ARCHITECTURE
Research & Experimentation

AGATHÓN – International Journal of Architecture, Art and Design | n. 19 | 2026 | pp. 192-211
ISSN print: 2464-9309 – ISSN online: 2532-683X | doi.org/10.69143/2464-9309/19112026

Article Info

Received 11 March 2026
Revised 13 April 2026
Accepted 14 April 2026
Published 30 June 2026

ECOSISTEMI SOCIO-CIRCOLARI
Innovazione sociale, strategie circolari e ambiente costruito

SOCIO-CIRCULAR ECOSYSTEMS
Social innovation, circular strategies, and the built environment

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Abstract

Sebbene le metriche ambientali ed economiche della circolarità siano consolidate, la sua dimensione sociale resta poco sistematizzata. Le politiche europee riconoscono il ruolo della transizione circolare nei processi di inclusione, equità e benessere ma in letteratura il valore sociale della circolarità è spesso ricondotto ad ambiti come edilizia sociale, co-progettazione e imprese sociali. Il paper propone il concetto di Ecosistema Socio-Circolare (SCE), inteso come sistema spaziale e relazionale in cui attori a diverse scale condividono e cogestiscono risorse tangibili e intangibili. Applicato a casi europei il quadro interpretativo consente di riconoscere configurazioni organizzative e spaziali degli SCE, attivare processi circolari, generare valore sociale e sviluppare nuovi modelli abitativi e insediativi.

Although the environmental and economic metrics of circularity are well established, its social dimension remains insufficiently systematised. European policies recognise the role of the circular transition in processes of inclusion, equity, and well-being, yet in the literature the social value of circularity is often addressed within fields such as social housing, co-design, and social enterprise. The paper proposes the concept of the Socio-Circular Ecosystem (SCE), understood as a spatial and relational system in which actors operating at different scales share and jointly manage tangible and intangible resources. Applied to European cases, this interpretative framework enables the identification of organisational and spatial configurations of SCEs and their capacity to activate circular processes, generate social value, and develop new housing and settlement models.

Keywords

economia circolare, condivisione delle risorse, valore sociale, ecosistema socio-circolare, modelli abitativi e insediativi

circular economy, resource sharing, social value, socio-circular ecosystem, housing and settlement models

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Nell'ambito dell'ambiente costruito l'economia circolare è passata dall'essere intesa come insieme di strategie ambientali focalizzate sull'ottimizzazione delle risorse[1] a una visione più ampia che include anche aspetti legati al progetto di architettura, alla rigenerazione urbana (Semprebon et alii, 2021) e allo sviluppo territoriale, come si evince, ad esempio, nelle proposte contenute nell'iniziativa del New European Bauhaus (Gkatzogias, Romano and Negro, 2024). Mentre le più consolidate interpretazioni delle strategie circolari riguardano principalmente la scala 'nano' (ciclo dei materiali e riduzione dei rifiuti), più recentemente il tema della circolarità si è allargato alle scale micro (edifici), meso (quartieri, distretti e reti) e macro (città e regioni), come evidenziato da Khadim et alii (2022).

Esperienze quali quelle dell'housing cooperativo per la rigenerazione rurale (Eixerés Ros, 2025), dei distretti energetici collaborativi (Crippa et alii, 2024), degli spazi di welfare co-progettati (Campagnaro et alii, 2025; Arquilla and Caruso, 2025), delle infrastrutture di servizio per il riuso e il riciclo (Olivastri and Tagliasco, 2024), delle micro-reti locali operanti in vari ambiti della transizione verde (Gaddi and Mastrolonardo, 2024) e dei materiali pro-sociali sviluppati attraverso micro-filiere locali inclusive (Del Curto, Valassina and Santi, 2025) dimostrano come le strategie circolari sempre più coinvolgano alle diverse scale modelli di governance partecipativi, infrastrutture collettive e co-progettazione.

Questa evoluzione nell'implementazione delle strategie circolari suggerisce un cambiamento di prospettiva, da edifici circolari isolati a interventi a scala più ampia, in cui le dimensioni insediative, sociali, organizzative ed economiche interagiscono sinergicamente. Su scala più ampia le dinamiche sociali generate dalle iniziative circolari rivelano un elevato grado di complessità e aprono a modelli abitativi e insediativi sperimentali, oltre che a nuove modalità collaborative di abitare e lavorare e a nuove relazioni a livello dei territori. Di conseguenza spostando l'attenzione sulle scale meso e macro, le sinergie tra le dimensioni tecniche, ambientali e sociali[2] richiedono l'adozione di originali chiavi interpretative.

Partendo da queste premesse e sulla base di un'analisi di progetti europei 'circolari' e orientati alla sperimentazione sociale il presente articolo propone il concetto di Ecosistema Socio-Circolare che deriva e amplia il concetto di 'cosistema circolare'. L'ipotesi alla base è che le strategie circolari implementate nell'ambiente costruito possano generare valore sociale all'interno dei sistemi relazionali e spaziali (ecosistema socio-circolare), in cui gli stakeholder condividono e co-gestiscono risorse tangibili e intangibili. In questo senso l'Ecosistema Socio-Circolare si pone come schema interpretativo, teso a incorporare le dimensioni tangibili (tecniche) e intangibili (sociali) della circolarità nell'indagine sulle implicazioni ambientali, tecniche e sociali nel breve e nel lungo termine, alle varie scale, dalla micro alla meso. In particolare assumere la prospettiva della 'meso-scala' consente di indagare i progetti circolari da diverse angolazioni, collocandoli in una visione sistemica che comprende: 1) l'organizzazione e la gestione di risorse condivise; 2) i ruoli degli stakeholder e i modelli relazionali; 3) le condizioni in cui la governance e i modelli di impresa basati sulla comunità supportano la generazione di valore a lungo termine. Il contributo ha dunque l'obiettivo di proporre il concetto di Ecosistema Socio-Circolare quale innovativo schema interpretativo, utile a leggere congiuntamente la circolarità, l'innovazione sociale, la governance e la condivisione delle risorse nell'ambiente costruito. Adottando un approccio olistico e superando la visione parziale del già noto concetto di Ecosistema Circolare il paper contribuisce a colmare una lacuna interpretativa emersa dalla letteratura.

In particolare nella prima sezione il paper delinea lo stato dell'arte in tema di Ecosistemi Circolari, sottolineando le principali lacune della letteratura legate alla dimensione sociale della circolarità. La seconda sezione introduce il concetto innovativo di Ecosistema Socio-Circolare (SCE), inteso come sistema spaziale e relazionale basato su strategie di condivisione e integrazione di molteplici categorie di risorse tangibili (spazi e materiali) e intangibili (informazioni, servizi ed energia). Nella terza sezione, a partire dal concetto di SCE, si propone uno schema interpretativo utile a definire, nell'ambito degli ecosistemi circolari, i diversi possibili approcci (chiuso, ibrido e aperto) alla gestione delle risorse, mettendo in luce le tipologie di relazione tra aspetti di circolarità e innovazione sociale. Nella quarta sezione lo schema interpretativo è applicato a un campione di casi di SCE selezionati a livello europeo, con l'obiettivo di testarne l'efficacia nell'individuare strategie di circolarità basate sulla condivisione delle risorse e in grado di promuovere l'innovazione sociale. Il fine è definire, a diverse scale, condizioni e modalità di sviluppo e di crescita di modelli abitativi e insediativi caratterizzati da strategie collaborative. Gli esiti dell'indagine sono oggetto di discussione critica nella quinta sezione.

Il concetto di ecosistema circolare: revisione della letteratura | La transizione all'Economia Circolare, nel coinvolgere e integrare aspetti di carattere ambientale, economico e sociale (Geissdoerfer et alii, 2017) presuppone un approccio di indagine sistemico (Barquete et alii, 2022). In questa direzione il concetto di ecosistema circolare appare utile per riconoscere e indagare le interdipendenze e le interazioni tra gli attori nella loro appartenenza a una comunità, nonché i processi di condivisione delle risorse (ad esempio informazioni, materia, energia e risorse economiche) nel tempo (Geissdoerfer, Kanda and Kirchherr, 2025). In letteratura il concetto di ecosistema circolare sembra sempre più consolidato, come dimostrato dalla proliferazione di definizioni (Tab. 1) e dall'articolazione delle tematiche coinvolte (Tab. 2).

L'analisi della letteratura evidenzia come gli studi sugli ecosistemi circolari siano principalmente incentrati su tematiche di carattere tecnico e organizzativo – ad esempio flussi di risorse, modelli di business, organizzazione degli stakeholder, ecc. – mentre la dimensione sociale merita ulteriori approfondimenti. Tuttavia, anche se non direttamente collegata al concetto di ecosistemi circolari, la dimensione sociale sta iniziando ad attirare l'attenzione di studiosi e operatori nel dibattito sull'economia circolare.

Analizzando la letteratura è infatti possibile individuare segnali di una recente attenzione per le relazioni tra i temi dell'economia circolare e dell'innovazione sociale (Tab. 3), ma non emerge ancora una sistematizzazione delle possibili declinazioni di tali relazioni e della loro collocazione all'interno del concetto di 'ecosistema circolare'. L'Ecosistema Circolare appare ancora sostanzialmente indagato nei suoi aspetti tecnico-organizzativi; tuttavia molteplici dinamiche tipiche (accesso equo e condivisione di risorse, partecipazione ai processi collettivi, mantenimento di comunità coese e resilienti, accordi istituzionali, processi partecipativi, ecc.) possono avere una forte influenza sulle relazioni tra gli stakeholder (ad esempio sull'intensità delle collaborazioni, sull'entità dei benefici collettivi raggiunti) e generare innovazione sociale, nuovi modelli gestionali, abitativi e insediativi.

Secondo questa prospettiva la circolarità può offrire fertili opportunità per l'innovazione sociale in progetti circolari che, a diverse scale, possono agire come laboratori di sperimentazione, combinando strategie circolari con nuove forme di collaborazione, reti di supporto sociale, potenziamento degli abitanti e sviluppo territoriale (Marchesi and Tweed, 2021; Marchesi, Tweed and Gerber, 2020).

Il concetto di Ecosistema Socio-Circolare | Sulla base di queste premesse il paper propone di estendere il concetto di ecosistema circolare a quello di Ecosistema Socio-Circolare, inteso come sistema spaziale e relazionale, basato su strategie di condivisione e integrazione di molteplici categorie di risorse tangibili e intangibili, (Fig. 1) ossia: 1) informazioni / conoscenze / competenze (condivisione e messa a sistema di esperienze, conoscenze, competenze e know-how; K); 2) spazi (spazi resi disponibili per uso individuale e/o collettivo; S); 3) servizi (attività, funzioni e forme di supporto forniti agli utenti e/o alle comunità; SV); 4) materiali / prodotti (beni fisici, prodotti e oggetti che vengono riutilizzati, scambiati o messi in circolazione; M); 5) energia (flussi di energia, sistemi e infrastrutture per la produzione, distribuzione e utilizzo; E); 6) acqua (flussi d'acqua, sistemi e infrastrutture per la raccolta, il trattamento, la distribuzione e il riutilizzo; W).

Secondo questa interpretazione un Ecosistema Socio-Circolare può assumere la forma di un luogo fisicamente delimitato (un edificio, un quartiere, un campus o un distretto) oppure di una rete distribuita che mette in relazione più luoghi contemporaneamente. In tutti i casi, l'ecosistema socio-circolare persegue due obiettivi principali interdipendenti: 1) ottimizzare l'utilizzo delle risorse; 2) generare innovazione sociale.

All'interno di un Ecosistema Socio-Circolare il modo in cui ogni risorsa può essere prodotta, gestita, condivisa e resa accessibile (in relazione sia agli stakeholder interni all'ecosistema che agli esterni) influisce sull'intensità delle collaborazioni, sull'entità dei benefici collettivi raggiunti / raggiungibili e sulla capacità dell'ecosistema di supportare il contesto fisico-relazionale circostante.

Da questa prospettiva la gestione delle risorse può essere interpretata secondo tre approcci: 1) un approccio chiuso, in cui le risorse sono prodotte e condivise internamente all'Ecosistema Socio-Circolare; 2) un approccio ibrido, in cui le risorse sono prodotte all'interno dell'Ecosistema Socio-Circolare, ma condivise sia con utenti interni che esterni; 3) un approccio aperto, in cui la risorsa viene prodotta all'interno dell'Ecosistema Socio-Circolare e condivisa principalmente con utenti esterni, collegando l'ecosistema a un territorio più ampio.

