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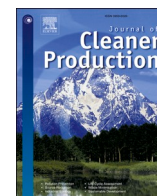
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Review

The circular built environment toolbox: A systematic literature review of policy instruments

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ABSTRACT

The built environment plays a central role in the transition towards the circular economy as they concentrate major consumer and polluter human activities. However, the way BEs are – and need to be – driven by policy to reach cities' circular goals is still an under-researched aspect. Particularly, there is limited knowledge of policy instruments aimed to foster the transition towards a circular built environment. Therefore, we conduct a systematic literature search and a review of scientific publications to characterize the relation between the circular built environment and policy instruments suggesting its implementation from a circular city development perspective. We do so by answering: (1) how many publications elaborate on CBE policy instruments, (2) what type of circular actions in relation to circular city development are mentioned, and (3) what policy instruments are proposed to implement a CBE. The literature search is performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Our results show that 53% of publications address policies instruments for circular built environment transitions. Although different circular actions are identified, looping actions prevail. Adapting and ecologically-regenerating actions, which are essential for circular city development, remain insufficiently researched. Finally, among policy instruments for circular built environment implementation there is a clear tendency towards regulation as means for leverage, which calls for bigger research efforts concerning the mix of policy instruments, as well as in more general challenges in governance and policy coherence.

1. Introduction

Integrating circular economy (CE) strategies into the built environment (BE) has been identified as crucial for sustainable urban transitions (Schröder et al., 2020) since the BE is a major global resource consumer and polluting human activity (Ness and Xing, 2017; Pomponi and Moncaster, 2017; van Bueren, 2009). In 2020, global anthropogenic mass (the mass embedded in all human-made objects) surpassed that of global biomass. Most of this mass comprises materials in the BE –e.g., concrete and aggregates such as gravel, and bricks. The total mass of buildings and infrastructure is thus greater than that of trees and shrubs, and that is without considering anthropogenic mass waste (Elhacham et al., 2020).

At different scales, a variety of concepts, measurements and tools are used to express or measure the BE's performance in terms of flows of materials and energy, the key indicators of a circular BE (CBE): urban metabolism, material flow analysis, input/output analysis, and lifecycle assessment, among others. Although these environmental concepts,

measurements and tools are essential for understanding the extent to which the BE is circular, and what the opportunities are for making it more circular (Kaviti Musango et al., 2017; Lucertini and Musco, 2020), a predominant perspective on environmental performance (Kirchherr et al., 2017; Munaro et al., 2020) may not inform us on how to bring about a CBE (Pomponi and Moncaster, 2017). For instance, these concepts, measurements, and tools neglect political, social, economic, and behavioural aspects, which are known to present essential barriers and drivers to systemic change (Korhonen et al., 2018a; Schröder et al., 2020). In particular, the challenges in the governance and management of CBE and the transitions needed in policy making, including the roles of governments and industry, are under-researched (Munaro et al., 2020).

However, policymaking for systemic sustainable change or transition in the BE, with the aim of bringing about a CBE or otherwise, is challenging, both conceptually and empirically. While change in the BE as a research object has received increased attention in the last decades, a clear and widely accepted conceptualization of the 'BE' itself is still

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lacking. Moffatt and Kohler (2008, p. 249) define it as the “*manmade surroundings that provide the setting for human activity, ranging from the large-scale civic surroundings to the personal places*”. Yet, they claim that the only way to really define the BE is in opposition to the *un-built* environment, or the biosphere. Other authors approach it from its ‘constituting elements’, namely: buildings and infrastructure (Hart et al., 2019). In a BE-specific research methodology book (Knight and Ruddock, 2008) it is not defined explicitly but referred to as the object of construction management. Similarly, in recent research frameworks put forward for the analysis of CE in the BE, the authors’ understanding of the BE is not specified but rather used loosely to describe (components of) the building sector or the research field (Munaro et al., 2020) at different scales, starting from objects to buildings to urban agglomerations (Pomponi and Moncaster, 2017).

In the report ‘From principles to practice: first steps towards a CBE’ by the Ellen MacArthur Foundation ((2018)), the CBE is conceptualised as reaching well beyond mere buildings and construction to include that it has to: (1) support human-wellbeing and natural systems; (2) be guided by system thinking; (3) be leveraged by digital technology; (4) implement holistic urban planning; (5) foster continuous material cycles; (6) design for maintenance and deconstruction; (7) provide flexible productive buildings; and (8) combine integrated infrastructure systems. The EMF has also introduced the “ReSOLVE” framework for businesses and countries willing to move towards a CE, which stands for Regenerate, Share, Optimize, Loop, Virtualise, and Exchange, as six main circular actions for policymakers (EMF, 2015). However, creating effective policies that address these actions for the circular transition of the BE involves multi-level decision making by a variety of actors, usually with conflicting interests, operating in various markets (van Bueren and Priemus, 2002) within different physical and administrative boundaries (van Bueren and De Jong, 2007).

The understanding of the BE gets even trickier when the policy goal of a circular city is introduced. In general, a circular city has the goal of improving the ecological impact of existing in- and out-going flows of materials and energy in urban buildings and infrastructures by making them as circular as possible (Bucci Ancapi et al., 2022). It is therefore not a coincidence that the BE is linked to an urban dimension rather than to a rural one. Cities are expected to concentrate more than 60% of the global human population by 2030, and though they occupy only 3% of Earth’s land, they are responsible for 60–80% of global energy consumption and up to 70% of human-induced greenhouse gas (GHG) emissions (UN, 2020). Consequently, circular cities have become a focal policy concept for different international organizations, such as the United Nations (Kaviti Musango et al., 2017) and the European Commission (COM, 2020), for governments –e.g., China, the Netherlands, Belgium, Chile– and for scholars (Kebłowski et al., 2020; Marin and De Meulder, 2018; Paiho et al., 2020; Pomponi and Moncaster, 2017; Thelen et al., 2018; Van den Berghe and Vos, 2019; Williams, 2019a).

