Ex ante analysis of circular built environment policy coherence

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RESEARCH

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ABSTRACT

As European governments adopt new circular built environment policies to cope with the socio-ecological crisis, the need for evaluating such policies gains in urgency. *Ex post* evaluation is, however, difficult as these policies have not been in place long enough to have had significant effects. Nonetheless, *ex ante* policy evaluation may be possible by assessing policy coherence or the alignment and synergies of policy goals, instruments and implementation practices. This paper proposes a framework to analyse circular built environment policies. This framework is based on a combination of two existing analytical frameworks: circular city development and policy coherence analysis. The framework is tested for the case of a circular built environment in campus development at Delft University of Technology in the Netherlands, which is regarded as an urban development proxy. Policy documents and semi-structured interviews were analysed and coded. Results confirm previous findings about a prevailing focus on looping actions and indicates limited policy instrumentalisation across governance levels. Identified multilevel (in)coherence in circular city policy is pointed out as consequence of siloed-led and supply chain-based thinking and underdeveloped circular policy frameworks. Finally, the analytical benefits of circular city development and policy coherence frameworks are discussed.

POLICY RELEVANCE

Circular economy policies are conceptually limited in delivering a more circular city and built environment. By proposing and testing a circular city policy coherence framework, this article reveals the limited effect of circular economy policies in coping with unsustainable urbanisation. Policymaking and implementation for circularity in the built environment require frameworks that embrace urban complexities instead of reductionist approaches seeing the built environment as a mere agglomeration of supply-chains. Policymakers may use the proposed circular city policy coherence framework as a tool for *ex ante* policy evaluation in diverse areas of urban development, and specifically for built environment interventions. The combination of both content- and process-based frameworks enables the identification of possible (in)coherence in current and future policy goals, instruments and implementation practices. This can improve policy in early stages of implementation and create more effective policy outputs and outcomes in the long term.

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1. INTRODUCTION

Unsustainable urban development is a major driver of the current socio-ecological crisis (Millennium Ecosystem Assessment 2005). The making and operation of the built environment (BE) accounts for 40% of global raw material use, contributes between 25% and 40% of energy-related global CO_2 emissions (Pomponi & Moncaster 2017), and produces 40% of global waste (Ness & Xing 2017). Such a critical context has motivated different governments to adopt policies to change current unsustainable urban trends (Paiho *et al.* 2020).

Circular city policies are being developed by various governments to tackle unsustainable urban development. A circular city is:

> a concept inspired by biological metabolic systems that seeks to apply the principles and strategies of the circular economy (CE) at the different scales of urban functioning.
>
> (Bucci Ancapi *et al.* 2022a: 1)

It aims to reduce a city's intake of non-renewable inputs (*e.g.* energy and materials) and consequently reduce harmful outputs (*e.g.* waste and emissions). This avoids a linear urban metabolism (*i.e.* make–use–waste). The BE is often included in European CE policies as it is the result of linear supply-chains that can be intervened (*e.g.* Government of Scotland 2022; Government of Serbia 2020; Government of the Netherlands 2016). Yet urban metabolism studies have been criticised due to their prevailing technocratic thinking, which tends to depict the city as an agglomeration of supply-chains and resource flows as naturally occurring, ignoring human agency and power aspects (Wachsmuth 2012). CE frameworks for cities have also been criticised as they tend to overlook basic urban elements such as land, and tend to be reductionist by not treating the city as a complex adaptive system, a result of siloed urban interventions (Williams 2021).

Since European CE policies have been in place for a short while they have yielded limited effects in target cities. On the one hand, most national CE policies are to date in early development phases defined by either the absence of policy or recent policy advances (Cramer 2022). On the other hand, circular built environment (CBE) policy research, although increasing rapidly, is still immature (Bucci Ancapi *et al.* 2022b; Munaro *et al.* 2020). Previous research has identified barriers to circularity in infrastructure policy (Coenen *et al.* 2022), studied a CBE in relation to the so-called policy cycle (Yu *et al.* 2022), and pointed out that the current state of research in relation to policy instruments for a CBE is not sufficiently informing policymaking (Bucci Ancapi *et al.* 2022b).

The concept of policy coherence and its analysis deals with consistency in policymaking and implementation. In principle, coherence is part of policy as different policies' objectives share common ideas (May *et al.* 2006). Previous research has shown the benefits of better aligning BE and climate policy (Herbert *et al.* 2022), urban policy and wellbeing (Chapman & Howden-Chapman 2021), and urban regeneration and climate change (Song & Müller 2022) in accelerating local climate actions. Given the early stage of most CBE policies and research, an operationalised understanding of policy coherence may be useful as a tool for *ex ante* policy evaluation. *Ex ante* evaluation is a broad assessment conducted in the early stages of policy or project development. It identifies which possibilities could yield the greatest benefits once implemented. Its premise is that the possibility of influencing a process is greater in early phases of decision-making rather than in operational ones (Samset & Christensen 2017). Although frameworks already exist to assess 'the level' of circularity of a city, they have not been combined with insights into policy evaluation.

The aim of this paper is to develop and test a framework for *ex ante* policy coherence analysis of policies contributing to a CBE. This leads to the main research question: How could an *ex ante* policy coherence analysis of circular BE policies contribute to policy consistency?

The paper is structured as follows. The next section introduces a framework for *ex ante* policy coherence analysis of CBE policies. The methodology is then explained and the case study is presented to test the framework. The results are presented in relation to both frameworks,

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separately. The benefits arising from framework for circular city policy coherence and the validity and reliability of our study are then discussed. Finally, conclusions and policy recommendations in relation to the different stakeholders contributing to CBE policies are provided.

2. CIRCULAR CITY POLICY CHALLENGES

2.1 BACKGROUND

CE policies seek to intervene in the so-called linear metabolism of cities, which denotes unsustainable urbanisation through the intake of unsustainably sourced primary resources for the construction of buildings and infrastructure and the subsequent ever-increasing production of waste (Bucci Ancapi *et al.* 2022a). (Inter)national and local governments have included the BE in their CE policies aiming for a CBE in the coming decades. Generally, in such policies a CBE is fostered by intervening in the supply-chains in the construction and renovation processes through the substitution of primary by secondary resources (*e.g.* sustainably sourced or recycled materials), by standardising circular practices in the design, construction, and deconstruction of buildings and infrastructure (*e.g.* design for disassembly and reuse), by creating markets for secondary resources (*e.g.* through developing norms and standards for secondary use), and by creating, gathering and sharing the necessary knowledge to make a CBE work alongside construction value-chains.