Tutti questi approcci si basano sullo sviluppo e sulla gestione di strategie di condivisione[3] all'interno di un sistema: in questo senso la condivisione è riconosciuta non solo come una pratica sociale (Katrini, 2018), ma anche come strategia circolare si-

Definition of Circular Ecosystem	Source	Features
«Circular economy ecosystems describe systems of stakeholders (producers, suppliers, etc.), their different roles (orchestrators, brokers, etc.), and the interactions and interrelations (knowledge and information, material and energy, and economic flows) between them, focused at extending, cycling, intensifying, and dematerialising resource loops».	Geissdoerfer, Kanda and Kirchherr, 2025	· multi-actor system · multi-flow interactions · resource-loop strategies
«Circular Ecosystem (CE) is a symbiotic economic model that advocates for a paradigm shift from circular individualism to circular holism achieved through collaboration / platformization, networking and configuration among a community of non-hierarchical heterogeneous actors who are independent yet interdependent and co-create value beyond what a single actor can generate, to achieve sustainable environmental quality, economic prosperity and social equity for customers and ecosystem actors».	Aryee, 2024	· platformisation / networking / configuration · non-hierarchical heterogeneity · independent yet interdependent · value co-creation · triple sustainability outcomes
«A circular ecosystem consists of a group of interdependent, autonomous actors that collectively generate a circular value proposition».	Gomes et alii, 2023	· Autonomous + interdependent actors · collective circular value proposition
«Describes relationships, interdependencies and co-evolutionary interactions between entities exchanging (i) material and energy resources, (ii) economic value, or (iii) knowledge in a particular context».	Kanda, 2023	· Relational / interdependent system · co-evolutionary interactions · exchange flows · context-specificity
«[...] promotes the co-creation of mutual benefits among industrial units based on symbiotic exchanges of materials, energy, and services».	Yu et alii, 2023	· industrial symbiosis · co-creation of mutual benefits · symbiotic exchanges · tangible resource flows · inter-firm collaboration
«Circular ecosystem is a fast-growing phenomenon in which a set of autonomous but interdependent actors jointly create and deliver a coherent circular value proposition». «We define a circular ecosystem as: a system of interdependent and heterogeneous actors that go beyond industrial boundaries and direct the collective efforts towards a circular value proposition, providing opportunities for economic and environmental sustainability».	Trevisan et alii, 2022	· autonomous + interdependent actors · collective effort and delivery · coherent circular value proposition · circular value · economic and environmental outcomes
«Ecosystem as affiliation in the CE context means that all relevant stakeholders along the material flow chain (or loop) must be considered to make circularity a reality. Ecosystem as structure focuses on the activities needed per stakeholder and, hence, the interdependent coordination of activities like the collection of materials at the end of a product's lifecycle and their reintroduction into the circular flow».	Pietrulla, 2022	· affiliation · material flow · coordination across stakeholders · end-of-life collection and reintroduction (take-back / logistics implied)
«We define CE ecosystems as communities of hierarchically independent, yet interdependent heterogeneous set of actors who collectively generate a sustainable ecosystem outcome [...] defined as a system-level outcome typified by circular processes of recycling, reuse, and reduction». «A circular economy (CE) ecosystem is a multi-actor entity in which interdependent actors play complementary roles. Actors include for-profit companies, public services, governmental bodies such as ministries, municipalities and cities, universities, non-profit organizations, and citizen–consumers. A CE ecosystem emerges or is created around a common, system-level goal related to resource circularity, and may involve the creation of CE knowledge, CE businesses, and economic value. Agency varies from focal actor-driven ecosystems to being widely distributed, and the ecosystem structure varies from tightly coordinated CE business models to loosely coupled affiliation structures oriented around CE goals».	Aarikka-Stenroos, Ritala and Thomas, 2021	· community of actors · independent and interdependent · complementary roles · common system-level goal (resource circularity) · circular processes · knowledge / business / value creation · variable agency · variable structure
«A circular ecosystem results from the contributions of various stakeholders; however, the claims and value propositions of these stakeholders can differ, hampering long-term sustainability of the ecosystem. […] sharing people, infrastructure and knowledge, together with mutual trust among stakeholders, are the preconditions of a circular ecosystem. Long-term continuity depends on additional tools that enhance financial self-sufficiency, namely, participative governance, a co-designed circular business model, accountability, frequent engagement, local actions and the development of advocacy power».	Moggi and Dameri, 2021	· stakeholder plurality · value conflicts · shared resources · trust as a precondition · continuity / long-term sustainability · participative governance · local action · co-designed circular business model and financial self-sufficiency
«Building a circular ecosystem needs not only Circular Business Models (BMs) but also expects Circular Supply Chains (CSCs), circular customer behaviours, circular value chains, and circular ecosystem infrastructures in terms of relationships and communities».	Asgari and Asgari, 2021	· circular business models, supply chains, and value chains · customer behaviour · relationships / communities
«We define a Circular Economy (CE) innovation ecosystem as the evolving set(s) of actors, activities, and artefacts, and the institutions and relations that are important for the innovative performance within a circular economy».	Wurster et alii, 2020	· actors, activities, artefacts, institutions, and relations · evolving system · innovation-orientedgoal
«[...] location-specific community of hierarchically independent, yet interdependent actors (such as companies, municipalities, associations, citizens) aiming for environmentally sustainable energy and material flows through optimizing and innovating with material flows and stocks in symbiotic collaboration and by utilizing / contributing / reacting to the wider urban operating environment within which they are located. Industrial CE ecosystems are furthermore place- and time-dependent physical set-ups providing place-specific needs and assets related to the ecosystem. All industrial CE ecosystem actors and materials do not need to be collocated, nor can they as some resources (e.g., rare minerals) and producers are not locally available. This means that the boundaries of an industrial CE ecosystem can vary between different resources. Nevertheless, the ecosystem is characterized by issues specific to a certain area (such as available local side streams or the transport costs of rarer raw materials to that specific area)».	Uusikartano, Väyrynen and Aarikka-Stenroos, 2020	· place-based community · urban operating environment linkage · energy / material flows · optimise / innovate in symbiosis · place / time dependence · resource-dependent· local side-streams and transport constraints
«Co-evolving, dynamic and potentially self-organizing configurations, in which actors integrate resources and co-create circular value flows in interaction with each other».	Aminoff et alii, 2017	· co-evolving · self-organisation · resource integration · circular value flows · interaction

Tab. 1 | Definitions of the concept of 'circular ecosystem' in the literature (credit: the Authors, 2025).

nergicamente integrata con quelle di riparazione, riuso e riciclo (Bocken et alii, 2016). La condivisione si configura quindi come una strategia centrale nell'Ecosistema Socio-Circolare, capace di attivare l'innovazione sociale e le sperimentazioni progettuali attraverso la riformulazione dei modi di usufruire delle risorse e l'introduzione di pratiche quali la partecipazione collettiva, la condivisione della proprietà, la cogestione, ecc. (Mont and Voytenko Palgan, 2025; Rathnayake et alii, 2024; Pérez-Pérez and Nebreda-Calvo, 2024; Atstaja et alii, 2022; Kenter et alii, 2015; Frischmann, 2012).

Nell'ambiente costruito la condivisione implica lo spostamento dalla proprietà all'uso basato sull'accesso collettivo alle risorse fisiche, tecniche e organizzative e si traduce in condivisione dello spazio (coworking, co-living, servizi condivisi, hub logistici o stoccaggio condivisi), delle utenze (infrastrutture condivise di energia, acqua o mobilità), dei servizi (attività partecipative di manutenzione e riparazione, ecc.) e di materiali / prodotti / attrezzature ('library of things', riuso di prodotti, ecc.).

Schema interpretativo dell'utilizzo delle risorse all'interno di un ecosistema socio-circolare | A partire dal concetto di SCE e dalla sua articolazione nei tre approcci (chiuso, ibrido, aperto) viene proposto uno schema interpretativo, finalizzato a leggere le possibili modalità di produzione, uso e condivisione delle risorse e caratterizzato da un duplice ambito di applicazione (ex post ed ex ante), ossia da una parte l'interpretazione di casi reali che possono essere riconosciuti come SCE al fine di valutare l'efficacia delle iniziative esistenti e di individuare possibili strategie per potenziare la generazione di valore sociale, dall'altra il supporto alla pianificazione di nuovi interventi di sviluppo caratterizzati dalle valenze tipiche di un SCE. In questa prospettiva lo schema interpretativo fornisce una griglia di lettura, focalizzata sulle relazioni tra aspetti di circolarità e innovazione sociale, sulle modalità di produzione, uso e condivisione delle sei categorie di risorse (K, S, SV, M, E, W) in relazione agli approcci di ecosistema circolare (chiuso, ibrido, aperto).

La griglia di lettura è stata costruita secondo una metodologia articolata in una serie di fasi. In primo luogo un'indagine sul campo con selezione e analisi di casi caratterizzati da strategie di circolarità fortemente legate al contesto fisico e sociale e riconducibili al concetto di ecosistema circolare. Attraverso il confronto dei casi è stato possibile definire, per ciascuna delle sei categorie di risorse, diverse modalità di gestione in relazione a possibili modelli di condivisione che coinvolgono varie tipologie di stakeholder. Le relazioni tra le modalità di gestione delle risorse e le loro forme di condivisione sono state formalizzate e caratterizzate nella costruzione della griglia di lettura con riferimento ai tre approcci ecosistemici (chiuso, aperto e ibrido): l'applicazione di tale griglia ad ecosistemi circolari consente di riconoscere il loro potenziale di innovazione sociale e quindi di attribuire loro i connotati di SCE. L'ultima fase della metodologia ha previsto la verifica dell'applicabilità della griglia sperimentandola su casi selezionati. La griglia di lettura formalizza le relazioni tra le strategie di circolarità e i modelli di condivisione per ciascuna categoria di risorsa, come riportato di seguito.

Per la categoria 'Informazioni, conoscenza e competenze'[4] (K; Fig. 2):
– 'Self-produced and shared internally' (approccio chiuso); la conoscenza viene principalmente generata all'interno dell'ecosistema (da residenti, utenti, manager e organizzazioni locali) e diffusa solo tra i suoi membri, ad esempio attraverso attività di apprendimento collettivo, formazione tra pari, workshop interni e rapporti;
– 'Self- and externally-produced, and shared internally' (approccio ibrido); la conoscenza deriva da una combinazione di fonti interne (personale tecnico, responsabili di progetto) ed esterne (professionisti, accademia); una volta acquisita, viene condivisa all'interno dell'ecosistema (tramite assemblee, workshop, documentazione, formazione), ma non è condivisa con utenti esterni;
– 'Self- and externally-produced, and shared externally' (approccio aperto); informazioni e competenze sono generate all'interno dell'ecosistema, spesso co-prodotte con partner esterni (Università, Comuni, ONG), e poi condivise sia internamente che esternamente attraverso pubblicazioni, toolkit, linee guida, open data, attività didattiche, conferenze, ecc.; l'ecosistema diventa in questo modo un 'hub di conoscenza' per la comunità.

Per la categoria 'Spazi' (S; Fig. 3)[5]:
– 'User-managed and selectively shared internally' (approccio chiuso); gli spazi sono dedicati agli utenti (locatari a lungo termine di un ufficio, aziende / start-up ed edilizia sociale) e sono gestiti direttamente dall'occupante; la gestione e la eventuale condivisione di questi spazi è dunque basata su decisioni individuali e non su regole collettive di utilizzo;
– 'Self-managed and shared internally and externally' (approccio ibrido); gli spazi sono concepiti come infrastrutture comuni dell'ecosistema (cucine condivise, laboratori, aree di coworking, giardini comuni, sale comunitarie, ecc.) il cui accesso è tipicamente regolato da accordi interni (iscrizione, orari, codici di condotta) e la manutenzione è spesso collettiva; questi spazi condivisi rappresentano aree cruciali in cui si sviluppano legami sociali e pratiche collaborative e possono essere gestiti in modo collettivo (associazione, cooperativa, comitato dei residenti, ecc.) con regole condivise di utilizzo e manutenzione; l'accesso è principalmente riservato ai membri dell'ecosistema, mentre gli utenti esterni possono accedere a tali spazi secondo condizioni specifiche, tipicamente tramite un costo aggiuntivo (ad esempio pagando per utilizzare spazi di coworking).
– 'Self-managed and shared externally' (approccio aperto); gli spazi, esplicitamente orientati al quartiere e alla città, diventano interfacce tra l'ecosistema e il suo contesto urbano; sono aperti (in modo continuativo o in orari specifici) ai non membri e ospitano attività, eventi e servizi per la comunità esterna; questi spazi funzionano come interfacce con il contesto esterno (quartiere, città), generando flussi di persone, idee e risorse che estendono il valore sociale oltre il confine dell'ecosistema, rafforzandone il ruolo di 'hub' locale.

Per la categoria 'Servizi' (SV; Fig. 4)[6]:
– 'Self-organised and shared internally' (approccio aperto); i servizi (ad esempio cooperative di assistenza all'infanzia, 'library of things' e 'repair café') sono organizzati, gestiti e utilizzati dai membri dell'ecosistema (residenti, inquilini e cooperative);
– 'Self-organised and shared internally and externally' (approccio ibrido); i servizi (bar, negozi, atelier e spazi di coworking) sono gestiti da attori interni all'ecosistema (cooperative, PMI e professionisti), ma offerti a pagamento sia agli utenti interni che a quelli esterni;
– 'Self-organised and shared externally' (approccio aperto); servizi (ad esempio programmi di formazione, eventi culturali, consulenza e incubatori) progettati intenzionalmente a servizio della comunità esterna (quartiere o città), spesso con uno scopo sociale o educativo.

