etc.), climate impacts (e.g. droughts, floods, mudflows, etc.) and enabling activities (e.g., policy, financing, youth involvement etc.). Moreover, in terms of 'categories' (of knowledge products) there is ambivalence of e.g., best practice versus case study, and presentations versus conference materials. And the 'tags' listing covers both sponsoring/

33 https://centralasiaclimateportal.org/
34 https://centralasiaclimateportal.org/document-library/

partner organisations (e.g., ADB, UNICEF, etc.) and generic climate change contents (e.g., greenhouse gas, climate resilience, landscape restoration, etc.).

The CACIP is embedded in and promoted for use through the climate, energy and related sustainable development programme of CAREC, in particular its flagship annual CACCC.

Circular Economy Coalition for Latin America and the Caribbean (CECLAC)

The CECLAC[35] was launched in February 2021 as the regional platform to enhance inter-ministerial, multi-sectoral and multi-stakeholder cooperation to increase CE knowledge and understanding and to facilitate training, capacity building and technical assistance for the development of public policies on CE and Sustainable Consumption and Production (SCP). CECLAC's goals are broadly to: promote a regional agenda on CE; facilitate South-South and triangular cooperation involving government, business and development partners; development of CE tools, indicators and capacity building; facilitating and mobilising financing for CE pilot projects; and policy and stakeholders' advocacy.

Since its inception CECLAC has continued to prioritise development of national CE strategies and the circular plastics transition. Since its inception, CECLAC has developed and published several knowledge documents, including, amongst others: a regional CE visionary framework[36] and the regional circularity gap assessment[37].

The CECLAC is governed by a Steering Committee composed of five elected regional governments (currently Brazil, Argentina, Paraguay, Ecuador and Chile) and representatives of six permanent partner organisations (respectively: United Nations Environment Programme (UNEP, also serving as CECLAC Secretariat), United Nations Economic Commission for Latin America and Caribbean (UNELAC), Interamerican Development Bank (IADB), Climate Technology Centre and Network (CTCN), Ellen MacArthur Foundation (EMF) and World Economic Forum (WEF)).

CECLAC operates a keyword-searchable CE knowledge repository on its website, which contains its own publications and other relevant documents of partner organisations and governments in the region, in Spanish, English and Portuguese. These are broadly covering: food and agriculture; resource circularity; cities and construction; manufacturing industry; fashion and textiles; plastics; and tourism.

CECLAC has developed and delivered capacity building and communication activities with its strategic partners, yet at the time of this assessment did not have a comprehensive communication and outreach strategy, due to a paucity of resources. As emphasised in the knowledge management literature, strategic communication planning, including clear value propositions, defined target audiences, and measurable metrics, is central to effective platform operation and should not be treated as secondary to technical or content functions.

ASEAN Circular Economy Stakeholder Platform (ACESP)

ACESP[38] is a regional facility helping ASEAN Member States (AMS) achieving SCP by accelerating the CE transition. It was initiated within the framework of the EU-ASEAN Partnership on Circular Economy, endorsed by the Meeting of the ASEAN Senior Officials on the Environment (ASOEN) in 2018. The development, launch and operation of ACESP was until December 2025 partially supported by the Enhanced EU-ASEAN Dialogue Instrument (E-READI), a cooperation programme facilitating dialogues between the EU and ASEAN. Following extensive scoping and preparation, the Platform's Secretariat was launched during a planning workshop on 14-15 September 2022, with ACESP officially launched on 27 June 2023 at the ASEAN Secretariat in Jakarta. ACESP is hosted by the ASEAN Centre for Sustainable Development Studies and Dialogue (ACSDSD)[39], an official ASEAN entity, supported by the Ministry of Foreign Affairs (Thailand). ACSDSD operates under the guidance of a Committee of the Ambassadors of ASEAN Member States to Thailand.

35 https://coalicioneconomiacircular.org/

36 *Circular Economy in Latin American and the Caribbean: a shared vision* (2023), CECLAC, https://coalicioneconomiacircular.org/publicacion/economia-circular-na-america-latina-e-nas-caraibas-uma-visao-partilhada/

37 *The Circularity Gap Report: Latin America and the Caribbean* (2023), Circle Economy for CECLAC, https://coalicioneconomiacircular.org/publicacion/informe-sobre-la-brecha-de-circularidad-en-america-latina-y-el-caribe/

38 https://ce.acsdsd.org/

39 https://www.acsdsd.org/about/

ACESP has established a knowledge management system which operates as an online repository of CE documents with specific relevance to the region, as summed up in Box 3.

Box 3: The ACESP knowledge platform

ACESP presents its online knowledge products in following categories:

- 'topic' – with following subcategories: circular economy; waste management; plastics; circular solutions; ASEAN strategies and policies; case study; extended producer responsibility (EPR); sustainable lifestyle; sustainable consumption and production (SCP); digitalisation; education; behavioural change; circular cities; design; trade; circular product; financing; food system; business; climate change; E-waste; green public procurement (GPP); informal sector; logistics; recycling; and small and medium enterprises;
- 'type' (of document), respectively: ASEAN Strategies and Policies; report; project; programme; platform; publication; research; brief; toolkit; indicator; press release; booklet; and presentation;
- 'country' – each of the ASEAN Member States individually and a multi country category;
- 'language' - currently English, Indonesian, Thai, Burmese, Vietnamese and Japanese; and
- 'year' (of publication) currently 2013 and onwards.

The present tagging system reduces the effectiveness of its knowledge management function. The subcategories overlap between 'topic' and 'type' (e.g., 'ASEAN strategies and policies' subcategory appears both under 'topic' and 'type' main categories), the meaning of the 'type' subcategories is not clearly defined (e.g., difference between 'project', 'programme' and 'platform', or between 'publication', 'report' and 'booklet') and the 'topic' subcategories appear to overlap (e.g., 'behavioural change' overlaps with 'sustainable lifestyle', 'business' partially overlaps with both 'small and medium enterprises', and 'informal sector').

The knowledge platform is supported by complementary communication and engagement activities, particularly through social media, newsletter and – contributions to – webinars and seminars. Moreover, ACESP acts as coordinator for the organisation and hosting of a flagship annual ASEAN Circular Economy Forum (ACEF)[40], inaugurated in 2023, and operating since then in collaboration with the World Circular Economy Forum (WCEF)[41].

2.3 Improving Knowledge Management

To further improve the understanding of the needs, opportunities and challenges for effective CE knowledge management, the EU SWITCH-Asia PSC and GGKP jointly organised and hosted four global webinars during October 2024 – May 2025 [12]. Box 4 provides a summary of the main discussion points.

40 https://ce.acsdsd.org/event/the-asean-circular-economy-forum-acef-2025/
41 https://www.sitra.fi/en/the-world-circular-economy-forum/

Box 4: Summary of joint SWITCH-Asia and GGKP knowledge management webinars

The first webinar (16 October 2024) was themed: Bridging Circular Economy Knowledge and Action through Enhanced Knowledge Generation, Management and Sharing[42]. It brought together in the main the representatives of open-access publicly-funded CE knowledge platforms and discussed opportunities and challenges from the platform operators' perspective. As also elaborated in section 2.2, in most cases, the knowledge platform is only one of the activities of its hosts, creating a continuous competition for resources and focus to improve the knowledge management platform. Key challenges are both operational and substantive. At operational level, the lack of interoperability of the platforms is the major bottleneck – meaning that CE knowledge products need to be re-tagged (and then potentially tagged differently) and re-uploaded on each platform. Moreover, platform effectiveness and impact are compromised by the static functionality (as a digital document repository) and ad-hoc communication activities, including the absence of dedicated communications and knowledge management expertise to align platform design with user needs and to measure and communicate impact. Substantively, tagging of knowledge products has become different and inconsistent between and within knowledge platforms, due to combination of the ambivalence and overlaps of the tags being used, the limited resources available to platforms to manually tag all knowledge products, and general divergence of stakeholders' and platforms' understanding of CE scope, policies and solutions. It was suggested to improve knowledge classification by applicability across value chain segments, industry sectors and geographies.

The second webinar (28 November 2024) addressed: Advancing Circular Solutions: Regional Knowledge Platforms and Users' Perspectives[43], and brought together representatives of different policy, business and professional user categories. The panellists voiced widely-different key knowledge demands, including material resource flow and life cycle assessment data, knowledge on effectiveness of policy instruments (including tacit knowledge of synergies with other national policies and enablers), specific circular solutions (both successes and failures, with context analysis), actionable CE methodologies, toolkits and indicators, and CE practices. This presents a mismatch with the current contents of CE knowledge platforms, which appear overly dominated by reports (on CE concepts, CE policy and strategy and CE applications). Moving forward would require addressing the divide between global knowledge (CE context, concepts, etc.) and locally-appropriate CE solutions, suited to the decision-making needs of policy makers, businesses and other CE professionals and interested parties. Moreover, knowledge products may indicate specific end users and applications of the knowledge, complementing current tagging focused on contents and type of the knowledge products.

The third webinar (27 February 2025) was themed: Turning Knowledge Hubs into Circular Economy Transition Facilitators[44]. Panellists explored ways and means for creating active knowledge collaboration at regional level. Success would be contingent on stressing the importance of upstream circular design of products, services and business processes, providing independent and science-based knowledge, and zooming in on technology, policy and financing as enablers for the CE transition.

The fourth webinar (6 May 2025) covered: Harnessing Artificial Intelligence (AI) to Scale the Impact of Circular Economy Knowledge[45]. AI has by now proven its ability to improve research, knowledge extraction and customisation and end-user engagement, provided sufficient and high-quality training data have been utilised. Specifically for CE knowledge management, the relative absence of specific training data is of concern. Panellists nonetheless expressed optimism for improving efficiency and effectiveness of CE knowledge management through the development of CE domain-specific taxonomies in combination with customised AI tools trained on ringfenced repositories of 'validated' CE knowledge products. Importantly, panellists also stressed that human oversight and expert curation remain indispensable. AI can accelerate classification and retrieval, but human judgement is essential for contextual appropriateness, quality assurance, and combating 'circular washing'. Transparency and explainability of AI systems were similarly identified as prerequisites for stakeholder trust and meaningful engagement.

42 https://www.youtube.com/watch?v=rmd69aY21Qw
43 https://www.youtube.com/watch?v=SkpyjlEJ2jo&feature=youtu.be
44 https://youtu.be/yW8JCfpuhDs
45 https://youtu.be/iFRci3j4q0U

A recurring observation was that the CE knowledge platforms function primarily as static repositories; they operate as well-organised archives or libraries of reports, tools and cases studies, rather than as living systems that actively support learning, interpretation, and action [13]. This reveals a gap between the institutional ambition and operational impact of the platforms in terms of facilitating knowledge into action. The challenge remains to turn knowledge platforms from – passive – repositories to – active – intermediaries, for which three cross cutting themes emerged [13].

- The first theme is the need for ***active intermediation***, so that platforms facilitate the translation of research, formal and tacit knowledge into actionable and context-appropriate insights. This calls for content curation and facilitation of dialogue and debate between platform users, including both traditional knowledge providers ('experts'), users (business, policy makers, etc.) and other stakeholders. This is only possible with a move away from hot, broadcast-oriented architectures towards cooler environments that support dialogue, interpretation and situated use. Platforms must also invest in dedicated communications and knowledge management expertise to ensure that knowledge is translated into accessible, context-appropriate formats and that platform objectives are clearly articulated and their impact measurable.
- The second theme centres on the imperatives of ***interoperability and standardisation***; there are persistent bottlenecks in data quality, vocabularies, technical integration, etc. that constrain platform effectiveness. Given the ongoing dynamic development of CE theory, methodology, policy and practice, this is likely to persist as new insights and classifications will evolve, highlighting the need for evolving taxonomies and quality control over their application.
- The third theme is ***inclusivity,*** as the CE knowledge domain is dominated by the theory, concepts, methods and policy and business practices originating from the pioneering CE countries (chiefly Europe and East Asia) and sectors (including particularly plastics, packaging, E-waste, etc.). Moreover, the voices and lived experiences and insights of many remain underrepresented, e.g., of the informal waste, recycling and other workers, foresters, farmers and fishers and Micro-, Small and Medium Enterprises (MSMEs). Inclusivity must be embedded not only in platform architecture and governance, but also in the processes of content submission and validation, so that diverse voices and knowledge contributions are fully represented.

In terms of understanding of the CE knowledge domain, the discussions during the webinar series validated and further supported the findings from the qualitative review of existing regional knowledge platforms (presented in section 2.2). Taken together, two main avenues for CE-domain specific action to improve knowledge generation, management and diffusion emerged:

1. ***CE domain specific knowledge management taxonomy*** – a consistent set of categories and subcategories to classify existing knowledge products relevant to the CE transition, ideally with some provision for gradual further development and refinement of the taxonomy, considering the rapid development of the CE field, in theory, policy and practice. This taxonomy will improve the discoverability of existing CE knowledge products, i.e., enable current and potential future users of the knowledge platforms to find and interpret those knowledge products that are most relevant to their specific application context, interests and decision-making needs; and
2. ***CE solution ontology*** – a consolidated set of characteristics or features to analyse and describe any specific CE solution. This means interpreting in a standardised manner how the CE idea has been operationalised into a circular solution that is specific to the particular application context and the – diversity – of benefits this creates. Doing so can drive CE knowledge curation and creation, and can further inform and improve knowledge management.

The remainder of this report zooms in on the second opportunity by developing a Circular Solution Canvas.

Chapter 3: Navigating the Circular Economy

3.1 Introduction and context

CE has been researched and debated in the scientific community for several decades (e.g., [7], [8], [15] and [16]), and. Interest and acceptance in business and policy circles, however, has witnessed a rapid surge since the mid 2010's (e.g., [1], [4], [5], [6] and [17]).

This relative recent acceleration in the interest in and acceptance of the CE concept has different grounds.

