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A Policy Coherence Framework for Circular Built Environment Implementation: the Case of a Campus Development

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Abstract— Dozens of cities around the world have already envisioned a circular built environment by establishing a variety of sectorial policies, strategies, and roadmaps, among other policy documents. As circularity is introduced in the making and operation of the built environment, caveats have been raised upon the governance of circular transitions. Policy coherence – or the extent to which policies are well-aligned and create synergies for implementation – in circular built environment research remains an unaddressed aspect of policymaking that, when lacking, may affect the transition’s effectiveness. This article aims to synthesize what policy coherence entails and how can it be assessed particularly in the transition towards a circular built environment. To do so, we developed a two-step approach. Firstly, resorting to academic literature we developed a framework for policy coherence and combined it with an existing framework for circular city development. The resulting framework combines four elements: policy levels, dimensions of coherence, actions for circular city developments, and levers for circular development. Secondly, we tested our framework for the transition of Delft University of Technology’s campus, in the Netherlands, towards a circular and carbon-neutral campus by 2030. Results show that the campus transition policy is increasingly improving its coherence, however, a narrow focus on looping actions over ecologically regenerating and adaptation ones may hinder a more integral campus development in the coming years. A circular city development perspective offers the opportunity to embrace more holistic goals, instruments, and implementation measures. Valuing policy coherence as desirable, our framework highlights the benefits and difficulties towards improving coherence. It also shows the importance of understanding the circularity imperative embedded in policy documents by policy makers formulating and implementing the policies for more coherent transitions in the built environment.

Keywords— circular built environment, circular city, policy coherence analysis, urban governance, urban development, campus?.

I. INTRODUCTION

Although homo sapiens are not the only species to construct built environments [1], undoubtedly, we are the only one to deal with the negative ecological impacts the very making and operating of such artifacts produce globally. To cope with the ever-increasing consumption of global resources and energy that built environments require for construction and maintenance, as well as with the waste and emissions that such processes generate, many cities have envisioned a circular built environment. This can be understood as a new paradigm aimed to

reduce the intake of primary resources, close loops of secondary material and energy flows, and reduce the overall waste and emissions otherwise produced in the construction and maintenance process.

Such a transition to a circular built environment requires transverse efforts. From governments, to markets, to citizens, new regulations, incentives, business models, and both producing and consuming practices must be thought, designed, and put into practice. Most of these efforts are embedded in policy documents – e.g., strategies and roadmaps – at different levels of governance – i.e., international, national, regional, and local. Normally, such policies are also divided into different levels of abstraction. They usually start by stating a goal, understood as a normative claim depicting how the future would look like if the policy is effective. Subsequent instruments narrow down the goal(s) by providing a means to reach the goal – i.e., regulation, economic incentives, and information instruments [2]. Finally, implementation processes are the sum of actions carried out to operationalize the instruments, and ultimately the policy goal(s) – e.g., construction and real estate management, procurement, design, research, organizational capacity building.

Although this translation from ideas to actions may seem apparently simple, reaching policy coherence – the idea that goals, instruments, and implementation are well-aligned and contribute to each other towards policy success – is but an intricate task. This is especially significant in policy transitions that require multi-sectorial changes [3], such as the case of the built environment, an elemental aspect of cities, for it is not simply a matter of buildings and infrastructure aggregation. In fact, it is arguably through the built environment that different city functions are enabled, such as health care, housing, education, leisure, production, as well as urban systems of provision [4]. Here lies the complexity of decision-making for the built environment of a city. In the last decades, as policy studies advanced, the question around policy coherence has caught the attention of different fields. Some authors have attempted to approach policy coherence from a historical perspective, unraveling decades of sectorial (un)coherent policy developments [5]. Other have proposed frameworks to analyze policy coherence by identifying different dimensions [5]. The truth is that, compared to other research topics in policy science, policy coherence has not been continued but piecemeal efforts. This brings us to our research question: what is policy coherence and how can it be assessed for the transition towards circular built environments?

The remaining of this article is as follows. Firstly, we introduce the background theoretical grounds of policy coherence and circular built environments. Secondly, the method used to come up with a framework for policy coherence analysis is described, as well as the case study. Thirdly, the results of the analysis are presented. Fourthly, a discussion of the results, the usefulness of the framework, and its limitations is provided. Finally, we draw conclusions and further research directions.

II. LITERATURE

2.1. Policy coherence

Policies do not exist in a vacuum. When a new (circular) policy is put to work, it usually coexists with others and in presence of old ones that cease to be effective or adequate. Even in the absence of a prior policy it often will encounter overlaps with other sectoral ones. Thus, a (new) policy may either catalyze policy effectiveness or create unintended negative consequences.

Policy coherence is one of the analytical concepts that deals with the issue of consistency in the making and implementation of policy. Following May et al. [6], coherence indicates that different policies go together for they share a certain set of ideas and objectives. A more comprehensive concept defines it as a policy attribute that

fosters the ‘systematic promotion of mutually reinforcing policy actions across government departments and agencies creating synergies towards achieving the defined objective’ [7] (p. 24). While it is a concept easier to understand than to measure, it is acknowledged among scholars that greater coherence is often desirable, for it is associated to greater policy stability [6]. At the same time, policy coherence is both a political and economic imperative because it seeks to avoid the image of an inconsistent governor from political competitor and the public, and because it tries to avoid the wasting of scarce resources, respectively [8]. However, difficulties in policy coherence assessment arise from (1) the identification of policies that should in principle cohere, and (2) the apparent impossibility to measure it directly [6].