2. Literature review: policy (instruments) in circular built environment research

There are a wide variety of concepts, frameworks and measurements related to BE, CBE and circular cities. Inevitably, this has consequences for policymaking. The apparent interchangeability of CBE and circular city concepts makes it difficult to come up with clear and effective CBE policies and policy instruments. It is acknowledged that the relationship of CBE ambitions with policies and policy making are often over-looked (Munaro et al., 2020; Pomponi and Moncaster, 2017). Certainly, the governance of circular economies is covered in research. Some examples are the case of international comparisons about the effectiveness of governance in relation to CE (Cramer, 2022), policy mixes for advancing towards a CE (Milios, 2018), and the analysis of institutional drivers and barriers of circular economies (Ranta et al., 2018). Recently, some authors have investigated the relation between the construction industry, circularity, and policymaking, approaching CBE governance challenges

in relation to the so-called policy cycle (Yu et al., 2022). Bucci Ancapi (2021) analysed the relation between BE, circularity, and policy instruments, providing a general classification of policy instruments in relation to CBE that distinguishes regulatory, economic, and information instruments. While Yu et al. (2022) state the importance of policy instruments and synergetic policy mixes to bring about a CBE from a supply chains perspective, and Bucci Ancapi (2021) provides a preliminary policy instrument analysis for CBE implementation based on a review of academic literature, none of them conceive the BE as a distinct element of cities and urban development. Rather they follow the mainstream understanding of BE as a matter of construction management, and circularity as making supply chains more sustainable. Therefore, there is a lack of understanding concerning the role of CBE in circular city development. Accordingly, the aim of this research paper is to provide an analysis of what CBE policy instruments are discussed and proposed to implement a CBE from a circular city development perspective, based on a selection of relevant scientific publications. This leads to our research question: what is the current understanding of the relation between CBE and policy instruments needed to bring about a CBE?

To answer this research question, the remainder of this article is structured as follows. Firstly, we explain how we define policy focused on CBE in relation to circular city development and introduce the analytical framework by Williams (2021) used to analyse our empirical results. Secondly, in our methodology section we explain the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA) (Moher et al., 2009) that we applied as research protocol for our literature review. Thirdly, we present the results of the systematic literature review. Fourthly, we discuss the role of policy instruments in implementing CBE, and the required coherence between different policy instruments to improve the effectiveness of radical societal changes, such as the CE transition. We do this by answering the following sub-research questions: (1) how many publications elaborate on CBE policy instruments; (2) what type of circular actions in relation to circular city development are mentioned; and (3) what policy instruments are proposed to implement a CBE? Finally, we provide both conclusions from the review and policy recommendations to improve the effectiveness of CBE policy goals.

3. A framework for analyzing policies and instruments for circular built environment

Prior to our analysis, we need to fulfil two analytical requirements. Firstly, we need a framework to understand the contributions to the CBE that the policies mentioned in our selection are making, and, secondly, we need a framework to understand the type of policy instruments mentioned.

An effective implementation of CBE requires contextualization. We argue that such contextualization is possible through the circular city concept, for a BE does not exist without the complex adaptive system that creates it: the city. As explained by Bucci Ancapi et al. (2022) many scholars have recently studied different urban phenomena from a circular city perspective, yet relatively few authors have provided a conceptualization of what a circular city entails, and even fewer propose a comprehensive framework for circular city transitions. Among the available frameworks, the one by Fusco Girard and Nocca (2019) is worth noting, as it proposes a set of indicators for circular city implementation based on both theoretical papers and case studies of specific circular city programmes, strategies, or agendas. Such indicators emerged as a response to a generalized lack of assessment of the effectiveness of cities’ policies moving towards circularity. From another perspective, Paiho et al. (2020) sought to conceptualize the circular city, and to point out what indicators and tools are available for planning a circular city. In summary, although a few circular city frameworks elaborate on policy-related topics to CBE, we conclude that, firstly, they do not give an overall typology of policy instruments and, secondly, do

not inform us about how these policies can be operationalized through instruments to implement a CBE.

A recent publication by Williams (2021) offers a feasible way to understand both the contributions of policy to the CBE and a typology for policy instruments, the focus of our article. Williams (2021, p. 157) argues that “circular cities are urban systems in which resources are looped, the ecosystem is regenerated, and the socio-technical systems (infrastructure and communities) evolve with changing contexts. Thus, circular cities are resource efficient, resilient and operate within the global carrying capacity”. Cities shifting towards circularity do so through circular development, which Williams (2021) understands as the process which integrates three circular actions –i.e., *looping* actions, *ecologically regenerative* actions, and *adaptive* actions– into urban systems of provision (Fig. 1).

Looping actions relate to the commonly known waste hierarchy and value retention options, also known as ‘R-imperatives or strategies’ (Prins and Rood, 2020; Reike et al., 2018; Savini, 2019) of sustainability, such as energy recovery, recycling and reuse of resources. Ecologically regenerating actions seek to regenerate the urban ecosystem and the provision of ecosystem services, actions normally linked to the implementation of blue and green infrastructure –e.g., green roofs and rain-water storages facilities. Adaptive actions aim to capacity building among communities to adapt to change –e.g., through collaborative planning. Some opportunities given by circular cities are to close resource loops, to enable people’s reconnection with nature, the protection and enhancement of ecosystem services, to create adaptive cities and to enable learning within and by communities. Williams (2019a) also introduces four urban supporting actions, namely: optimization, sharing, substitution and localization. However, as stated from case studies, Williams (2021) shows that most cities in their circular transition focus solely on local looping actions for organic and construction waste streams, and focus their attention on integrating CE actions rather than aiming for broader circular development or systemic change. The focus on looping actions has enabled the identification of usual challenges in their implementation, which are linked to the lack of: political support; an integrated and supportive framework for regulation and standardization; data; and institutional capacity (Williams, 2019b). Yet the three circular actions are meant to work synergistically to deliver circular development (Williams, 2021). Whether or not such synergies happen should be the subject of study and not taken for granted. European case studies have shown how cities may fail in implementing more ambitious circular and sustainable strategies in general as they are locked-in to low waste hierarchy strategies such as waste-to-energy systems (Van den Berghe et al., 2020; Williams, 2021). The circular city development framework by Williams (2021) based on three circular actions and four supporting actions will thus be used in this article as our analytical framework to analyse the relation between policy instruments and CBE implementation, as stated in academic literature. We argue that

without a holistic perspective, the CBE transition is hindered by unbeneficial reductionism, such as mainstream technocratic approaches that see circularity as a matter of getting resource flows right (Newell and Cousins, 2015; Wachsmuth, 2012). Therefore, seeing the BE from a city perspective enables a circular development beyond mere resource efficiency, for adaptive and regenerative capacities to climate change and ecological debacle are also considered to deliver urban sustainable development.