- Firstly, the **triple planetary crises** of climate change, nature and pollution have become omnipresent with adverse impacts on the rise, including in particular from extreme weather events [18]. Their common root cause lies in the increasing and unsustainable extraction and use of material resources (biomass; fossil fuels; metals; and non-metallic minerals) [19]. In other words, mitigating and adapting to the triple planetary crises has become more urgent, which requires a systemic transition in the way materials are used, as envisioned by the CE idea.
- Secondly the accelerated interest in CE has been attributed to its **ideational features** [20], i.e., the features linked to the core idea of circularity rather than its practical applications. The first ideational feature is the CE economic model that is based on material flows and framed principally as the counter idea of the linear economy that the CE replaces. The second ideational feature is the conceptual innovation that CE reflects in terms of requiring ambitious and coordinated change across different levels, sectors and actors in both consumption and production systems. Thereby the CE's overall objective ('*from linear to circular*') connects and potentially synergises diverse and more specific actions, such as sustainable (eco)-design, remanufacturing and recycling, resource efficiency and waste minimisation and sustainable consumption. This enables the third ideational feature, namely, the diversity of policy objectives CE can support upon hybridisation of its overall objective with different policy, business and stakeholders' agendas, including for waste minimisation and pollution prevention, climate action, innovation, economic resilience and growth, inclusiveness and job and livelihood creation.
- Thirdly, CE is recognised as an **umbrella concept** that groups a range of sub-concepts (e.g., resource efficiency, eco-design, pollution prevention, cleaner production, industrial symbiosis, etc. [9]) and imbues them with a new meaning by highlighting a shared feature of these sub-concepts [15]. In line with the general progression of umbrella concepts, now that the transformative potential of CE idea has been recognised, the proponents of the sub-concepts have accelerated the operationalisation of frameworks, tools, methods and approaches, in turn spurring wider attention, examination and consolidation of the umbrella concept.

This observed widening and deepening of support and endorsement of CE has also given rise to **ambiguity and flexibility in interpretation**. Kirchherr et al [8] found that CE definitions have in recent years simultaneously consolidated (around key solution features, such as circularity practices) and proliferated (in terms of impacts and stakeholders' involvement). There is concern for a possible collapse of CE as has been observed in the past with several other umbrella concepts [15]. And there are calls to refocus on the overarching **meta-idea** of CE (e.g., [11] and [21]). Moreover, gaps are being observed between the CE ambition of closed-loop material cycles and the promoted CE applications displaying lower ranked materials downcycling and waste-to-energy recovery practices. One interpretation holds that CE adoption by businesses has become stuck between '*utopia*' – the fully closed, loss-free materials cycles that are physically not entirely possible - and '*paralysis*' – the inability to act on proclaimed business and policy strategy [22]. Competing, both supportive and dismissive, CE narratives co-exist – ranging from (opportunistic) positive, to sceptical with a reformative middle ground narrative based on both positives and negatives of the CE discourse (e.g., [9] and [23]). Such divergent narratives provide fertile ground for opportunistic green-washing (in all its forms [24]) further feeding CE scepticism among stakeholders [9].

As starting point for the development and justification of the Circular Solution Canvas (being developed and introduced in Chapter 4), this chapter provides a summary and reflection on the principal discourses on ambition, scope and impact of CE, across theory, policy, practice and academia. Section 3.2 covers the ***CE idea***, its operational conceptualisations and perspectives. Bringing these together positions CE as an innovation strategy for the sustainable extraction, use and recovery of materials and other natural resources. Next, section 3.3 zooms in on the ***objects*** of circular innovation covering - circular - products, business processes, business models, value networks and ecosystem. Next, section 3.4 addresses the ***impacts*** of circular innovation, intentional and unintentional, both desired, positive, and undesired, negative, including risks, for business, for climate and environment, and for communities and society at large. Finally, section 3.5 connects the – umbrella – CE idea (i.e., innovation inspired by natural resource strategies) with its objects (product, service and/or business process innovations, potentially supported by innovations in the business model, the value networks and/or the ecosystem with impacts for business, environment and society – which provides the foundation for the Circular Solution Canvas, to be introduced in Chapter 4.

3.2 Circular Economy Idea

CE is positioned as the ambitious opposite – ***or counter-idea*** - of the current linear economy, which is characterised by taking material resources from nature, making and using these in products, and discarding these products after their useful life. The material resources include: biomass; metals; non-metallic resources; and fossil fuels [19]. The predominant linear extraction and use of the material resources have caused global material resources' use to more than triple between 1970-2020 and continue to increase by 2.3% annually, whilst the productivity of material resource use increased by an average of 0.7% annually over the same period of time [19]. This linear materials' use model is unsustainable, as it – globally - causes 60% of climate emissions, contributes up to 90% of loss of nature on land, and 40% of particulate matter pollution [19].

Beyond the overarching idea that CE counters the environmental and resource shortcomings of the linear economy, there is currently **no single, commonly accepted CE operationalisation** or interpretation. The plurality of operational CE concepts is a reflection of the different disciplines involved [23]. Beyond narrow disciplinary divergence, CE plurality arises from the different theoretical perspectives, or schools of thought, that seeded leading CE principles, strategies, methodologies and their practice ([11] and [25]). Table 1 provides a summary. Whilst these have distinct and separate origins, over the course of times, synergies have started to emerge.

Table 1: Summary of CE schools of thought (based on: [11] and [25]).

Schools of Thought	Ecosystem metaphor	Precautionary principle	Value hill	Decoupling
Guiding idea	In nature nothing goes to waste, so economy may adopt the material flow principles observed in nature	Activities that may cause harm (such as generation of waste) are to be avoided	Materials increase progressively in value when converted into products, and this value is to be retained at the end-of-life stage of the product	Well-being and economic activity are to be decoupled from further increase in use of resources and in creation of pollution
Operationalisation	**Circularity principles** 1. Eliminate waste 2. Circulate products and materials (at their highest value) 3. Regenerate nature	**Circularity (R) practices** R0: Refuse R1: Rethink R2: Reduce R3: Reuse R4: Repair R5: Refurbish R6: Remanufacture R7: Repurpose R8: Recycle R9: Recover	**Circular business models** • Slow – use longer • Narrow – use less • Close – use again • Regenerate – make clean • Inform – provide supportive information	**Resource strategies** • Resource circularity • Resource efficiency • Resource substitution

The first school of thought is the **ecosystem metaphor** that replicates the material flow principles observed in nature into industrial systems, as in nature '*nothing goes to waste*'. The resulting circularity principles are: eliminate waste; circulate products and materials (at their highest value); and regenerate nature [17]. Following business examples illustrate these circularity principles.

- TCI Group (Taiwan) transforms agricultural wastes initially classified as '*plant-based waste*' into raw materials for nutritional and health products giving them high economic value using its proprietary biotechnology [26]. For example, the endemic red quinoa species is cultivated by organic methods (illustrative for nature regeneration) and then used for four consecutive products. The shelled red quinoa is used as a staple food. Extract from the hulls of red quinoa is processed into an active ingredient for a functional product designed for reducing glycosylation of collagen and the occurrence of wrinkles and the remaining dregs of red quinoa are added to noodles as the source of dietary fibre (both are illustrative for circulation of materials). The dregs left after the manufacturing process of noodles are fermented by microorganisms to make organic compost (illustrative for elimination of waste), and the compost is used as fertiliser for the farmlands (supporting nature regeneration).
- Husk Ventures (Cambodia) uses pyrolysis to produce bio-char and an organic insect repellent from rice husk, an abundant by-product from rice milling [27]. The process turns rice husk into valuable products for agricultural applications, which illustrates recycling of materials and eliminates rice husk going to waste. The use of biochar in agriculture sequesters carbon in the soil which reduces the need for fertilisers, in turn supporting the regeneration of nature. This is furthermore achieved by using the organic insect repellent as a substitute for chemical insecticides.

The second school of thought is based on the **precautionary principle**, which has since the 1980's been operationalised into a waste prevention hierarchy. The CE has become an extension and refinement of the established waste prevention and management hierarchy based on 3Rs (Reduce, Reuse, and Recycle). As illustrated in Figure 1, this hierarchy has expanded into an elaborate classification with 10 R-practices, primarily aimed at end-of-life products: R0: Refuse; R1: Rethink; R2: Reduce; R3: Reuse; R4: Repair; R5: Refurbish; R6: Remanufacture; R7: Repurpose; R8: Recycle; and R9: Recover [28]. These are in principle equally applicable for pre-consumption and non-material waste (including water and energy). Further refinements of these R-practices for manufacturing are contained in the Circular Strategies Scanner [29].

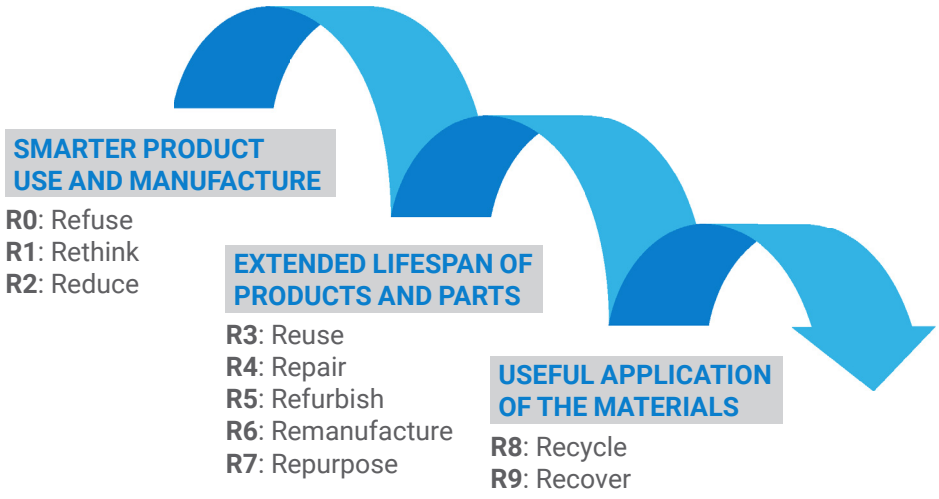

Figure 1: Circularity practices (author's elaboration of [28])

Different combinations of R-practices are fore example illustrated by:

- Volvo Group is a leading global manufacturer of trucks, buses, construction equipment and industrial and marine engines[46]. The Volvo remanufacturing (R6) program is well-matured and established for engines, filters, gearboxes and rear-axle transmissions, and remanufactured components are supplied with '*as-new*' performance and guarantee. A recent expansion involves the remanufacturing of entire trucks for a new use in a different application (e.g., a long-haul truck converted to a short haul truck) which is already

46 https://www.volvogroup.com/en/sustainable-transportation/responsible-business/resources.html

operational for Renault Trucks. Moreover, across the Volvo Group, new trucks have about 1/3rd of their weight as recycled material (R8), particularly through 97% recycled contents in cast iron and 50% recycled content in wrought iron. By the end of 2024, 31 of Volvo's production locations did no longer dispose of any waste to landfill through concerted waste prevention initiatives (involving reduce, reuse and repair (R2, R3 and R4)), and diversion for materials recycling and/or energy recovery (R8 and R9).

- Sivatel Hotel Bangkok (Thailand) is a boutique city hotel that refuses (R0) all single-use plastics packaging and replaced ('rethinking' R1) these with refillable alternatives (for drinking water, bathroom amenities etc.) [30]. Through improved planning and operations, the hotel has significantly reduced food waste generation ('reduce' (R2)) and the remaining food scraps are fed to the onsite rooftop Black Soldier Fly farm, and thereby converted in composted frass (R8) which is used in the rooftop vegetable garden and larvae protein which is supplied to farmers as animal feed.

The third school of thought on CE is based on the **value hill,** illustrated in Figure 2. This is concerned with retaining the economic value of products and components, particularly at the end of their life, calling for circular business models that slow (use longer), narrow (use less), close (use again) or regenerate (make clean) the use of products and components, or provide the information to do so (e.g., [31]).

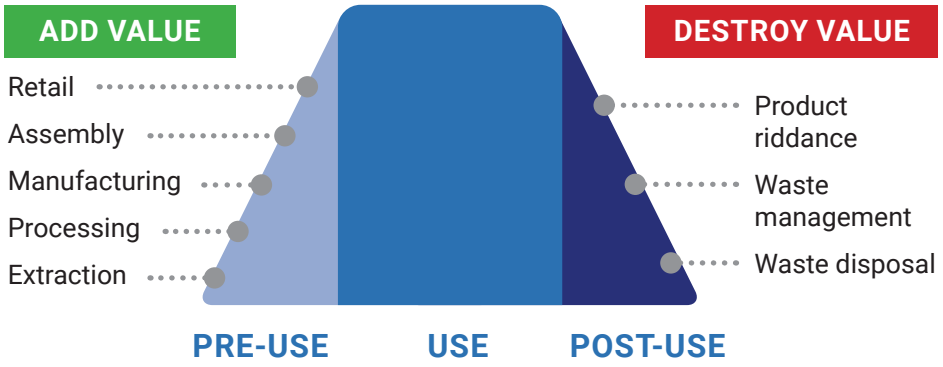

Figure 2: The value hill (author's elaboration of [32])

These circular business models can be applied in different combinations, for example:

- Lindström is a global leader in the linen services sector for the industry, hospitality, healthcare and other sectors with '*linens as a service*' as its business model[47]. The company advanced the 'close' business model by achieving 74% recycling of its end-of-life products in 2023, relative to the baseline of 0% in 2019. Moreover, in 2023, 18% of its products were made with recycled materials, led by 75% recycled materials in its mats. Lindström advances the 'slow' business model by having redoubled its focus on quality textile materials and durable products, combined with repair services, to extend the longevity of its textile products.
- Finnish 3stepIT has created a business based on ICT technology life span monitoring and management, illustrative for the 'slow' business model[48]. The company serves its clients in finding the right device, monitoring its use and ultimately ensuring the reuse (and repair and/or refurbishment as needed) once the customer no longer needs it. The company rents out and monitors about 2 million devices, of which around half a million are returned annually. After extensive checking and data cleaning, 98% of these returned devices are supplied to other users, with the remaining 2% sent for e-waste recycling.

The fourth school of thought recognises that CE is the practical way to operationalise the decoupling principle (illustrated in Figure 3). This means to **decouple** the economy and well-being from natural resource use through three resource strategies, respectively: resource circularity (endlessly recovering and returning materials into the economy), resource efficiency (using less materials and using them longer) and resource substitution (replacing non renewables by renewable alternatives) – each equally applies for materials, energy, water and possibly other natural resources [33].