To overcome these difficulties, scholars have proposed different analytical approaches. May et al. [6] claim that approaching coherence from different attributes –namely issues, interests and targeting– may be an adequate analytical approach. Mickwitz et al. [7] extends May’s suggestion by focusing on policy sectors or domains, target groups and geographical areas. Meanwhile, for Nilsson et al. [9] there are four types of coherence analyses: internal – policy interactions within a single policy domain (i.e., transport)–, external – between different sectoral policies –, horizontal – between policies at the same level of governance –, and vertical – for policy interactions across different spatial scales of governance; all of which should focus their analyses on the relationship between policy objectives, instruments, and implementation, including its outcomes. Nonetheless, Nilsson et al. [9] also identify that there are delineation problems that need to be solved before the coherence analysis. One of them is the case of the seemingly interchangeability of the concepts of policy coherence and integration. Nilsson et al. (ibid.) offer a solution by referring to coherence analysis by focusing on policy outputs, while integration primarily aims to study the upstream policy processes and their related institutional arrangements.

The work of Huttunen et al. [10] is arguably one of the most notorious efforts for policy coherence analysis. Starting from Nilsson et al. [9], though they stick to the need for studying policy’s objectives, instruments and implementation, they also recognize a temporal dimension as the current state of policies and their development through time must be taken into account for long-term systemic changes, so to foster sustainable path dependences and avoid unsustainable lock-ins. (Fig. 1). Huttunen et al. [10] also recognize the tendency in policy coherence analysis to prefer top-down approaches over top-down/bottom-up mixes. The issue of such preference shows when coherence is only analyzed in terms of its vertical consistency (from objectives to implementation) or procedural aspects [9], which does not give space to identify relevant policies and specific issues that the affected targeted groups may experience during policy implementation.

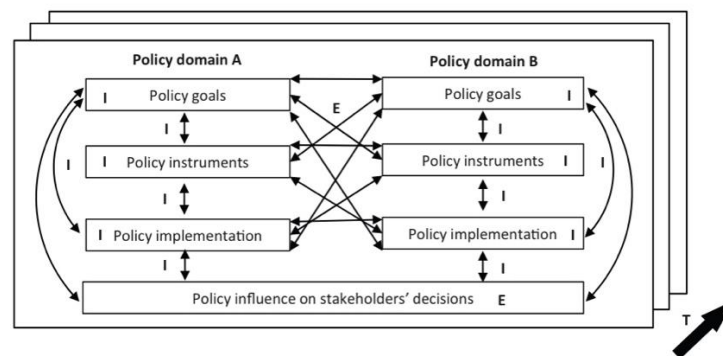


FIGURE 1. Dimensions of policy coherence by Huttunen et al. [10], modified from Nilsson et al. [9]. Internal coherence appears as I, external coherences as E, and its temporal dimension as T.

Policy coherence is not exempt from pitfalls. According to Carbone [8], coherence is often sacrificed in light of new interests, increasing levels of negotiation –e.g., as a consequence of decentralization–, or because a diversification of the elements of a certain policy. Similarly, May et al. [6] point out three major difficulties when analyzing coherence in policy. Firstly, policy goals and objectives can be written in multiple ways, they can be framed narrowly or broadly, straightforward, or merely symbolic. Secondly, given this context, an easy attempt to read through the lines is highly subjective to evaluate consistency. And thirdly, there is no operational degree for commonality or consistency for policy goals, therefore it cannot be measured directly. The work of Huttunen et al. (2014) raise questions around the usefulness of centering the analysis solely on vertical or top-down coherence and not including the perspectives of those groups affected by the policy.

2.2. Circular built environment implementation

A circular economy (CE) can be described as an economy that maximizes the products and services produced by using cyclical material flows, renewable energy sources and cascading energy flows, while respecting the ecosystems' natural reproduction rates (Source). In that perspective, circular built environments have been pointed out as a solution to the ecological impact and for a more sustainable development of cities [11]. Research for circular built environment has rapidly increased in recent years. Munaro et al. [12] show how publications went from 7 articles in 2014 to more than 150 in 2019. They also identified five main research themes, namely: recycled/reusable materials, circular transition, tools, and assessment to support circular buildings, product and building design, and stock and flow analysis of resources and materials. Most research is concentrated in Europe (74%) and Asia (17%), being the United Kingdom, China, Italy, Spain, and the Netherlands the predominant countries in terms of volume of publications. Both Ness and Xing [13] and Kirchherr et al. [14] provide an extensive account of the principles and approaches commonly used in CE in the built environment research. Some of the approaches were adopted from earlier stages of development in CE, such as those coming from Industrial Ecology –i.e., Material Flow Analysis (MFA) and Life Cycle Assessment (LCA). Others have been developed within circular built environment research –i.e., Urban Mining and Material Passport. Yet, the development of a circular built environment has not depended entirely on academic work. Actually, the CE is characterized by important contributions from practitioners, for instance, consulting firms and international organizations [14].

Recently, different cities and countries have envisioned a circular built environment or introduced specific circular strategies in the way they construct and manage their built environment [15]. Arguably, the majority of cases are in a pre-development phase, wherein governments have initiated the formulation of long-term visions and the mobilization of other actors, but usually the status quo does not show visible changes [16].