Per la categoria 'Materiali e prodotti' (M; Fig. 5)[7]:
– 'Internally sourced and internally circulated' (approccio chiuso): materiali e prodotti vengono recuperati internamente all'ecosistema; il recupero e la rilavorazione possono essere effettuati direttamente dagli utenti o da aziende e organizzazioni che forniscono servizi di riutilizzo e riparazione; materiali e prodotti possono essere condivisi e scambiati tra i membri dell'ecosistema, sia gratuitamente (donazioni e scambi reciproci) sia tramite transazioni monetarie (vendite, affitti e prodotto come servizio);
– 'Externally sourced and internally shared' (approccio ibrido); materiali e prodotti vengono recuperati esternamente all'ecosistema attraverso diversi canali (piattaforme online, donazioni da parte di residenti e organizzazioni, collaborazione con cantieri locali o centri municipali di riutilizzo, acquisto di componenti riutilizzati o materiali riciclati da enti locali) e poi utilizzati all'interno dell'ecosistema;
– 'Externally and internally sourced and externally circulated' (approccio aperto); materiali e prodotti possono essere reperiti sia all'interno dell'ecosistema sia da fornitori esterni (hub di riutilizzo e produttori) per essere riutilizzati dalla comunità esterna; l'ecosistema opera quindi come un nodo all'interno di un sistema più ampio di scambio, generando flussi (in ingresso e in uscita) di materiali e prodotti riutilizzati su scala distrettuale o urbana e non solo all'interno dei propri confini.

Per la categoria 'Energia' (E; Fig. 6)[8]:
– 'Self-produced and shared internally' (approccio chiuso); l'energia è generata all'interno dell'ecosistema (ad esempio impianti fotovoltaici) e distribuita agli utenti interni tramite infrastrutture condivise; la governance è solitamente collettiva (cooperative energetiche e accordi di condominio), con regole comuni per la manutenzione e la ripartizione dei costi;
– 'Self- and externally produced and shared internally' (approccio ibrido); l'energia è prodotta in parte internamente (fotovoltaico, cogenerazione su piccola scala) da fornitori esterni; l'energia è condivisa internamente attraverso infrastrutture comuni e contratti collettivi; residenti e utenti sono collegati agli stessi sistemi e possono negoziare congiuntamente tariffe e selezionare fornitori esterni;
– 'Self-produced and shared externally' (approccio aperto): l'eccesso di energia prodotto internamente all'ecosistema (generazione locale, stoccaggio) viene distribuito all'esterno (distretto) creando comunità energetiche estese.

Per la categoria 'Acqua' (W; Fig. 7)[9] si presume che l'acqua potabile per l'igiene sia fornita dall'acquedotto municipale, mentre le strategie circolari si concentrano principalmente sugli usi non potabili (acqua sanitaria, pulizia e irrigazione) e sulla gestione delle acque meteoriche:
– 'Self-produced and shared internally' (approccio chiuso); l'acqua per usi non potabili della comunità viene raccolta, gestita e riutilizzata internamente (raccolta dell'acqua piovana, stoccaggio); la governance è tipicamente affidata a una cooperati-

va, condominio, associazione o società di gestione che prende decisioni sulla progettazione, sulla manutenzione e sulla ripartizione dei costi;
– 'Self- and externally produced and shared internally' (approccio ibrido); l'acqua per usi non potabili viene prodotta solo parzialmente internamente, tramite l'implementazione di strategie di raccolta e riutilizzo, e fornita in misura prevalente dal Comune;
– 'Self- and externally produced and internally / externally shared' (approccio aperto): i sistemi idrici sono ottimizzati internamente pur essendo funzionalmente integrati in infrastrutture territoriali più ampie (quartiere o distretto).

Features	Topics	Sources
Nature of involved actors	· Business-oriented definitions: ecosystem framed mainly as a network of firms · Territorial definitions: ecosystem expanded to include public agencies and society	Geissdoerfer, Kanda and Kirchherr, 2025; Aryee, 2024; Gomes et alii, 2023; Kanda, 2023; Pietrulla, 2022; Trevisan et alii, 2022; Aarikka-Stenroos, Ritala and Thomas, 2021; Moggi and Dameri, 2021; Wurster et alii, 2020; Uusikartano, Väyrynen and Aarikka-Stenroos, 2020; Aminoff et alii, 2017
Types of resource flows	· Material/product flows: reused products, components, and secondary materials · Energy flows · Information / knowledge flows: data, traceability, know-how, and standards · Economic flows: incentives, value capture, and business models	Geissdoerfer, Kanda and Kirchherr, 2025; Aryee, 2024; Gomes et alii, 2023; Kanda, 2023; Yu et alii, 2023; Pietrulla, 2022; Trevisan et alii, 2022; Aarikka-Stenroos, Ritala and Thomas, 2021; Moggi and Dameri, 2021; Wurster et alii, 2020; Uusikartano, Väyrynen and Aarikka-Stenroos, 2020; Aminoff et alii, 2017
Scale of analysis	· Focal entity (micro): ecosystem as an organisational configuration centred on a focal actor, such as a firm or project · Supply chain (meso): ecosystem as a network of organisations collaborating through exchanges, reverse logistics, and take-back systems · Territorial level (macro): ecosystem as a wider coordination arena shaped by platforms, institutions, policies, and social actors, generating industrial symbiosis, eco-industrial parks, or urban circular initiatives	Pietrulla, 2022; Aarikka-Stenroos, Ritala and Thomas, 2021; Asgari and Asgari, 2021; Moggi and Dameri, 2021; Uusikartano, Väyrynen and Aarikka-Stenroos, 2020; Wurster et alii, 2020
Governance and coordination	· Orchestration by a platform or lead actor · Intermediary roles enabling matches and exchanges · Shared standards and traceability systems · Contractual arrangements for take-back, warranties, and liability · Collaborative governance, sometimes including public actors	Geissdoerfer, Kanda and Kirchherr, 2025; Yu et alii, 2023; Pietrulla, 2022; Aarikka-Stenroos, Ritala and Thomas, 2021; Asgari and Asgari, 2021; Moggi and Dameri, 2021;Uusikartano, Väyrynen and Aarikka-Stenroos, 2020

Tab. 2 | Features of the concept of 'circular ecosystem' in the literature (credit: the Authors, 2025).

Social innovation clusters	Topics	Sources
Collaborative governance and participation	Co-design, participatory decision-making, multi-actor governance, stakeholder cooperation, community engagement, and collective stewardship of resources	Bullinger and Schiller, 2025; Bullinger, 2025; Sica et alii, 2025; Quintelier et alii, 2023; Marchesi and Tweed, 2021
Sharing-based access and collective use	Shared spaces, shared infrastructures, pooling of services, collective use instead of individual ownership, commons-oriented practices, and collaborative consumption	Bullinger, 2025; Bullinger and Schiller, 2025; Quintelier et alii, 2023; Marchesi and Tweed, 2021
Adaptive reuse and life extension of buildings	Reuse of existing buildings, prolongation of building life, regeneration of underused assets, heritage reuse, and neighbourhood revitalisation through circular reuse	Bullinger, 2025; Bullinger and Schiller, 2025
Affordability, inclusion, and community support	Social housing, affordable access, inclusion of vulnerable groups, community services, support for everyday needs, and improved liveability through circular initiatives	Bullinger, 2025; Marchesi and Tweed, 2021
Learning, knowledge exchange, and behavioural change	Circulation of competences, peer learning, community knowledge, awareness-building, capacity building, and behavioural shifts towards circular practices	Bullinger, 2025; Bullinger and Schiller, 2025; Marchesi and Tweed, 2021
Social value creation and well-being	Well-being of inhabitants, quality of life, social relations, sense of belonging, collective benefit, people-centred circularity, and social value as an end rather than a by-product	Quintelier et alii, 2023; Bullinger and Schiller, 2025; Marchesi and Tweed, 2021; Marchesi, Tweed and Gerber, 2020
Justice, ethics, and people-centred circularity	Fair distribution of benefits, ethical motivations, attention to stakeholders, trade-offs between circularity and social outcomes, and the need to put people at the heart of circularity	Carreño-Ortiz, Escobar-Sierra and Lopez-Perez, 2025; Quintelier et alii, 2023
Territorial regeneration and local ecosystem building	Urban regeneration, neighbourhood transformation, local networks, place-based innovation, and circular transition as a territorial and relational process	Bullinger, 2025; Bullinger and Schiller, 2025; Marchesi and Tweed, 2021; Marchesi, Tweed and Gerber, 2020

Tab. 3 | Main clusters and topics emerging from the literature on social innovation issues related to circular economy practices in the built environment (credit: the Authors, 2025).

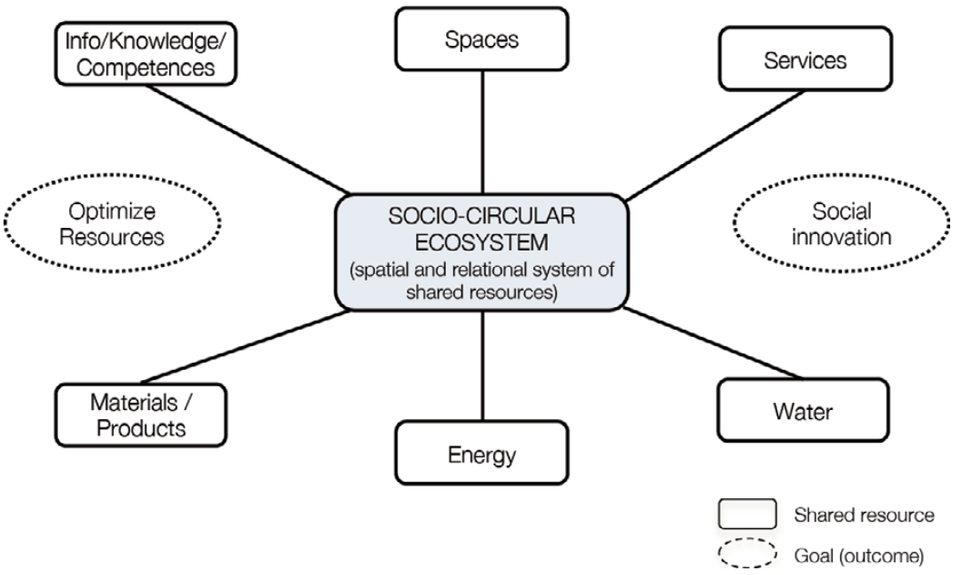

Fig. 1 | Diagram showing the shared resources and the two main objectives of a socio-circular ecosystem (credit: the Authors, 2025).

Applicazione dello schema interpretativo proposto a casi di studio | La proposta di schema interpretativo per l'Ecosistema Socio-Circolare viene applicata a un campione di casi di studio ritenuti significativi. Sono stati considerati i seguenti criteri di selezione per la scelta dei casi:
– Corrispondenza concettuale; ogni caso combina strategie circolari con uno scopo esplicito di innovazione sociale, superando la visione della circolarità come obiettivo puramente ambientale o tecnico;
– Disponibilità dei dati; ogni caso è documentato attraverso rapporti, interviste e osservazione diretta ed è già stato implementato in un contesto reale;
– Contesto geografico; tutti i progetti si trovano in contesti urbani europei, garantendo un certo grado di comparabilità in termini di quadri normativi e sistemi di welfare.

È stata anche presa in considerazione, per la definizione del campione, la diversità degli insediamenti; i casi selezionati coprono quindi scale diverse (edificio, isolato, quartiere) e differenti tipi di insediamento (ex aree industriali, abitazioni, hub a uso misto) e di iniziativa (pubblica, privata e comunitaria). Sono stati identificati dieci casi: Hof van Cartesius (Utrecht, Paesi Bassi); De Ceuvel (Amsterdam, Paesi Bassi); Schoonschip (Amsterdam, Paesi Bassi); People's Pavilion (Eindhoven, Paesi Bassi); BlueCity (Rotterdam, Paesi Bassi); R-URBAN (Colombes, Francia); Royal Docks Circular Construction Hub (Londra, Regno Unito); Ashley Vale (Bristol, Regno Unito); Hammarby Sjöstad (Stoccolma, Svezia); Ekostaden Augustenborg (Malmö, Svezia).

Una prima analisi è stata orientata a fornire una panoramica delle principali informazioni di ciascun caso studio, tra cui: località, anno di avvio, dimensioni, utilizzi principali, proprietà e gestione (relative a terreni, edifici e servizi), fonti di finanziamento e modello economico (Tab. 4)[10]. La seconda fase di analisi riguarda la mappatura dei flussi delle sei categorie di risorse per identificare relative le configurazioni (chiusa, ibrida e aperta). A titolo di esempio la Tabella 5 mostra l'analisi condotta sul progetto Hof van Cartesius (Figg. 8-17); la stessa analisi è stata applicata ai dieci casi studio (Tab. 6).