47 https://lindstromgroup.com/circularity-in-textiles-our-circular-economy-business-model/
48 https://www.sitra.fi/en/cases/3stepit-offers-more-than-just-the-leasing-of-laptops-up-to-98-per-cent-of-devices-re-enter-circulation/

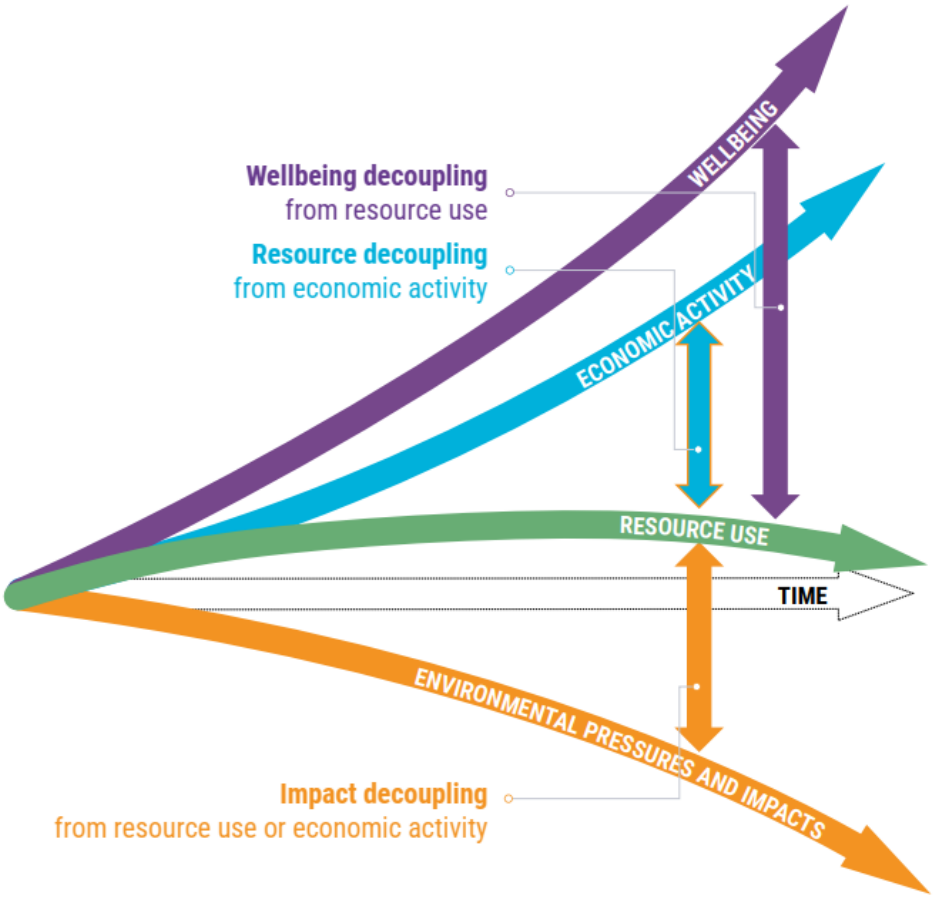

Figure 3: Decoupling principle (source: [19])

These resource or decoupling strategies are applied in complementary manners by firms, such as:

- ASSESSA is a Brazilian company that pioneered the development and production of high-performance bioactive ingredients for the personal care industries, derived from the exotic Brazilian biodiversity and other sustainable botanical sources – showcasing resource substitution [34]. The company developed a range of bioactive ingredients from sustainably-cultivated and harvested seaweeds, solar-dried by local communities. It also manufactures ingredients from the milling residues of golden flax and chia seeds, which showcases resource circularity. Furthermore, it pursues waterless products, using no water, requiring fewer preservatives and less packaging per functional unit delivered to the customer – each illustrative for resource efficiency.
- Fortune Parts Industries, a manufacturer of plastic automotive parts in Thailand redesigned the parts with its customers to reduce the weight of parts (by up to 25% depending on size, geometry and performance requirement) – illustrative of resource efficiency - whilst increasing the use of recycled plastics (achieving 82% recycled material (6,400 tonnes across its entire production in 2023) – illustrative of resource recovery [35]. Moreover, it is already achieving 36% renewable energy use from bio- and solar energy – illustrative for resource substitution.

The drawback of these CE frameworks is that the categories used are a reflection of – groups of – circularity solutions (e.g., [29]). There is a risk that these do not cover circular solutions that may have more transformative potential in other particular situations. Put differently, re-engineering linear products using the specified circular solution categories, may not yield the most impactful circular product. Hence there is a need for less constrained circularity frameworks that equally facilitate the meaningful adaptation of already tried circular solutions (as captured by the circularity principles, practices and business models) as well as '*out-of-the-box*' pivoting of new circular product or process solutions (see e.g., [25] and [29]).

Combining these schools of thought, CE can be approached as a system's solution to the use of – *virgin* - materials and other natural resources and discharge of – *wasted* – materials and other natural resources, with a view to bring both the net inflows and the net outflows into and from the economy and society as close

as possible to zero [36]. This system's perspective is aligned with the definitions and guidance provided in the international ISO59004 CE guidance standard [37].

A central element across the different CE frameworks is the reliance of CE on '*new*' products, services or technologies that improve the sustainable use of materials and other resources: or – in other words – CE is the result of innovation towards sustainable materials and resource use, or, in short, circular value chains. This innovation can take different forms (as also illustrated by the business examples), and appears open-ended, just constrained by the ability to '*think outside of the* box' (specifically outside of the habitual linear flow mindset).

This positions CE as an **open-ended circular innovation space** with two dimensions, namely the circular value chain and the resource management strategies. This is visualised in Figure 4: the circle, or loop, has the successive key stages in the circular use of materials and other resources that constitute circular value chain(s), and the horizontal arrows show the resource management strategies that apply across all value chain stages, i.e., resource circularity; resource efficiency; and resource substitution.

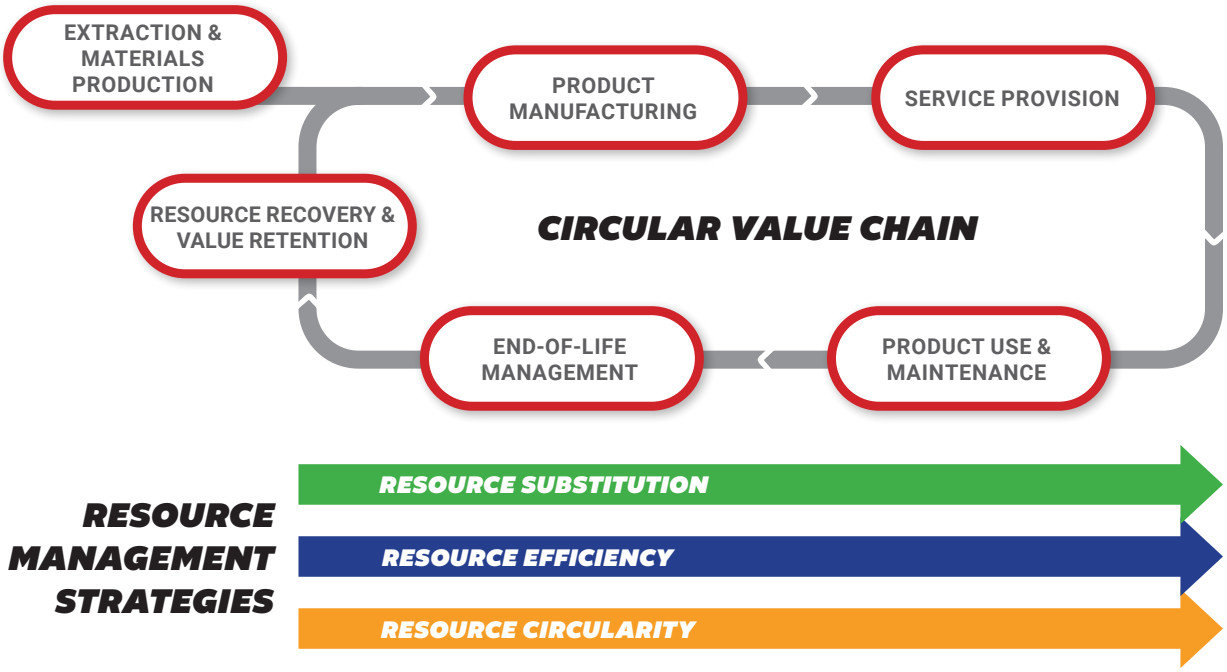

Figure 4: Circular Economy: resource management strategies driving innovation to achieve circular value chains [36].

3.3 Circular Economy Objects

The CE turns practical with the use of products and/or associated processes that do increase or improve resource circularity, resource efficiency and/or resource substitution. This positions CE as a subset of – business - innovation, as per the definition of the Organisation for Economic Cooperation and Development (OECD) [49] [37]. The OECD differentiates between product innovation (including services and packaging) and process innovation, with the latter applicable to all business functions/processes, including: operations; product and process development; administration and management; procurement; logistics and distribution; and marketing and sales.

The OECD thus defines innovation by its outcome, i.e., the improved product or business process. In contrast, the CE literature (e.g., [31], [39], [40], and [41]), is predominantly focused on circular design, or the systematic process delivering the circular product and process innovations, against circularity principles, practices or business models (as covered in section 3.2).

49 Specifically, the OECD defines: *"A business innovation is a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm"*

Circular design is commonly approached as a three-pronged, iterative undertaking that results in a combination of a circular product, business model and ecosystem (e.g., [39]). Herein, the **product** is generally well and uniformly understood as the item (the – physical - product or - non-physical - service) that delivers value to the target customers. The **business model** is often used to cover both the earnings model as well as the activities and processes the business needs to perform. However, for clarity, business model is used here in its narrow interpretation of the business's earnings model, i.e., how the firm creates, delivers and captures value for itself and thereby remains viable and profitable. Complementary to this business model, the **business processes** concern the required activities and functions of the business, including operations, product and process development, procurement, logistics, etc. (as in [38]). Moreover, **ecosystem** may cover actors involved in the material flows caused by the business as well as those providing support services and the stakeholder relationships supporting and regulating the firm. Commensurate with ISO59010 [42], here, however the term **value network** is used narrowly to include all actors managing material in- and/or outflows associated with the firm and its products; the value network realises the web of circular value chains the firm – and its products and services - contributes to or participates in. The term ecosystem, on the other hand, is reserved for interactions with stakeholders that support and enable the business operations, in terms of e.g., policy and regulations, financing, technology, standards and innovation services.

Figure 5 illustrates the circularity lens in the design process towards any circular solution. Put shortly, the product offers value to the consumer, is produced and delivered through business processes, that create value for the firm through the business model, and cause the exchange of materials and other natural resources in value network(s) and is supported by an ecosystem that provides business support services. Any circular innovation is expected to materially increase resource circularity, resource efficiency and/or resource substitution which is only possible with a change in the – physical - material and natural resource flows. This requires a physical change in at least the product and/or one business process. The market adoption, commercialisation and scaling-up of the circular innovation, may – but does not necessarily - require or benefit from complementary innovations in business model, value chain and/or ecosystem. Table 2 provides a summary of two practical CE-relevant business cases, dissected by the respective main changes at each of these five levels of circular innovation.

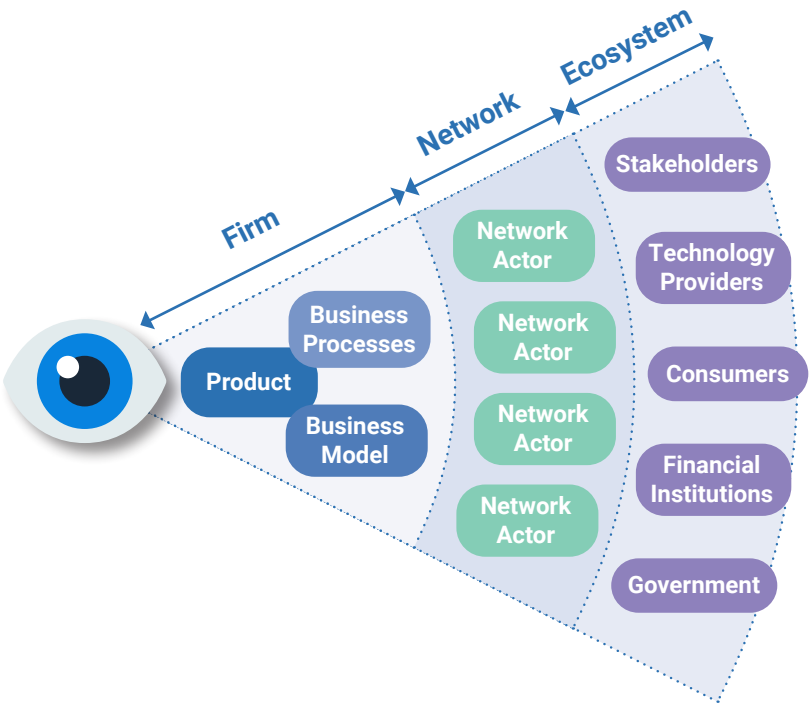

Figure 5: Circularity lens for design and innovation (author's interpretation and expansion of [39].

Table 2: Business examples illustrating elements of the circular innovation scope

Norn-norn (Thailand) pioneers '*mattresses-as-a- service*' to overcome the dual problem of non-affordability of premium mattresses and the low recovery and recycling of end-of-life mattresses [43]	**Renewcell** (Malaysia) provides battery monitoring, maintenance and rejuvenation services to extend the lifetime (2 to 3-fold) of industrial lead-acid and nickel cadmium batteries and improve the energy efficiency of their successive charging and discharging cycles [44]
PRODUCT • Premium quality mattresses designed for recycling **BUSINESS PROCESSES** • Mattresses' stock management **BUSINESS MODEL** • Subscription service for mattresses (access business model) **VALUE NETWORK** • Development of reverse logistics and mattresses recycling infrastructure **ECOSYSTEM** • Mobilization of alternative financing instruments for debt financing of mattresses stock	**PRODUCT** • Life-time extension and efficiency improvement services for industrial batteries **BUSINESS PROCESSES** • Battery monitoring, maintenance and rejuvenation processes **BUSINESS MODEL** • Traditional fee-for-service-delivery business model **VALUE NETWORK** • Support development of battery recycling and material recoverry **ECOSYSTEM** • No significant change

Circular product innovation incorporates contributions towards resource circularity, resource efficiency and resource substitution as performance criteria for newly (re)-developed products or services. This is rooted in eco-design, aimed at improving the lifecycle-based product environmental attributes and, sustainable product design or sustainable design, aimed at reduced environmental impact and increased community well-being (e.g., [45]). Different sets of circular product design strategies are available, either with generic applicability (e.g., [31] and [46]), or tailored to specific product categories, such as durable consumer goods (e.g., [47]), fast moving consumer goods (e.g., [48]) and/or packaging (e.g., [49]). Circular service design is most often approached from the angle of the business processes involved in service delivery, e.g., service design, procurement and operations. As an illustration, Table 3 provides an example set of sector-agnostic circular product development strategies.