4. Methods

4.1. Literature search

For this article, we adhered to the PRISMA guidelines to conduct a systematic literature search. PRISMA is the result of an analysis about available methods and tools for the process of systematic literature search and review originally developed within medical studies (Moher et al., 2009). Because of its reporting meticulousity, PRISMA is increasingly being used in social science and qualitative research –i.e., De Vries et al. (2015), Sadick and Kamardeen (2020) and Huijbregts et al. (2021). The PRISMA guidelines make use of a checklist and a flow diagram to summarize the process of study selection in terms of identification, screening, eligibility, and inclusion. Both the checklist and flow diagram enable a rigorous review that can be checked and replicated by others.

As eligibility criteria, considering the existence of previous reviews for CE in the BE of Munaro et al. (2020) and Pomponi and Moncaster (2017), our intention is only to address its policy perspective, avoiding those including so-called circular strategies (Potting et al., 2017) –i.e., reduce, recycle– in previous BE research and policy without a clear CE framework –i.e., publications based on waste or environmental management. The following criteria have been established. Firstly, from the literature search we will only consider published open access articles, reviews, and book chapters available in the selected online databases, so as to ensure full replicability of our results. Secondly, the period 2010–2020 was chosen because it guarantees that eligible early developments in the BE in China, Japan, United Kingdom, Germany, and European countries in general, as CE frontrunners (Geissdoerfer et al., 2017; Munaro et al., 2020), are considered. Thirdly, eligible manuscripts must be written in English. Fourthly, the words ‘polic*’, ‘govern*’, ‘plan*’, ‘lever*’ or ‘manag*’ must be included either in the text’s title, abstract or keywords. We acknowledge that this selection criteria may lead to the omitting of relevant articles, reviews, and books; however, it ensures that only manuscripts explicitly linked to the field of CE in the BE are covered, thus reducing bias in the selection process. It is important to highlight that these decisions frame the main assumptions and simplification in our data collection process and are derived from using ‘circular* economy’, ‘built environment’, ‘city OR cities’, ‘manag*’, ‘polic*’, ‘govern*’, and ‘plan*’ as criteria for exclusion. There might be articles, reviews, and books that implicitly address policy related aspects of CBE that were not considered in our review.

Our systematic literature search strategy is presented as follows. We searched two online databases, namely: Web of Knowledge and Scopus, to ensure a wide pool of scientific inputs in our literature search. The search was conducted on April 29, 2021. We searched for the strings “circular* economy” AND “built environment” and “circular* economy” AND (“city OR cities”). In Web of Science, we selected the field ‘topic’, which searches authors, abstracts, and keywords. In Scopus, we selected the field ‘Article title, Abstract, Keywords’. Only articles, reviews and book chapters were included in the search. The resulting findings were exported as RIS, CSV and Plain text files containing full information. They were stored and analysed using EndNote’s X9 to further identify those publications containing ‘polic*’, ‘govern*’, ‘plan*’, ‘lever*’ or ‘manag*’. Data extraction was done manually and independently by the authors. Cross-checks were performed by the authors to ensure a correct data extraction.

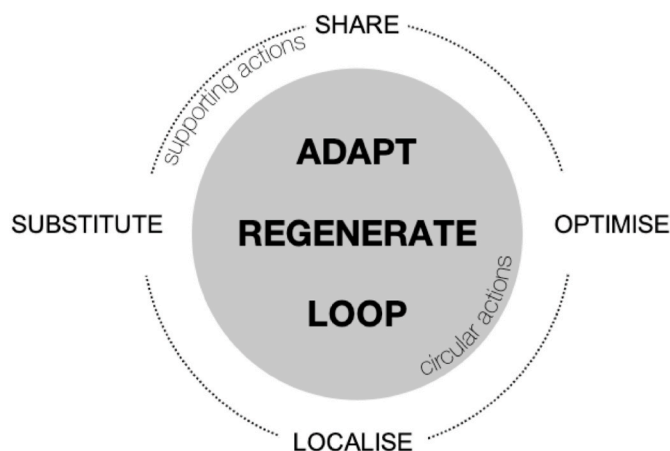


Fig. 1. Circular city development. Adapted from Williams (2021).

4.2. Policy instrument analysis

The circular city development framework has also been selected for it provides a set identified policy instruments or levers gathered from case studies in Europe. Williams (2021) identified commonalities among the circular development pathways of Amsterdam, Stockholm, Paris, and London. The main trends highlighted are the evident economic and environmental motivations to pursue circular development, the tendency to focus on looping actions for organic and construction waste streams, and the renewal of grey infrastructure by blue-green ones. There are also commonalities in levers for implementation, as instruments for capacity building, regulation, fiscal arrangement, and land or financial incentives. Policy instruments are divided into four main categories: regulation, provisioning, capacity building, and financial incentives (Table 1).

In addition, we resort to knowledge on the appropriateness and effectiveness of the use of distinct types of policy instruments to enable a more meaningful discussion. This decision was taken as the levers identified and classified by Williams (2021) are arguably specific policy instruments, and not an actual typology of the latter. Hence, we use the work of Verdung (1998) as his classification is the most frequently used instrument typology in environmental policy as policy field to date (Acciai and Capano, 2021). Verdung (1998) provides a threefold typology of policy instruments: *regulations* – rules and directives mandating receivers to act in accordance with that is ordered in them –, *economic means* – both the taking away or handing out of material resources of all kinds –, and *information* – measures undertaken to influence people through the transfer of knowledge, communications, and persuasion (Verdung, 1998, p. 51).

Table 1
Levers for circular development. Based on Williams (2021).