CBE research has rapidly increased in the last decade with a growing interest in policymaking. Ness & Xing (2017) provided the first conceptual model for a resource-efficient BE based on CE principles aimed at, among other goals, guiding policymakers in the CBE transition. Pomponi & Moncaster (2017) proposed a CBE research framework, which contains six dimensions including a governmental one. They concluded by recommending more in-depth policy research as it was found to be one of the least explored dimensions. Munaro *et al.* (2020) identified a research gap in 'circular transition', *i.e.* general policies for the rehabilitation and maintenance of materials, products and systems, and policy instruments such as taxation and regulation. Bucci Ancapi *et al.* (2022b) identified different policy instruments discussed for CBE implementation. To date, most instruments are linked to the adoption of material recycling and reuse, leaving urban aspects of a CBE, such as ecological regeneration and urban adaptation, insufficiently covered. These findings echo criticism raised about the current understanding of urban metabolism for the purpose of urban development. On the one hand, urban metabolism research is critiqued given its limited concern over human agency and power behind resource flows in cities (Wachsmuth 2012). On the other, the early adoption of business-driven CE frameworks for urban development has also been critiqued as they neglect fundamental aspects of cities (Van den Berghe & Vos 2019; Williams 2019a, 2019b, 2021).

The conceptual and analytical benefits of urban metabolism in developing CBE theory are well documented (*cf.* Ness & Xing 2017) and have yielded the possibility to intervene in resource flows in a more efficient and sustainable manner. However, its limited resourcefulness in explaining why resource flows stream the way they do towards, within and out of urban areas has raised questions. Ultimately, urban (re)development is an outcome of power relations (Ness 2022). Wachsmuth (2012) illustrates the difference between treating cities as places where urban metabolism occurs versus cities as the result of their metabolism. Such a distinction goes back to a more fundamental debate about the city–nature relation. The former develops from the work of Wolman (1965) and the use of material flow analysis to get 'the flows right' in a context of ever-increasing resource exhaustion amidst the 20th century. A more sustainable metabolism of a city means being aware of and controlling the intake and discharge of resources in and for cities: nature fuels the city. The latter conceptualisation of urban metabolism comes from the development of urban political ecology (Wachsmuth 2012), a discipline that bridges political ecology and urban geography. Within it, urban metabolism is linked with the socio-ecological drivers of urban development, framed according to eras of economic paradigms (*e.g.* industrialisation, post-industrialisation and globalisation) (*cf.* Pill 2021). Urban political ecology problematises resource flows as socio-ecological drivers and mechanisms through which they are produced and streamed: the city as a socio-ecological product. Although resource scarcity remains central to the understanding of a

city's metabolism, questions concerning who wins and loses with respect to a specific flow are gaining importance. While the study of urban metabolism has absorbed some of the issues on which urban political ecology has shed light, most of its research trajectory remains mainstreamed to the idea of nature as fuel for cities (Wachsmuth 2012).

Mainstream CE frameworks for the development of cities have also been met with critiques. What could be understood as a way to expand a CE to the urban context in the early stages of conceptual development is also seen as an oversimplified notion of what a city really is (Williams 2019a). Williams (2021: 11) explains what moving from CE to a circular city concept entails. A CE focuses on increasing economic efficiency of production systems that results in environmental benefits, and its goal is mainly capital and wealth accumulation. Meanwhile, a circular city (or circular urban system) is a spatially bounded, locally governed system that focuses on systems of provision (*i.e.* infrastructure and services) instead of systems of production. Williams discusses the RESOLVE framework by the Ellen MacArthur Foundation (2015) to make the distinction between a CE and a circular city. Widely known for its 'butterfly diagram', the RESOLVE framework defines a CE as one that creates value through different mechanisms in technological and biological processes. It includes six actions related to ecological regeneration, closed loops of resources, sharing resources, optimisation and efficiency of products, the dematerialisation of products, and the substitution of linear products. Williams's (2021) criticism can be summarised in three main points:

- RESOLVE does not consider space: where those technological and biological processes occur.
- RESOLVE is blind to land and infrastructure as fundamental components of urban development.
- RESOLVE does not consider infrastructure in its conceptualisation, thereby omitting a major stock of urban resources.

Wachsmuth (2012) and Williams (2019a, 2021) trigger the need to question whether circular city policies are consistent enough and if current policy trajectories encompass the necessary knowledge and content to effect urban change.

Policies for a CBE have been framed mainly from the perspective of construction management. The building sector is a major polluter and resource consumer (Nußholz *et al.* 2023), which has motivated policymakers to focus their circularity efforts on construction supply-chains. Williams (2019b, 2021) and Bucci Ancapi *et al.* (2022b) have argued that such flow-centred perspectives come at the cost of understanding the BE as a component of the complex adaptive system. Put another way, the mere juxtaposition of circular flows in cities alone will not bring about more circular urban metabolism (Wachsmuth 2012). A BE possesses artefactual complexity as each built element has its place and changes depending on the agency of people through which the city emerges (Marshall 2012). Hence, the BE is not only an artefact but also the enabler of most urban activities and systems of provision.

Williams (2021) developed a framework for circular cities that bounds three circular actions (Figure 1):

- *Looping actions* composed of reuse, recycle, reduce and other circular strategies. This is related to the so-called 'R-Ladder' (*cf.* Potting *et al.* 2017).
- *Ecologically regenerative actions* foster the regeneration and support of ecosystem (services) diminished by historical processes of unsustainable urbanisation.
- *Adapting actions* in turn seek to improve and support capacity-building and adapt to change.

Williams's framework has previously been used to analyse the state of research concerning policy instruments for a CBE (Bucci Ancapi *et al.* 2022b).

