CITIES AS LOCAL GOVERNMENTS FOSTERING THE CIRCULAR ECONOMY IN THE CONSTRUCTION SECTOR – UNRAVELLING THE KEY ACTIONS AND OPERATIONAL ROLES OF CITIES THROUGH A MULTIPLE-CASE STUDY

Lauri Alkki[1*], Johanna Alakerttula[1], and Leena Aarikka-Stenroos[1]

[1]Tampere University, Unit of Industrial Engineering and Management, Finland

*Corresponding Author: lauri.alkki@tuni.fi

ABSTRACT

Background and aim. Climate change and environmental issues have driven cities to adopt more sustainable practices, with the circular economy seen as a solution. Cities, as built environments are responsible for 75% of global resource use and over 70% of greenhouse gas emissions, play a critical role in the circular transition. Harnessing the potential of circular construction is a key means for cities as local governments to achieve sustainability goals and reduce negative environmental impacts in the built environment. However, research largely describes circular actions in construction at general and conceptual levels. In addition, although the city's role in the circular transition within construction is recognised, few studies identify specific actions enabling cities to contribute to this transition.

Methods and data. To address these gaps, we conducted a qualitative multiple-case study of four Finnish construction cases engaging cities – the construction of an eco-industrial park and a circular city district; construction waste management through mass coordination; and a circular construction research project – based on primary (n=11 interviews and ethnographic observation) and secondary (n=over 100 documents) data.

Findings. We recognised that cities as local governments play an important role in fostering circular construction through 26 key actions categorised as facilitate collaboration, govern and monitor, develop, and operate. We also identified that cities actions manifest through two operational roles, actor and platform, where actions tend to have identifiable characteristics of both roles, depending on the action and its implementation.

Theoretical / Practical / Societal implications. This study contributes to research on circular cities and construction by highlighting cities' potential in the circular transition of the construction sector. It also provides practical guidance for city-level managers and policymakers on circular decision-making at the local level.

KEYWORDS: circular actions; circular economy; circular city; circular construction; operational roles.

1 INTRODUCTION

Given the tension between the planet's resources and economic growth, the circular economy (CE) has been proposed as a solution to replace linear pollutive and waste-generating actions (Kirchherr et al., 2017; Reike et al., 2018). Implementing more circular actions enables a move towards more sustainable consumption and production while simultaneously limiting environmental impacts such as climate change and biodiversity loss by maintaining the value embedded in products and resources for longer (Ghisellini et al., 2016; Kirchherr et al., 2017).

Cities can be seen as a core part of the CE transition, from both a built environment and local government perspectives (Prendeville et al., 2018; Petit-Boix & Leipold, 2018; Christensen, 2021; Paiho et al., 2021; Hürlimann et al., 2022). Cities, as built environments, are not only significant consumers of raw materials and energy but also hotspots of innovations, policy action, capital, data, talents, and resources (Ellen MacArthur Foundation [EMF], 2022). Cities account for approximately 60% of global gross domestic product,

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60% of the resources used, and 70% of global carbon emissions (United Nations [UN], 2022). In addition, it is expected that by 2050 almost 70% of the world's population will live in cities (World Bank Group, 2023). While we acknowledge that the cities as built environments have significant environmental and economic impacts, in this study we focus on the perspective of the cities as local governments and their actions to facilitate the transition toward more sustainable and circular actions.

Consequently, it is acknowledged that cities, as local governments, have a crucial governmental role to play regarding the built environment: cities are responsible, for example, for land-use planning (Turcu & Gillie, 2020; Williams, 2019) and street, water, and waste infrastructures and their maintenance (Caragliu et al., 2011). Cities are also landowners and owners of several properties, such as schools, daycare facilities, and hospitals. Cities issue building permits and oversee the construction and demolition of buildings (Ministry of the Environment, 2021) as well as take care of municipalities' waste management (Christensen, 2021). Therefore, understanding how a city, as a local government, can contribute to and foster circular construction is critical in reducing the harmful environmental impacts of cities as built environments. While focusing on circular construction we refer to actions that maintain construction materials, buildings, and infrastructure in use and circulation by reducing, sharing, reusing, refurbishing, repairing, and recycling in all lifecycle phases (Pomponi & Moncaster, 2017; Ghaffar et al., 2020; Benachio et al., 2020; Dams et al., 2021).