Table 3: Example circular product strategies (adapted from: [46])

Overarching circular business purpose				
narrow	*slow*	*close*	*regenerate*	*inform*
• Design with low impact inputs • Design light-weight products • Design for multiple functions	• Design for physical durability • Design for emotional durability • Design for ease of maintenance and repair • Design for easy dis- and reassembly • Design for upgradability • Design for standardisation and compatibility	• Design with recycled inputs • Design components, where appropriate, with one material • Design with materials suitable for recycling	• Design for biodegradability • Design with biobased materials • Design with non-toxic materials • Designs inspired by nature	• Use Artificial Intelligence to develop new materials with circular properties • Virtualise products and services • Design connected products

Circular process innovation incorporates operational circularity objectives into all business functions, particularly: operations; product and process development; administration and management; procurement; logistics and distribution; and marketing and sales. This builds upon the established practices of Resource Efficient and Cleaner Production (RECP) (e.g., [50], and [9]), and its predecessor concepts, such as cleaner production, eco-efficiency, pollution prevention, waste minimisation, toxics use reduction, etc. (e.g., [51]). RECP applies preventative environmental and resource productivity strategies across relevant business functions to improve the efficiency of use of materials, energy and water, thereby reducing the generation of waste, effluents and emissions, and contributing to occupational and community well-being [33]. This is commonly achieved through – combinations of – eight prevention practices (or innovation lenses), namely: good housekeeping; input substitution; better process control; equipment modification; technology change; on site recovery and reuse; production of useful byproduct; and/or modification of product (inclusive of its packaging) [33].

Circular business model innovation involves changing the business' earnings model to commercialise and scale-up circular products, services or processes through an enterprise, either as profit-oriented, governmental, social or community enterprise. The commonly-used business model canvas [14], defines any business model by: (1) the ***value proposition*** (product or service offer to the customer); (2) the ***value creation*** (the activities, resources and stakeholders required to create the product or service for the customer); (3) the ***value delivery*** (the customer segments, customer relationships and channels required to deliver the product or service to the customer); and (4) the ***value capture*** (the cost structure (for value creation) and revenue streams (from value delivery), that create earnings for company and maintain its profitability. A business model innovation hence needs to involve a change in at least one of these four business model elements. For example, only changing the supplier from which to procure identical business inputs would not amount as a business model change, unless for example the procurement conditions change from e.g., a volume-based to a performance-based procurement relationship. Bocken [52] reworked this generic business model canvas to a circular and sustainable business canvas, by (1) introducing specific people, profit and planet dimensions for the value proposition (a reflection of the sustainable business orientation adopting the Triple Bottom Line approach); and (2) superimposing the resource flows invoked by the business, and driving these towards circularity, by narrowing, slowing, closing and regenerating such resource flows (the circularity dimension). This has been further amended with a (resource) value retention layer in the business model canvas with the three resource strategies (introduced in section 3.1), resulting into a circular and sustainable business model canvas (displayed in Figure 6).

<table>
<tr><th colspan="2">VALUE CREATION</th><th colspan="2">VALUE PROPOSITION</th><th colspan="2">VALUE DELIVERY</th></tr>
<tr><td>Key Stakeholders
Suppliers, co-financiers, distributors, reverse logistics and other partners to create positive impact</td><td>Key Activities
Processes, development, technology from systemic point of view</td><td colspan="2">Profit
Superior value to customer that leads to financial value for stakeholders, e.g., owners, employees, partners, etc.</td><td>Customer Segments
Target groups who make use of the offering</td><td>Channels
Touchpoints with customers including ways to retrieve products for reuse, recycling, etc.</td></tr>
<tr><td colspan="2" rowspan="2">Key Resources and Capabilities
Materials, human, financial, network, infrastructure, brand image, data, knowledge</td><td>People
Positive impact for common interest of society</td><td>Planet
Positive impact for environment, climate & biodiversity</td><td colspan="2" rowspan="2">Customer Relationships
Materials, human, financial, network, infrastructure, data, knowledge, etc.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><th colspan="6">VALUE CAPTURE</th></tr>
<tr><td colspan="3">Cost Structure For stakeholders in the entire system</td><td colspan="3">Revenue Streams For stakholders in the entire system</td></tr>
<tr><th colspan="6">(RESOURCE) VALUE RETENTION</th></tr>
<tr><td colspan="2">Resource Substitution
Maximize the substitution of non-renewable with renewable materials and energy</td><td colspan="2">Resource Efficiency
Improve the efficiency and longevity of the use of materials, energy and water</td><td colspan="2">Resource Circularity
Perpetually recover and return materials, energy and water back into economic use</td></tr>
</table>

Figure 6: Circular and sustainable business model canvas (author's further elaboration based on [52]).

Circular value network innovation involves changes in the management of the resource flows between the implementing business or other organisation and third parties, to increase the circularity of resource inflows (through the use of secondary (i.e., recycled or recovered) and/or renewable inputs) and/or to increase the recovery from resource outflows (through the use of recyclable and biodegradable inputs and improved end-of-life material, water and energy recovery). This converts the linear resource flow and its associated value chain into a web of circular resources' flows creating a value network that may comprise businesses and other organisations (e.g., municipalities collecting and recovering waste) [42]. The underlying idea that a business or organisation uses the waste from its neighbouring industries or cities as a substitute input material has been proven beneficial in the practice of industrial and municipal symbioses (e.g., [53] and [54]), which have been equally applied to material, water and energy waste streams (e.g., [55]).

Finally **circular business ecosystem innovation** involves changes in the enabling environment that facilitate adoption and scaling-up of circularity initiatives by businesses and other organisations. The circular transformation of business or any other organisation has been observed to benefit from a menu of business activities, from which a customised - rather than an 'one-size-fits-all' - transformation roadmap can be constructed. Key activity clusters are: stocktake (assessment of circularity opportunities and risks); ambition (determination of circular ambition and delivery pathways); delivery (develop and implement portfolio of circularity projects); and integration (mainstream and hard-wire circularity in core business processes) (SADI framework, as illustrated in Figure 7) [25]. These business actions benefit from innovation in the business ecosystem so as to provide: coherent and comprehensive policy frameworks that foster resource circularity, efficiency and substitution; availability of appropriate best practices and techniques for circular products and processes; market demand and standards that reward circular products and services; and availability of affordable financing instruments that are appropriate to requirements of specific circular business models [25].

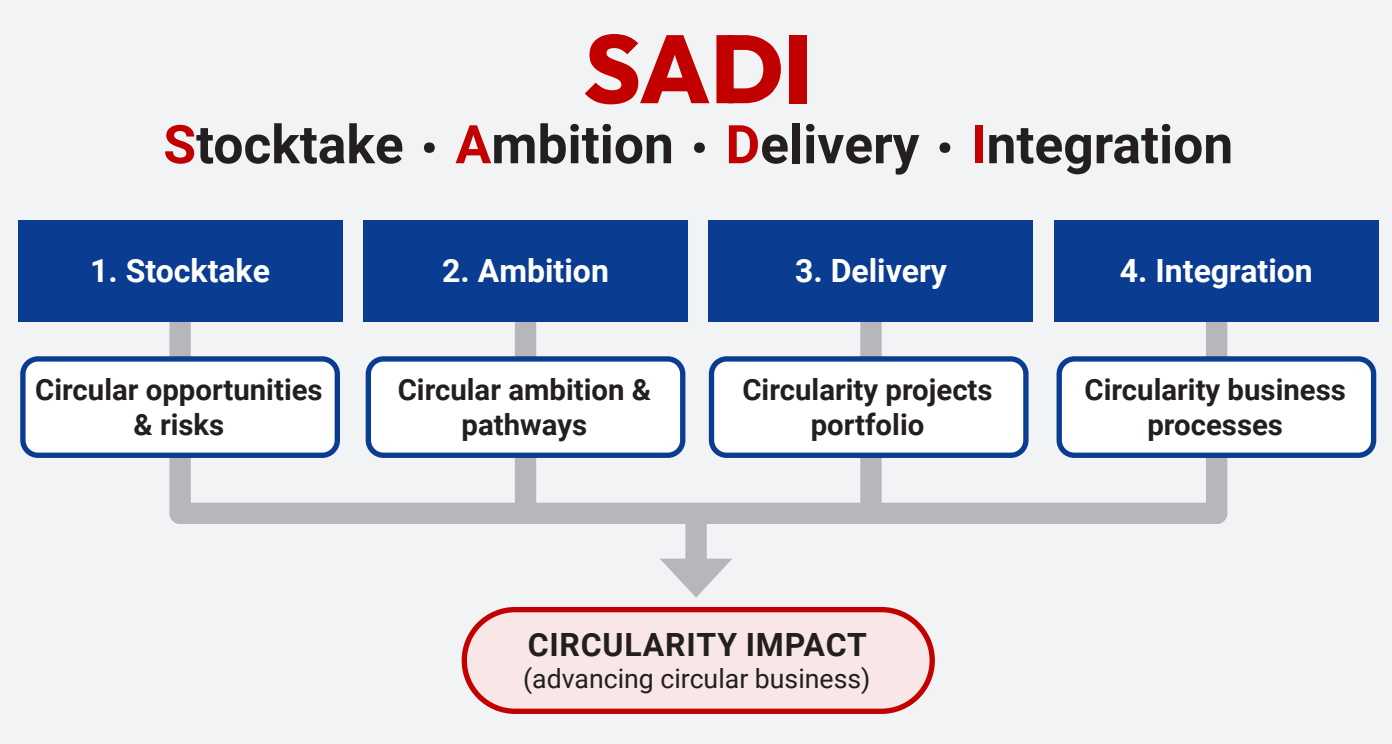

Figure 7: Stocktake – Ambition – Delivery – Integration (SADI) framework for circularising business [25].

3.4 Circular Economy Impacts

As elaborated in section 3.2, as its distinguishing feature, CE solutions reduce the scale and improve the sustainability of the extraction and use of material and other natural resources, principally through their repeated reutilisation (resource circularity), more efficient and longer use (resource efficiency) and/or increased use of renewable materials and energy (resource substitution). Circularity thus directly reduces the total use of materials and/or other natural resources. Beyond that it affects all impacts caused by the

extraction and use of materials and natural resources (on environment, society, economy, etc.) as well as the rules, regulations, institutions and stakeholder relations that govern this utilisation of materials and natural resources, and the distribution of its benefits and adverse impacts. CE thus impacts well beyond sustainable natural resources management, across the key subject areas of responsible – business and organisational – conduct, or social responsibility.

The international ISO2600 standard defined social responsibility as the "*responsibility of an organisation for the impacts of its decisions and activities on society and environment through transparent and ethical behaviour, that: contributes to sustainable development (including health and welfare of society); takes into account the expectations of stakeholders; is in compliance with the applicable law and consistent with international norms of behaviour; and is integrated throughout the organisation and is practiced in its relationships*" [56]. Social responsibility applies to any kind of organisation, including for-profits as well as social enterprises of all sorts, governmental and non- governmental organisations, and other economic and societal entities. Notwithstanding the international ISO26000 standard that emphasises the consideration of impacts on society and environment in core business decisions and activities, in many jurisdictions, social responsibility continues to be narrowly interpreted and promoted as corporate philanthropy, i.e., charitable giving by businesses for charitable societal, environmental and/or other public purposes, from corporate earnings that is isolated from the impacts on society and environment arising from the business' own decisions and own activities. In a similar manner, social responsibility is also regularly equated with Environment, Social and Governance (ESG), the practice of corporate sustainability reporting, wherein businesses either voluntarily or mandatory (under instruction from respective national corporate and financial regulators) provide information on their non-financial performance. However, corporate sustainability reporting is only effective for achieving sustainable development when combined with sustainability strategy, planning and implementation, as highlighted by ISO in its workshop consensus report on the topic ISO (IWA48, 2024). It states "*Environmental, Social and Governance (ESG) is a strategic and operational framework that aims to assist organisations, of any size and type, to implement and report on their activities, products, services and commitment to support the achievement of sustainable development, social justice and good governance*" [57].

Social Responsibility is being advanced through holistic approaches dealing with seven interdependent subject areas: organisational governance; human rights; labour practices; environment; fair operating practices; consumer issues; and community involvement and development [56]. CE is directly relevant to the environment subject area by reducing the use and improving the sustainability of materials use by organisations. This most often involves reducing risks and impacts on occupational, community and consumer health and safety, as covered under the labour, community and consumer subject areas. Adopting CE can aid organisations to comply with environmental legislation and trade rules (relevant to the governance subject area), and to avoid accusations and potential litigation for unfair economic advantage from greenwashing or even from non-compliance (relevant to the fair operating practices subject area). Furthermore, advancing CE is a proactive step for actioning the internationally declared and recognised universal Human Right to a Clean, Healthy and Sustainable Environment (relevant to the human rights subject area) [58].

Complementary, the United Nations Global Compact (UNGC) has articulated Ten Principles responsible businesses are expected to adhere to, covering four domains: human rights; labour rights; environment; and anti-corruption[50]. CE is fully aligned with these Ten Principles, as CE: addresses the unsustainable extraction and use of materials as the root cause of the triple planetary crisis; respects and upholds the fundamental Human Right to a Clean, Healthy and Sustainable Environment; minimises hazardous materials and circumstances to improve working conditions; and demonstrates integrity, trust building and the ending of non-compliance as a root cause of bribery.

CE thus contributes across the spectrum of corporate sustainability and responsible business. Notwithstanding this comprehensive contribution, it is most practical to limit the CE impact analysis to direct contributions to business, environment and society – put simply, CE helps business **to *perform well*** (in terms of profitability, growth, resilience, etc.), while ***doing good for environment and society***. Within each, a further results-to-impact chain is useful to understand the full potential of CE. CE leads to – *intermediate* – results (or midpoints), that are within the control of the implementing organisation, and these results contribute to

50 https://unglobalcompact.org/what-is-gc/mission/principles

– *final* – impacts (or endpoints), that are of broader value to business, economy, environment and society. Figure 8 illustrates this results-to-impact chain and suggests key categories of results and impacts for business, planet and society. Final impacts, however, are not solely under the control of the implementing organisation. For example, redesigning a product to one using less material having equivalent product features, would achieve savings on materials costs (an intermediate result), which would be expected to contribute to competitive advantage/increased profit (the final impact), however, the latter would depend on range of other factors, e.g., market acceptance, price fluctuations etc. Table 4 below illustrates the distinction between intermediate results and final impacts, illustrated with three Southeast Asian CE business cases.