A circular built environment implies a complex, relational material and immaterial multi-level system of resources, institutions, and different entities. Construction materials are turned into components that together make a building, from buildings and the needed infrastructure we get a built environment, and that is still just part of a bigger system known as a city. Some authors have even claimed that buildings do not actually exist, instead they are systems of layers of built components [17]. In CE literature there are calls for systemic understanding of cities and the built environment they embody [18]. In fact, these calls refer to complex systems, since cities are dynamic and adaptive ecosystems [19]. Remarkably arguably current circular built environment research falls short in its understanding of the BE in a systemic way [20]. It often relies on reductionist or even over-simplistic perspectives. For instance, prevailing approaches in CE research are ultimately technocratic:

becoming circular is more about getting the resources and energy flows right than treating unsustainable patterns of production and consumption as a social-natural problem [21]. Yet, these environmental measurements are essential for managing a sustainable built environment [22, 23], but predominant narrow perspective on environmental performance [12, 14] may not be sufficient to bring about a circular built environment [20]. Therefore, a multi-level and multi-entity systemic perspective implies that there are certain causal mechanisms triggered by human and non-human entities that structure the process of built environment making [24]. Arguably, this process is relational in essence, as it depends on context-dependent long-term reciprocal relationships in specific modes of governance and economic coordination contextualized by relational closeness and spatial proximity [25]. Similarly, multiple entities that co-create the built environment, architects, planners, public agencies, real estate companies, civil society, and financial institutions, are often pointed out as incumbents in built environment making. However, when the CE is introduced, less relevant – not new – actors need to be called into decision-making processes; Among them, material and component producers, knowledge centers, and international organizations. Summarized, a circular built environment can be regarded as an complex adaptive multi-level network of local to non-local material and immaterial resources, assets, institutions, and entities.

III. FRAMEWORK DEVELOPMENT

3.1. Conceptual and analytical frameworks

Prior to our analysis, we need to fulfill an analytical requirement. We need a conceptual framework to understand circularity in the context of the built environment, and an analytical framework for the purpose of analyzing circular built environment policy coherence.

Building up on previous work (cf. Bucci et al. forthcoming), we decided to resort to the work of Williams [4] as it provides a concise conceptual framework for circular city development. There are several reasons to adopt this conceptual framework. Firstly, although to analyze the built environment within construction research may provide a well-defined system boundary, it may also fail to capture the characteristics of the complex adaptive system that enables a built environment, namely, the city. We claim that implementing a circular built environment is not an end, but a means to make a city and its urban systems of provision more circular and, thus, improve the ecological impacts of urban areas around the world. Therefore, it makes sense to look at the built environment from the perspective of city development. Secondly, the circular city development framework by Williams [4] has already been used successfully to identify what policies and policy instruments are referred to in academic publications for the implementation of circular built environment (Bucci et al. forthcoming). The identification of policies and instruments was possible as the circular city development framework distinguishes three circular city actions – i.e., looping actions, ecologically regenerating actions, and adaptive actions –, four supporting urban actions – i.e., optimization, sharing, substitution, and localization –, and four levers for circular development – i.e., regulation, capacity building, financial incentives, and provision. A summary and explanation of the different actions and levers is presented in table 1. Finally, the different actions and levers included in the framework can be assimilated to the interacting layers of policy, namely: goals, instruments, and implementation, which is useful for the purpose of policy coherence analysis.

To select our analytical framework for policy coherence, we conducted a series of searches in the Scopus database, so to come up with a framework that was both pertinent and well-established in literature. Date last

searched was September 29, 2021. At the time of writing, after trying different search strings in the Scopus database, we could not find any article focused on (“policy coherence” AND “built environment”). Slightly different results were obtained when searching the database for (“policy coherence” AND “circular economy”), for only one article was found – cf. Molocchi [26]. Yet, this recently-published article found offers a robust perspective on the relation between harmful chemicals and the policy instruments set for the circular economy transition in Italy. A different story followed from looking into (“policy coherence” AND “analy*” AND “framework”), as it resulted in 90 documents. Surprisingly, the above-explained framework by Nilsson et al. [9] happens to be the most cited publication with 158 references, followed by the work of Collin [27] with 57 citations, and Chandra and Idrisova [28] with 53 citations.

Therefore, considering that the work of Nilsson et al. [9] is (1) a framework for policy coherence analysis applied to environmental policies, (2) that it is academically recognized as it has been referenced in more than 150 publications, and (3) that it has proven to be adaptable to different contexts of policy coherence analysis, we decided to develop our framework upon their work, and the more recent adaptation of Huttunen et al. [10] (Figure 1).

TABLE 1. Circular city development actions and levers

Circular actions	Looping	i.e., reuse, recycling, and energy recovery
	Ecologically-regenerating	i.e., blue and green infrastructure
	Adaptation	i.e., flexible design, collaborative planning, co-provision, and systems for learning
Supporting urban actions	Optimization	i.e., biogas from organic waste, cascading
	Sharing	i.e., shared schemes of transportation to slow resource loops
	Substitution	i.e., replacing gray infrastructure by green infrastructure
	Localization	i.e., resources and energy flows
Levers for circular development	Regulations	i.e., legislation, policies, contracts, planning
	Capacity building	i.e., experiments and living labs, coordination and logistics, data platforms, for a & networks
	Provision	i.e., municipal provision, co-provision
	Financial incentives	i.e., local currencies, pension funds, taxation, public procurement

Description of circular city development actions and levers as described by Williams [4].

3.2. Case study

Campus-based universities in the 21st century can be arguably seen as cities on their own, although of course vastly less complex, as such making it interesting at least for research purposes. Depending on political regimes and their own inner organizational structures, universities may be governed by themselves as autonomous entities, and fund themselves with a mixture of public – e.g., national budgets –, private – e.g., donors –, and self-generated resources – e.g., consultancy projects and university-(semi-)owned companies. Given the extensive area of a campus, universities often have specialized organizational units in charge of campus development and the implementation of their own master plans. The complexity of a university’s functioning may also contemplate the existence of different faculties, institutes, and departments responsible for education, research,

and management. Some universities even have housing, shopping, sport, and cultural facilities within their campus.