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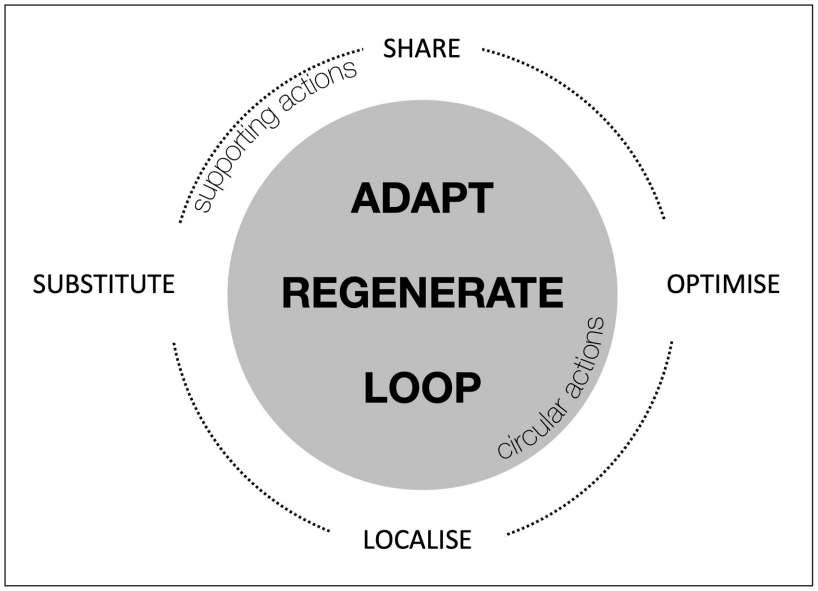

Figure 1: Circular city development framework.
Source: Williams (2021), adapted by the author.

2.2 POLICY COHERENCE FOR *EX ANTE* POLICY ANALYSIS

Policy coherence is:

> an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives.
>
> (Nilsson *et al.* 2012: 396)

Greater policy consistency, stability and effect is an expected result of increased coherence (May *et al.* 2006). Research about policy coherence gained traction in the 2000s (*e.g.* Carbone 2008; May *et al.* 2006; Picciotto 2005), but it was not until 2015 that publications on the topic started to have a sustained increase encompassed in two main groups: governance coherence (related to multilevel policymaking processes) and policy-specific coherence (linked to policy objectives and instruments within a specific policy domain) (Righettini & Lizzi 2022). According to Nilsson *et al.* (2012) coherence deals with relationships between policies, which account for interaction within a single policy domain (internal coherence) or between different policy domains (external coherence). Interactions can also be vertical or horizontal, the former referring to policy relationships at the same level of governance, the latter to relationships across different spatial scales of governance. For the sake of coherence analysis, policy domains are divided into goals, instruments and implementation practices. Although policy coherence analysis has established different research directions and methodological frameworks (*cf.* Righettini & Lizzi 2022), according to May *et al.* (2006: 382), it normally faces two complications when assessing policy: (1) system boundaries: identifying the policies that should in principle cohere; and (2) the inability to directly measure the consistency of policies.

Given the current state of CE policies for cities, its prevalent focus on supply- and value-chains, and the short time most CE policies have been in place, policy coherence may well serve as a policy evaluation tool. Policy coherence analysis has been used as an *ex post* evaluation tool (*cf.* Righettini & Lizzi 2022), but its use for *ex ante* policy evaluation has not yet been tested. However, the European Union (EU) acknowledges that greater coherence is an expected output of *ex ante* policy evaluation. Although *ex ante* evaluation is a EU legal requirement, it is only meant for the appraisal of expenditure programmes (Smismans 2015). What is more, the link between *ex ante* and *ex post* evaluation for policy analysis remain under-theorised (Mergaert & Minto 2015).

Nilsson *et al.* (2012) introduced a framework that builds on the relationships within and/or between policy domains. The analysis is enabled by an analytical template that considers: (1) the overall assessment of interactions; (2) key synergies and conflicts; (3) opportunities for

synergy enhancement and conflict mitigation; and (4) issues and implications. Given its analytical strengths and usage for environmental policy analysis, this framework has become the most cited one for the sake of policy coherence analysis (Figure 2).

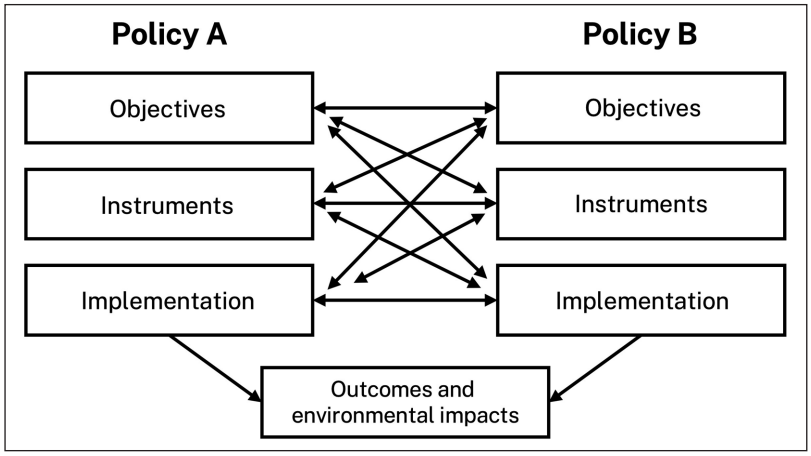

Figure 2: Policy coherence analysis.

Source: Nilsson *et al.* (2012), adapted by the author.

2.3 CIRCULAR CITY POLICY COHERENCE

This paper combines the framework for policy coherence analysis by Nilsson *et al.* (2012) and the circular city development framework of Williams (2021) (Figure 3). Policy coherence analysis can identify possible inconsistencies based on the available evidence: policy documents, their goals, instruments and implementation practices (*process*-based analysis). If policy coherence analysis is paired with a circular city framework (*content*-based analysis) it might provide insights to inform policymakers about the coherence of CBE policies.