Regulation	Legislation	To encourage circular actions and circular development
	Policies	Policy targets and policies for encouraging circular actions and circular development
	Contracts	Tendering, contractual agreements, environmental programmes to enforce circular development principles
	Planning	Spatial plans, integrated plans, temporary planning permissions, flexible planning, performance-based planning & collaborative planning to enable circular development
Financial incentives	Local currencies	To encourage circular activities or the localised looping of resources
	Pension funds	Invested in circular businesses, services, and infrastructure
	Capital and operational subsidies	For circular infrastructure and circular activities
	Taxation	To reduce waste and encourage circular activities
	Public procurement	To encourage the development of circular products and services
Provisioning	Municipal provisioning	Of services and infrastructures to enable a circular transformation
	Co-provisioning	State/private sector partnering with the community to provide circular systems of provision
Capacity building	Experiments and living labs	To determine the challenges to circular activities and circular development
	Coordination and logistics	To enable circular actions across city-regions
	Data platforms, training, and tools	To enable learning, exchange or resources and enforcement of circular actions
	Fora and networks	To enable learning and coalitions to be built to enable circular actions
	Provision of land	For circular activities

5. Results

5.1. Literature search

A total of 166 articles, reviews, and book chapters met the aforementioned selection criteria and were included for analysis, representing 53% of the total 314 publications initially identified after duplicates were removed (Fig. 2). The reasons for further exclusion of full-text records can also be found in the data set published in the 4TU. ResearchData repository by searching the following <https://doi.org/10.4121/19626861.v1>, which contains the complete list of publications and the analysis carried out. 144 (87%) publications correspond to articles, 4 (2%) to book chapters and 18 (11%) to reviews. In terms of most contributing journals, Sustainability (Switzerland) provided 52 publications, followed by Journal of Cleaner Production with 11, and Journal of Resource Conservation and Recycling with 7. Except for 5 publications, all of them were published between 2016 and 2020 (Fig. 3). 117 articles used qualitative research designs, while 80 quantitative ones, and 29 mixed methods. 119 publications (72%) resort to case studies, being China (n = 19), Italy (n = 19), The Netherlands (n = 12), Spain (n = 11) and United Kingdom (n = 9) the countries with most case studies.

A co-occurrence analysis was conducted to identify the most used keywords in the final literature selection. By using VOSviewer we created Fig. 4, only keywords with at least 5 occurrences were included. The main keywords identified were “circular economy”, “waste”, “sustainability”, “city”, “waste management”, “circular city”, “smart city”, and “economy”. Main keyword co-occurrences link “circular economy” with “waste”, “waste management”, “city”, and “sustainability”.

5.2. Findings according to circular actions

In relation to Williams (2021) circular city development framework, the resulting sample was analysed and sorted out in terms of *circular actions* –looping (n = 119), regenerative (n = 24), and adaptive (n = 50)–, supporting *urban strategies* –localize (n = 90), optimize (n = 59), share (n = 21), substitute (n = 55)–, and *levers for circular development* –regulation (n = 120), financial incentives (n = 30), provision (n = 29), and capacity building (n = 60) –, respectively (Fig. 5).

There is no doubt about looping actions being the most developed in our sample. Table 2 shows the most discussed themes we identified:

We also identified a clear tendency to link circularity with recycling as compared to strategies with higher circularity potential. Articles elaborating on looping actions were often focused solely on such actions, while those on ecologically regenerating and adaptation actions normally were paired with others.

Although ecologically regenerating actions were the least covered kind of action, different themes were identified and shown in Table 3.

Finally, Table 4 shows the identified adaptation actions, which are mostly concerned about (circular) urban adaptation, collaborative governance, capacity building, and knowledge sharing.

5.3. Policy instruments analysis

Our findings were also analysed in relation to the classification of mainstream policy instruments by Verdung (1998), introduced in section 2.2. Regulations are covered, for instance, by Wuyts et al. (2020) advocating for revising existing norms and standards to transit towards a CBE and the prevention of obsolete stock accumulation in terms of vacant housing in Japan. Looking to improve circular ambitions in port-cities, Van den Berghe et al. (2020) call for revising existing CE ambitions in relation to waste incineration operational capacity of two port-cities (Ghent and Amsterdam) as it may create unsustainable development lock-ins. Romero Perez de Tudela et al. (2020) consider that BE material stocks and flows should be included in strategic planning and management of demolition waste as secondary resource. On

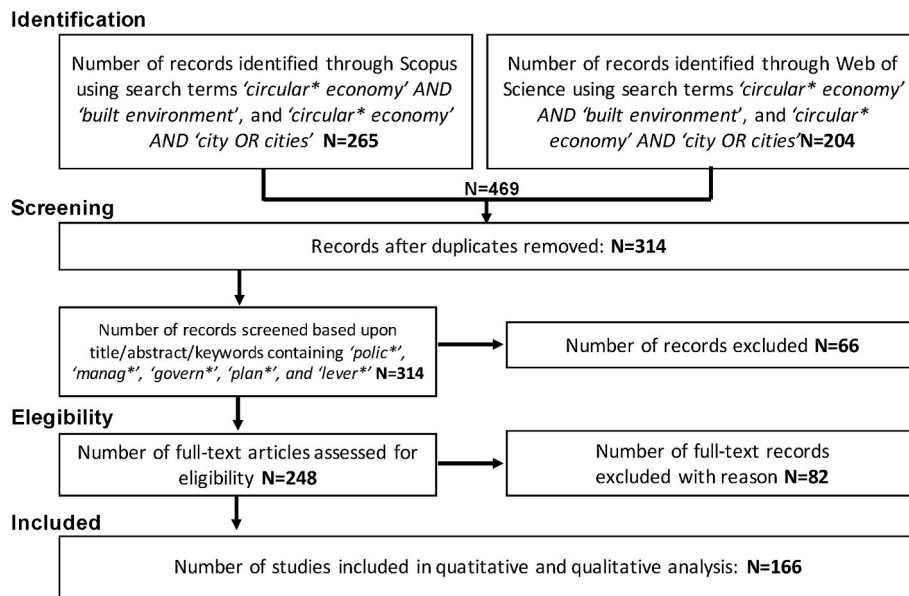


Fig. 2. Information flow for final selection of studies included in review, based on the PRISMA guidelines. Search date April 29, 2021.