Hof van Cartesius può essere letto come un Ecosistema Socio-Circolare aperto. In particolare la categoria 'informazioni, conoscenza e competenze' combina gli approcci K1 (chiusa) e K3 (aperta): il know-how interno viene condiviso principalmente all'interno della comunità che segue un'organizzazione a gruppi di lavoro, mentre workshop, visite guidate e la partecipazione a reti circolari aprono questa conoscenza verso l'esterno. Gli 'spazi' presentano un approccio diversificato, dall'accesso chiuso (S1) degli atelier privati a quello ibrido (S2) del cortile e del giardino condivisi, fino all'apertura (S3) degli spazi dedicati a eventi e attività comunitarie. I 'servizi' rappresentano la dimensione più orientata all'esterno, combinando approcci chiusi (SV1), ibridi (SV2) e soprattutto aperti (SV3), poiché le attività volontarie interne coesistono con laboratori pubblici, festival, visite guidate e iniziative orientate alla comunità.

I materiali e i prodotti sono prevalentemente ibridi (M2), poiché la costruzione si basa principalmente su materiali riutilizzati e a base biologica provenienti da reti esterne di riutilizzo, mentre sono presenti anche scambi interni (M1, sistema chiuso) e la redistribuzione verso l'esterno tramite hub di riutilizzo (M3, sistema aperto). Al contrario 'energia' (E1, sistema chiuso) e 'acqua' (W1, sistema chiuso) sono gestite internamente tramite sistemi locali e accordi collettivi. Nel complesso Hof van Cartesius dimostra come un luogo fisicamente delimitato possa generare un valore sociale più ampio attraverso la condivisione selettiva di risorse specifiche (in particolare conoscenze, spazi e servizi) con il quartiere e la città.

Discussione critica e risultati dell'implementazione dello schema interpretativo basato sull'Ecosistema Socio-Circolare | L'analisi dei casi studio tramite il modello dell'Ecosistema Socio-Circolare ha permesso in primo luogo di identificare nuovi legami tra circolarità e effetti sociali: modelli organizzativi basati sulla comunità (l'iniziativa congiunta di imprenditori e costruttori presso Hof van Cartesius), nuovi modi di gestione delle risorse condivise (condivisione di beni, reti di riparazione di mobili e abbigliamento), pratiche circolari orientate alla comunità (uso di materiali di riutilizzo locali derivanti ad esempio da siti di demolizione o da eccedenze di magazzino proveniente dalle imprese edili), creazione di legami sociali all'interno della comunità (scambio di conoscenze, costruzione di reti tra piccole imprese, resilienza economica locale, coinvolgimento della comunità attraverso eventi e attività aperte al pubblico).

Inoltre l'analisi dei casi è stata integrata con un focus sulla dimensione spaziale della strategia di insediamento: ogni caso è stato analizzato all'interno di un diagramma spazio-risorsa (Fig. 18), unendo la strategia di insediamento (dimensione dello spazio – da concentrato a diffuso) e i modelli di condivisione (dimensione delle risorse – da chiuso ad aperto). Sebbene l'approccio 'aperto' del modello di condivisione delle risorse combinato con la strategia di insediamento 'geograficamente diffusa' (ad esempio R-Urban, Ashley Vale) sembri rappresentare il caso ottimale per massimizzare il potenziale complessivo (es. coinvolgimento del pubblico) e il valore (incluso il valore sociale) del progetto circolare, è possibile identificare due strategie spaziali-organizzative ricorrenti.

Un approccio di condivisione 'aperta' funge da facilitatore delle interazioni esterne per progetti geograficamente concentrati; secondo questo approccio alcuni casi studio (Hof van Cartesius, De Ceuvel, BlueCity e il People's Pavilion) operano come centri geograficamente concentrati (edifici) all'interno di una rete spaziale più ampia di ecosistemi aperti. Queste realtà sono spesso caratterizzate da spazi condivisi, servizi collaborativi e attività orientate alla comunità; il loro carattere aperto si manifesta attraverso l'accessibilità, la programmazione culturale, lo scambio di conoscenze e la sperimentazione, ma la loro impronta geografica rimane relativamente limitata. In questo approccio la circolarità implica un'intensa interazione sociale tra diversi progetti (a scala di edificio) all'interno di una dimensione geografica delimitata (distretto).

Un approccio 'chiuso' di condivisione delle risorse e progetto geograficamente diffuso; in questo caso la scala distrettuale e territoriale agisce come generatore di esternalità positive per la comunità. Nei progetti che operano su scala più ampia (distretto e città – Hammarby Sjöstad, Ekostaden Augustenborg) la gestione delle risorse (energia,

acqua, materiali e rifiuti) è principalmente gestita dai Comuni (Royal Docks Circular Conconstruction Hubs) e non dalla comunità stessa. I residenti o gli utenti traggono tuttavia beneficio dai sistemi fisici (principalmente dalle infrastrutture), ma non li gestiscono direttamente. In questi casi la circolarità si persegue principalmente attraverso soluzioni infrastrutturali, mentre gli hub più piccoli risultano maggiormente efficaci nell'attivare pratiche partecipative e nella gestione condivisa delle risorse.

Conclusioni e sviluppi futuri | Il concetto di Ecosistema Socio-Circolare propone un nuovo punto di vista sulle già diffuse realtà di 'ecosistemi circolari' enfatizzando l'importanza della dimensione sociale e contribuendo a colmare una lacuna nella letteratura relativa alle ricadute per la collettività della circolarità – in linea con gli Obiettivi di Sviluppo Sostenibile (SDG) 9, 10, 11 e 12 sui quali il contributo può avere benefici diretti e riscontrabili; si ritiene inoltre ci possa essere un impatto indiretto rispetto agli SDG 1, 2, 3, 4, 6, 7, 8 e 13 che sono legati alle sei categorie di risorse individuate nello schema interpretativo.

Lo schema proposto supporta l'analisi delle iniziative di economia circolare e in particolare: a) fornisce un modello di interpretazione che supporta la comprensione delle iniziative circolari e ne mette in evidenza le potenzialità in termini di innovazione sociale; b) consente di riconoscere come le risorse vengono prodotte, condivise e governate all'interno di un ecosistema, facilitando il confronto tra diverse iniziative attuate a diverse scale applicative; c) evidenzia il ruolo dei modelli di governance collaborativa e delle pratiche collettive negli SCE; d) contribuisce a mettere in luce l'innovazione sociale incorporata nelle strategie circolari, legandola a sperimentazioni di modelli insediativi, fruitivi e abitativi sperimentali.

Le limitazioni di applicabilità dello schema proposto devono essere verificate in relazione alla disponibilità e alla trasparenza dei dati, in particolare di quelli relativi a risorse intangibili quali conoscenze, competenze e servizi. Per quanto concerne la ripetibilità e la trasferibilità lo schema interpretativo proposto può essere applicato a diverse scale (edificio, quartiere, città, territorio) e in diversi contesti d'uso, sociali e culturali, caratterizzati dalla condi-

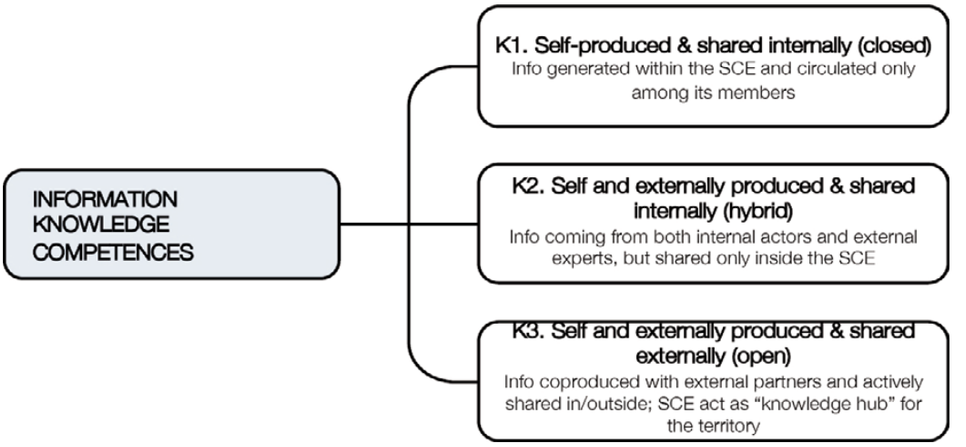

Fig. 2 | Diagram representing the possible approaches to the resource 'Information / knowledge / competences' in a socio-circular ecosystem: (K1) self-produced and shared internally; (K2) self- and externally produced and shared internally; and (K3) co-produced and shared externally (credit: the Authors, 2025).

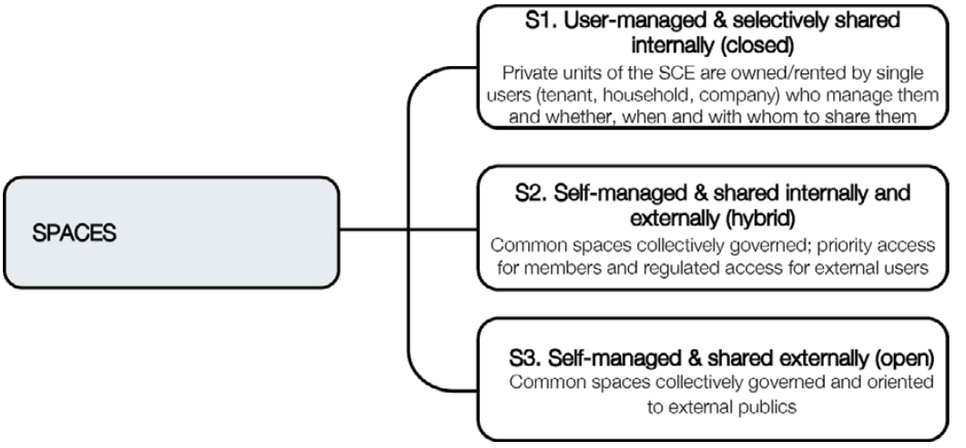

Fig. 3 | Diagram representing the possible approaches of the resource 'Spaces' in a socio-circular ecosystem: (S1) user-managed and selectively shared; (S2) self-managed and shared internally and externally; and (S3) self-managed and shared externally (credit: the Authors, 2025).

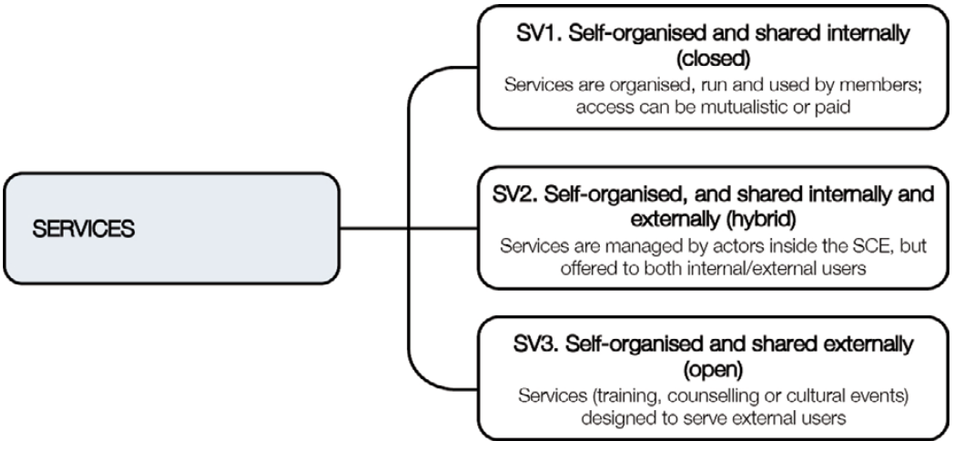

Fig. 4 | Diagram representing the possible approaches to the resource 'Services' in a socio-circular ecosystem: (SV1) self-organised mutual services; (SV2) self-organised services shared internally and externally; and (SV3) self-organised services open to external users (credit: the Authors, 2025).

visione di risorse (housing sociale, residenze pubbliche convenzionate, living lab, co-working, co-living, hoteling, franchising, ecc.).

Gli sviluppi futuri dovrebbero mirare ad ampliare e approfondire il campione di casi analizzati che nello studio è stato concentrato sui Paesi del Nord Europa, per i quali esistono pratiche consolidate di condivisione delle risorse. Al fine di testare ulteriormente la solidità dello schema interpretativo in diversi contesti geografici, tipi di insediamenti e strutture di governance, gli sviluppi dovranno comprendere un'estensione del campione a Paesi diversi. Un altro aspetto riguarda la definizione dei criteri per delineare i confini degli SCE, al fine di valutarne l'area di influenza anche al di là dei confini fisici del sistema. Infine appare rilevante il coinvolgimento di esperti delle discipline sociali, al fine di perfezionare l'analisi dell'innovazione sociale, anche in relazione agli aspetti della partecipazione, della coesione sociale, dell'accesso alle risorse e dell'evoluzione a lungo termine delle comunità.