The construction sector is among the key areas of focus for cities seeking to meet their sustainability goals and reduce negative climate impacts (Paiho et al., 2021; Rios et al., 2022). As construction accounts for 36% of global final energy use and 39% of energy-related carbon emissions, while construction and demolition waste (CDW) accounts for 36% of all waste generated in the European Union (UN Environment, 2018; European Commission, 2019; Eurostat, 2020). In addition, the construction sector is one of the largest consumers of natural resources, accounting for more than half of the total materials used globally (Organisation for Economic Co-operation and Development [OECD], 2018). As a result, the construction sector plays a crucial role in ensuring future sustainability and preserving biodiversity.

Based on the construction sector's huge potential in the circular transition and the critical role of cities in this regard, this study focuses on key actions taken by cities, as local governments, to foster circularity in the construction sector. We look at the actions taken by the cities through two operational roles – the *city as a platform* (e.g., Tukiainen et al., 2015; Anttiroiko, 2016; Bollier, 2016; Haveri & Anttiroiko, 2021), in which the city is seen as an enabler of different actors' actions; and the *city as an actor* (e.g., Acuto et al., 2020), in which the city is considered to take an active role in planning, implementing, and operating. However, these roles are not mutually exclusive. Cities must often act as both platform and actor simultaneously, depending on how the action is implemented, to enable the CE transition.

Previous studies of circular cities have identified certain key actions that cities can take when implementing circular strategies to foster circularity across their functions (Alhola et al., 2018; Lakatos et al., 2021; Bonoli et al., 2021). However, many studies have been either product- or policy-oriented (Bonoli et al., 2020) or presenting more general strategies and actions that a city can follow to implement CE and sustainability goals (Prendeville et al., 2018). Concrete circularity plans and actions remain scarce (Paiho et al., 2021), and little is known about the practical implications and applications of what cities can do regarding the CE in the construction sector (Caragliu et al., 2011; Turcu & Gillie, 2020; Williams, 2021). In addition, while studies have identified various roles that can be played by public actors and cities (von Malmborg, 2004; Frantzeskaki et al., 2016; Kronsell & Mukhtar-Landgren, 2018; Uusikartano et al., 2020; 2021). Less emphasis has been given on the city's fundamental operational roles—whether as an actor or a platform—that serve as the foundation for identifying specific actions and responsibilities. Overall, research on circular construction has highlighted the need for more empirical studies to determine which actions can effectively drive the transition to a circular economy in the construction sector (Adams et al., 2017; Munaro et al., 2020; Guerra & Leite, 2021) and how cities can contribute to this shift (Girard & Nocca, 2019).

By focusing on city-level solutions in circular construction, our study complements a wider discussion of circularity in the construction sector. It contributes to an understanding of how cities as local governments can be involved in a wide range of circular construction projects and promote, facilitate, enable, and manage circularity in the built environment. Accordingly, this study aims to clarify how cities, as local governments, can actively implement circular initiatives in construction—either through direct own action or by facilitating the efforts of other actors and stakeholders. In particular, this study aims to answer two research questions: i) *what are the key actions a city can take to foster circular construction?* and ii) *how do the operational roles of the city manifest in actions fostering circular construction?*

To meet our research aim, we conducted a qualitative multiple-case study (including 11 interviews, ethnographic follow-up, and over 100 secondary sources) in the Finnish context focusing on four different circular construction cases engaging cities with different set of actions enabling and fostering circular construction. Therefore, the cases provide an insightful empirical setting to explore how a city as a local government can

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implement its circular strategy in the construction sector by delving into the key actions of cities and their operational roles in fostering circular construction.

Our study contributes to circular city research by providing a categorisation of how cities can foster circularity through construction with empirically based examples of actions. Moreover, it deepens the understanding of the roles of public actors, thus not only contributing to circular city research but also to circular construction research. Furthermore, our research provides insights for decision-makers in city organisations and construction companies by providing a comprehensive understanding of how a city can contribute to and foster circular construction in its own organisations and public–private partnerships.