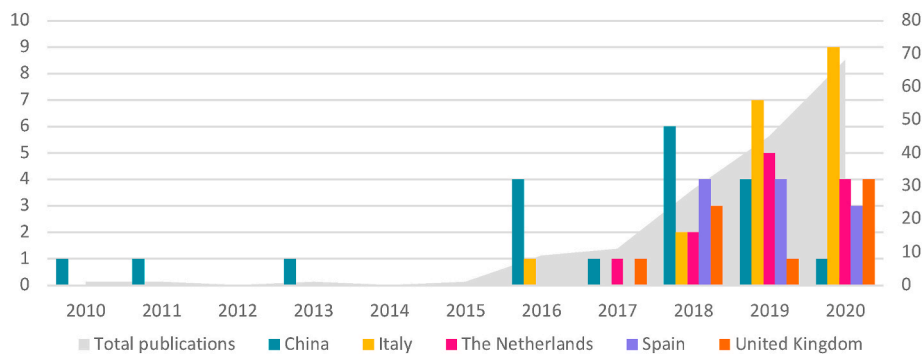


Fig. 3. Yearly publications from 2010 to 2020 for the final literature selection (N = 166). On the right axis, the number of case studies per country, on the left axis the total number of publications for the selected period. Source: the authors.

shared mobility, Patel and Patel (2020) call for governments to be infrastructural and technological facilitators in the transition towards a public bicycle sharing system in India. Similarly, Lazaroiu et al. (2020) advocate for an active role of governments in regulating green public procurement to lead the CBE transition through the purchasing power of states. Finally, on the integration of anaerobic digesters for food waste in urban environments, Fuldauer et al. (2018) advocate for necessary legal reforms in London to make it possible.

Economic policy instruments are also abundant in our selection. Among the most relevant, Sun et al. (2017) propose both tax exemptions to companies adopting urban industrial symbiosis, and an overall carbon tax to fuel the circular transition in China. It is noteworthy that this is the only reference to the internationally acclaimed carbon tax in our selection. Also, Yang et al. (2019) summarize the importance of carbon emission trading markets and carbon emission reduction targets in China. Tax reform is also suggested for Italy and the Netherlands by Amenta et al. (2019) to incentivize the use of secondary materials and circular labour by decreasing taxes in the construction sector. Giorgi et al. (2020) advocate for economic incentives to promote the design for disassembly and the use of secondary resources in circular building regeneration processes. Economic incentives by governmental investments in infrastructure are also covered for the inclusion of waste pickers in emerging urban CE markets in Ecuador by Burneo et al. (2020). Concerning Waste-to-Energy (WtoE) plants, Gutberlet et al. (2020) suggest disincentivizing their usage by economic means, since

WtoE plants show a low degree of circularity as resources are incinerated instead of being mined in landfills in Brazilian and Swedish cities. Nonetheless, WtoE plants are also incentivized in our selection, as it in the case of Thabit et al. (2020) and their research in Jordan wherein WtoE plants are also used to produce clean water. We would also include market formation as an economic policy instrument as for the case of Russia and the extended producer responsibility scheme over the import of tires, documented by Khudyakova et al. (2020), for a market for worn tires is lacking, as tends to be common for secondary resources.

On information instruments, Lanau and Liu (2020) developed an urban resource cadaster to assist urban mining for secondary resources and conclude by incentivizing its usage along supply chains and among stakeholders aiming for component recovery and smart waste management. Awareness campaigns are suggested to improve waste from electrical and electronic equipment (WEEE) in the United Kingdom by Wilkinson and Williams (2020). Free information exchange is claimed as necessary by Yerznkyan and Fontana (2020) to shift the urban water processes towards a circular one. Knowledge transfer and redesign is advocated by Dabrowski et al. (2019) as sine-qua-non action for CE innovation in territories. To make use of urban brownfields for urban ecosystem service provision, Chowdhury et al. (2020) suggest knowledge development and policy guidelines to incentivize different actors at the city level.

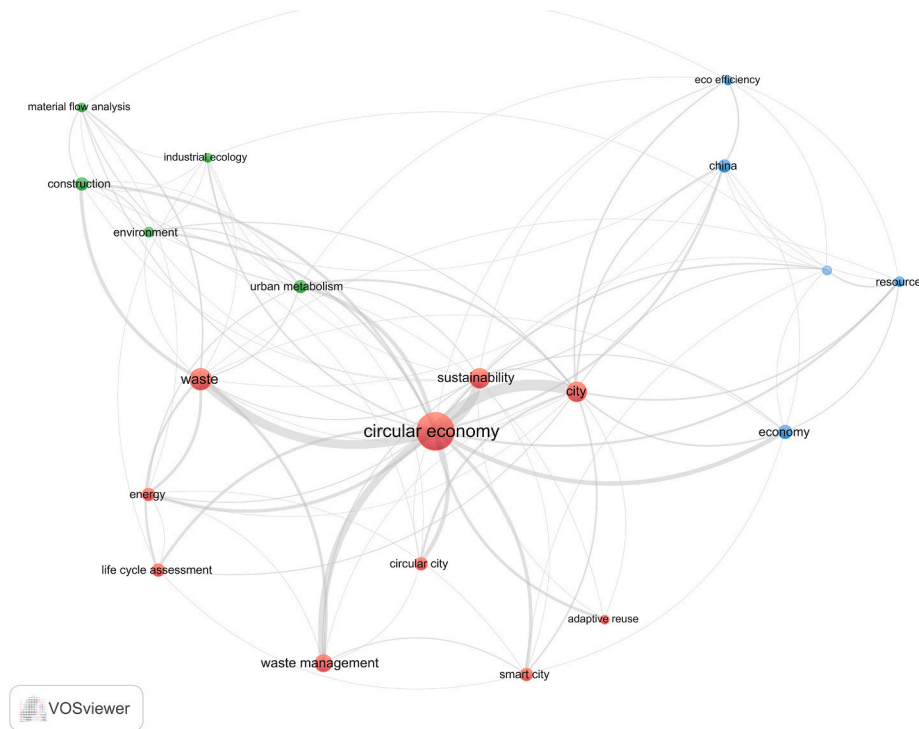


Fig. 4. Keywords co-occurrence network for final literature selection (N = 166). Made with VOSviewer, co-occurrence threshold = 5, colour clusters are automatically assigned by the software. Source: authors.