In the built environment, the circular economy has progressively moved from being understood as a set of environmental strategies focused on the optimisation of resources[1] to a broader vision that also includes aspects related to architectural design, urban regeneration (Semprebon et alii, 2021), and territorial development, as mirrored, for example, in the New European Bauhaus proposals (Gkatzogias, Romano and Negro, 2024). While the most consolidated interpretations of circular strategies mainly concern the 'nano' scale (material cycle and waste reduction), more recently the topic of circularity has expanded to the micro (buildings), meso (neighbourhoods, districts, and networks), and macro (cities and regions) scales, as highlighted by Khadim et alii (2022).

Experiences such as cooperative housing for rural regeneration (Eixerés Ros, 2025), collaborative energy districts (Crippa et alii, 2024), co-designed welfare spaces (Campagnaro et alii, 2025; Arquilla and Caruso, 2025), service infrastructures for reuse and recycling (Olivastri and Tagliasco, 2024), and local micro-networks operating in various areas of the green transition (Gaddi and Ma-

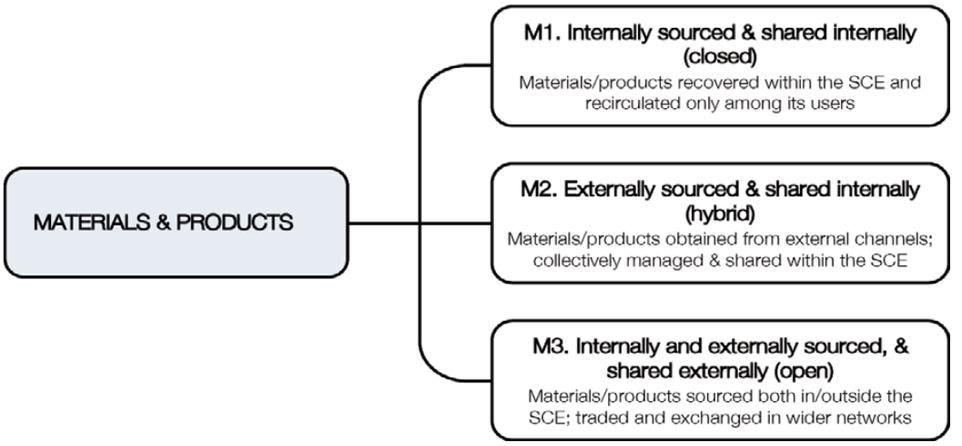

Fig. 5 | Diagram representing the possible approaches to the resource 'Materials and products' in a socio-circular ecosystem: (M1) internally sourced and internally circulated; (M2) externally sourced and internally shared; and (M3) internally and externally sourced and externally circulated (credit: the Authors, 2025).

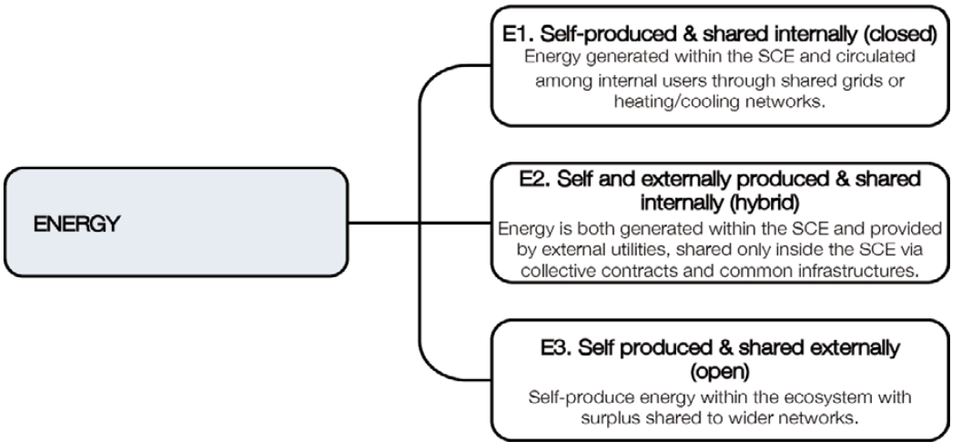

Fig. 6 | Diagram representing the possible approaches to the resource 'Energy' in a socio-circular ecosystem: (E1) self-produced and shared internally; (E2) self- and externally produced and shared internally; and (E3) self-produced and shared externally (credit: the Authors, 2025).

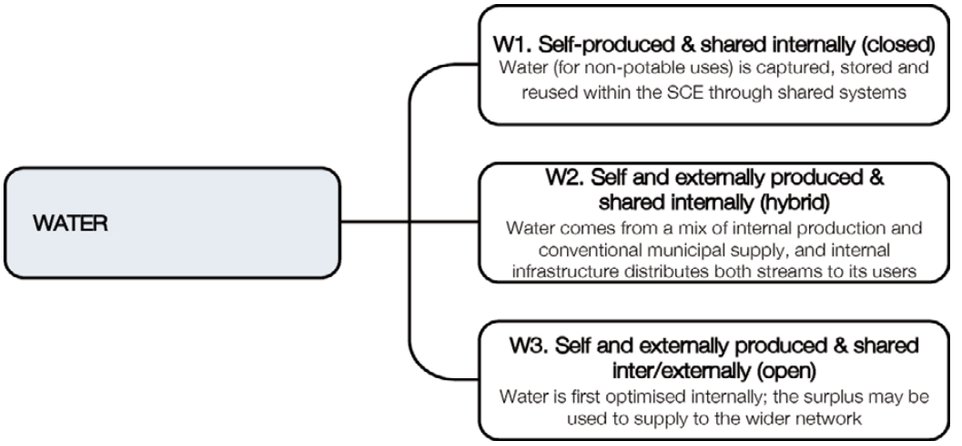

Fig. 7 | Diagram representing the possible approaches to the resource 'Water' in a socio-circular ecosystem: (W1) self-produced and shared internally; (W2) self- and externally produced and shared internally; and (W3) self- and externally produced and shared internally and externally (credit: the Authors, 2025).

	Hof van Cartesius	De Ceuvel	Schoonschip	People's Pavilion	BlueCity	R-URBAN	Royal Docks Circular Construction Hub	Ashley Vale	Hammarby Sjöstad	Ekostaden Augustenborg
Location	Utrecht NL	Amsterdam NL	Amsterdam NL	Eindhoven NL	Rotterdam NL	Colombes FR	London UK	Bristol UK	Stockholm SE	Malmö SE
Opening year	2017	2014	2020	2017	2015	2014	2026	2001	1999	1998
Size	~3,500 m²	~3,700 m²	~5,000 m²	~250 m²	~12,000 m²	network	network	2.1 ac (~8,500 m²)	~200 ha (~2,000,000 m²)	32 ha (~320,000 m²)
Settlement type	NBHD	NBHD	NBHD	BLD	BLD	NET	NET	DIST	DIST	DIST
Development type	REG	REG	NEW	NEW	REG	NEW+REG	NEW+REG	REG	REG	REG
Initiative type	CIV	CIV	CIV	PUB-PRIV	CIV-PRIV	CIV-PUB	PUB-CIV	CIV	PUB	PUB
Main uses	WSP	WSP	RES	EXH	HUB	AGR, RES	HUB	RES	RES	RES
Ownership (Land)	PUB	PUB	PUB	PUB	PRIV	PUB	PUB	PRIV	PUB	PUB
Ownership (Built assets)	COOP	PRIV	PRIV	PUB	PRIV	NPO	PUB	PRIV	PUB-PRIV	PUB
Ownership (Services)	COOP	CIV	COOP	PUB	NPO	NPO	NGO	CIV	PUB	PUB
Management (Land)	PUB	PUB	PUB	PUB	PRIV	PUB	PUB	CIV	PUB	PUB
Management (Built assets)	COOP	CIV	PRIV	PUB	NPO	NPO	NGO	CIV	PUB-PRIV	PUB
Management (Services)	COOP	CIV	COOP	PUB	NPO	NPO	NGO	CIV	PUB	PUB
Funding sources	INV, LOAN, SELF	GRANT, SELF	INV, LOAN	GRANT, INV	GRANT, INV, SELF	EU, GRANT	GRANT	INV, LOAN, SELF	GRANT, INV	GRANT
Economic model	RENT, MEM, SERV, EVENT	RENT, SERV, EVENT	SERV, MEM	EVENT, SERV	RENT, SERV, EVENT	SERV, MEM, EVENT	SERV, SUB	SELF, SERV	SERV, RENT	SUB, SERV

Tab. 4 | Overview of the selected European socio-circular ecosystem initiatives; the sources of information for the analysis of the case studies include project documentation, policy reports, academic literature and semi-structured interviews with key actors. The table reports location, opening year, size, main uses, ownership and management (related to land, built assets, and services), funding sources, and the economic model of each case study (credit: the Authors, 2025).

strolonardo, 2024), and pro-social materials developed through inclusive local micro-supply chains (Del Curto, Valassina and Santi, 2025) demonstrate how circular strategies increasingly involve participatory governance models, collective infrastructures, and co-design at different scales.

This evolution in the implementation of circular strategies suggests a conceptual shift, from isolated circular buildings to larger-scale interventions, in which settlement, social, organisational, and economic dimensions interact synergistically. On a larger scale, the social dynamics generated by circular initiatives reveal a high degree of complexity and open up experimental housing and settlement models, as well as new collaborative ways of living and working, and new relationships at territorial level. Consequently, at the meso and macro scales, the synergies between technical, environmental, and social dimensions[2] require the adoption of original interpretative keys.

Starting from these premises and on the basis of an analysis of European 'circular' and socially oriented projects, this paper proposes the concept of Socio-Circular Ecosystem, which derives from and expands the concept of the circular ecosystem. The underlying hypothesis is that circular strategies implemented in the built environment can generate social value within relational and spatial systems (socio-circular ecosystem), in which stakeholders share and co-manage tangible and intangible resources. In this sense, the SCE acts as an interpretative framework for incorporating the tangible (technical) and intangible (social) dimensions of circularity in the investigation of environmental, technical, and social implications in the short and long term, at various scales, from the micro to the meso scale. In particular, adopting a 'meso-scale' perspective allows to investigate circular projects from multiple perspectives, placing them in a systemic vision that includes: 1) the organisation and management of shared resources; 2) the roles of stakeholders and relational models; 3) the conditions under which governance and community-based business models support long-term value generation.

Therefore, the paper aims to propose the concept of Socio-Circular Ecosystem as an innovative interpretative framework, useful for analysing circularity, social innovation, governance, and resource sharing in an integrated manner within the built environment. By adopting a holistic approach and overcoming the partial view of the well-known concept of the Circular Ecosystem, the paper helps fill an interpretative gap that has emerged in the literature. In particular, in the first section, the paper outlines the state of the art of Circular Ecosystems, highlighting the main gaps in the literature regarding the social dimension of circularity. The second section introduces the innovative concept of the Socio-Circular Ecosystem (SCE), understood as a spatial and relational system based on strategies for sharing and integrating multiple categories of tangible (spaces and materials) and intangible (information, services, and energy) resources. In the third section, starting from the concept of SCE, an interpretative framework is proposed to define the different possible approaches (closed, hybrid and open) to the management of resources within circular ecosystems, highlighting the types of relationships between aspects of circularity and social innovation. In the fourth section, the interpretative framework is applied to a sample of SCE cases selected at the European level to test its effectiveness in identifying circularity strategies based on resource sharing and capable of driving social innovation.

The aim is to identify, at different scales, the conditions and modes of development and growth of housing and settlement models characterised by collaborative strategies. The survey results are critically discussed in the fifth section.