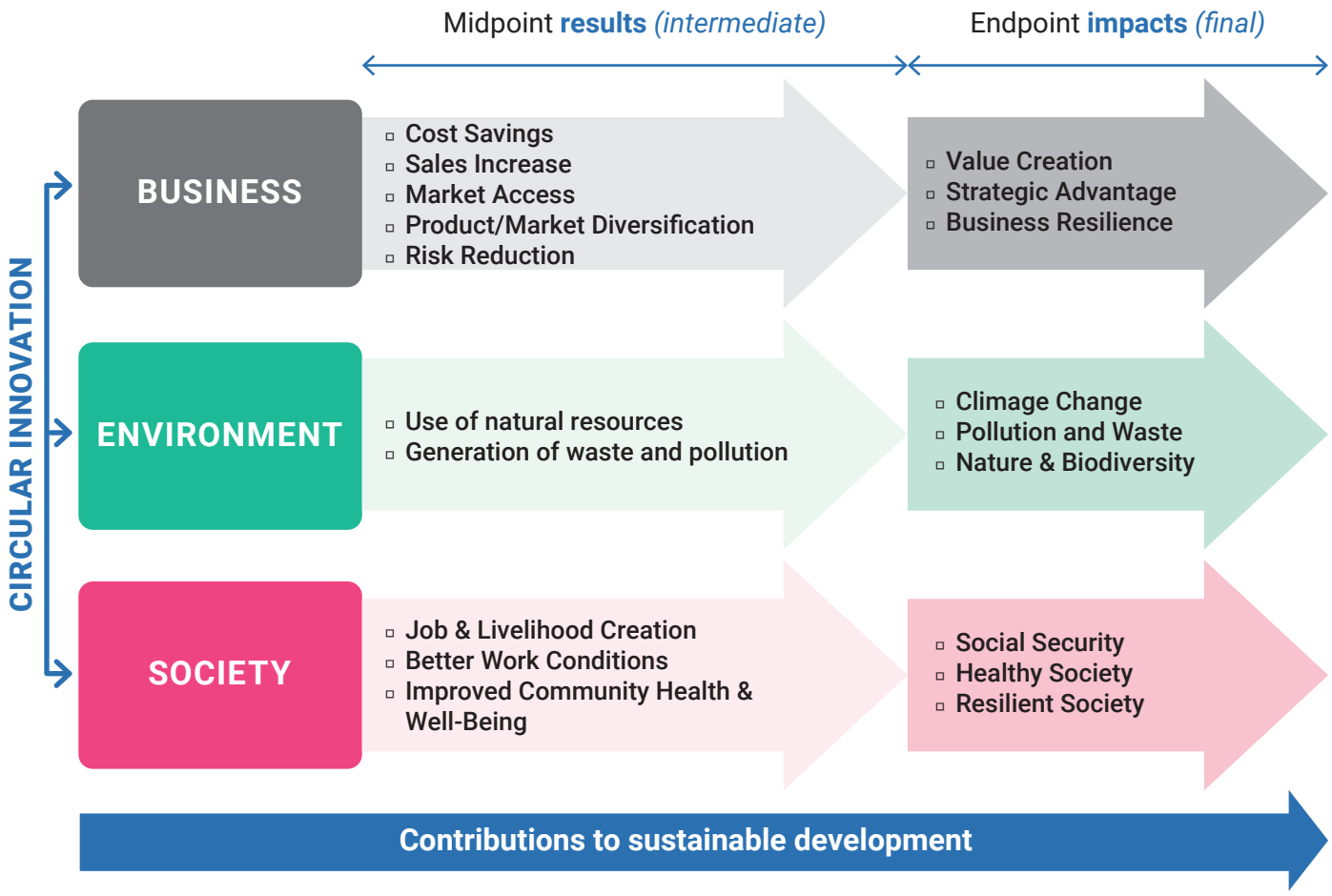

Figure 8: (Intermediate) result and (final) impact categories for CE solutions (author's elaboration).

Table 4: Illustrative intermediate results and final impacts of circular business cases.

Circular business case	Impact category	*Midpoint* (Intermediate) results	*Endpoint* (Final) impact
TONTOTON [Cambodia]: community-based collection of ocean-bound and other orphan plastic waste, materials sorting for material and/or energy recovery of commercially recyclable fractions and onsite use of non-commercially-recyclable fraction into mixed plastic boards, and its onward use in low-cost furniture and building and furnishing products [59]	Business	• Mixed earnings model from sales of recyclable plastic waste, recycled plastic products, plastic credits and tourism services • Registration and sales of certified recycled Ocean Bound Plastic • New product and market development for recycled plastic board furniture, building and furnishing products	• Sustainable operation as a social enterprise
	Environment	• Recovery – for recycling and/or energy recovery - of ~ 2,300 tonnes orphan plastic waste [2021-23]	• Pollution prevention, chiefly of (potentially) Ocean Bound Plastics (OBP) (reducing marine plastic litter) • Reduction of impacts associated with virgin plastics production
	Society	• ~ 300 families and ~ 450 informal waste workers involved in retrieving and collecting plastic waste and company operations	• Improve community's social security through new livelihood opportunities • Improve community's amenity through reduction of plastic litter
Great Giant Foods [Indonesia]: an integrated plantation, livestock and processing operation. Plantation and processing waste is used as animal feed and for bromelain production. Manure is digested and the biogas and digestate are used in processing areas and plantation. Efficiency has been improved with precision farming, integrated pest management, efficient technology and digitalisation [60]	Business	• Cost savings from reduced use of agrochemicals and energy • New revenue from bromelain sales • Increased revenue due to 50% increase in plantation yields	• Business growth • Improved profitability
	Environment	• Reduced fertiliser and fuel intensity in plantation by 30% and 40% respectively • Production and use of 4,000 m^3 biogas • Carbon footprint of main pineapple products reduced by 24% to 63%	• Reduced climate impacts • Regeneration of degraded soils benefiting nature in and around the plantation estate
	Society	• Reduced (plantation) workers' and community exposure to agrochemicals	• Improved workers and community health and wellbeing

Circular business case	Impact category	*Midpoint* (Intermediate) results	*Endpoint* (Final) impact
SC Grand [Thailand]: collection of pre- and post-consumer textile waste for mechanical recycling, colour sorting and recycled fabric and garment production, using efficient technology, partially powered by onsite roof top solar plant [61]	Business	• New product and market development for garments and home textiles made from recycled fibres	• Strategic advantage to become a leader in circular textiles
	Environment	• Monthly recovery of around 400 tonnes textile waste, diverted from landfill or incineration • Operation of 1 MW rooftop solar plant • Annual GHG emission and water use reduction compared to use of virgin textile fibres (18,000 tons GHG and 2.1 million m^3 water)	• Reduced climate impacts • Waste prevention (textile) and pollution prevention (avoided dyeing) which benefit environment and nature
	Society	• Job creation in collection and sorting of textile waste	• Contribution to social security

Improved efficiency and circularity of materials use, through CE, provides a positive contribution towards reduced and more sustainable extraction and use of materials as common root cause for the triple planetary crises of climate, nature and pollution. Despite this macro level planetary benefit, however, caution is needed to avoid or minimise the - risk(s) of – negative impacts particularly on environment and people. These may for example arise due to cycling back substances of concern (additives, pollutants, etc.) into recycled materials or through the high material losses during recycling (e.g., microplastics creation and dispersion as a result of mechanical plastic recycling). Hence it is imperative to include an environmental, health and safety assessment of CE projects, particularly those involving resource recovery, as part of their overall impact assessment.

3.5 Integration

The previous sections provided a deep dive into CE in terms of its idea (and associated operational concepts), its objects and its impacts. Their inter-relatedness is graphically displayed (in Figure 9) as the conceptual pathway for CE deployment, moving from on overall idea, articulated in the form of concepts, principles, criteria etc., to products, services and business processes as objects for innovation, leading to impacts toward sustainable development.

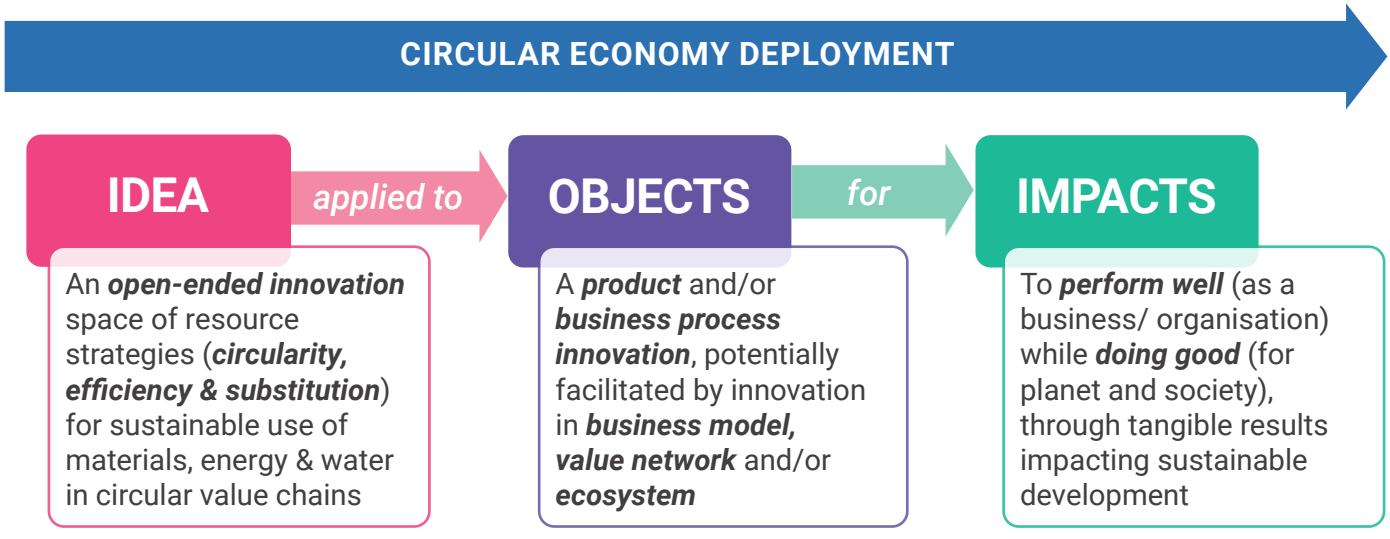

Figure 9: Circular Economy deployment (from idea to impact) (author's elaboration).

In terms of the overall **idea**, this moves away from strictly-defined categories of CE strategies or practices, that reflect commonly-observed – categories of - solutions, in favour of an open-ended innovation space, to allow, or rather encourage, transformative and ambitious context specific CE solution development. This caters for two-pronged CE implementation [25] through, firstly, adaptation of CE solutions already documented or observed elsewhere (i.e., a *'copy-adjust-paste & learn'* logic), and, secondly, circularity-driven concept development and design specific to the core product, service or business process (i.e., a '*pivot*' into the circular future through lighthouse circular solutions).

The primary **objects** for CE-oriented innovation are either the product (including services, auxiliaries and packaging) and/or the business processes (e.g., operations, product and process design, logistics, etc.) as these have the potential for direct improvements in circularity, efficiency and/or substitution in the use of materials, energy and/or water in the value chain. The implementation and commercialisation of these circular product and/or business process innovations can benefit from complementary innovations in business model, value network and/or ecosystem.

The intended **impacts** include both 'private' benefits (to the immediate benefit of the implementing business or other organisation) as well as 'public good' benefits (to the benefit of society and environment). A results chain applies where intermediate results which are under the control of the implementing business or organisation, then contribute towards final impacts, which are no longer on the control of the implementing organisation (as depicted in Figure 8).

This causal deployment narrative from idea to – innovation - objects to impacts provides the foundation for the Circular Solution Canvas.

Chapter 4: Circular Solution Canvas

Encouragingly, the number of businesses and other organisations developing and adopting circular solutions is on the rise (e.g., [11], [26], and [62]). CE adoption nevertheless remains limited to front-runner companies. A make shift CE transition is contingent on expanding and increasing CE activity to a majority of, or ultimately all, businesses and other organisations - an ambition that is customary captured as '***scaling (up)***'. Schagen and colleagues [63] describe three scaling mechanisms for sustainability initiatives: ***deepening*** (becoming more ambitious, radical, impactful and sustainable/circular); ***broadening*** (connecting with other domains and agendas); and ***spreading*** (becoming larger and more numerous). Moreover, they observed that deepening can get triggered by (1) focus and (2) reorganisation, broadening can be driven by (3) unusual collaboration, (4) aligning interests and (5) establishing clear focus, and spreading can occur through (6) increasing capacity, (7) credibility and (8) offering perspective. The unlocking of any – or a combination of – these triggers calls for structured decomposition of the initial initiatives, i.e., the circular solutions adopted by frontrunner businesses and/or other organisations.

Unleashing any of these scaling triggers, requires a thorough understanding of the solutions that are to be scaled up, using objectivated and agreed upon, comparable features. There is, however, no common and agreed set of features or characteristics – and subordinated subject codes within each – to analyse and deconstruct circular solutions to identify appropriate scaling strategies. Hence the Circular Solution Canvas is proposed here as a set of features to systematically analyse and describe – or ***canvass*** - any CE solution. Using the canvas allows for clearly articulating the essence of specific CE solution(s), which can support meaningful learning (leading to knowledge creation) about its origin, key elements, etc. and their contribution to adoption, impact and replicability, both within apparently similar applications (e.g., in the same sector or region) as well as outside thereof (through application of its abstractions in other application contexts).

Section 4.1 develops and introduces the Circular Solution Canvas with its elements and subject categories based on the CE concept analysis covered in Chapter 3. Section 4.2 elaborates and illustrates applications of the Circular Solution Canvas, for the dual objectives of improving learning and knowledge curation from implemented CE solutions and improving and guiding circular business development for greater impact on business, environment and/or society.

4.1 Canvas Development

The Circular Solution Canvas is intended to describe and analyse any circular solution. It is structured in three main elements, respectively: circular value *proposition*; circular value *creation*; and circular value *capture*. Figure 10 provides a sketch of the canvas with circular value proposition in the top right position and the circular value creation in the top left position, enabling circular value capture positioned in the bottom row.