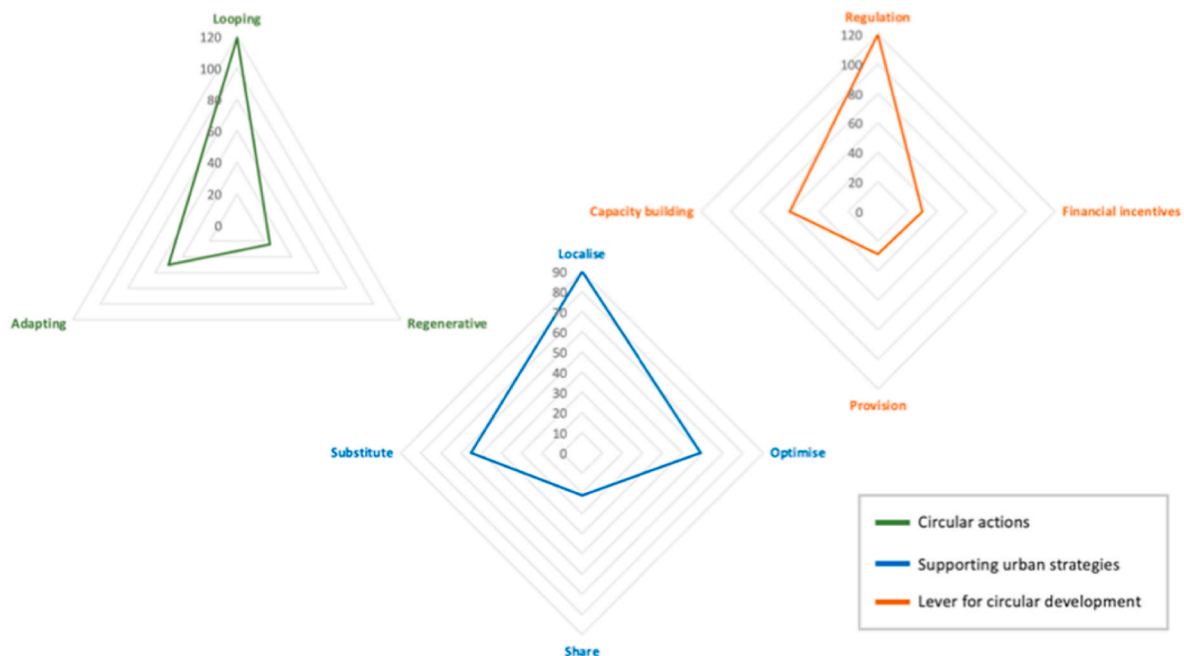


Fig. 5. Final selection sorted out in accordance with Williams' (2021) circular city development framework.

6. Discussion

6.1. Built environment in relation to circular city development

Our results are both expected and unexpected. Firstly, the number of publications that built upon CBE policy instruments is considerable, showing the field is increasing in importance and attention. We also identify the tendency to focus mainly on looping actions in practice is also the case for academic work. Hence, to date, both practically and

theoretically it is clear that circular city development is approached mostly through recovery, recycle and reuse actions. This was expected as several authors point out that in CE literature and operationalization the technically driven and arguably 'easy to understand and implement' approaches dominate, instead of more holistic ones (Korhonen et al., 2018a). A marked focus on looping action also makes the work of Williams (2021) crucial: a circular city is not a compilation of flows, value, and supply chains, and thus a circular perspective to urban development is more than simply getting resource flows right. Also expected was the

Table 2
Selected articles in relation to looping actions and grouped in themes.

Themes	Publications
Circularity in the built environment	Calvo-Serrano et al. (2020); Densley Tingley et al. (2017); Eray et al. (2019); Foster (2020); Foster and Kreinin (2020); Gallego-Schmid et al. (2020); Geldermans et al. (2019); Giorgi et al. (2020); Huang et al. (2018); Lanau et al. (2019); Ness and Xing (2017); Poykio et al. (2019); Sierra-Perez et al. (2018); Talamo et al. (2020); Wuyts et al. (2020)
Waste flows management	Ali et al. (2019); Ghaffar et al. (2020); Huang et al. (2018); Khudyakova et al. (2020); Laso et al. (2019); Oncioiu et al. (2020); Ribic et al. (2017); Schneider et al. (2017)
Resource flows quantification and technology	(Alberti et al., 2019; Ali et al., 2019; Arbabi et al., 2020; Bian et al., 2020; Chang et al., 2019; Esmailian et al., 2018; Fuldauer et al., 2018; Gassner et al., 2020; Hara et al., 2011; Lanau and Liu, 2020; Lausset et al., 2020; Lederer et al., 2020; Macintosh et al., 2018; Marcellus-Zamora et al., 2020; Stephan and Athanassiadis, 2017; Sun et al., 2017)
Resource economics	Aceleanu et al. (2019); Burneo et al. (2020); Diddi and Yan (2019); (Kennedy et al., 2016); Laurenti et al. (2018); Lu et al. (2016); Tong and Tao (2016); Veenstra et al. (2010)
Resource governance	Andersson and Stage (2018); Fassio and Minotti (2019); Gravagnuolo et al. (2019); Kalmykova et al. (2016); Lehmann (2018); Marin and De Meulder (2018); Molina-Prieto et al. (2019); Predeville et al. (2018); Taelman et al. (2018); Wright et al. (2019)

Table 3
Selected articles in relation to levers for circular development and grouped in themes.

Themes	Publications
Urban agriculture and food production	Barthel et al. (2019); Corcelli et al. (2019); Dobe and Zvirbulė (2020); Fassio and Minotti (2019); Gwynn-Jones et al. (2018); Nadal et al. (2018); Saumel et al. (2019)
(urban) ecosystem regeneration and remediation	Dewick et al. (2019); Macintosh et al. (2018); Miguez et al. (2020); Peng et al. (2017)
Urban ecosystem services provision	Cerreta et al. (2020a); Chowdhury et al. (2020); Stefanakis (2019)

Table 4
Selected articles in relation to ecologically regenerating actions and grouped in themes.

Themes	Publications
(circular) urban adaptation	Maria Cerreta et al., 2020b; Hernández-Hernández et al. (2020); Mazzocchi and Marino (2020); Van den Bergh et al. (2020); Wuyts et al. (2020)
Collaborative governance	Cohen and Munoz (2016); Cuomo et al. (2020); Fabbicatti and Biancamano (2019); Fassio and Minotti (2019); Fleischmann (2019); Lehmann (2018); Petrescu et al. (2016)
Capacity building	M. Cerreta et al. (2020a,b); Koop and van Leeuwen (2017); Lu et al. (2016); Obersteg et al. (2019); Ribic et al. (2017); Saumel et al. (2019)
Knowledge sharing	Dabrowski et al. (2019); Izdebska and Knieling (2020)

strong predominance of regulation levers for circular city implementation that shows the pre-development stage of most research efforts. In other words, we think this pattern can be associated with contexts wherein drastic changes in cities' ways to deal with their unsustainable BE have been just recently identified, and for which ways forward are proposed and tested. Thus, academic voices point out the need for envisioning new policy perspectives as well as getting rid of institutional

barriers and lock-ins to foster such new directions – e.g., [Aceleanu et al. \(2019\)](#), [Liu et al. \(2019\)](#), [Pellegrini and Micelli \(2019\)](#), [Predeville et al. \(2018\)](#). Next, it was also expected that optimization and localization as supporting urban strategies were to be abundant in literature, as these two strategies have been widely supported in different circular city and circularity-in-cities frameworks – e.g., [EMF \(2017\)](#) –, over those of substitution and sharing. Likewise, CE frameworks that do not take spatial scales per se into consideration would still call for closing loops at the local scale, which are normally related to the city level.