The concept of circular ecosystem: a literature review | The transition to the circular economy, involving and integrating environmental, economic, and social aspects (Geissdoerfer et alii, 2017), requires a systemic approach to investigation (Bar-

Resource category	Specific resources	Shared? Yes	Shared? No	Configuration	Sources
Information, knowledge, competences (K)	Internal know-how on circular construction, reuse logistics, and cooperative management among initiators, board members, and tenants	✓		K1 (closed)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Knowledge organised by teams among the 120 involved entrepreneurs (Garden / Events / Communication / Maintenance / Renters / Finance / Caring teams), for internal users	✓		K1 (closed)	Authors' interviews and site visit (2026)
	Sociocratic governance knowledge shared among the 120 members (i.e. consent-based decision-making and collective responsibility), who meet every four months	✓		K1 (closed)	Authors' interviews and site visit (2026)
	Internal workshops (circular economy, social media, photography, sewing, carpentry, and finance) open to visitors, professionals, and students	✓		K3 (open)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Guided tours presenting Hof van Cartesius as a circular hotspot for external visitors (companies, municipalities, students, etc.)	✓		K3 (open)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Participation in wider circular networks and events (e.g. Week of the Circular Economy and the Circular Economy Booster), as well as cultural events and festivals (Summer Festival and Music Festival) open to external visitors	✓		K3 (open)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Collaboration with universities and inclusion in reports / funding programmes as a circular hotspot	✓		K3 (open)	Hof van Cartesius official website
Spaces (S)	Private ateliers and studios rented by individual entrepreneurs (user-managed units)	✓		S1 (closed)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Shared courtyard / garden as an internal common space for tenants, occasionally used by neighbours	✓		S2 (hybrid)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Event / meeting spaces and outdoor areas used for public workshops, festivals, and cultural events open to the wider community	✓		S3 (open)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Solidarity shop, free-goods corner, and book library oriented towards the neighbourhood (on the adjacent strip)	✓		S3 (open)	Authors' interviews and site visit (2026)
Services (SV)	Provision of affordable workspaces for sustainable and creative entrepreneurs	✓		SV2 (hybrid)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Workshops, cultural events, and festivals open to external visitors (e.g. circularity and culture programmes)	✓		SV3 (open)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Guided tours for external groups (professionals, students, municipalities, companies)	✓		SV3 (open)	Hof van Cartesius official website
	Networking and visibility platform for circular makers and SMEs at district / city scale	✓		SV3 (open)	Hof van Cartesius official website
	Public café accessible to non-tenants	✓		SV2 (hybrid)	Authors' interviews and site visit (2026)
	Public solidarity shop (free-goods corner)	✓		SV3 (open)	Authors' interviews and site visit (2026)
	Open book library for neighbours and visitors	✓		SV3 (open)	Authors' interviews and site visit (2026)
	Voluntary work by internal users contributing to the internal functioning of the site (maintenance, event / workshop organisation, garden care)	✓		SV1 (closed)	Authors' interviews and site visit (2026)
	Voluntary work by internal users contributing to public-facing services (festivals, workshops, and solidarity shop)	✓		SV2 (hybrid)	Authors' interviews and site visit (2026)
Materials and products (M)	High level (> 90%) of reused and bio-based materials in construction (structural and façade elements, sandwich panels, doors, windows, beams, hemp insulation, sheep wool for sealing gaps, etc.)	✓		M2 (hybrid)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	New materials used mainly for screws, glues, small framing and some insulation		✓		Hof van Cartesius official website
	Sourcing reused products from secondary-material brokers (Superuse) and online platforms (Marktplaats, Oogstkaart, Gebruiktebouwmaterialen, Insert, and Excess Exchange Materials)	✓		M2 (hybrid)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Sourcing reused products from industrial waste from the public railway sector (ProRail, Nederlandse Spoorwegen) at the end of their service life: yellow timetable panels used as façade cladding, train windows, and rail tracks repurposed as structural elements	✓		M2 (hybrid)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Sourcing reused products from donations or offers of surplus or damaged products from private buildings (schools in Rotterdam, warehouses, and Dudok-designed garage elements): reclaimed CLT and steel trusses	✓		M2 (hybrid)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Sourcing recycled materials / reused products from on-site hubs (Buurman, Upcycle, and Meublowski) acting as collectors of good municipal waste and as storage and internal redistribution hubs (household appliances, textiles, wood, e-waste, and bikes)	✓		M3 (open)	Hof van Cartesius official website; Authors' interviews and site visit (2026)
	Informal internal exchange of products and leftover materials between tenants (e.g. clothes swap)	✓		M1 (closed)	Authors' interviews and site visit (2026)
Energy (E)	Energy consumption regulated by common agreements: no heating above ~18 °C and no mechanical cooling, with design assumptions based on Dutch maximum summer temperaturesofaround 35 °C	✓		E1 (closed)	Authors' interviews and site visit (2026)
	Hybrid renewable-energy system combining air-to-air and air-to-water heat pumps, enabling some pavilions to be self-sufficient and to distribute energy to other pavilions	✓		E1 (closed)	Authors' interviews and site visit (2026)
	Different heating configurations across buildings: underfloor heating on ground floors, and solar-supported heating (PV panels) and heat pumps on upper floors		✓		Authors' interviews and site visit (2026)
Water (W)	Rainwater harvesting and on-site storage Conventional connection to the municipal drinking-water network Conventional connection to municipal sewer for wastewater	✓		W1 (closed)	Hof van Cartesius official website; Authors' interviews and site visit (2026)

Tab. 5 | Implementation of the SCE interpretative framework for the resources of the Hof van Cartesius case (credit: the Authors, 2025).


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quete et alii, 2022). In this regard, the concept of a circular ecosystem is useful for recognising and investigating interdependencies and interactions among actors within a community, as well as the processes of sharing resources (e.g., information, matter, energy, and economic resources) over time (Geissdoerfer, Kanda and Kirchherr, 2025). In the literature, the concept of a circular ecosystem is increasingly well established, as evidenced by the proliferation of definitions (Tab. 1) and the articulation of its related features (Tab. 2).

The literature analysis shows that studies on circular ecosystems are mainly focused on technical and organisational issues – e.g., resource flows, business models, stakeholder organisation, etc. – while the social dimension deserves further investigation. However, even if not directly related to the concept of circular ecosystems, the social dimension is starting to attract the attention of scholars and practitioners in the Circular Economy debate.

Analysing the literature, it is possible to identify emerging signals (Tab. 3) of recent attention to the relationships between the themes of Circular Economy and social innovation, but there is still no systematisation of the possible declinations of these relationships and their placement within the concept of Circular Ecosystem. The Circular Ecosystem still appears to be substantially investigated in its technical-organisational aspects, however many of its typical dynamics (equitable access and sharing of resources, participation in collective processes, maintenance of cohesive and resilient communities, institutional agreements, participatory processes, etc.) can have a strong influence on relationships between stakeholders (e.g., on the intensity of collaborations, on the extent of collective benefits achieved) and generate social innovation, new management, housing, and settlement models.

According to this perspective, circularity can offer promising opportunities for social innovation in circular projects that, at different scales, can act as laboratories of experimentation, combining circular strategies with new forms of collaboration, social support networks, community empowerment and territorial development (Marchesi and Tweed, 2021; Marchesi, Tweed and Gerber, 2020).

The concept of Socio-Circular Ecosystem | On this basis, the paper proposes extending the concept of circular ecosystem to that of Socio-Circular Ecosystem, understood as a spatial and relational system, based on strategies for sharing and integrating multiple categories of tangible and intangible resources (Fig. 1): 1) information / knowledge / competences (sharing and systematisation of

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Figg. 8, 9 | Street-side and corner view of the Brandweer pavilion (gateway building), showing the patchwork façade of reclaimed timber boards and coloured panels, the permeable metal screen and the entrance signature of 'Het Hof van Cartesius' (credits: the Authors, 2025).

Fig. 10 | Street-side view of the circular materials hub Buurman (the warehouse, workshop and shop of second-hand and upcycled wood products) within 'Hof van Cartesius', characterised by a patchwork façade of reused cladding panels (credit: the Authors, 2025).

Fig. 11 | Rear façade of Spoor pavilion within 'Hof van Cartesius', the two-storey studio strip with reused cladding systems and a continuous balcony, where climbing vegetation forms a green buffer between indoor workspaces (credit: the Authors, 2025).


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Fig. 12 | The Bomtoren tower within 'Hof van Cartesius', multi-storey timber volume with a fully glazed south façade, making visible the layered coworking and meeting spaces (credit: the Authors, 2025).

Figg. 13, 14 | Reused train windows in façade of the Burmese pavilion within 'Hof van Cartesius': the window on the left is integrated into a green-and-grey corrugated metal façade; the window on the right is framed by reused Dutch railway timetable panels (credits: the Authors, 2025).

Fig. 15 | Outdoor storage of salvaged construction materials at Buurman within 'Hof van Cartesius': external storage area where reclaimed steel beams, timber joists and concrete blocks are stacked (credit: the Authors, 2025).

Fig. 16 | Interior view of the circular timber warehouse at Upcycle within 'Hof van Cartesius', with sorted reclaimed wood stock and workstations, accessible to professional makers and local residents for small-scale construction, repair and experimentation (credit: the Authors, 2025).

experiences, knowledge, skills, and know-how) – K; 2) spaces (spaces made available for individual and/or collective use) – S; 3) services (activities, functions and forms of support provided to users and/or communities) – SV; 4) materials/products (physical goods, products and objects that are reused, exchanged or put into circulation) – M; 5) energy (energy flows, systems, and infrastructures for production, distribution and use) – E; 6) water (water flows, systems, and infrastructure for collection, treatment, distribution and reuse) – W.

According to this interpretation, a Socio-Circular Ecosystem can take the form of a physically delimited place (a building, a neighbourhood, a campus, or a district) or a distributed network that connects several places simultaneously. In all cases, the socio-circular ecosystem pursues two main interdependent objectives: 1) to optimise the use of resources; 2) to generate social innovation.

Within a Socio-Circular Ecosystem, the way in which each resource can be produced, managed, shared, and made accessible (in relation to both internal and external stakeholders) affects the intensity of collaborations, the extent of collective benefits achieved and potentially achievable and the ability of the ecosystem to interact and support the surrounding physical-relational context.

From this perspective, resource management can be interpreted according to three approaches: 1) a closed approach, in which resources are produced and shared within the Socio-Circular Ecosystem; 2) a hybrid approach, in which resources are produced within the Socio-Circular Ecosystem but shared with both internal and external users; 3) an open approach, in which the resource is produced within the Socio-Circular Ecosystem and shared mainly with external users, connecting the ecosystem to a wider territory.

All these approaches are based on developing and managing sharing strategies[3] within a system. In this sense, sharing is recognised not only as a social practice (Katrini, 2018), but also as a circular strategy synergistically integrated with those of repair, reuse, and recycling (Bocken et alii, 2016). Sharing is therefore configured as a central strategy in the Socio-Circular Ecosystem, capable of activating social innovation and design experimentation through the reformulation of ways of using resources and the introduction of practices such as collective participation, shared ownership, co-management, etc. (Mont and Voytenko Palgan,

Fig. 17 | Example of upcycled furniture by Upcycle, within 'Hof van Cartesius', displayed against an interior wall clad with reclaimed timber offcuts, illustrating the transformation of recovered materials into new products and finishes (credit: the Authors, 2025).

2025; Rathnayake et alii, 2024; Pérez-Pérez and Nebreda-Calvo, 2024; Atstaja et alii, 2022; Kenter et alii, 2015; Frischmann, 2012).

In the built environment, sharing implies the shift from ownership to use based on collective access to physical, technical, and organisational resources and translates into sharing space (co-working, co-living, shared services, shared logistics hubs, or shared storage), utilities (shared energy, water, or mobility infrastructure), services (participatory maintenance and repair activities, etc.) and materials / products / equipment ('library of things', reuse of products, etc.).

Interpretative framework for resource use within a Socio-Circular Ecosystem | Based on the concept of SCE and its articulation in the three approaches (closed, hybrid, open), an interpretative framework is proposed, aimed at reading the possible methods of production, use and sharing of resources and characterised by a dual scope of application (ex post, ex ante): on the one hand, the interpretation of real cases that can be recognised as SCEs in order to evaluate the effectiveness of existing initiatives and to identify possible strategies to enhance the generation of social value; on the other hand, support for the planning of new development interventions characterised by the typical values of a SCE.

From this perspective, the interpretative framework provides a reading grid focused on the relationships between circularity and social innovation, and on the modes of production, use and sharing of the six categories of resources (K, S, SV, M, E, W) in relation to circular ecosystem approaches (closed, hybrid, open).

The reading grid was built using a methodology divided into a series of phases. First, a field investigation was conducted through the selection and analysis of cases characterised by circularity strategies strongly linked to the physical and social context and attributable to the concept of circular ecosystem. By comparing the cases, it was possible to define, for each of the six resource categories, different ways of managing them in relation to possible sharing models involving various types of stakeholders.

The relationships between the methods of resource management and their forms of sharing have been formalised and characterised in the construction of the reading grid with reference to the three ecosystem approaches (closed, open, and hybrid): the application of this grid to circular ecosystems allows for the recognition of their potential for social innovation and therefore to attribute SCE connotations to them. The last phase of the methodology consists of verifying the applicability of the grid by testing it on selected cases. The reading grid formalises the relationships between circularity strategies and sharing models for each resource category as follows.

For the category 'Information, knowledge and competences'[4] (K; Fig 2):
– Self-produced and shared internally (closed approach); knowledge is mainly generated within the ecosystem (by residents, users, managers and local organisations) and disseminated only among its members, for example, through collective learning activities, peer training, internal workshops, and reports;
– Self- and externally-produced, and shared internally (hybrid approach); knowledge comes from a combination of internal (e.g., technical staff, and project managers) and external (e.g., professionals, academia) sources; once acquired, it is shared within the ecosystem (through assemblies, workshops, documentation, training), but is not shared with external users;
– Self- and externally-produced, and shared externally (open approach); information and expertise are generated within the ecosystem, often co-produced with external partners (Universities, municipalities, and NGOs), and then shared both internally and externally through publications, toolkits, guidelines, open data, educational activities, conferences, etc.; the ecosystem thus becomes a 'knowledge hub' for the community.