Thus, we claim that a campus offers a great opportunity to test policy coherence, as the multiple dimensions of policy coherence are more easily recognizable. *Internal* coherence is to be found in every policy document a university establishes for its internal functioning and outreach. *External* coherence can be checked among different policy documents embedded in the same organizational unit or department. The *horizontal* dimension of coherence differs from the external one as the former relates the policies of the different organizational units within the university. The *vertical* dimension is rather evident as a university receives directives from the national level through, for instance, a ministry of education. Finally, the *temporal* dimension shows when considering the historical development of policy for a particular policy domain and the policy signals towards future development that can be either identified in policy documents or communications.

3.2.1. Delft University of Technology: a circular and carbon-neutral campus by 2030

In its 2018-2024 Strategic Framework, Delft University of Technology (TUD) set the ambition to become a carbon-neutral and circular campus by 2030. Although, and literally, this ambition is a single phrase in a fifty-pages document, it unchained a series of internal ambitions, policies, guidelines, and action plans at different organizational levels. Thus, circular and carbon-neutral ambitions were set for the entire University, its campus, and the different organizational units that build up and maintain the campus' assets. Campus development at TUD is a historical process that started in the 19th century and continues to date. What is now known as TUD campus in the south edge of the city of Delft started to be built in the late 1890's. It was not until the 1990's that the Dutch government transferred the ownership of the campus to TUD [29]. The university's campus covers 161 hectares of land and has the ambition to redevelop its north and central areas, as well to develop the south end in a circular and carbon-neutral manner. There are three main linked target to do so: energy transition, buildings, and health and well-being on campus.

While the entire University is on board the transition process, the Campus & Real Estate (CRE) Department has taken the lead as it is its responsibility to manage the construction and maintenance of assets within the campus. Therefore, we decided that their policies to be the main scope of our analysis. Thus, both the internal and external dimensions of coherence will be focused on TUD Campus & Real Estate policy.

IV. RESULTS

4.1. Policy documents reviewed

A total of 12 documents were selected, reviewed, and coded using Atlas.ti – for more information see Yin [30]. Codes were extracted from the different aspects of policy coherence shown in Figure 1 – i.e., goals, instruments, and implementation – and Table 1 (N=14). We decided to leave out the policy coherence analysis aspect of Policy influence in stakeholders' decision shown in Figure 1 as the perspective of stakeholders involved in the transition is the next step of our research, for which we do not have results yet. The selected documents are shown in Table 2. As some policies are confidential and only for internal use of TUD they had to be anonymised. Nonetheless, a short and clear description is provided to guide the readers. Some documents were only available in Dutch and therefore had to be translated prior analysis.

TABLE 2. Policy documents reviewed for analysis

Dimension	Scale	Document
V	International	Circular Economy Action Plan (2020)
V	National	A circular economy in the Netherlands by 2050 (2016)
V	National	Grondstoffenakkord (Raw Materials Agreement) (2017)
V	National	Transitieagenda Circulaire Bouweconomie (Transition Agenda Circular Building Economy) (2018)
V	National	Naar een circulaire bouweconomie (Towards a circular building economy) (2019)
V	National	Klimaatakkord Nederland (Climate Agreement for Dutch Universities) (2019)
V/T/H	Local	TU Delft Strategic Framework 2018-2024 (2018)
V/T/H	Local	TU Delft Campus Strategy (web)
I/E/T	Local	CRE-01 – Vision and Ambition for development, new buildings, and operations (2018)
I/E/T	Local	CRE-02 – Key Performance Indicators and Criteria for making a sustainable campus (2020)
I/E/T	Local	CRE-03 – Guide for Circular Renovation (2021)
I/E/T	Local	CRE-04 – Deployment of sustainability resources (2021)

Policy documents organized according dimension and scale. I = internal, E = external, V = vertical, H = horizontal, T = temporal.

4.2. Dimensions of policy coherence

In this section, for each dimension we offer a summary of the goals, instruments, and implementation measures identified, followed by their relation regarding the circular city development actions and levers.

4.2.1. Internal

4.2.1.1. policy levels

Four policy documents from CRE were analyzed for this dimension. *CRE-01* states the vision and ambition of CRE for sustainable campus development, new construction, and operations. There are three main goals: a (1) carbon-neutral campus, a (1) circular campus, and (3) better health and well-being on campus, all by 2030. The document also highlights explicitly the early stage of development of these goals and its focus mainly on campus carbon-neutrality and circularity and while new directions are explored through living labs for health and well-being. Although the general ambition has not been mapped out yet, CRE decided to follow six policy measures: (1) to reduce the demand for energy and materials as much as possible, (2) to fulfill the functions for which energy and materials are used as efficiently as possible – i.e., with a minimum use of energy –, (3) to obtain energy as much as possible from sustainable sources or from existing residual flows, (4) to produce, wherever possible, more renewable energy than is directly needed for use elsewhere, (5) to enable the reuse of energy and material flows after they have fulfilled their original function, and (6) to take possible future needs into account at an early stage and provide for flexibility and adaptability.