The most unexpected result is the limited number of publications that touch upon the three circular actions altogether. For instance, [Kennedy et al. \(2016\)](#) discuss the three circular actions in the context of China's ecological balance with a focus on energy consumption and generation. [Yu et al. \(2016\)](#) do this as well by analysing the Chinese transition of resource-based cities to more sustainable ones. [Lehmann \(2018\)](#) resorts to the Urban Nexus Approach implementation for energy, water, waste, and food streams in Asian countries, and starting from resource-efficiency he proposes measures for regenerative planning and urban resilience. [Marin and De Meulder \(2018\)](#) analyse circular cities representations and transition drivers, making clear that circular cities should embrace more than the mere multiplication of urban circular economies. [Nadal et al. \(2018\)](#) study the feasibility of rooftop agriculture implementation in Spain while highlighting the importance of school community acceptance and infrastructural technical properties. [Petit-Boix and Leipold \(2018\)](#) present a catalogue of city practices towards circularity. According to them, cities are implementing several initiatives that aim to turn them into sustainable circular systems. Whether these initiatives achieve their sustainability goals, however, is unknown. [Petit-Boix and Leipold \(2018\)](#) analyse the extent to which research focuses on quantifying the environmental balance of CE initiatives promoted at the municipal level. [Fassio and Minotti \(2019\)](#) focus on using CE indicators and strategies to shape urban food policies to create a new business and political model towards sustainability in Italy. Their project resulted not only in the collection of food waste and redistribution of food surplus, but also on social inclusion incentives and in the creation of a new systemic governance approaches. A last example is [Gravagnuolo et al. \(2019\)](#) that aimed to develop an extensive 'screening' of CE actions in emerging circular cities, focusing on eight European historic port cities self-defined as 'circular'. Their results show the existence of an open field of research that is mainly focused on the assessment of circular cities by 'enriched' urban metabolism assessments that could transcend from the accounting of material and energy flows to more economic, social, environmental, and cultural dimensions of circular cities and regions. All the above-mentioned publications show varied circular city policy considerations, yet the total number of publications working with all three circular actions is 13, equivalent to just 7.8% of the total selection. Likewise, and as it can also be seen from the example just presented, most of the publications to some extent consider aspects of the BE into their analysis, but do not put the focus on it.

6.2. Policy instruments for a circular built environment in cities

Specifically on policy instruments, we discuss our findings by pointing out the publications' distribution according to the four different levers or policy instruments that [Williams \(2021\)](#) has identified in European case studies. Regulation levers, i.e. rules and directives mandating receivers to act in accordance with what is ordered of them, are clearly the predominant ones. This prevalence can be explained by the theory of sustainability transitions, wherein complex transition such as the one of circular cities undergo different phases of development and change to generate radical societal changes ([Köhler et al., 2019](#)). The first transition phase is known as pre-development, wherein the status-quo has not visibly changed, yet governmental action is focused on catalysing and directing actors' efforts towards a desired change. Hence, the pre-development phase is characterized by the creation and fostering of visions, the setting-up of spaces for collaboration, and first

attempts to norm and incentivize desired changes (Loorbach, 2010; Rotmans et al., 2001).

Something worth noting is that when suggesting policy recommendations, authors seem to shy away from discussion of who should oversee the implementation some of the suggested policy changes. For instance, normally when a material bank or database for material flows and stocks is proposed, it is not clear whether public, private, public-private partnerships or communities should be data keepers and managers –i.e., Marin et al. (2020), Obersteg et al. (2020). This is extremely important as ‘discourse on public policy instruments is discourse on power’ (Verdung, 1998, p. 50) and CBE governance is a major aspect of the transition upon which more research is needed (Munaro et al., 2020). Verdung (1998) and Acciai and Capano (2021) also warn that exhaustive typologies for policy instruments are difficult to come up with, which also goes for Verdung’s. What is more, policy instruments may fit in all three kind of policy instruments, depending on their verticality, for instance, a mandate for firms to keep databases of their secondary resources may also be a source of information policy instruments for consumers as secondary resources data is public to access.

Considering the circular city development framework proposed by Williams (2021), we find that comprehensive approaches towards CBE implementation in academic work are still lacking. The prevalence of looping actions supports the thesis that CBE and circular city developments have a marked technocratic direction in research (Korhonen et al., 2018b; Wachsmuth, 2012). A more integrative perspective in research will certainly favour more coherent and comprehensive transition policies. As circular actions are partially covered in academic literature, transition policy for CBE implementation may not be well-informed, hence affecting policy coherence towards effective circular city transitions. This is not to say that CBE research has been unfruitful, for it has to date provided promising innovative design standards, technologies, material substitutes and resource data and measurements, among many others (Ness and Xing, 2017). While CBE research has increased in recent years, its perspectives remain restricted to professionals directly involved in the construction, design, and environmental performance of the BE (Munaro et al., 2020; Pomponi and Moncaster, 2017). What is more, those decision-making spaces where the BE meets the city for the purpose of a circular transition remain under-researched, resulting in unbeneficial reductionism. More holistic frameworks for circular city development are available, for example the Doughnut Economics framework currently being implemented in the city of Amsterdam (Gemeente Amsterdam, 2020). However, the Doughnut was mentioned only once in our selection –by Marin et al. (2020)– for a case study in Belgium, and it is still an infant in the policy process. All the above-mentioned is but a call to increase and spread transdisciplinary actions to embrace complexity instead of trying to reduce it analytically in CBE transitions.