For the category 'Spaces' (S; Fig. 3)[5]:
– User-managed and selectively shared internally (closed approach); spaces are dedicated to users (e.g., long-term tenants of an office, companies / start-ups and social housing) and are managed directly by the occupant; therefore the management and possible sharing of these spaces is based on individual decisions and not on collective rules for use;
– Self-managed and shared internally and externally (hybrid approach); spaces are conceived as common ecosystem infrastructures (e.g., shared kitchens, laboratories, coworking areas, communal gardens, community rooms, etc.) whose access is typically regulated by internal agreements (membership, hours, codes of conduct) while maintenance is often collective; these shared spaces represent crucial areas where social ties and collaborative practices are developed and can be managed collectively (association, cooperative, residents' committee, etc.), with shared rules of use and maintenance; access is primarily reserved for ecosystem members, while external users can access such spaces under specific conditions, typically via an additional fee (e.g., paying to use co-working spaces);
– Self-managed and shared externally (open approach); the spaces, explicitly oriented to the neighbourhood and the city, become interfaces between the ecosystem and its urban context; they are open (continuously or at specific times) to non-members and host activities, events, and services for the external community. These spaces function as interfaces with the external context (neighbourhood, city), generating flows of people, ideas, and resources that extend social value beyond the ecosystem's boundary, strengthening its role as a local 'hub'.

For the category 'Services' (SV; Fig. 4)[6]:
– Self-organised and shared internally (closed approach); services (e.g., childcare cooperatives, a 'library of things', and a 'repair café') are organised, managed, and used by ecosystem members (residents, tenants and cooperatives);
– Self-organised and shared internally and externally (hybrid approach); services (e.g., bars, shops, ateliers, and coworking spaces) are managed by actors within the ecosystem (cooperatives, SMEs and professionals), but offered for a fee to both internal and external users;
– Self-organised and shared externally (open approach); services (e.g., training programmes, cultural events, counselling, and incubators) intentionally designed to serve the external community (neighbourhood or city), often with a social or educational purpose.

For the category 'Materials and products' (M; Fig. 5)[7]:
– Internally sourced and internally circulated (closed approach); materials and products are recovered within the ecosystem; recovery and reprocessing can be carried out directly by users or by companies and organisations that provide reuse and repair services; materials and products can be shared and exchanged between members of the ecosystem, either free of charge (donations and mutual exchanges) or through monetary transactions (sales, rentals, and product-as-a-service);
– Externally sourced and internally shared (hybrid approach); materials and products are recovered outside the ecosystem through different channels (e.g., online platforms, donations from residents and organisations, collaboration with local construction sites or municipal reuse centres, purchase of reused components, or recycled materials from local authorities) and then used within the ecosystem;
– Externally and internally sourced and externally circulated (open approach); materials and products can be sourced both within the ecosystem and from external suppliers (reuse hubs and manufacturers) to be reused by the external community; the ecosystem therefore operates as a node within a broader system of exchange, generating flows (in and out) of reused materials and products on a district or urban scale, and not only within its own borders.

For the category 'Energy' (E; Fig. 6)[8]:
– Self-produced and shared internally (closed approach); energy is generated within the ecosystem (e.g., photovoltaic systems) and distributed to internal users through shared infrastructure; governance is usually collective (e.g., energy cooper-

Case study	Description	Resource Configuration	Spatial Configuration	Strengths	Weaknesses / criticalities	Feasibility requirements	Transferability
Hof van Cartesius	Circular workspace community built with reused and recycled materials	O	Concentrated	Strong mix of circular workspaces, shared services, and collaborative community; adaptive reuse logic combined with entrepreneurial and social interaction; openness to external networks and visitors	Dependence on active community management and tenant engagement; economic viability tied to occupancy and the local ecosystem; partly context-dependent governance model	Access to affordable land or transitional sites, strong coordination body, local entrepreneurial network, and capacity to manage shared spaces and services	Medium
De Ceuvel	Regenerative hub created from reused houseboats on polluted land	H	Concentrated	Strong mix of circular experimentation, community-building, and external openness; shared workspaces and public-oriented services; knowledge exchange with external actors	Complex management; dependence on committed actors; temporary and context-specific conditions	Supportive regulation, interdisciplinary design capacity, active local network, and willingness to experiment	High
Schoonschip	Floating residential community	C	Concentrated	Strong resident community; shared energy and water systems; integration of technical circularity with collective organisation	High technical complexity; high initial costs; model mainly tailored to a specific residential community	Advanced technical expertise, coordinated governance, financial capacity, and resident commitment	Medium
People's Pavilion	Temporary pavilion built from borrowed materials	O	Concentrated	High symbolic value; strong demonstration of reuse and reversibility; public visibility and educational impact	Temporary character; limited long-term organisational continuity; reduced everyday social embeddedness	Event-based funding, strong curatorial and design coordination, and access to reused materials	Medium
BlueCity	Circular hub for entrepreneurs located in a former swimming pool	O	Concentrated	Circular entrepreneurship hub; strong networking and knowledge-sharing role; services and spaces open to external users	Dependence on business viability and ecosystem management; risk of uneven access to benefits	Entrepreneurial ecosystem, governance capacity, economic sustainability, and local demand	Medium
R-URBAN	Network of civic hubs promoting urban resilience through local food, recycling, and housing services	O	Widespread	Systemic integration of social, environmental, and economic aims; strong community orientation; resourcesharing across functions	Organisational complexity; dependence on public support and long-term coordination; fragile continuity	Political support, active civic participation, multi-actor governance, and flexible implementation framework	Medium
Royal Docks Circular Construction Hub	Urban hub for construction-material reuse	H	Widespread	Strong role in material reuse at urban scale; links circular construction to local resource flows; strategic infrastructural potential	Strong dependence on policy support and construction-sector coordination; limited direct community management	Public backing, active construction supply chain, logistics infrastructure, and stable institutional support	Medium
Ashley Vale	Self-build housing project	H	Widespread	Strong self-build and community dimension; collective ownership logic; high social cohesion	Difficult to replicate; highly dependent on local land conditions, community capacity, and specific historical context	Cohesive community, access to land, participatory culture, and long-term resident engagement	Low
Hammarby Sjöstad	Eco-district integrating energy, water, and waste flows in a closed-loop	C	Widespread	High infrastructural efficiency; strong integration of energy, water, and waste systems; large-scale urban impact	Mainly top-down model; limited direct participation in resource management; social innovation less explicit	Strong public governance, major investments, advanced infrastructure, and integrated planning framework	Low
Ekostaden Augustenborg	Regenerated neighbourhood with green infrastructure	C	Widespread	Effective integration of water and environmental infrastructures; positive neighbourhood-scale regeneration effects	Strong dependence on public governance; limited shared management by users; context-specific welfare conditions	Institutional continuity, public investment, long-term maintenance, and supportive policy framework	Low

Tab. 6 | Critical analysis of case studies. For each case study, the table shows: the predominant approach classified as Open – O, Hybrid – H, or Closed – C; spatial configurations, classified as Concentrated or Widespread; strengths, weaknesses, feasibility requirements, and transferability, classified as High, Medium, or Low (credit: the Authors, 2025).

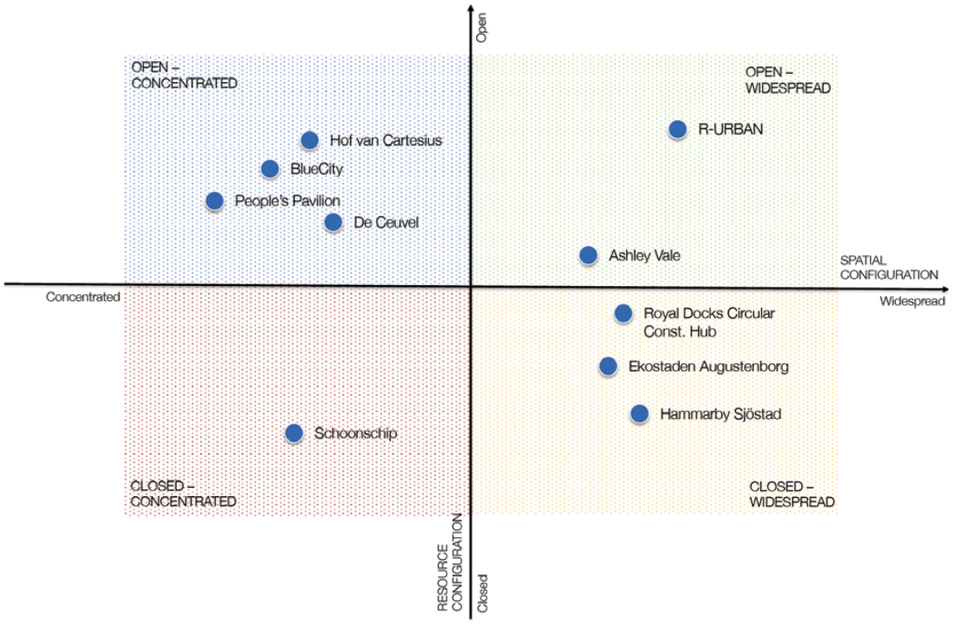

Fig. 18 | Cartesian diagram positioning the analysed socio-circular ecosystem case studies according to the two complementary dimensions: the spatial configuration – x axis, from concentrated to widespread; the resource-sharing approach – y axis, from closed to hybrid and open, based on the analysis of the governance and sharing of the six resources K, S, SV, M, E, and W (credit: the Authors, 2025).

atives and condominium agreements), with common rules for maintenance and cost sharing;
– Self- and externally produced and shared internally (hybrid approach); energy is produced partly internally (e.g., photovoltaic systems and small-scale cogeneration) and partly by external suppliers; energy is shared internally through common infrastructure and collective agreements; residents and users are connected to the same systems and can jointly negotiate rates and select external suppliers;
– Self-produced and shared externally (open approach); the excess energy produced within the ecosystem (local generation, storage) is distributed outside (district), creating extended energy communities.

For the category 'Water' (W; Fig. 7)[9], potable water for hygiene is assumed to be provided by the municipal water supply network, while circular strategies focus mainly on non-potable uses (sanitary water, cleaning, and irrigation) and rainwater management:
– Self-produced and shared internally (closed approach); water for non-potable community uses is collected, managed, and reused internally (rainwater harvesting, storage); governance is typically entrusted to a cooperative, condominium, association, or management company that makes decisions on the design, maintenance, and allocation of costs;
– Self- and externally produced and shared internally (hybrid approach); water for non-potable uses is only partially produced internally, through the implementation of collection and reuse strategies, and is supplied mainly by the municipality;
– Self- and externally produced and internally / externally shared (open approach); water systems are internally optimised while being functionally integrated into larger territorial infrastructures (neighbourhood or district).

Application of the proposed interpretative framework to case studies | The proposed interpretative framework for the Socio-Circular Ecosystem is applied to a sample of significant case studies. The following selection criteria were considered for the choice of cases:
– Conceptual fit; each case combines circular strategies with an explicit purpose of social innovation, overcoming the vision of circularity as a purely environmental or technical goal;
– Data availability; each case is documented through reports, interviews, and direct observation and has already been implemented in a real context;
– Geographical context; all projects are located in European urban contexts, ensuring a certain degree of comparability in terms of regulatory frameworks and welfare systems.

In defining the sample, the diversity of settlements was also taken into consideration; the selected cases therefore cover different scales (building, block, neighbourhood) and different types of settlement (former industrial areas, housing, and mixed-use hubs) and initiative (public, private and community). Ten cases have been identified: Hof van Cartesius (Utrecht, Netherlands); De Ceuvel (Amsterdam, Netherlands); Schoonschip (Amsterdam, Netherlands); People's Pavilion (Eindhoven, Netherlands); BlueCity (Rotterdam, Netherlands); R-URBAN (Colombes, France); Royal Docks Circular Construction Hub (London, UK); Ashley Vale (Bristol, United Kingdom); Hammarby Sjöstad (Stockholm, Sweden); and Ekostaden Augustenborg (Malmö, Sweden).

An initial analysis aimed to provide an overview of the main information for each case study, including: location, year of opening, size, main uses, ownership and management (relating to land, buildings, and services), funding sources, and the economic model (Tab. 4)[10]. The second phase of analysis concerns mapping the flows of the six resource categories to identify the approaches (closed, hybrid, and open). As an example, Table 5 presents the analysis carried out on the Hof van Cartesius project (Figg. 8-17). The same analytical procedure was applied to all ten case studies (Tab. 6).