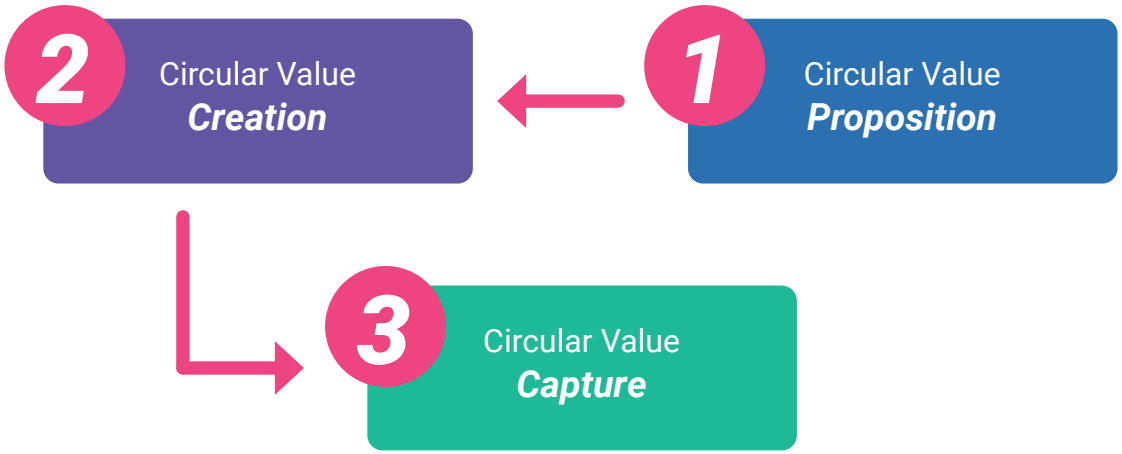

Figure 10: Structure of the Circular Solution Canvas (author's elaboration).

These three main canvas elements mirror the three-pronged CE deployment narrative (as displayed in Figure 9). Firstly, the **circular value *proposition*** explains the application of the CE main *idea*, specifically: the proposition articulates how the circular solution improves circularity, efficiency (including longevity) and/or substitution in the use of any of the natural resources. Secondly, the **circular value *creation*** covers the *objects* of change, thus *creation* describes which products, services and/or business processes have been innovated and at what stage(s) of the – circular – value chain. Thirdly, the **circular value *capture*** deals with the *impacts* (including both benefits as well a potential trade-offs and/or risks), thus *capture* elaborates how the circular solution delivers benefits to the implementing business or organisation, the environment, including sustainable resources' use and climate change, and/or society.

Figure 11 displays the full Circular Solution Canvas, in three rows. The top row is meant to capture a succinct narrative summary of the circular solution being canvassed, or as the case might be its contributing practices. The middle row intents to cover the circular value proposition (right) and the circular value creation (left). The bottom row is to be used for summarising the circular value capture, covering business, environment and society (from left to right).

CIRCULAR SOLUTION	
A brief description of the circular solution	
2 Circular Value *Creation*	**1 Circular Value *Proposition***
The change(s) in product(s), service(s) and/or business process(es) and associated value chains that created the circular solution	*The contribution to increased circularity, efficiency and substitution in the use of natural resources (materials, energy, water and possibly others) made by the circular solution*
3 Circular Value *Capture*	
The benefits and potential risks created by the circular solution	
3.a Business	**3.b Environment** / **3.c Society**
The change(s) in business performance resulting from the circular solution	*The change(s) in resource use and environmental burden resulting from the circular solution* / *The change(s) in wellbeing experienced by impacted stakeholders resulting from the circular solution*

Figure 11: Overview of the Circular Solution Canvas (author's elaboration)

The three main elements can each be broken down in sub-elements, as depicted with their leading questions in Figure 12. Specifically:

- First**, circular value *proposition*** addresses both resource strategy and targeted resources. Following the analysis in section 3.2, three resource strategies are being considered: resource circularity (re-introduction of recovered resources to keep these in closed loop circulation); resource efficiency (more efficient and longer use of resources); and resource substitution (replacing non-renewable materials and energy with renewable alternatives). The target natural resources are primarily materials, energy and water (in all their forms) used in the production and consumption system and may secondarily include the natural resources that are impacted by, but not physically used in, this production and consumption system, particularly land and nature (including biodiversity).
- Second, **circular value *creation***, essentially deals with characteristics of the innovation. The OECD innovation measurement framework [38] is used to analyse the circular value creation, in terms of products, business processes and value chain. Product innovation may change fast moving consumer goods, durable goods, packaging and/or services. Business processes would include: production of products and services; product and business process design; management and administration; information and communication systems; procurement and supplies; distribution and logistics; and sales and marketing (as per [38]).

Moreover, (circular) value chain covers: materials extraction and processing; product manufacturing; service provision; product use and maintenance; end-of-life management; and resource recovery and value retention (as in Figure 4).

- Third, **circular value *capture***, includes benefits for business, environment and society. Section 3.4 introduced the distinction between (intermediate) results (or mid-points), that are to the direct benefit and/or under the full control of the implementing business/organisation, and (final) impacts (or endpoints), that expand beyond the implementing business/organisation and contribute to sustainable development and socio-economic benefits at the level of sector, value chain, community or society. For the implementing business itself, intermediate results could cover costs savings, sales increase, product or service diversification, market access and/or risk reduction, each of which could facilitate impacts in terms of value creation, strategic advantage and/or business resilience. Regarding environment, intermediate results could be in terms of resource use and environmental impact creation, which would contribute to final impacts that mitigate the planetary crises of climate change, pollution and waste, and nature and biodiversity. With regard to society, direct results could cover job and livelihood creation, better work conditions and improved community health and well-being, each of which could drive final impacts in terms of social security, healthy society and resilient society.

CIRCULAR SOLUTION				
2 Circular Value *Creation*			1 Circular Value *Proposition*	
Product	**(Business) process**	**(Circular) value chain**	**Resource strategy**	**Targeted resource**
Which part(s) of product or service system has (have) been changed? And how?	*Which business process(es) has (have) been changed? And how?*	*Which stage(s) of circular value chain has (have) been changed? And how?*	*Which resource use strategy(ies) is (are) incorporated?*	*Which natural resources' uses are improved?*
3 Circular Value *Capture*				
3.a Business		**3.b Environment**		**3.c Society**
***Midpoint:* (intermediate) result**				
What changed in the economic performance of the implementing business/organisation?		*What changed in the use of natural resources and/or in the creation of environmental impacts by the implementing business/ organisation?*		*What changed in the impacts the business/organisation causes on its stakeholders?*
***Endpoint:* (final) impact**				
How do these changes contribute to future development and growth of the business/ organisation, and the sector and value chains it is part of?		*How do these changes contribute to improving environmental conditions, including reduction of environmental risks to society?*		*How do these changes improve the lives of and opportunities for people and society?*

Figure 12: Contributing sub-elements in the Circular Solution Canvas (author's elaboration)

Figure 13 provides an alternative presentation of the Circular Solution Canvas with a listing of the above key subjects for each sub-element to consider in the analysis of circular solutions. To support the application of the Circular Solution Canvas, Table 5 contains brief descriptions of all these subjects.

CIRCULAR SOLUTION

2 Circular Value *Creation*

Product	(Business) process	(Circular) value chain
▫ fast moving consumer good ▫ durable good ▫ packaging ▫ service	▫ production of products & services ▫ product & business process design ▫ management & administration ▫ information & communication systems ▫ procurement & supplies ▫ distribution & logistics ▫ sales & marketing	▫ materials extraction & processing ▫ product manufacturing ▫ service provision ▫ product use & maintenance ▫ end-of-life management ▫ resource recovery & value retention

1 Circular Value *Proposition*

Resource strategy	Targeted resource
▫ resource circularity ▫ resource efficiency ▫ resource substitution	▫ materials ▫ energy ▫ water ▫ land ▫ nature (incl. biodiversity)

3 Circular Value *Capture*

3.a Business	3.b Environment	3.c Society
Midpoint: **(intermediate) result**		
▫ costs saving ▫ sales increase ▫ product or service diversification ▫ market access ▫ risk reduction	▫ resource use (materials, energy, water, and others) ▫ environmental impact creation (waste and emissions (to air, water and land))	▫ job and livelihood creation ▫ better working conditions ▫ improved community health and well-being
Endpoint: **(final) impact**		
▫ value creation ▫ strategic advantage ▫ business resilience	▫ climate change ▫ pollution and waste ▫ nature and biodiversity	▫ social security ▫ healthy society ▫ resilient society

Figure 13: Subjects in the Circular Solution Canvas (author's elaboration).

Table 5: Description of elements, sub-elements and their subjects for the Circular Solution Canvas.

(Sub) element	Description	Subject	Description
Element 1: Circular value *proposition*			
Resource strategy	The manner in which the circular solution contributes to the more sustainable extraction, use and management of natural resources	Resource circularity	Keeping material and other natural resources in continued use through the recovery and repeat application of previously discarded materials, water and/or energy
		Resource efficiency	Using materials and other natural resources (including energy, water and others) more efficiently, including using these more intensively and/or for an extended useful period of time
		Resource substitution	Substituting a non-renewable (fossil- or mineral-based) material and/or energy resource by a renewable alternative
Targeted (natural) resource	The – natural – resource that is directly or indirectly (after processing in the organisation's supply chain(s)) sourced from the natural environment that is being targeted by the circular solution	Material	A physical material used by the organisation or in the lifecycle of its products and/or services, for any purpose e.g., raw materials, intermediaries, parts and subassemblies, auxiliaries, packaging materials, etc.
		Energy	An energy carrier used by the organisation or in the lifecycle of its products and/or services for any purpose, typically as thermal or electric energy, including fossil, renewable and other fuels and power, as well as other energy intermediates e.g., steam, compressed air, industrial gases, etc.
		Water	A water source used by the organisation or in the lifecycle of its products and/or services for any purpose, e.g., production, use, cleaning, cooling, sanitary, etc., coming from any water source, including scheme water, ground water, surface water, sea water, treated effluents, etc.
		Land	The land used and/or directly impacted by the organisation or in the lifecycle of its products and/or services
		Nature	The living environment used and/or directly impacted by the organisation or in the lifecycle of its products and/or services
Element 2: Circular value *creation*			
Product	A new or improved good or service that differs significantly from the organisation's previous goods or services	Fast Moving Consumer Good	Product that sells quickly in large quantity at relatively low cost and has a short shelf life and/or short use cycle because of high consumer demand (e.g., detergents, personal care, soft drinks and confectionary) or because they are perishable (e.g., packaged food, meat, dairy products, and baked goods) or disposable (e.g., cutlery, stationery) or otherwise quickly loose functionality (e.g., fast fashion, fast toys, etc.)
		Durable Product	A good that does not quickly wear out or, more specifically, one that yields utility over time rather than being completely consumed in one or few uses (e.g., whitegoods, ICT devices, vehicles, machinery, buildings, infrastructure)

Table 5: Description of elements, sub-elements and their subjects for the Circular Solution Canvas

(Sub) element	Description	Subject	Description
Product	A new or improved good or service that differs significantly from the organisation's previous goods or services	Packaging	A good that encloses or protects other product(s) for distribution, storage, sale, and use and may convey product information to consumers and other involved parties (includes consumer, display, distribution, wholesale and other forms of packaging)
		Service	Intangible activity that is produced and consumed simultaneously and that changes the conditions (e.g., physical, psychological, etc.) of user(s) in a manner that is of value to the user(s)
Business Process	A new or improved business process for one or more business functions that differs significantly from the firm's previous business processes	Production of products and services	Activities of the organisation that transform inputs into goods and/or services, including engineering and related technical testing, analysis and certification activities that support production
		Product and business process development	Activities of the organisation that scope, identify, design, develop and/or adapt its products (covering goods and services) and/or its business processes
		Administration & management	Activities of the organisation that ensure efficient and effective strategic and general management, (corporate) governance, financial transactions and accountability, human resource management and external relationships
		Information & communication systems	Activities of the organisation that provide and maintain its information and communication functions, including hardware and software, data processing and storage, maintenance and repair, and web hosting and other information processing activities
		Procurement & supply chain	Activities of the organisation for obtaining (including, as appropriate, the production by third party suppliers) its necessary material, utility and service business inputs to meet its needs, including supplier development activities
		Distribution & logistics	Activities of the organisation for transportation and product and service delivery, warehousing and order processing
		Marketing & sales	The commercial activities of the organisation for its market development (through advertising, direct marketing, exhibitions & fairs, market research etc.), pricing (strategy & methods) and sales and after-sales (including customer relationship activities)
(Circular) value chain	Stages in the development, use and retention of the user value of a product and/or service	Extraction & primary production	The production of primary (also '*virgin*') materials as inputs for product manufacturing and/or service provision, including extraction, mining, agriculture, forestry and fisheries and associated primary materials production
		Product manufacturing	The production of products, including their parts, components and packaging
		Service provision	The provision of services, including the sourcing of the products consumed for and during the service provision

Table 5: Description of elements, sub-elements and their subjects for the Circular Solution Canvas

(Sub) element	Description	Subject	Description
(Circular) value chain	Stages in the development, use and retention of the user value of a product and/or service	(Product) Use & maintenance	The use of products, including all activities required for their continued, efficient and effective utilisation, such as servicing, cleaning, repairing, etc., as required
		End-of-life management	The segregation, collection and sorting of post-consumer waste of discarded products (and/or its consumables, parts and/or packaging) and of pre-consumer waste of discarded materials, water and/or energy generated during extraction, primary production, product manufacturing and/or service provision, and logistics and distribution
		Resource recovery & value retention	The conversion of end-of-life material, water and/or energy resources into valuable secondary inputs and their application in any of the preceding stages of the same or any other circular value chain
Element 3: Circular value *capture*			
Midpoints: (intermediate) results under direct control of the organisation and primarily in its own interest			
Business	The creation of direct economic and/or other business value for the implementing organisation	Cost saving	Reducing the costs of producing and supplying the organisation's products and/or services
		Sales increase	Increasing the sales of the organisation's products and/or services
		Product or service diversification	Supplying and sales of new or substantially different products and/or services
		Market access	Supplying and sales of products and/or services into a market not previously served by the organisation
		Risk reduction	Reducing the risks the business is exposed to, including supply, price, climate, market, regulatory, reputational and other risks
Environment	The resource use and environmental impact created by the implementing organisation	Resource use	Reducing the net consumption of any of the natural resources (materials, energy, water, land and/or nature) by the organisation or in the lifecycle of its products or services, and/or switching to using natural resources with lower environmental impact
		Environmental impact	Reducing the net generation of any forms of waste (solid, liquid, etc.) and/or pollution (to air, land and/or water) by the organisation or in the lifecycle of its products or services
Society	The impact of the organisation on its stakeholders	Job or livelihood creation	Creating new jobs and/or livelihoods in the organisation or the lifecycle of its products and services
		Better working conditions	Improving the conditions of work for employees and/or contractors of the organisation or in the lifecycle of its products and services, including through improvement of occupational health and safety in workplaces
		Health & safety	Improving the health and safety of stakeholders of the organisation or impacted in the lifecycle of its products and services, including the communities it operates in and its consumers

Table 5: Description of elements, sub-elements and their subjects for the Circular Solution Canvas

(Sub) element	Description	Subject	Description
Endpoints: (final) impacts benefitting economy, society and environment, not within the direct control of the organisation			
Business	Advancing a competitive economy and its growth	Value creation	Increasing productivity and profitability of the economy
		Strategic advantage	Innovating business and/or economy to capitalise on emerging business, market and/or economic opportunities
		Business resilience	Reducing risks to business and/or the economy and their development and/or improving preparedness of business and/or economy to such risks
Environment	Advancing the mitigation of unsustainable natural resource use as the root cause of the triple planetary crisis and adaptation to their impacts	Climate change	Mitigating climate emissions, enhancing GHG capture, adapting to climate change and/or improving resilience including through reducing losses and damages
		Pollution and Waste	Avoiding the generation of waste, effluents and other emissions and their release and accumulation into the environment.
		Nature and Biodiversity	Conserving and restoring nature and biodiversity by reducing the pressures and drivers for nature and biodiversity decline and/or regenerating natural environments and/or ecosystem health.
Society	Advancing an inclusive and resilient society.	Social security	Contributing physically and/or financially to ensuring basic needs of all in society are being met
		Healthy society	Contributing to ensuring that all members of society are being able to enjoy good health
		Resilient society	Contributing to ensuring that communities and their members are prepared for and able to recover in case of adverse events

4.2 Canvas Applications

The well-known and widely-used business model canvas [14] provides a structure for - *retrospectively* - analysing (or canvassing) the success of a given business and – *prospectively* – (re-)designing a new or existing business for growth and improved business success. Likewise, the Circular Solution Canvas is equally suitable for retrospective and prospective applications.