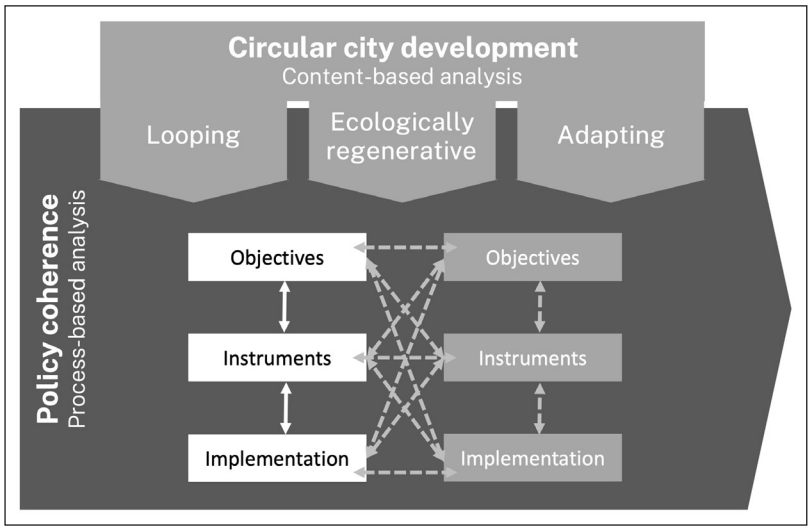

Figure 3: Circular city policy coherence framework.

3. MATERIALS AND METHODS

3.1 CASE STUDY: TU DELFT CAMPUS DEVELOPMENT

To test the proposed framework, a qualitative approach is used. This is based on a test case. Sustainable campus development at TU Delft was selected as a proxy for urban development. The selection of this case follows an information-oriented selection of a critical case (Flyvbjerg 2006), and is expected to deliver enough information for the analysis.

TU Delft is a self-contained, 'touched-by-the-city' campus (den Heijer & Magdaniel 2018), and a public institution. It offers a concrete opportunity to go from national policy goals to local implementation in a single project. This study focuses on the vertical and internal coherence of

BE development as policy domain within TU Delft. The TU Delft campus possess a large spatial scale (6.6% of the total area of the city of Delft) and its development strategy includes the goal of bringing the campus and city closer together (under the concept of 'univercity') (Delft University of Technology 2021).

The use of this case as a proxy for urban development has limitations. Urban development occurs at the intersection of different levels of governance and multiple actors (Pill 2021; van Bueren & de Jong 2007; van Bueren & Priemus 2002). This is not the case for TU Delft as it owns and operates its BE. However, the BE of TU Delft must comply with European, national, and local urban and construction policies which makes it suitable to for the purpose of this study.

The campus of TU Delft has constantly grown and changed during the last century. TU Delft has a long-lasting history of campus-related research (*i.e.* den Heijer 2011; Valks *et al.* 2021) and recently on its campus circularity and carbon emissions (Herth & Blok 2022). It is governed autonomously and funded by its own resources and public–private partnerships. It contains faculties and research centres; administrative departments and specialised units for campus and real estate development (Curvelo Magdaniel 2016; Rymarzak *et al.* 2020); services such as supermarkets, restaurants and gyms; housing for students and staff; and its own energy-production facilities and grid.

In 2018, TU Delft decided to become a circular campus by 2030. By adding this goal to its multi-annual plan 2018–24, the university has taken actions to bring about a more sustainable campus. Most of such changes were recently included in Sustainable TU Delft: Vision, Ambition and Action Plan for a Climate University (van den Dobbelsteen & van Gameren 2021), a sustainability strategy prepared by a recently appointed sustainability coordinator. Of seven strategic operations within campus, three have a direct impact on the campus's BE: ecocampus, construction and renovation, and energy systems. TU Delft aims to halve its intake of primary resources by 2030, in line with the national ambition of lessening by 50% the intake of primary resources in 2030 and 100% by 2050. These three operations are managed by the Campus Real Estate and Facility Management (CRE&FM) Department. Hence, this case study focuses on the internal coherence of policies developed by and for CRE&FM as well as its vertical relationships from the international to the TU Delft level. In 2022, TU Delft announced a budget of €100 million to make its campus more sustainable (Delft University of Technology 2022). To steer the TU Delft sustainable transformation, its governance is a convergence of top-down and bottom-up approaches. Top-down actions come from the university's executive board (College van Bestuur—CvB), while the bottom-up ones come from the cooperative efforts of faculties, administrative departments and the broader university community. A core team with one representative from each university unit articulates collective action together with the CvB (van den Dobbelsteen & van Gameren 2021).

3.2 EVIDENCE

Fourteen policy documents specifically referring to CBE were analysed to assess the relationship between policy goals and instruments. These ranged from the European level to that of TU Delft (see Table S1 in the supplemental data online). This provides an answer to the question of which policies should in principle cohere posed in Section 2.2. The study only includes policy documents with an explicit consideration of CBE goals without considering policy documents that build upon non-BE-related CE policies nor in relation to waste management frameworks. Except for internal TU Delft documents, all are open access. Policy documents from CRE&FM Department were gathered.

Semi-structured interviews (n = 12) with the participants were also conducted to analyse the relationship of previously identified policy objectives, instrument and implementation practices. The recruitment of participants with specialised knowledge on sustainable campus development was conducted by identifying collaborators of the CRE&FM department at TU Delft in internal documents and the university press. The participants are experts in campus health and wellbeing, innovation on campus, energy systems, ecology on campus, construction, and renovation, and from TU Delft sustainability and strategic planning teams. The interviews took place between December 2021 and February 2022 and were conducted online. They were semi-structured

following the factors for policy coherence analysis by Ranabhat *et al.* (2018), which distinguishes five factors, namely: motivation, measures, implementation plans, resources, and monitoring and evaluation. These factors provide information about implementation practices. Interviews were transcribed, anonymised and stored in an encrypted file. Although the sample includes the relevant areas of campus development at TU Delft, it is relatively small and therefore a mitigation strategy was required. Besides selecting interviewees with different expertise in the BE, their insights were triangulated across the sample and with other sources. Thus, cross-validation was possible with secondary data, including the above-mentioned 14 analysed documents (Dąbrowski 2018).