Hof van Cartesius can be read as an open SCE. In particular, the 'Information, knowledge and competences' category combines the K1 (closed) and K3 (open) approaches: internal know-how is shared mainly within the community following a team-based organisation, while workshops, guided tours, and participation in circular networks open this knowledge outward. 'Spaces' present diversified approaches, from closed access (S1) of the private ateliers to the hybrid approach (S2) of the shared courtyard and garden, and to the open approach (S3) of the spaces dedicated to events and community activities. 'Services' represent the most open-oriented dimension, combining closed (SV1), hybrid (SV2) and especially open (SV3) approaches, as internal voluntary activities coexist with public workshops, festivals, guided tours, and community-oriented initiatives.

'Materials and products' are predominantly hybrid (M2), as the construction is mainly based on reused and bio-based materials from external reuse networks, while there are also internal exchanges (M1, closed system) and redistribution to the outside via reuse hubs (M3, open system). In contrast, 'Energy' (E1, closed system) and 'Water' (W1, closed system) are managed internally through local systems and collective agreements. Overall, Hof van Cartesius demonstrates how a physically delimited place can generate broader social value through the selective sharing of specific resources (in particular knowledge, spaces, and services) with the surrounding neighbourhood and city.

Critical discussion and results of the implementation of the interpretative framework based on the Socio-Circular Ecosystem | The analysis of the case studies through the Socio-Circular Ecosystem model has first made it possible to identify new links between circularity and social effects: community-based organisational models (the joint initiative of entrepreneurs and builders at Hof van Cartesius), new ways of managing shared resources (sharing of goods, furniture-repair and clothing-repair networks), community-oriented circular practices (use of local reused materials deriving, for example, from demolition sites or surplus stock

from construction companies), creation of social ties within the community (exchange of knowledge exchange, network-building between small businesses, local economic resilience, community involvement through events and activities open to the public).

Furthermore, the case analysis was integrated with a focus on the spatial dimension of the settlement strategy: each case was analysed within a space-resource diagram (Fig. 18), combining the settlement strategy (space size – from concentrated to widespread) and sharing models (resource size – from closed to open). Although the 'open' approach of the resource-sharing model combined with the 'geographically distributed' settlement strategy (e.g., R-Urban, Ashley Vale) seems to represent the optimal case to maximise the overall potential (e.g., public engagement) and value (including social value) of the circular project, it is possible to identify two recurring spatial-organisational strategies.

An approach of 'open' sharing and geographically concentrated design. In this case, the open approach to resource sharing serves as a facilitator of external interactions among geographically concentrated projects. According to this approach, some case studies (Hof van Cartesius, De Ceuvel, BlueCity, and the People's Pavilion) operate as geographically concentrated centres (buildings) within a wider spatial network of open ecosystems. These realities are often characterised by the presence of shared spaces, collaborative services and community-oriented activities; their open character is manifested through accessibility, cultural programming, knowledge exchange, and experimentation, but their geographical footprint remains relatively limited. In this approach, circularity implies an intense social interaction between different projects (at the building scale) within a delimited geographical dimension (district). A 'closed' approach to resource sharing and geographically distributed design. In this case, the district and territorial scales act as a generator of positive externalities for the community. In projects that operate on a larger scale (district and city – Hammarby Sjöstad, Ekostaden Augustenborg), the resource management (energy, water, materials, and waste) is mainly handled by the municipalities (the Royal Docks Circular Construction Hub) rather than by the community itself. However, residents or users benefit from physical systems (mainly infrastructure), but do not manage them directly. In these cases, circularity is pursued mainly through infrastructure solutions, while smaller hubs are more effective in activating participatory practices and shared management of resources.

Conclusions and future developments | The concept of Socio-Circular Ecosystem proposes a new point of view on the already widespread realities of 'circular ecosystems' by emphasising the importance of the social dimension and helping to fill a gap in the literature relating to the repercussions of circularity for the community – in line with Sustainable Development Goals (SDGs) 9, 10, 11, and 12, on which the contribution can have direct and verifiable benefits; it is also believed that there may be an indirect impact with respect to SDGs 1, 2, 3, 4, 6, 7, 8, and 13, which are linked to the six categories of resources identified in the interpretative scheme.

The proposed scheme supports the analysis of circular economy initiatives, in particular: a) it provides a model of interpretation that supports the understanding of circular initiatives and highlights their potential in terms of social innovation; b) it makes it possible to recognise how resources are produced, shared, and governed within an ecosystem, facilitating the comparison between different initiatives implemented at different scales of application; c) it highlights the role of collaborative governance models and collective practices in SCEs; d) it contributes to highlighting the social innovation incorporated in circular strategies by linking it to experimentation with experimental settlement, use, and housing models.

Limitations to the applicability of the proposed scheme must be verified in relation to the availability and transparency of data, in particular those relating to intangible resources such as knowledge, skills and services. As far as replicability and transferability are concerned, the proposed interpretative scheme can be applied to different scales (building, neighbourhood, city, territory), in different use-related, social, and cultural contexts characterised by sharing of resources (social housing, public housing, living labs, co-working, co-living, hoteling, franchising, etc.).

Future developments should aim to expand and refine the sample of cases analysed, which in this study focused on northern European countries, for which there are consolidated practices of sharing resources. In order to further test the robustness of the interpretative scheme in the reading of different geographical contexts, types of settlements and governance structures, future developments should include an extension of the sample across different countries. Another aspect concerns the definition of criteria for determining the boundaries of the SCEs in order to assess their areas of influence even beyond the system's physical boundaries. Finally, the involvement of experts from social disciplines appears relevant, in order to refine the analysis of social innovation, also with respect to aspects related to participation, social cohesion, access to resources and the long-term evolution of communities.

Acknowledgements

This paper presents the partial results of ongoing doctoral research at the Department of Architecture, Built Environment and Construction Engineering (DABC) of the Politecnico di Milano.

Notes

1) In the Circular Economy transition, the building sector represents a determining area of action due to its substantial environmental footprint: in Europe, it accounts for 33% of energy-related greenhouse gas emissions (EEA, 2024) and 38.4% of total waste generation. For more information on Eurostat 2024 statistics, please visit the webpage.: ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics#Total_waste_generation [Accessed 10 March 2026].

2) In particular, the social dimension in this paper is developed in terms of social innovation, i.e. the development of new practices, services, organisational models or governance arrangements that address social needs while generating new forms of collaboration and social value (Milotay, 2017).

3) By allowing multiple users to access the same assets over time, sharing increases utilisation rates, extends the useful life of products, buildings and infrastructure, postpones the need for new production (Kjær et alii, 2019; Tukker, 2015), and reduces the demand for primary raw materials (Aldieri et alii, 2021). In this sense, sharing contributes directly to circular economy goals by optimising the use of existing resources rather than focusing only on end-of-life strategies such as recycling (Henry et alii, 2021). The sharing strategy, if implemented in practice, requires a circular ecosystem approach because it cannot be implemented by a single actor, nor reduced to a simple provider-user dynamic. It involves multiple interdependent roles. Abdalla, Amankwah-Amoah and Badewi (2023) identify primary (new and current customers, product and service providers; and small, medium, and large mediators) and secondary participants (local and national governments), while Leung, Xue and Wen (2019) lists as participants the platform, the provider, the consumer, the competitor, the partner, the government, and the community. Moreover, the sharing practice raises specific ecosystem-related requirements that extend beyond any single firm or project: alignment of interests, roles, and responsibilities across all participants (Leung, Xue and Wen, 2019). Thus, each player needs to pursue its own goals without harming others' interests.

4) The closed approach in relation to the 'Knowledge' category can be recognised in Ashley Vale in Bristol (Broer and Titheridge, 2010), where practical know-how was largely developed through the residents' own self-build process and internal organisation. The hybrid approach can be recognised in cases such as Hof van Cartesius (European Commission, n.d.), where a bottom-up cooperative of makers and entrepreneurs developed the project while also relying on collaboration with contractors and external expertise. Lastly, the open approach is particularly evident in De Ceuvel in Amsterdam (Williams, 2023), where guided visits, workshops and events are periodically organised with the goal of sharing knowledge among internal and external stakeholders.

5) The closed approach in relation to 'Spaces' can be recognised, for example, in Ashley Vale (Bristol), where the dwellings created through the self-build process remain primarily under the control of the individual households, and in the private ateliers or work units of projects such as Hof van Cartesius (Utrecht), which are assigned to specific makers or entrepreneurs. The hybrid approach is clearly recognisable in cases such as De Ceuvel (Amsterdam), which includes creative workspaces and common venues that support a community of circular and creative entrepreneurs – spaces are mainly used by the members; however, some of them are occasionally accessible to external users. Lastly, BlueCity (Rotterdam), which combines workspaces with event spaces and programmes addressed to broader urban audiences, is a representative case of the open approach (European Commission, 2017).

6) Closed approaches of the resource category 'Services' can be observed in projects such as Ashley Vale, where residents collectively organise services and mutual-support practices, or in cooperative communities like Schoonschip in Amsterdam (Cutieru, 2021), where shared services are primarily

designed to support internal households. Hybrid approaches, instead, can be observed in initiatives such as De Ceuvel, where creative workspaces and services operate within the project while attracting external visitors, and Hof van Cartesius, where ateliers, workshops and professional services are run by resident entrepreneurs but accessible to broader audiences. Elements of the open approach are recognisable in initiatives such as BlueCity, which offers incubation programmes, events and training on circular economy for external actors, and R-Urban in Colombes (Petrescu, Petcou and Baibarac, 2016), where services such as urban agriculture, repair activities and educational programmes are oriented towards the surrounding community.

7) In relation to the resource category 'Materials and products', elements of a closed approach can be found in Schoonschip (Amsterdam), where residents share electric cars and bicycles within the neighbourhood. The hybrid approach can be recognised in De Ceuvel, where salvaged houseboats and recycled materials were transformed into workspaces for the internal community. Lastly, the open approach is particularly evident in R-Urban or Royal Docks Circular Construction Hub in London (Greater London Authority, 2026), where reused materials collected from surrounding construction sites are stored, transformed and recirculated through a wider local reuse system, and in the People's Pavilion (Eindhoven) (Halleran and Waldstrom, 2017), whose materials were borrowed from external suppliers and returned after use, demonstrating how material flows can be organised across project boundaries rather than retained within a single site.

8) Examples of the closed approach of the resource category 'Energy' are recognisable in the case Schoonschip in Amsterdam, where the houses generate electricity through photovoltaic panels, use heat pumps and exchange electricity through an internal smart grid, or De Ceuvel, where energy flows are partly managed through on-site renewable systems and internal optimisation strategies. The hybrid approach can be recognised in Schoonschip, where photovoltaic production and battery storage are combined with a single connection to the national electricity grid, and in Hof van Cartesius, where locally generated solar energy complements electricity supplied through the conventional grid while supporting a community of circular entrepreneurs. Lastly, the open approach can be recognised in district-scale systems such as Hammarby Sjöstad in Stockholm (Iverot and Brandt, 2011), where buildings are connected to Stockholm's broader district heating and cooling networks.

9) Examples of the closed approach in relation to the resource category 'Water' can be recognised in the case of Vätterhem YEAH in Jönköping, described as fully off-grid public rental housing using rainwater harvesting and greywater processing (HEH, n.d.), and Patch22 in Amsterdam, where rainwater collection feeds a greywater system within the building (Frantzen, 2015). An example of the hybrid approach can be recognised in the Schoonschip case, where the houses combine a central clean-water supply with internal water innovations, including shower-water reuse, while black water is still discharged to the sewer; another relevant precedent is De Ceuvel, where the houseboats use conventional drinking water but treat greywater locally through individual biofilters and composting-based sanitation systems. Lastly, examples of the open approach can be recognised in Ekostaden Augustenborg in Malmö (EEA, 2017), where open stormwater infrastructures mitigate flooding and contribute to neighbourhood resilience, Hammarby Sjöstad, where local water management is integrated into a wider urban eco-cycle system, and Seestadt Aspern in Vienna (Williams, 2023), where rainwater retention and blue–green infrastructures support climate adaptation at district scale. In such cases, the ecosystem operates as a node within the urban water system, requiring new forms of coordination, co-governance and collective responsibility between the local community and public authorities.

10) The acronyms used in Table 4 are the following. Settlement type: BLD = building; NBHD = neighbourhood; DIST = District; NET = network. Development type: NEW = new development; REG = regeneration of existing asset. Initiative type: PUB = municipality or public institutions; PRIV = private entities; CIV = civic actor (cooperative, NGO); PUB-PRIV = Public–private partnership. Main uses: RES = Residential; WSP = Workspaces; EXH=exhibitions; AGR = Urban agriculture; HUB = central facility. Ownership / Management: PUB = Public; PRIV = Private; CLT = Community Land Trust; COOP = Cooperative; NGO = Non-governmental organisation; NPO = Non-profit organisation. Funding sources: GRANT = Public grants; EU = European funds; LOAN = Bank loans or other debt; INV = Private investment; CROWD = Crowdfunding; SELF = Self-financing. Economic management model: RENT = Rents and leases; MEM = Memberships, dues and participation fees; SERV = Paid services; EVENT = Income from events and programming; SUB = Subsidies and public support.

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