CRE-02 presents a set of Key Performance Indicators (KPI) as an instrument for carbon-neutrality by 2030. Carbon-neutrality is one out of five spearheads established by CRE for the development of KPI, next to circular campus, campus that contributes to health and well-being, biodiversity and ecology, and climate adaptation. Carbon-neutrality is the only spearhead to have concrete values or units as indicators. Circularity has

KPI but units or values are being decided. Indicators for the remaining spearhead are said to be available in the short-term. The KPI for carbon-neutrality distinguishes three scopes, namely: Scope 1, concerned with direct emissions from the facilities and activities of the TUD; Scope 2, which concerns with the indirect emissions from the purchase and activities of the TUD, and; Scope 3, focused on the indirect emissions caused by all up- and downstream emissions in the value chain, from sources that are not owned by TUD. Scope 3, in turn, is responsible for the largest part of the total campus footprint. Within scope 3, 'Construction & Real Estate' causes the most emissions, reason why the KPI are focused on embodied carbon. There are three sub-targets to a carbon-neutral campus by 2030. Circular campus instead is based on circular principles for creating, linking, continuing, and closing cycles. Two principles are followed to come up with KPI for circular campus: climb as high as possible up the R-Ladder [31] so to prioritize Refuse, Reduce, and Reuse; and to think buildings as a system of multi-temporal components so to foster adaptability, desassembly, reusability, the sustainable sourcing of materials and components, and the design and plan of maintenance and new building.

CRE-03 is a guide for circular renovation seeks to adapt renovation processes in relation to the R-Ladder, and thus it aims to assess the materials and components released from all disciplines in their reuse potential. *CRE-03* also lists a set of six rules for new construction. Rule 0 is precondition all the other rules: sustainability is approached integrally. Rule 1 says that sustainability is financially supported by innovative financial models. Rule 2 sets a hierarchy for material selection: avoid material use, reuse existing materials, and select new materials based on circular, renewable potential. Rule 3 impose the detachability of building components. Rule 4 is about the avoidance of waste generation and transport before, during and after a construction phase. Finally, rule 5 states that circularity requires innovative monitoring and recording methods.

CRE-04 frames the deployment of resources for sustainable campus development at TUD. It puts emphasis on alignments to the TUD ambitions to become carbon-neutral and circular by 2030. Great attention is put on the development of the South-side of the campus, which will contain most of new buildings on campus. The budget execution also builds upon the KPI developed by CRE a year before in *CRE-02*.

4.2.1.2. Relation to circular city development actions and levers

By using networks on Atlas.ti for the codes we created prior to the analysis, we were able to identify the most relevant circular city actions and levers for each document.

- *CRE-01* builds upon two circular city actions, namely, looping and adaptation actions. Identified supporting urban actions were localization, substitution, and optimization. The only identified lever was capacity building.
- *CRE-02* instead focuses on supporting urban actions such as localization, substitution, and optimization.
- *CRE-03* covers looping and adaptation as circular city actions. All four supporting urban actions were identified. In terms of levers, regulations, financial incentives, capacity building, and provision were observed.
- *CRE-04* included adaptation and looping as circular city actions. All supporting urban action but sharing were identified. Likewise, all levers for circular city development were mentioned in the document.

4.2.2. External

4.2.2.1. *policy levels*

The same four documents used for analyzing the internal dimension of coherence were used for the external one. To fulfill the TUD ambition toward a carbon-neutral and circular campus, CRE put into place different goals, instruments, and implementation measures. As main policy goals CRE-01 states carbon-neutrality, circularity, and health and well-being. To fulfill these goals CRE-02 provide a series of KPI as policy instrument, although it is still underconstruction. Both CRE-03 and CRE-04 cover implementation measures on circular renovation and budget execution for circular renovation and construction. Thus, the three policy levels under study can be identified. Nonetheless, there is a mismatch between the spearheads pointed out in CRE-01 and CRE-02, for the former establishes three spearheads (i.e., carbon-neutrality, circularity, and health & well-being) and the latter establishes two more, making a total of five (i.e., biodiversity and ecology and climate adaptation).

4.2.1.2. *Relation to circular city development actions and levers*

In relation to the actions it is clear by now that the main foci these documents are on looping and adaptation actions. Policy changes are driven in a way that from goals to implementation there is a coherent policy signal considering those two actions. However, the lack of ecologically-regenerating actions is rather concerning as, from the perspective of renovation and new buildings, it is an action that is better taken in the designing and planning phases of a project. To this, CRE states that it is a result of the early stages of policy development, and that in the short-terms there will be, for instance, KPI related to ecological regeneration and the remaining spearheads.

When it comes to supporting urban actions, we identified three predominant foci, namely: localization, substitution, and optimization. This is arguably logical given the prioritization of the first spearhead: carbon-neutrality. Thus, efforts have been put into creating sources of renewable energy on-site, to substitute fossil fuels with sustainable alternatives, and to optimize the current use of TUD energy and spaces to meet the reduction targets of 2030. Yet, the trade-off in terms of the circularity potential of those sustainable solutions for energy generation and distribution are still to be considered. Sharing, as supporting urban action, is barely touched upon in these documents.

Concerning levers for circular city development, arguably there is an evolution from CRE-01 to CRE-04. CRE-01 highlights the need for capacity building through, for instance, living labs, as the policy transition is understood as a ‘journey of discovery in co-creation’, but does not elaborate in relation to other levers. When looking into CRE-02, the upcoming set of KPI can be seen as a normative lever in terms of monitoring and evaluation of target accomplishment, yet its technical nature does not encounter any other levers in its way. Not surprisingly, provision as lever is an overarching action, for CRE is strictly related to the provision of services and infrastructure within TUD campus. CRE-03 and CRE-04, the two most recently developed policy documents, do refer about a more diversified set of levers. All four levers are to be found to a certain extent in CRE-03 when guiding circular renovation processes. Perhaps, the most relevant levers included in CRE-03 are capacity building and regulation, for it highlights the need for a material passport and an internal inventory of furniture and components so to partly supply TUD demand with what is already within the organization, as well as it provides a set of rules for renovation and transformation. CRE-04, as it mainly deals with the deployment of economic resources, is strongly focused on providing sufficient financial means – according to the document – to new developments in the south area of TUD. The existence and execution of a dedicated budget to TUD circular and

carbon-neutral campus development is a clear example of financial incentives as lever for circular city development.