3.3 QUALITATIVE ANALYSIS

The qualitative analysis of both documents and interviews was conducted with Atlas.ti 22. The analysis of policy documents started by gathering them in a single project. As the project is based on Dutch policy documents, some had to be translated into English. Three rounds of coding followed, starting with open coding as a preliminary attempt to identify information of interest, and two further rounds of theoretical coding to identify references to policy levels and circular actions, and factors of policy coherence. In total, 11 codes were created and used for this study. The interviews were recorded in English with prior informed consent. Additionally, the identification of circular actions in the selected policy documents distinguishes between actions explicitly and implicitly referred to. The analysis of internal and vertical coherence was done using the analytical template of Nilsson *et al.* (2012).

4. RESULTS

4.1 ASSESSING CIRCULAR ACTIONS

4.1.1 Loop

In relation to Williams's (2021) circular city development framework, the policy document analysis shows a predominant focus on looping actions (Table 1). In all documents explicit mentions to the R-Ladder were identified. At the university level, policy documents from the CRE&FM department—CRE&FM-01 (2018), CRE&FM-02 (2020), CRE&FM-03 (2021) and CRE&FM-04 (2021)—relate to circularity by defining policy measures such as reduce resource demand, energy efficiency, (locally produced) renewable sources of energy, reuse of energy and material flows, and design flexibility and adaptability of buildings for future needs. CRE&FM-03 (2021) establishes six rules for building renovation:

- sustainability is approached integrally
- sustainability is supported by innovative financial models
- hierarchy for material selection from the avoidance to the reuse of existing materials
- detachability of building components
- waste and transport traffic is avoided in all construction phases
- innovative monitoring and recording methods.

Both the Campus Strategy (Delft University of Technology 2021) and the TU Delft Strategic Framework 2018–2024 (Delft University of Technology 2018), as more generalist documents, only mention a more circular campus as goal. The Sustainable TU Delft: Vision, Ambition and Action Plan (van den Dobbelsteen & van Gameren 2021: 118) summarises most looping actions mentioned earlier in CRE&FM documents and introduces a *New Stepped Strategy* for new buildings design, which:

> commences with reducing the demand by passive, smart & bioclimatic design, then the residual streams such as waste heat, wastewater, and waste material are reused and finally renewable sources are used to solve the remaining demand and only clean and nutritious waste is let into nature.

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At the local level, the Omgevingsvisie Delft 2040 (2021) sets the ambition to improve the circularity of buildings. However, no direct reference to concrete actions was identified. At the regional level, the strategy Circulair Zuid-Holland samen versnellen (Provincie Zuid-Holland 2019) seeks to stimulate innovation in construction by supporting research and applications of new materials (*e.g.* recycled concrete and timber) and flexible building forms (*i.e.* modular buildings). At the national level, policy measures cascade from A Circular Economy in the Netherlands by 2050 (2016) down to The Raw Materials Agreement (Government of the Netherlands 2017), the Transition Agenda Circular Building Economy (Government of the Netherlands 2018), and annual implementation plan Towards a Circular Building Economy (Government of the Netherlands 2019). Thus, these documents share three main goals set by A Circular Economy in the Netherlands by 2050 (2016), namely:

- raw materials in existing supply-chains must be used in high-quality manner
- in the case of needing new materials, these must be sustainably produced, based on renewables, and generally available
- new design and production methods must be organised differently as to promote new ways of consumption.

At the supra-national level, the EU's Circular Economy Action Plan (European Commission 2020) mentions the needs for recycled content requirements in construction projects as well as material recovery targets.

4.1.2 Regenerate

Ecologically regenerative actions are the least mentioned ones. Only three documents include explicit references and only one a more implicit one in relation to the BE. At the university level, CRE&FM-01 (2018) seeks to create a healthy living environment by considering aspects such as greenery, water, biodiversity and climate adaptation in the development of new areas and buildings within campus. The Sustainable TU Delft: Vision, Ambition and Action Plan (2022: 96) states:

> The university will be a natural, biodiverse, circular, self-sufficient, climate positive campus where people and nature co-exist. The campus will be embedded and connected to the green and blue structures around it.

This document is the only one to directly link regeneration and buildings. Hence, greenery does not only take place in green areas but also in hard surface areas (*e.g.* roofs, facades, terraces). The university's botanical garden should be improved to host more flora and fauna. At the local level, Delft's Omgevingsvisie Delft 2040 (Gemeente Delft 2021) envisions a nature-inclusive city through infrastructural green networks spread throughout neighbourhoods, as well as via buildings that offer ecosystem services provision. Only implicitly A Circular Economy in the Netherlands by 2050 (Government of the Netherlands 2016: 59), includes in its vision for 2050 that 'buildings will utilise ecosystem services wherever possible' yet ecologically regenerative actions are not included in the measures the document sets for circularity in the BE, nor anywhere else in the document.

4.1.3 Adapt

Adaptation actions are explicitly mentioned in eight documents and somewhat implicitly in the other three. At the university level, the TU Delft Strategic Framework 2018–2024 (Delft University of Technology 2018: 45) establishes the goal to improve participation by setting up living labs—or local co-creative experimental projects (*cf.* Kris & Ellen van 2017)—through which the university's community 'builds up know-how, financial resources and organisational tools for an effective organisation'. CRE&FM-01 (2018) states that buildings must take future needs on campus into account in early stages of construction processes, thus allowing the flexibility and adaptability of buildings. CRE&FM-03 (2021) requires innovative monitoring and recording methods in the demolition of buildings to reuse components in new construction projects,

thus prioritising the use of locally sourced resources. CRE&FM-04 (2021) includes an integrated approach to a living lab with different TU Delft departments, faculties and research institutes to involve them in the building projects. The Sustainable TU Delft: Vision, Ambition and Action Plan (van den Dobbelsteen & van Gameren 2021) introduces a myriad of positive stimuli to influence the university community's behaviour. Living labs are to be created for the engagement of the university's campus development through workshops, lectures, debates, hackathons, guidelines and tools. A Circular Economy in the Netherlands by 2050 (2016) mentions city deals and local value-chain agreements for a CE by which regional governments, companies and knowledge institutes collaborate in systems of learning, and the construction of indicators for monitoring progress, thus adding additional capacity to local governments. In the Transition Agenda Circular Building Economy (Government of the Netherlands 2018) living labs are also included as a driver for experimentation, cooperation and knowledge-sharing.