1. ***Learning and knowledge creation (retrospectively)*** to canvass any operational, existing circular solution for improving the understanding of its contributing (sub)elements and the subjects these have addressed. To the implementing organisation or business this can identify opportunities for improvement and adjustment of product, business processes and/or business model to scale up the initiative. For the CE-professional community, this generates practice-informed analytical and tactical insights to inform theory-practice dialogue, experiential learning and further knowledge creation that can be deployed elsewhere and can guide the design and deployment of specific scaling up strategies, through the established mechanisms of deepening, broadening and extending [63]. The guiding canvas questions (as shown in Figure 12) serve as the starting point for the further contextual analysis and interpretation of existing circular solutions.
2. ***Designing and implementation (prospectively)*** to develop and elaborate a circularity idea (arising from a conceptual application of circularity objectives, practices or design strategies) into a specific circular solution, with its unique and optimised circular value proposition, creation and capture. The circularity idea

is thus assessed and thereby progressively improved on its feasibility, market acceptance and readiness for implementation and investment. Applying the Canvas provides the framework for value-engineering any conceptual circularity ideas into product, service and business prototypes and their implementation. The subject categories in the canvas (as displayed in Figure 13) can be taken as prompts for such value engineering by seeking answers to the question how the impact of the circularity idea for each subject category can be increased.

Figure 14 provides a summary of the use of the Canvas for reflection and learning from four practical examples: community-based mechanical recycling of mixed plastic wastes (Precious Plastics – Philippines); redesign of bra-products for extended use and with increased contents of recycled and renewable materials (Thai Wacoal – Thailand); production of sustainable leather-like and board materials with mycelium grown on organic wastes (Mycotech Lab – Indonesia); and organic, fair-trade pepper farming with cover- and inter-cropping (Fair Farms – Cambodia). This analysis and interpretation is based on publicly-available information, which may not have covered all CE-relevant initiatives, nor the full details of the business decisions involved.

Circular Solution **Appropriate technology and product designs for community-based plastics recycling** Precious Plastics [Philippines]	
Precious Plastics develops and supplies low cost, small scale appropriate mechanical recycling equipment for mixed plastic wastes and develops network of grassroots plastic waste collection and recycling initiatives that produce and sell recycled plastic board-based furniture and decorative items.	
2 Circular Value ***Creation***	**1** Circular Value ***Proposition***
Design and manufacturing of plastic recycling equipment. *Operation of in-house plastic recycling facility.* *Delivery of designs and moulds for recycled products manufacturing and of business development services to community recycling hubs (including impact monitoring).*	*Resource circularity for materials by collection of mixed plastic waste and its mechanical recycling into furniture and decorative items.*

3 Circular Value ***Capture***		
3.a Business	**3.b Environment**	**3.c Society**
Diversified business model based on sales of equipment, recycled plastic products and business development services. *300+ (and counting) pieces of recycling equipment manufactured and sold.* *Potential expansion of business model as a recycling provider under Extended Producer Responsibility (EPR) Act.*	*~ 8 tonnes plastic waste monthly collected and processed in house [2024]*	*20+ (and expanding) community recycling hubs supported that create livelihood opportunities from collection and processing of plastic waste into value added products.*

Figure 14.a: Illustration of Circular Solution Canvas for Precious Plastics [Philippines] [64].

Circular Solution

Towards fashion circularity through material substitution

Thai Wacoal [Thailand]

Thai Wacoal redesigned bra-products to: include recycled PET and recycled nylon fabric and palm-oil derived eco-foam; reduce material diversity; extend product's useful lifetime; and offer a repair service and end-of-life management. It also installed a rooftop solar plant for onsite power generation.

2 Circular Value *Creation*

Redesign of bra-products, using new materials with increased recycled or renewable contents, for extended product use and having lower materials complexity to support end-of-life recycling.

New business processes including operation of rooftop solar plant, provision of repair and end-of-life management services, and for consumer information (enabling better and longer product use).

1 Circular Value *Proposition*

Resource circularity for materials through use of materials in the product that have better recyclability or increased recycled contents.

Resource efficiency for materials by enabling extended product use by the consumers.

Resource substitution through partial shift to renewable energy and materials.

3 Circular Value *Capture*

3.a Business

Product diversification targeting growing eco-conscious market segment.

Medium term corporate goal to achieve 30% of total sales from eco-redesigned products.

Initial cost penalty for new recycled and/or renewable materials gradually overcome with economies of scale.

3.b Environment

Solar power generation substitutes 30% of power requirement of manufacturing plant.

Recovering 20 tonnes end-of-life bra products for energy recovery (in 2023 and increasing).

3.c Society

Supporting livelihoods by procuring plastic waste collected by communities in vicinity of its plant as input for third party recycling and energy recovery.

Figure 14.b: Illustration of Circular Solution Canvas for Thai Wacoal [Thailand] [65].

Circular Solution

Using mushrooms to produce sustainable materials from agricultural waste

Mycotech Lab [Indonesia]

Mycotech Lab grows mycelium threads as bio-adhesive to turn agricultural waste products into sustainable leather-like and board materials, suitable for use in fashion, home décor and furnishings. Furthermore, it developed and now applies energy and water efficient production practices and composting of the remaining organic waste.

2 Circular Value *Creation*	1 Circular Value *Proposition*
Applies proprietary biotechnology in a new production process that produces new materials suitable for application by textile, leather, furniture and furnishing industries. *Uses previously discarded agricultural residues and generates organic waste that is being composted.*	*Resource circularity for materials by using agricultural residues to grow mycelium-derived novel materials and use remaining organic waste for compost production.* *Resource efficiency in the use of water and energy through efficient technology for processing of the mycelium materials into ready-to-use leather-like and board materials.*

3 Circular Value *Capture*		
3.a Business	**3.b Environment**	**3.c Society**
New business and market development driven by novel application of proprietary mushroom biotechnology.	*30 to 50% reduction of GHG emissions in processing of the mycelium-based materials.* *Water use reduction and GHG emission reduction by substitution of traditional leather with the alternative leather-like materials*	*Partnerships created with local farmers that generate additional income through procurement of agricultural residues for mycelium production.*

Figure 14.c: Illustration of Circular Solution Canvas for Mycotech Lab [66].

Circular Solution

Organic and inclusive spices cultivation

Fair Farms [Cambodia]

Fair Farms deploys organic and regenerative farming and fair trading of Kompot pepper, including through intercropping with vanilla and use of cover crop (of local peanut grass), leading to improved soil quality, and reduction of water and fertiliser use and reduced soil erosion.

2 Circular Value *Creation*	1 Circular Value *Proposition*
New organic cultivation system (process) in pepper cultivation that incorporates the use of peanut grass cover crop, intercropping with vanilla and use of organic fertilisers.	*Resource efficiency for materials, energy and water with improved soil quality and reduced soil erosion.* *Resource substitution for materials by use of cow dung, fish bones and peanut grass for soil fertilisation.*

3 Circular Value *Capture*

3.a Business	3.b Environment	3.c Society
Reduced costs for fertilisers, irrigation and for erosion recovery. *Premium price achieve with organic and fair-trade certified pepper.* *Business diversification with sales of vanilla.*	*Halving of water and energy requirements for irrigation.* *Soil wash out reduced by 3,600 m^3 annually* *Soil regeneration and farm diversification benefit local nature and biodiversity.*	*Cooperative, fair trade business model rewards affiliated local farmers with a better price for their pepper crop to support their livelihoods.*

Figure 14.d: Illustration of Circular Solution Canvas for Fair Farms [67].

Canvassing through the main elements of circular value proposition, creation and capture provides a rich understanding of these business cases, compared to a classification only on R strategy or business model (as introduced in Section 3.2). By comparison, Precious Plastics would be R8 (Recycle); Thai Wacoal would combine R2 (Reduce), R4 (Repair), R8 (Recycle) and R9 (Recover); and Mycotec Lab and Fair Farms would be principally R8 (Recycle) with some contribution to R2 (Reduce). In terms of circular business model, all would be primarily working towards 'closing' the loop, with some contributions to 'slowing' the loop (Thai Wacoal), or 'narrowing' the loop (Mycotec Lab) or 'regenerating' the loop (Fair Farms). The added value of the use of the canvas has also been demonstrated in terms of training and engagement of stakeholders, as observed during SWITCH-Asia learning and networking events using subsequent draft versions of the canvas in Thailand[51], Indonesia[52] and Philippines[53,54] during October 2025 – March 2026.

A further retrospective, analytical application involves scoring any circular solution against all subject categories identified in the Circular Solution Canvas (as shown in Figure 13 and described in Table 5). This means determining whether or not the circular solution makes a discernible and material contribution to each subject category. The findings from multiple circular solutions in a country, a sector or any other collection of examples can then in principle be summed up and interpreted. This is illustrated for 16 CE-relevant business cases in Indonesia, that were uncovered, analysed and written up with the support of the EU SWITCH-Asia Policy Support Component during 2023-2024 [11]. Brief narrative summaries of these CE-relevant Indonesian business cases are provided in Table 6, and the assessment results are displayed in Figure 15.

51 https://www.switch-asia.eu/resource/7th-switch-asia-annual-meeting-report/
52 https://www.aceba.co/blog/circular-economy-advantage-for-business-west-java-industry-forum/
53 https://www.aceba.co/blog/aceba-and-its-philippine-partners-call-on-businesses-to-lead-the-transition-to-a-circular-economy/
54 https://www.aceba.co/blog/aceba-launches-circular-business-facilitation-initiative/

Table 6: Summary of CE-related business cases in Indonesia (source: [11]).

Company	Sector	Business case	Summary
Electrum	automotive	Two-wheeler EVs to reduce climate and air emissions	Design and manufacturing of 2-wheeled electric vehicles (e-scooters) which are customised for use in dense urban areas. Development and operation of supportive battery-swapping ecosystem, partially powered with renewables (through grid).
Mycotech Lab (MYCL)	biotechnology	Using mushrooms to produce sustainable materials from agricultural waste	Use of mycelium threads as bio-adhesive to turn agricultural waste products into sustainable leather-like and board materials, suitable for use in fashion, home décor and buildings. Energy and water efficient production practices and composting of remaining organic waste.
Solusi Bangun Indonesia (SBI)	building & construction	Municipal solid waste as alternative fuel in cement industry	Use of biomechanically processed municipal solid waste and other industrial wastes as alternative fuel for cement making.
Trimegah Bangun Persada		Recycling nickel slag into concrete bricks	Utilisation of nickel slag (by-product of ferro nickel smelting) into bricks as substitute for concrete and ceramic bricks in road and building construction.
Wijaya Karya Bangunan Gedung (WEGE)		Modular: future for sustainable construction	Resource efficient factory-based production of pre-fabricated and pre-fitted building modules, with inclusion of secondary materials as fillers, that significantly reduce total material use for the building and enable reuse of the building at a different location or in a different building configuration.
Chandra Asri Group (CAG)	environment	Recycling plastic waste into road asphalt	Use of plastic waste (1) in asphalt for construction of roads with extended durability and (2) for decentralised production of pyrolysis oil as alternative fuel.
Masaro		Revolutionising waste management with zero waste techniques	Sorting of municipal waste and subsequent processing of waste fractions through bioprocessing and pyrolysis into suitable products for use in agriculture.
Robries		Unique recycled plastic home décor	Recycling of source-segregated PET and HDPE plastics into stylish recycled plastic board-based home decoration and furniture items.
Pan Brothers	fashion	Operationalising circularity towards net zero garment-making	Energy and water efficiency in production, minimisation and recovery of fabric offcuts (with external partners to produce fabric or rugs). Experimenting with use of kapok fibre and organic dyes in fashion products. Integration of roof top solar as renewable power source.

Table 6: Summary of CE-related business cases in Indonesia (source: [11]).

Company	Sector	Business case	Summary
ANJ Agra Papua (ANJAP)	food & beverage	Sago as an alternative starch source	The sago plantation and its processing support the circular economy transition by making efficient use of natural resources (resource efficiency), and by recovering biomass waste (resource circularity) to replace fossil fuel use (resource substitution).
Burgreens		Vegan food for a better planet	Vegan dining chain and manufacturer of ready-to-eat frozen vegan meals, which substitute animal protein with plant- and mushroom-based proteins that are more resource efficient to produce. Minimisation and recovery of food preparation waste in products or through composting.
Gading Mas Indonesia Teguh (GMIT)		Value chain innovation in domestic edamame production	Application of good agricultural and processing practices for increased efficiency of use of water, fertilisers and energy in cultivation and processing of edamame and other high value frozen vegetables in water stressed growing area.
Great Giant Food		Integrated operations for sustainable agriculture	Extraction of bromelain enzyme from pineapple stems, use of recycled materials for packaging, recovery and reuse of plantation and fruit processing residues for animal feed. Production of biogas and liquid fertiliser from manure for use in plantations to regenerate soil and reduce fertiliser inputs. Rainwater harvesting and reuse, advanced irrigation and processing technology, including digitalisation for improved resource efficiency.
Galeri Wong Kito	handicraft	Using gambier waste for sustainable fashion	Using waste liquid from gambier extraction with other natural wastes (leaves, bark, skins) for artisanal dyeing and production of ethnic-inspired jumpatan fashion.
Unilever Indonesia	plastic packaging	Less Plastic – Better Plastic – No Plastic: towards circular plastics packaging	Redesign of consumer goods plastics packaging for lower packaging weight and/ or volume and introduction of refill stations. Started with partial shifts to using recycled plastics and to replacing non-recyclable aluminium barrier laminate with recyclable plastic barrier laminate materials.