4.2.3. Vertical

4.2.3.1. *policy levels*

The analysis of this dimension considered six policy documents from the International to the national level. At the national level two streams of policy documents were selected, namely, that of a circular economy for construction and that of a climate agreement for universities in the Netherlands. The *Circular Economy Action Plan* (2020) states the goal to achieve climate neutrality by 2040 and decoupling economic growth from resource use in Europe, and identifies ‘construction and buildings’ as a key product value chain. A new Strategy for Sustainable Built Environment is to be launched in 2021-2022, which will resort to different instruments, namely: construction production regulation; digital logbooks for buildings; sustainable finance framework and public procurement that integrates life cycle assessment; material recovery targets; and, soil sealing reduction.

A Circular Economy in the Netherlands by 2050 [15] is the Dutch national strategy towards circularity launched in 2016. Three strategic goals are mentioned: (1) raw materials in existing supply chains are utilized in a high-quality manner; (2) in cases which new materials are needed, fossil-based, critical and un-sustainably produced raw materials are replaced by sustainably produced, renewable, and generally available raw materials; and, (3) to develop new production methods, design new products and organize areas differently, as well as to promote new ways of consumption. Among five priority sectors, construction is central to the strategy. There are also five main instruments in this strategy, namely: fostering legislation and regulation, intelligent market incentives, financing, knowledge and innovation, and international cooperation. In terms of implementation measures, the strategy highlights sector-wide Green Deals such as the Circular Building Green Deal, the Biobased Building Green Deal, the Infra-Nature Green Deal, and the Urban Green and Blue Values City Deals. Measures to follow in the coming years are: sector agreements, more innovative and circular construction projects, CO₂ reductions, material reuse, an implementation agenda for innovation in the construction sector, a Life cycle costs approach by Central Government Real Estate Agency RVB, and more circular Soil and Civil Engineering (Grond- Weg- en Waterbouw – S&CE) construction by the government.

The *Raw Materials Agreement* [32] from 2017 sets the ambition towards ‘realizing a circular economy, with which the efficient and smart handling of raw materials helps to achieve climate and other environmental goals. The three strategic goals set by the strategy *A Circular Economy in the Netherlands by 2050* are followed in this Agreement. The Agreement also set five transition agendas as instruments, from which one is dedicated to construction. Each transition agenda contains agreements on implementation measures about implementation plans, action agendas, knowledge agendas, and investment agendas.

The *Transition Agenda Circular Building Economy* [33] from 2018 is an instrument of the Raw Materials Agreement has the general goal of making the built environment circular by 2050, by mobilizing the construction column, which consists of clients, developers, architects, specifiers, contractors, and suppliers. As instruments, the strategy establishes four spearheads, namely: market development; measurement; policy, legislation and regulation; and knowledge & awareness. Such spearheads are implemented through different actions and interventions, these are: (1) all governmental procurement circular by 2030, (2) an approach to reduce CO₂ emissions in the construction industry, (3) decision on compulsory material passport by 2020, (4)

subsidy for circular business and earning models, (5) further development of a uniform measuring method for circularity, (6) incorporating circularity into government standards for construction, (7) circular building as an integral part of education in 2021, (8) setting up a knowledge institute for circular construction, (9) set up awareness campaigns on circular construction.

Towards a Circular Building Economy [34] from 2019 is annual implementation plan for the Transition Agenda Circular Building Economy. Its goal is to further concretize and deepen the national implementation programme for the circular economy in the built environment. The implementation plan describes how market parties, government bodies and knowledge institutions can work together towards a circular transition in the construction sector by mean of actions and activities. Implementation measures are organized through four spearheads: (1) market development; (2) measuring; (3) policy, legislation, and regulation; and, (4) knowledge and awareness.

The *Climate Agreement for Dutch Universities* [35] from 2019 aims to steer universities towards carbon-neutrality in 2050 at the latest, as to comply with the Paris Agreement. The following principles are the instruments of the Climate Agreement for Dutch Universities: (1) major interventions in buildings take place as much as possible at natural pace of replacement and major maintenance of buildings; (2) the ‘trias energetica’ principle is applied everywhere: energy demand is reduced as much as possible, the energy still required is generated or purchased as sustainably as possible, and the fossil energy still required is used as efficiently as possible; (3) natural gas is beign phased out using individual or collective heat and cold storage, a central heating network or geothermal energy; (4) all buildings will eventually be switch to LED lighting; and, (5) universities will renovate a substantial part of their property over the next 10 years, which will lead to significant energy savings.

TU Delft Strategic Framework 2018-2024 [36] was established in 2018 and seeks to guide everyone within the organization in the coming years on how to deal with changes in the environment an embrace opportunities. Among many strategic goals under the section ‘Campus & services’, the TUD Strategic Framework states (1) to make effective and efficient use of space, energy, equipment and materials; (2) developing and execute a sustainability plan flor a carbon-neutral and circular campus in 2030. The TUD Strategic Framework does not refer to any specific instruments or implementation measures.

Finally, the *TU Delft Campus Strategy* [37] sets the future of TUD campus development powered by the challenging ambition of becoming CO₂-neutral and circular by 2030. The underpinning campus strategy seeks to ensure its effectiveness and thus limit the university’s environmental impact, while also putting attention to campus adaptation and development towards its southern end, improving its connectivity with the city of Delft under the concept of ‘university’, and using spaces smartly. Further instruments and implementation measures are not mentioned in the website. A written, more detailed version of the Campus Strategy is to be launched in the coming years.