Table 1: Circular actions covered in selected policy documents

Note: e = explicit reference; i = implicit reference.

POLICY DOCUMENTS	CIRCULAR ACTIONS		
	LOOPING	ECOLOGICALLY REGENERATIVE	ADAPTATION
Circular Economy Action Plan (European Commission 2020)	e		
A Circular Economy in the Netherlands by 2050 (Government of the Netherlands 2016)	e	i	e
The Raw Materials Agreement (Government of the Netherlands 2017)	e		
Transition Agenda Circular Building Economy (Government of the Netherlands 2018)	e		e
Towards a Circular Building Economy (Government of the Netherlands 2019)	e		i
Circulair Zuid-Holland samen versnellen (Provincie Zuid-Holland 2019)	e		i
Omgevingsvisie Delft 2040 (Gemeente Delft 2021)	e	e	i
TU Delft Strategic Framework 2018–2024 (Delft University of Technology 2018)	e		
Campus Strategy (Delft University of Technology 2021)	e		e
Sustainable TU Delft: Vision, Ambition and Action Plan (2022)	e	e	e
CRE&FM-01 (2018)	e	e	e
CRE&FM-02 (2020)	e		e
CRE&FM-03 (2021)	e		e
CRE&FM-04 (2021)	e		e

4.2 ANALYSING POLICY COHERENCE

4.2.1 Overall policy assessment

Internal coherence in the selected policy documents contributes to synergic interactions. Since circularity became a(n) (inter)national policy goal, it has been operationalised into more strategic objectives and an ever-increasing set of instruments. Given the initial stage of development concerning circularity, most implementation practices have not yet produced visible impacts.

At the European level, the EU's Circular Economy Action Plan (European Commission 2020) includes the BE as a key value-chain in the transition towards a more CE. A Circular Economy in the Netherlands by 2050 (Government of the Netherlands 2016), the root strategy for all later developments in the country in relation to circularity policy, establishes a common framework to move towards an economy that should reduce their primary resource intake by 50% in 2030 and by 100% in 2050. This national strategy creates The Raw Materials Agreement (Government

of the Netherlands 2017) which in turn creates the Transition Agenda Circular Building Economy (Government of the Netherlands 2018), which is executed annually through an implementation plan: Towards a Circular Building Economy (Government of the Netherlands 2019). These policy documents converge in four action lines, namely: market development; measuring methods; policy, legislation and regulation; and knowledge and awareness. At regional and local levels, both the Circulair Zuid-Holland samen versnellen (Provincie Zuid-Holland 2019) and the Omgevingsvisie Delft 2040 (Gemeente Delft 2021) set their circular ambitions in direct relation to the national ones. Although not explicitly, TU Delft policies seem to follow the same national ambitions as they coincide in the timeline for primary resources reduction. The university policy started in 2018 and since then has developed a series of internal actions. The CRE&FM department in four years provided itself with a vision and ambition document on circularity and other sustainability aims, followed by a set of key performance indicators (KPIs), a guideline for circular (de)construction and a special budget for sustainability.

4.2.2 Key synergies and conflicts

At the level of *objectives*, there are no immediate conflicts portraying the BE as a value-chain requiring sustainability interventions. The overarching objective to reduce by 50% and 100% the use of primary resources in the Dutch economy is further detailed in objectives that in our selection can be grouped in eight themes (see Table S1 in the supplemental data online).

At the level of *instruments*, they are all aligned towards the operationalisation of the goals and themes mentioned above. Regulatory instruments cover compulsory material passport and digital logbook use in construction projects and incorporate circularity into governmental standards for construction. Economic instruments cover circular public procurement, including life cycle assessment; subsidies for circular businesses and earning models; incentives for increasing the demand for circular products and services; incentives for research and development (R&D), experiments, prototypes and specific projects; carbon tax; and carbon pricing. Information instruments instead cover strategies, agendas and implementation plans at different governance levels; KPIs; guidelines for demolition; sustainable construction certificates; awareness campaigns; and the inclusion of circularity in education. Although all these instruments are included, only a few have been implemented to date. Most relate to information instruments, as they can be created and put to action by existing institutions within their powers. Instruments with more levering power such as regulations and taxes depend on wider, slower political discussions and hence take longer to be implemented.

For *implementation practices*, advances are observed at two distinctive levels: national and TU Delft. National policy implementation is concretised in Towards a Circular Building Economy (Government of the Netherlands 2019), which defines four action lines, namely: market development; measuring; policy, legislation and regulation: and knowledge and awareness. At the TU Delft level, implementation has changed from the siloed actions of the CRE&FM department to a university-wide, integrative governance process involving all faculties and services on campus. Conflicts were not directly observed, yet considering the existence of other goals such as ecological regeneration and climate neutrality on campus, conflicts may rise when building projects are executed as KPIs are available for carbon neutrality (specified in units), while circularity and ecological regeneration do not have a set of indicators.

4.3 FACTORS OF POLICY COHERENCE

4.3.1 Motivation

Sustainability experts at TU Delft pointed out how motivation comes from a slow but constant process of awareness that first started with researchers, staff members or grassroot movements within the university. Compared with previous policy goals resulting from national policies with which they had to comply, circularity—in the absence of legal standards for circularity—was initially driven and taken up by enthusiasts.

> People are switching and also looking at their own behaviour and that of their own work. The university is really, really working on becoming sustainable and it comes from a lot of people from within and not because they must.
>
> (interviewee 10)

4.3.2 Measures

The interviewees had a clear understanding of the goals and measures to be taken on campus. Most referred to internal CRE&FM circularity goals or to the overall university goals to become circular by 2030. Responses reveal that people have been hired for sustainability purposes on campus. Next to the measures described in Sections 4.1. and 4.2, given the context of the pandemic, new studies and measures are being carried out. Worth noting is the new pilots on hybrid ways of working, which have the potential to optimise the use of office spaces and reduce the demand for new buildings.