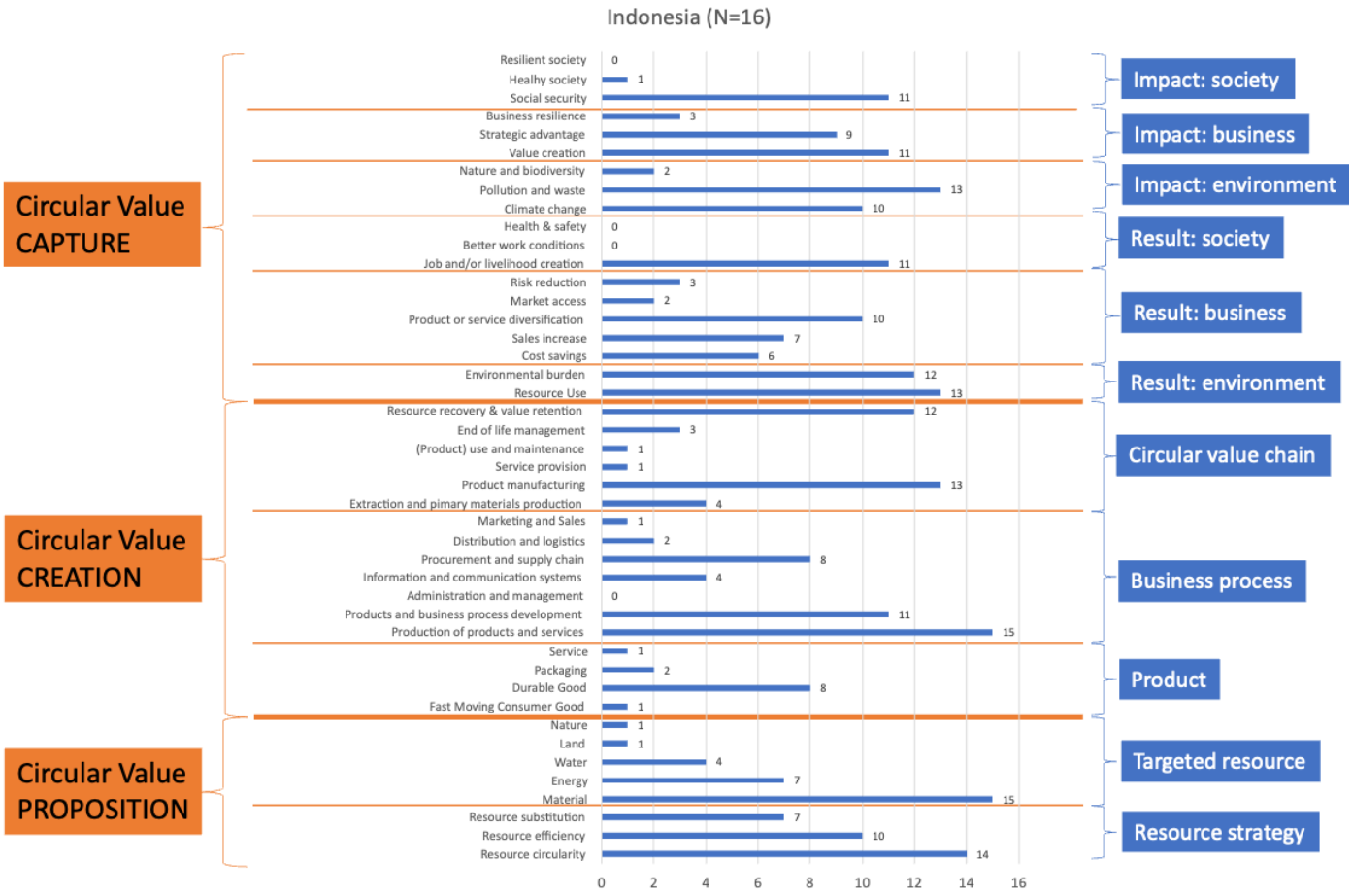

Figure 15: Classification of Indonesian business cases on their contribution to subject categories of the Circular Solution Canvas.

Figure 15 shows the number (out of total of 16) of the business cases that materially contribute to each of the subject categories, which have been grouped by element and sub-element of the Circular Solution Canvas. The Figure shows diversity: the majority of the business cases contributes to in particular resource circularity, resource efficiency, materials use, production business function, production and resource recovery value chain stages; and most subject categories are addressed in at least a couple of business cases (with the exception for e.g., land use, administration and management, product use, etc.). This is though illustrative only as a statistical analysis is not warranted considering the process of business case identification and development [11]. Firstly, these businesses have been purposely sampled through referrals and from awards and sustainability reports on the basis of their self-declared CE commitment and achievement. Secondly, for each business case only the self-reported initiatives have been included, and these may not provide the complete picture of the entire business effort and achievement towards CE.

In addition to this - *retrospective* - use of the Circular Solution Canvas for the analysis of and learning from practical, implemented CE solutions, the Canvas has potential for - *prospective* - use during the detailed development, commercialisation and scaling up of conceptual CE ideas. The optimism for such beneficial prospective use of the Canvas is grounded in the reflection that successful Asian circularity - or more broadly cleantech – start-ups have during their development journey more organically explored and captured the key canvas elements to improve and scale their circular business. For example:

- Before founding Science for Society (S4S)[55], its founders studied the performance of solar dryers, and created a design and prototype of an efficient and controlled solar dryer for their final year engineering project at the Institute of Chemical Technology (Mumbai, India). They saw a potential for its application for the controlled dehydration of fresh spices and vegetables in rural India that at the peak harvest time go to waste, because of oversupply in the market and lack of cold-chain or processing facilities. Next S4S Technologies was conceived on the circular value proposition of preventing the post-harvest loss of fresh

55 www.s4stechnologies.com

produce, particularly onions, tomatoes, chillies, etc., which, depending on perspective, operationalises resource circularity (creating valuable food ingredients from previously discarded fresh produce) or resource efficiency (achieving the more efficient use of the fresh farm produce). The solar conduction dryer design was operationalised for use at farm/community level and ease of operation and maintenance, to be operated by local women self-help groups. In addition to sales of its low-cost solar dryers, often with some initial financial support from rural development initiatives, S4S Technologies diversified into providing training and advisory services to improve hygiene and quality control of the dehydrated produce and assistance with the management and organisation of the producer groups. They also started buying the dehydrated produce from producer groups for onward sales to food and beverage producers to achieve a better price and long-term offtake agreements. The women benefit from additional income to support health and education of their families and communities. Significant environmental benefit is being achieved by avoiding post-harvest food losses, and potentially greenhouse gas emissions, odour and other nuisances from its uncontrolled decomposition. In the process, S4S Technologies matured and expanded as a business running on revenues from sales of its equipment, provision of advisory services and trade in an expanding range of solar dried dehydrated fruits and vegetables, grains and pulses and spices. By 2024 2,600 solar dryers had been supplied to over 800 micro-enterprises in 15 countries.

- ZeroCircle[56] is a cleantech start-up that develops and produces novel bio-polymers from seaweed for food-grade packaging applications [68]. Seaweed grows fast in coastal waters, requiring zero inputs, save for hand-made bamboo rafts as structure for the seaweed cultivation and manual labour for harvesting, cleaning and sun-drying. The seaweed bio-polymers are equally bio-based, made from renewable material, as well as biodegradable, as they dissolve within hours in seawater or instantly in boiling water, or when processed with other organic waste into compost or biogas. ZeroCircle's circular value proposition is the substitution of plastic with its biopolymers, with an additional benefit of resource efficiency due to lower lifecycle energy use and GHG emissions compared to regular plastics. The circular value creation is driven by proprietary biomaterials material and process knowledge. ZeroCicle sought and achieved partnerships with lead buyers to develop and start commercialising specific product applications (clamshells and grease resistant paper and trays), with further efforts underway for e.g., fresh food packaging and seaweed pellets for thin films. Each of these is being optimised for use in existing equipment, avoiding the need for machinery investments by prospective users. A considerable effort has been made to develop an inclusive and sustainable seaweed supply chain, availing an additional income stream to coastal communities, that earlier depended largely on fishing. Product and application development has further focused on combining with compatible substrate materials, to ensure that after use the biopolymer biodegrades with the substrate or does not impede its material recycling (e.g., with grease-resistant paper and cardboard).

These and other examples show that CE-minded start-ups appear to have benefitted from organic navigation through key elements of the Circular Value Canvas. This suggests that intentional and structural application of the Canvas may facilitate, drive and/or improve circular business development. This may be operationalised by embedding the Canvas in circular design frameworks and methodologies, which have thus far been almost exclusively dominated by circular product and business design strategies (see e.g., [69] and [70]). The addition of the Canvas in the circular business development process is expected to help bridge the gap between development of circular design concepts (typically with a degree of utopianism or as boundary objects[57] during product design) and feasible circular solutions that would be investable and able to attract financing. The SWITCH-Asia PSC plans to trial this in 2026 through the ASEAN Circular Economy Business Alliance and its national partners in Indonesia, Philippines and/or Thailand[58].

56 www.zerocicle.in

57 Boundary objects are prototype products that incorporate a maximum of novel features to explore user experience, manufacturability, etc. in turn informing a final product design with fewer features included.

58 The results and learnings from these expected trials will in due course be uploaded and accessible from: https://www.switch-asia.eu/our-work/multi-country/asean-circular-economy-pact-acep-mobilizing-business-action-for-circular-economy/ and www.aceba.co.

Chapter 5: Towards Scaling Circular Economy Impact

The exploratory analyses and the development of a Circular Solution Canvas covered in this report were initiated by the desire to more effectively capture, analyse and utilise the diversity and richness of CE experiences, particularly those of pioneering businesses, for scaling-up and accelerating the development and implementation of – ambitious - circular solutions.

The sustainability literature (e.g., [63]) has thus far identified three scaling mechanisms for sustainability initiatives: *deepening* (becoming more ambitious, radical, impactful and sustainable/circular); *broadening* (connecting with other domains and agendas); and *spreading* (becoming larger and more numerous). These scaling mechanisms may unlock, or as the case might be, can work in tandem with, mobilising the means of implementation, which include public policy, capacity building, technology and standards, and access to appropriate financing.

The applicability and operationalisation of the scaling mechanisms is specific to the circularity solutions to be scaled up. Spreading of some circularity innovations may require changes in public perception and consumer behaviour (e.g., in the case of slow fashion), whilst others can remain unnoticed to the consumer and depend on acceptance and implementation by producers (e.g., use of remanufactured components or recycled materials with no change in product features). In the case of broadening, some circularity solutions broaden to waste management (e.g., in the case of plastics recycling), others to innovation and digitalisation agendas (e.g., in the case of use of ICT and/or Artificial Intelligence for industrial resource efficiency) and others to food security (e.g., in the case of prevention of post-harvest losses) or for economic resilience (e.g., reduced dependency on virgin materials imports). Broadening fosters policy and strategy hybridisation (as observed by [20]), facilitating complementary and integrated policy interventions across different policy domains. Moreover, deepening is aimed to achieve greater and more ambitious impact, which is contingent on innovation, requiring context-specific expertise, technical, managerial and financial resources, and – calculated – risk taking.

Put simply, there is no one-size-fits-all for the scaling of circularity solutions, rather these will scale only following specific and custom-designed scaling strategies. This realisation pinpoints to the importance of canvassing circular solutions, to create the rich understanding of context and contributing elements of any circularity solution, which is necessary to guide the design of effective scaling activities. The Circular Solution Canvas proposed here can serve as a tool for analysing and designing, or canvassing, circular solutions.

The Canvas was conceptualised and elaborated with two inputs. First, an exploratory analysis of the current state and limitations of – open access - CE knowledge management. As elaborated in Chapter 2 the effectiveness of CE knowledge management is compromised by the observed ambivalence and discrepancies in capturing and classifying CE knowledge and the absence of CE knowledge collaboration spaces to co-create context-specific circular solutions. The second input comprised a deep dive into the current CE practice and supporting concepts and theories, which are rapidly evolving and diversifying. This was elaborated in Chapter 3, in terms of the – guiding - ideas, objects and impacts of CE.

Next, the Circular Solution Canvas was postulated from the perspective of CE impacts (the achievement of tangible net benefits to business, environment and climate, and people and societies) as opposed to the solutions perspective (the types of circularity solutions adopted) that is common across CE frameworks (as e.g., circularity principles, R-practices and/or circular business models). This CE impact is captured as the 'circular value', which sits at the heart of the Canvas, and extends to business, environment and society. The three main canvas elements concern respectively circular value *proposition* (the foreseen contribution toward sustainable and circular extraction, use and management of natural resources), circular value *creation* (the necessary changes or innovations in products, business processes and/or value chains) and circular value *capture* (the achievement of net benefits to business, environment and society). Further sub-elements and subject categories in these main elements are proposed as prompts to be used during the canvassing process.

Circular solutions from Southeast and South Asia illustrate practical applicability of the Circular Solution Canvas. Two applications appear promising: backward looking (retrospective) to capture insights and learnings from implemented circular solutions; and forward looking (prospective) to value-engineer circular ideas into circular solutions during circular business development. In the retrospective application, the Canvas is used to analyse existing – implemented – circularity solutions, to arrive at contextual understanding of the elements that contributed to its adoption and impact. The resulting insights are both an input (1) for improving business processes and model for scaling the solution by the implementing organisation or business; and (2) for CE knowledge generation and as starting point for the development of customised scaling strategies and activities. Such canvassing of existing circularity solutions can also be used for training and capacity building on CE. In the prospective application, the Canvas is applied during the detailed development of circular concept ideas, to develop and deliver opportunities for increasing the circularity value and/or reduce their potential risks (to business, environment and/or society). The Canvas then becomes a tool for circular value engineering during the circular business development, that would result in more impactful and more feasible circular solutions.

Beneficial application of the Circular Solution Canvas to scale circularity impacts thus appears plausible on the basis of currently available CE-solutions from Southeast and South Asia. Further experimentation and application are therefore encouraged.

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