4.2.3.2. Relation to circular city development actions and levers

As the *Circular Economy Action Plan* (2020) builds upon value chains, it is not surprising that the main focus of the policy are looping actions. Although it touches upon the empowerment of consumers and public buyers – i.e., better information and labels –, as well as the benefits of the circular economy on people, regions, and cities, – namely, job creation – they does not provide enough inputs to identify ecologically-regenerating and

adaptation actions. Where the Circular Economy Action Plan focuses on construction, the only supporting urban action to be identified is substitution as the document mentions future 'recycled content requirements' of products. Regulation, financial incentives, and capacity building levers were also identified in a future construction product regulation, a sustainable finance framework, and the implementation of digital logbooks for buildings.

A Circular Economy in the Netherlands by 2050 (2016) arguably focuses almost primarily on looping actions. However, this policy document is the only one in this vertical analysis – and in the entire sample of policy documents – to mention ecologically-regenerating actions based on building as providers of ecosystem services. On adaptation actions, it is not clear if the participatory mechanisms offered in the document refer to co-designing or co-creating processes. Two supporting urban actions were also identified, namely: substitution and optimization. Regulation, provision, and financial incentives were the levers identified.

The *Raw Materials Agreement* (2017) includes mainly looping actions as the goal is to apply circular economy principles to raw materials supply chains. There is a reference to the redevelopment of areas and new ways of consumption being promoted, but it is not clear whether these actions will consider adaptation actions as understood in the circular city development framework. About supporting urban actions, substitution and optimization actions are mentioned, which are directly linked to looping actions. Finally, capacity building and financial incentives are the main levers identified, through the agreements on knowledge and investment agendas.

The *Transition Agenda Circular Building Economy* (2018), following the Raw Materials Agreement, focuses mostly on looping action as it integrates circular strategies in construction. Adaptation actions are also included when pointing out that the transition will be fueled by experimentation, cooperation and sharing knowledge, living labs are mentioned as instruments for adaptation. Three supporting urban actions were identified, namely, localization, substitution, and optimization. This is logical as the main concern of the Transition Agenda is to apply circular strategies and to change energy sources to renewable ones. Regulations, financial incentives and capacity building were also identified.

The *Climate Agreement for Dutch Universities* (2019) is purely centered in carbon-neutrality and backed by the trias energetica. Thus, it is focused on energy reduction as looping action. The Climate Agreement mentions that Dutch universities will have to set their own plans, but does not reflect on the planning processes, therefore we did not identify adaptation measures. In terms of supporting urban actions, optimization, localization, and substitution guide the energy transition. The predominant lever in this case is financial incentives, as the Climate Agreement commits future resources to achieve its policy goals.

In the *TU Delft Strategic Framework 2018-2024* (2018) the strategic goals identified in the previous section (4.2.3.1) can be associated to looping actions as there are calls to make campus carbon-neutral and circular by 2030 as well as to make effective and efficient use of space, energy, equipment, and materials. Explicitly the Strategic Framework does not include supporting urban actions. In terms of levers, capacity building is the most predominant as living labs are proposed to 'build up know-how, financial resources, and organizational tools for an effective organization.

Finally, the *TU Delft Campus Strategy* [37] includes looping actions related to reduce energy consumption and apply circular principles to campus development. There are no explicit references to supporting urban actions in the website. The main lever is provision, as the campus strategy deals with the

maintenance of existing infrastructure and services, and the expansion of the TUD campus towards the south end.

4.2.4. Horizontal

The horizontal dimension analysis is pending, as this conference paper is part of an ongoing project for which interviews and focus groups are yet to be carried out. Therefore, no results can be drawn from this dimension yet.

4.2.5. Temporal

To analyze the temporal dimension, we took a look at the expectations the different policies raised and whether they were adequately instrumented. We provide preliminary results to this dimension. If one takes the *A Circular Economy in the Netherlands by 2050* (2016) as it happens to be the national strategic goal and the oldest document analyzed in this paper, it was interesting to identify that all three circular actions were somewhat addressed. Later, as the circular construction transition advanced in a top-down fashion, ecologically-regenerating actions were left behind. To the extent that all national-level policy document after *A Circular Economy in the Netherlands by 2050* are centered in looping actions and some include adaptative ones. This situation makes sense as circular construction is seen as a priority value chain but it does not when circularity is meant for circular city development. From the bottom-up, temporarily talking, CRE policies have integrated new aspects of campus development. From the *TU Delft Strategic Framework 2018-2024* (2018) to the most recent CRE policies in 2021 analyzed, the focus went from carbon-neutrality, circularity, and health and well-being to add other two focuses, namely, biodiversity and ecology, and climate adaptation. This advancements are more sound to circular city development. Yet, instruments are still to be designed for the new spearheads. In terms of energy resources, CRE policy shows a more detailed approach to the energy transition, as the university recognized three different scopes, while the *trias energetica* proposed by the *Climate Agreement for Dutch Universities* (2019) can be arguably said to be focused in the first two of such scopes.

V. DISCUSSION

This article aimed to synthesize what policy coherence entails and how can it be assessed particularly in the transition towards a circular built environment. We followed a two-step approach by developing a framework and test it in a case study, namely, the TUD campus transition towards a carbon-neutral and circular campus by 2030.