> Yes (I am aware). Because I was attracted to help reach those goals for the development on the South campus in at the Kluyver area.
>
> (interviewee 9)

> So there are different perspectives in that hybrid way of working. They're testing it now because they don't want to roll it out for the whole campus for a lot of money, and then maybe the situation is changing and we have to build it back. [...] It's also dependent, of course, of the development in the COVID situation.
>
> (interviewee 8)

4.3.3 Implementation plan

Two central roles were highlighted by the interviewees in relation to sustainability actions specifically: the appointment of a sustainability coordinator at the university level and that of a sustainability programme manager at CRE&FM, both of whom have structured the different circular actions in relation to campus goals. The development of KPIs was also pointed out as a key element to implement actions as they provide a sense of direction in implementation.

> It has absolutely changed. Then I don't know how long the sustainability program manager has been in his position, but I think that's new or relatively new on the campus. I think if you look at the whole sustainability team, we have all these people thinking about how can we speed up the thinking and the visibility of everything that is sustainability on campus, et cetera.
>
> (interviewee 11)

> So one big thing that the sustainability team has been working on is to identify and get sign of KPI's [key performance indicators] for sustainability and projects assessment. [...] If things don't come down to KPIs, then they weren't really, you know, be measurable, so the one is a hard outcome of driving towards actual KPI's for sustainability.
>
> (interviewee 2)

> the atmosphere that has changed and it's within the last year. 'Cause when I talked about other kinds of trees or more flowers make it visible. [...] But one and a half year ago they would hold me for a tree hugger, then all of a sudden I hear other people explaining my ideas to me!
>
> (interviewee 7)

4.3.4 Resources

Resources, both economic and human, have increased recently in relation to the sustainability goals. Interviewees agree that resources have been made more available and strictly aimed at circularity. Yet, as sustainability awareness has increased, also have increased the tasks to meet the increasing number of goals.

> If you would put the amount of attention that goes through sustainability in full time equivalence in CRE&FM, it's definitely gone up over the years. Not only from people who were working on it full time, but also if you look at attention paid by project managers, developers, people from the maintenance department.
>
> (interviewee 1)

> We know that we got €100 million or something, but it is not yet allocated in the campus strategy, so we don't have euros yet. [...] We see we don't have enough people for the job. I'm working to fill in the vacancy. We are 11 people, next year we will have 13.
>
> (interviewee 4)

> For us there are more people and money is put into sustainability, in the transition, yes, but there's more willingness to invest in sustainability and also for a budget but also with people. But I think it still isn't enough.
>
> (interviewee 5)

4.3.5 Monitoring and evaluation

The new sustainability goals require more and new sets of data. Compared with other goals such as carbon neutrality, for which KPIs and standards are available nationally, circularity and ecological regeneration are not as advanced. New ways of reporting are in the making, but at the same time some professionals do not consider them relevant in fulfilling their tasks.

> We should have a, uh, let's say quarterly report on our project portfolio. [...] So what's the combined effect of the interventions that you're going to do and what's the status in each project. Uh, and the second one is for like, I think regular reports on your existing buildings and those are made less frequent.
>
> (interviewee 1)

> Not yet, not yet. We are working on it with the sustainability team. Co-reporting, etc. And then we have to do monitoring. That's also very interesting. Resources monitoring. The request of data increased a lot.
>
> (interviewee 4)

> So basically the ecocampus vision was kind of trial and error way, working towards a known set of KPI's which we haven't developed yet ourselves but we have a pretty clear picture of where we would like to go if we would have to do it.
>
> (interviewee 6)

> No, no. There are goals and I'm free how to implement those goals [...] there are no guidelines.
>
> (interviewee 7)

5. DISCUSSION

5.1 SCALES OF FOCUS

While all circular actions were identified during the analysis, to a certain extent the predominance of looping ones and the noticeable lack of ecologically regenerative ones echoes previous findings about the manner in which the BE is currently treated in CE policy: based on supply-chains instead of circular systems of urban provision (*cf.* Bucci Ancapi *et al.* 2022b; Williams 2019a, 2019b, 2021). What has been characterised as a technocratic direction in circular city and BE research (Bucci Ancapi *et al.* 2022b; Korhonen *et al.* 2018; Wachsmuth 2012) was also identified in the analysis. The limited concern over land and infrastructure in CBE policy as consequence of picking a CE approach over a circular city one was also observed (Williams 2019a, 2021). In the case of TU Delft's campus development, looping actions, such as the reuse of secondary resources

from demolition or requirements for recycling targets in construction projects, appear to be well-equipped by adapting measures such as city deals and living labs, as co-creation mechanisms for decision-making at different governance levels. Nonetheless, the sourcing and availability of secondary resources to fuel a CBE remain insufficiently covered in policy documents, which is elemental for a CE to function (Andersen *et al.* 2020). On the contrary, ecologically regenerative actions are barely mentioned at the (inter)national level, which is portrayed by the inclusion of ecosystem services (such as green facades and roofs) as part of the vision of A Circular Economy in the Netherlands by 2050 (Government of the Netherlands 2016), but without reference to a specific goal or instrument. This may explain why this intention vanishes as the national circular ambition becomes sectoral policy actions. Thus, at the (inter)national level, policies tend not to see the city for the (circular) buildings. Ecologically regenerative actions receive more detailed attention at the regional and TU Delft levels through the inclusion of, for instance, blue and green infrastructure and ecosystem services provision in buildings' facades and roofs. The university's new governance approach offers a more integrative pathway to accomplish its sustainability goals and preventing otherwise siloed CBE developments. From all the analysed policy documents, the Sustainable TU Delft: Vision, Ambition and Action Plan (van den Dobbelsteen & van Gameren 2021) happens to be the most comprehensive in terms of the inclusion of circular actions.