6.3. Validity and reliability of the study

It is a scientific imperative to reflect on the validity and reliability of our methods and data. A systematic literature search through keyword-matching strategies in academic databases benefits from the plurality of sources that may or may not end up being part of a final selection. However, it comes at a cost, as it is not always possible to match the selected search strings to all publications touching upon a somewhat specific topic. This is even more difficult when considering emerging fields of studies in which a shared vocabulary is still in the making, such as those of CBE and circular cities. The validity of our method resorts to the ever-increasing use of the PRISMA guidelines for systematic literature search and review in medical sciences and, more recently, in social sciences. The reliability of our data is supported, firstly, by the selection of widely used policy terms such as *poli**, *manag**, *plan**, *govern** and *lever** as search strings. Secondly, by using two major scientific databases such as Scopus and Web of Science we ensure the inclusion of diverse and indexed sources of information. Finally, the decision to only

include open-access publications enables the full reproducibility of our search as well as the revision of our findings. We acknowledge that these decisions also result in the possibility of omitting relevant sources of data, as does our selection of English as the only accepted publication language for inclusion. Finally, we also focused our attention on the relation between cities and BE due to their known global impacts as different knowledge sources point out the transcendental role of cities as driver for planetary system collapse, leaving out the BE resulting in rural settings, yet the implications for rural BE also deserve detailed study.

The implications of our results are important both practically and theoretically. Increasingly, countries and cities have started or are starting to envision their transitions towards CBE as a main way to achieve their circular city policy goal. Whether transition policies are coherent and well-aligned towards achieving BE that contribute to circular city development requires more research. In practical terms, we claim that predominant reductionist and narrow perspectives resorting to mostly looping actions require revision and more transdisciplinary efforts to ensure that also ecologically regenerating and adapting actions should be considered in CBE policymaking and implementation. Yet, the interaction of all three circular actions is something to be analysed case by case, for each city has a unique context characterized by its space, geography, societies and institutions, and systems of provision, among others. The circular city development framework by Williams (2021) allows the analysis of the relation between CBE and policies for its implementation without focusing the analysis on the BE itself but as a distinctive element of part a city. In terms of theory, we claim that according to our results science is not well-informing CBE decision-making process as research efforts tend to focus on looping actions. Yet, it is widely accepted that sustainable and circular cities are those contributing to solve the ecological crisis that they have caused in the past, present and in the future as drastic societal changes are not undertaken (UN, 2020). Specifically, for the BE it is urgent to advance frameworks that comprehensively account for such ecological impacts and that offer systemic approaches to addressing them.

7. Conclusion

The tradition of policymaking talks about the creation and operation of policy ‘silver bullets’: solutions that from the beginning are understood as *the* pertinent ideas and effective tricks to change specific contexts; however, too often the outcomes of such policies are ineffective as they do not deal with the dynamism of complex adaptive systems (Colander and Kupers, 2014; Kupers, 2020). A circular city perspective for policy focused on CBE and urban transitions helps research and policymaking in not getting stuck in linear solution to complex phenomenon as the case of cities and their sustainability ambitions. For instance, the focus on mainstream ‘circular’ practices as those mainly related to waste management through the recovery, recycling and/or reuse of material flows is not enabling research and policymaking to transcend from looping actions alone to more integrative approaches wherein ecologically regenerating and adapting ones are also well-covered and included. This systematic literature search and review offers a snapshot to support the need for more coherent and comprehensive ways to come up with more sustainable cities and CBE in specific.

The aim of this systematic literature search was to review and analyse the relation between CBE and policies for its implementation as stated in academic literature. The circular city development framework by Williams (2021) was selected as an analytical framework. The goal was to characterize CBE implementation in terms of circular actions, supporting urban strategies and levers for circular city development. The significance of our findings resides in the usage of a circular city concept to approach CBE transition policy implementation, for it provides a more comprehensive multi-perspective set of circular actions for urban development, wherein the BE is not an isolated phenomenon but a result of the complex adaptive system that builds it up: the city. More

specifically, this review sought to contribute an early and concise critique of policy for CBE, while highlighting the need for more coherent and integrative policy decision-making processes.

Summarizing based on our sub-research questions, the three of them have been addressed as follows. Firstly, we identified that 166 publications between 2010 and 2020 elaborate on policy related topic for CBE. This suggests that in a significant, ever-increasing amount of CBE papers, the proposed actions towards a CBE are thus linked somewhat to policy development actions, which we see as a positive aspect for the transition towards a CBE. Secondly, when categorizing these actions, we observed that most of them focus their attention on looping actions, and both ecologically regenerating and adapting actions are not sufficiently covered. Unlike ecologically regenerating and adapting actions, looping ones resort to pre-existing, ongoing transitions in energy and waste management in the last decades in both European and Asian countries, regions the most represented by publications in our sample. This confirms what other authors argued before that CBE and circular city developments have a marked technocratic direction in research. Thirdly after identifying what kind of policy instruments are mentioned or suggested, we found that regulation levers are the most predominant kind in comparison with the other three – financial, provisioning, and capacity building – which we understand as a sign of the immaturity of circular city development approaches and implementation.

We end this article by pointing out different future research directions. Although policy coherence for sustainability transitions has gathered different perspectives in academic work (Huttunen et al., 2014; Kelleher et al., 2019; Nilsson et al., 2012; Rogge and Reichardt, 2016), it has not yet been identified what it means for the purpose of a circular city and built environment transition. ‘What is the meaning of policy coherence?’, ‘How to assess it?’ and ‘Whether or not it is possible to reach higher levels of coherence in policymaking and implementing processes?’ are, to us, research questions that deserve attention and answers. The need for policy coherence and more comprehensive frameworks for its study also talk about the extent to which circular city frameworks include sufficient perspectives to tackle the ecological consequences that their development has caused, as it is clear by now that recovering, recycling, and reusing strategies are already well-advanced but are not sufficient to cope with cities’ unsustainable development. Williams (2021) offers one of the first multi-perspective structured attempts to conceptualize circular city development, in opposition to past ones that did not see the city itself as a system that required changes but a mere space where supply and value chains take place. Yet, it would be beneficial to continue exploring possible missing dimensions to circular city development in the future. Finally, we pointed out just by conducting this systematic search and review that CBE research is not informing circular city development practices in a comprehensive manner, therefore it is imperative to study ways to enhance the theoretical contributions of academia in policymaking processes, as in sustainability transitions in which both science and policy are in pre-development phases to foster radical societal changes.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The dataset is available in an open data repository, as stated with a DOI in the methods section of this article.

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