The significance of our findings resides in applying a circular city development framework to a circular built environment transition; thus, approaching the phenomenon from the perspective of urban functioning, not strictly as a matter of value chains. Similarly, policy coherence was analyzed by using a well-cited framework searched for in a more systematic way. Resorting to the findings of Williams [4] and Bucci et al. (forthcoming) it was expected that circular actions were predominantly focus on looping actions, as it has been observed in both empirical case studies and literature review, respectively. What was not expected was the absence of ecologically-regenerating and more adaptation actions in most policy documents. We argue that this is the case for the different policy documents refer to construction and the built environment as supply chains, one of the reasons why the framework by Williams [4] was developed, as a criticism to the idea of cities as a collection of circular initiatives and/or supply chains.

We interpret the outcomes of this article as a necessary policy warning: circular city or urban development cannot follow the same approaches used to apply circularity to businesses and supply chains. We also understand the outcomes as proof for the validity and adequacy of policy coherence analysis as tool for more effective policy-making. By supporting policy coherence analysis with a scientifically-based conceptual framework, this analysis showed ways to determine whether coherence dimension are well-aligned and create synergies for more effective implementation.

Thus, we agree to previous work making a call for more systemic approaches to circularity in cities and, specifically, in the built environment as a element aspect of cities [4]. We also agree to some extent to the pitfalls of policy coherence analysis [6], as it is not clear what policy documents should in principle cohere, and for we were not able to measure coherence, but to point out inconsistencies through content analysis. We also agree with Huttunen [10] when they claim that policy coherence analysis based on solely top-down dimension analysis is not enough, as it is blind to some of the findings related to the other four dimensions of coherence.

This articles is not exempt from limitations. Firstly, our selection of policy documents may be lacking important documents to which we did not have access. Although we made sure to have enough documents to cover all dimensions – except from the horizontal ones –, perhaps policies from other policy domains could have been included to make our analysis more robust. Secondly, this analysis was conducted exclusively through content analysis, and therefore our interpretations rely only on what was written and found by the time of writing. The lacking horizontal dimension analysis will contribute to better interpretation through interviews and focus groups to analyze TUD policy, and CRE specifically, in relation to the remaining organizational units. Thirdly, although rather unlikely, key concepts could have been missed in translation, which in turn could have made us interpret content in the wrong way. However, the analysis of documents was done through full-text reading, so even if a concept was missed in translation, the paragraph where such a concept was embedded would have provided us sufficient clues. Fourthly, we used a campus as proxy for circular city development and, although we argue it makes a good research proxy, our policy coherence framework for circular built environment implementation needs to be tested out in real cities. Finally, the relation between coherence and global supply chains required to fulfill a circular built environment vision was not included in this analysis.

The reliability of our data and method resides in, firstly, using available and proven conceptual and analytical frameworks; secondly, the use of mostly open-access public documents, with the exception of CRE internal policies, and; thirdly, the use of Atlas.ti for the coding and analysis of texts, which in turns offers replicability of the findings as well as their inspection.

The research implications of this article are intended to make an impact in circular built environment implementation. Dozens of cities have started their transition towards a circular built environment. Although resorting to only one case study, our findings show the elemental limitation of using arguably predominant conceptual frameworks for circularity in the built environment that build up on value chains, rather than ones building on complex adaptive systems such as cities. We argue that policy coherence analysis is a great tool to analyze the on going transition towards a circular built environment, as well as we encourage the inclusion of the frameworks used in this article in earlier policy stages, such as policy design and planning. Most cities have not envisioned a circular built environment, or may be on the way to, so improving policy effectiveness from the beginning can be both more efficient and effective.

Future research would benefit from policy coherence analyses that consider the integration of stakeholders' inputs, so to assess what is written in documents in relation to stakeholders' decisions. Another interesting direction has to do with dimensions of coherence that escape our analysis, namely, that coherence between global value and supply chains – e.g., waste/resources commodity trading – required in and influencing circular city and built environment transitions. After all, circularity is a political strategy and a normative concept that will only provide sustainable policy outputs and outcomes if embraced in spatial scales that go beyond a single city or region for global supply chains make the global economy work. The question remains though in

what way the strategies towards a circular built environment could be used also to become more competitive than another, and as such become (even more) a tool within geopolitical discussions. Finally, research to provide measurability to policy coherence analysis in the context of circular city development would also contribute to a possible standardization of goals, instruments, and measures. Yet, the desirability of standardization in circular city development is something yet to be determined.

CONCLUSIONS

As cities embrace circularity as a way to diminish the ecological impact they have caused in the last centuries, governance aspects of such circular city and built environment transitions have remained vastly unexplored. Whether prevailing understandings of the circular economy in terms of value and supply chains are adequate to analyse the complexity of cities has caught the attention of different scholars recently. Our paper has offered a way to analyse policy coherence in terms different policy dimensions, circular and supporting urban actions and levers for circular development. We consider that the TUD campus transition towards a circular and carbon-neutral campus exhibits consistency and alignment in different policy dimensions. Considering that their policy transition has recently started, it is beneficial to consider a circular city perspective to campus development in the coming years. The narrow focus on looping actions in the horizontal dimensions for CBE implementation can certainly be steered towards a process that also embraces adaptation and ecologically regenerating actions from the very beginning. TUD policy coherence will also benefit from carrying out these analyses in the remaining organization units, such as finance, human resources, to understand how to improve their own internal goals, instruments, and implementation. Thus improving the transition's overall coherence. We conclude by encouraging policy-makers to analyse further circular built environment development by integrating a urban development perspective, and not solely as – still elemental – value or supply chains. We can argue that the aim of this article, namely understanding policy coherence and providing a policy coherence framework for circular built environment implementation, has been fulfilled. Further analysis will improve the proposed framework by integrating the policy effect on stakeholders' decisions. A more scientific basis for analysis is highly required in policy-making. Although policy-making is in essence political, science has much to contribute to better and more effective policy to improve the ecological impact of cities and their built environment.

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