In relation to policy coherence, noticeable is the development of a well-aligned and increasing set of objectives and instruments within CE policies in the Netherlands. This coincides with earlier findings that assessed the circular transition in the Netherlands as one close to an acceleration phase (Cramer 2022). The eight kinds of objectives included in Table S1 in the supplemental data online use 39 instruments including new regulations and standards, economic stimuli such as subsidies and taxes, and guidelines and data requirements. These instruments seek not only to enable looping actions in construction but also the subjacent need for change, such as market development, public procurement as a driver for concrete demand, awareness campaigns and education, and research and innovation. To date, most implemented instruments correspond to guidelines, roadmaps and strategies—or so-called information instruments (Vedung 1998). This became evident through the interviews. While other sustainability goals such as the energy transition are well-equipped with a defined and measurable set of requirements coming from regulations, circularity is not yet quantified through concrete-verifiable units as proposed regulations and standards are still to be established, thus making it difficult to monitor in local projects. Such a context of an underdeveloped set of instruments generates uncertainties in implementation practices. At the TU Delft level, an increasing, more comprehensive set of goals, instruments and implementation practices has been set up recently. From departmental policies in relation to circularity in construction, TU Delft has established a university-wide sustainability governance approach. Nonetheless, as implementation practices are carried out, the need for further vertical alignment becomes evident as many instruments require (inter)national decision- and policymaking.

5.2 BENEFITS OF A COMBINED FRAMEWORK FOR POLICY COHERENCE

The benefits of this combined framework reside in highlighting and uncovering general CBE policy blind spots in relation to circular city development. When coherence analysis is conducted for CBE policies, one may conclude that policies are highly coherent; however, it is not until they are cross-checked with circular city development that they show very general and crucial blind spots. In other words, the framework helps to improve the consistency of CBE policies by equipping an often purely process-based approach to policy coherence with one that is content specific. Thus, this framework serves well in overcoming some pitfalls of ill-informed policies for CBE implementation identified in the literature (Bucci Ancapi *et al.* 2022b) as well as more fundamental boundary limitations to policy coherence (see Section 2.2).

Policy coherence analysis has the potential to become an *ex ante* policy analysis tool. It can help early policymaking processes by identifying integrative opportunities such as pairing looping actions with ecologically regenerative ones for the sake of circular and nature-inclusive BE. Policymakers may use this framework to produce more ambitious and evenly developed policy frameworks that

consider all three circular actions, and the factors of policy coherence can provide justification needed to improve current policy goals and instruments or propose new ones. Likewise, different communities can benefit from this framework. Circular city researchers gain an analytical lens through which to explore the governance of circular urban system. Evaluators can advance towards more comprehensive KPIs and assessment frameworks for circular city development. Campus and city staff may use the framework either in the early phases of planning or in mid-term evaluation processes to yield more effective CBE changes. Circular city practitioners will get a more comprehensive idea about the progress of policy goals, the status of policy instruments and what is expected during implementation. Yet, further research is required to overcome the limitations of this study, which is discussed in the following section.

5.3 VALIDITY AND RELIABILITY

This study faced several limitations. First, it resorted only to explicitly related CBE policy documents without considering, for instance, existing policy frameworks for waste management in a broader sense. Yet this decision was made to highlight the current state of circularity-specific policy development. Second, from all possible policy interactions (*i.e.* internal/external, vertical/horizontal) only internal and vertical ones were considered. It is expected that more insightful analytical outputs result from linking circularity to policy domains such as construction, urban development or spatial planning. Third, campus development at TU Delft was used as an information-driven test case for framework exploration (Flyvbjerg 2006). However, TU Delft was considered only as a proxy for local urban development. Fourth, the data extracted from semi-structured interviews by no means provide an exhaustive account of the internal measures TU Delft has taken and continues to take. Nonetheless, once linked to the factors of policy coherence, the interviews achieve a somewhat detailed account of implementation practices.

The implications of this study are both theoretical and practical. Theoretically, it explores the need for linking CBE policies and its instruments to the urban context. Thus, policy coherence analysis benefits from system boundaries elaborated from scientifically based frameworks, such as that developed by Williams (2019a, 2021). Practically, TU Delft can use these findings to equip their current sustainability efforts with a more integral policy framework. Other local initiatives in the Netherlands might also benefit from this framework if the research limitations are overcome. The current socio-ecological crisis requires comprehensive policy responses that avoid treating complex phenomena such as cities (Portugali *et al.* 2012; Williams 2019a) through siloed policy interventions (Colander & Kupers 2014).

6. CONCLUSIONS

This study shows the potential of using a combined framework for an *ex ante* analysis of circular built environment (CBE) policies. It identifies gaps in governance (policies, instruments and practices) and can assist with creating a more coherent and integrative approach to decision-making processes. Governments as well as other actors can use the CBE policy coherence framework as a general and preliminary checklist for evaluating upcoming urban (re)development projects.

A case study shows the selection of CBE policies from the European to the campus level of TU Delft seems well-aligned to promote looping actions but less so in supporting circular urban development. In general, the underdeveloped policy instruments in (inter)national regulatory frameworks leave innovative local experiments, such as the TU Delft campus development, to their own devices; meanwhile the university waits for clear rules and guidelines for the application of circular strategies.

Echoing Song & Müller (2022), it is an imperative to increase the readiness of higher level authorities to learn from innovative local experiments and to produce flexible regulatory frameworks. Including this framework as a coherence checklist in BE and urban development can better inform CBE and improve readiness in early phases of policymaking processes or before beginning a new policy cycle.

Further research using Dutch cities as analytical objects will improve the validity of the framework and corroborate the generalisation of the findings. CBE policy coherence will also benefit from the study of other cities and countries where circular ambitions are considered for the BE. The expansion of this framework to other aspects of city development, such as urban food production or mobility, might yield greater policy consistency. The overall governance of a CBE would also benefit from a deeper understanding and testing of policy instruments that wait for development such as (updated) regulations, standards and indicators (Paiho *et al.* 2020), and economic stimuli including subsidies and taxes, as existing policy instruments may not bring about a more CBE. Policy instrument and mix research could accelerate the CBE transition. Future research should explore ways to improve policy coherence in the radical and urgent societal changes required to tackle the current socio-ecological crisis.

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COMPETING INTERESTS

The author has no competing interests to declare.

DATA AVAILABILITY

The data collected and used for the purpose of this study have been made publicly available in an open-access repository (10.4121/22250752.v1).

ETHICAL APPROVAL

A statement from the Human Research Ethical Committee from Delft University of Technology indicating approval of the research was obtained. Written informed consent was obtained from all participants of the study.

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SUPPLEMENTAL DATA

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