2 LITERATURE OVERVIEW

In this section, we provide an overview of cities' importance in the CE transition and describe why focusing on cities in the circular construction context is crucial.

2.1 CIRCULAR ECONOMY IN CITIES

Rapid urbanisation brings social, economic, technical, and environmental challenges, such as how to provide affordable housing, well-connected transport systems, water, energy, and waste infrastructure, basic services, and a safe environment for all citizens (Paiho et al., 2021; World Bank Group, 2023). Cities, as built environments, are the hotspots where environmental problems and challenges arise, but at the same time, they are cradles and ecosystems where sustainability challenges are solved and nurtured (Henrysson et al., 2022; UN Environment, 2018). Thus, the transition towards the CE and more sustainable practices is gaining attention within cities (OECD, 2020; Paiho et al., 2021; Prendeville et al., 2018).

Importantly, the CE offers new tools for cities to respond to climate change and resource challenges by rethinking how to use, reuse, recycle, and sustain the value of materials, products, and assets (Sodiq et al., 2019) in collaboration with other actors, such as citizens, companies, and researchers (Prendeville et al., 2018; Williams, 2021). Seven key CE sectors have been identified in the city context: construction, food, waste, procurement, water, transport, and energy (Paiho et al., 2021; Rios et al., 2022). These sectors are not entirely separate; rather, they are closely linked, as cities are complex ecosystems of public and private actors, innovation cultures, business networks, infrastructures, and resources (Paiho et al., 2020; Henrysson et al., 2022).

The actions identified in the literature on how cities can foster the CE indicate that cities can use their policy tools as catalysts for circular change and define and coordinate their CE actions through CE strategies and roadmaps (European Investment Bank [EIB], 2018; Prendeville et al., 2018). To add to this, the CE in cities is also driven by different levels of policy instruments (e.g., national- and EU-level), providing different tools to promote the CE. For example, the waste framework directive (2008/98/EC) and circular economy action plan (COM(2020)98) that enhances sustainability requirements, promote waste prevention as well as utilisation and recycling of waste, and encourage resource-efficient practices. As key components of the EU Green Deal, they collectively support the transition to a circular and environmentally responsible built environment. City administrations can lead by example, for instance, by offering, procuring, and tendering circular solutions and services and accelerating circular business development (e.g., EIB, 2018; Prendeville et al., 2018; Alhola et al., 2018). Economic support is identified as a way to promote the circular transition, as it can include indirect financial incentives as well as direct economic help, such as financing for sustainability projects (e.g., Uusikartano et al., 2021). Cities can include circular principles in their technical infrastructure and services, such as energy, water, transport, infrastructure, and education (e.g., Rios et al., 2022). In addition, cities can promote circular awareness and create a culture of collaboration among city organisations, citizens, companies, and other organisations (e.g., Paiho et al., 2020; Henrysson et al., 2022). Cities may call themselves circular cities; nonetheless, it remains challenging for them to define which combinations of CE initiatives will result in the most environmentally friendly performance (ICLEI, 2021; Paiho et al., 2021; Lakatos et al., 2021).

In addition to the actions identified by cities as fostering the CE transition, different roles for cities and public actors have been identified, such as innovator, operator, coordinator, organiser, financer, enabler, catalyser, influencer, supporter, policymaker, and regulator (e.g., von Malmborg, 2004; Frantzeskaki et al., 2016; Kronsell & Mukhtar-Landgren, 2018; Uusikartano et al., 2020; 2021). Circular actions taken by cities have also been studied from intra-urban and interurban perspectives. Intra-urban studies focus on one city, either the whole city or a limited area within it, such as a district or an even smaller unit, such as an area, neighbourhood, or household, and the actors and their interactions inside it (Bork-Hueffer, 2014). Common to all identified public actors' roles is that cities cannot be seen as isolated entities. Rather, they need to work with their surrounding environment in the CE transition and must therefore leverage the actions they take on their own as well as those taken in cooperation with other actors and stakeholders.

However, in this study, we dive deeper into the overarching starting point of the role division; that is, we focus on the nature of the actions taken as part of the operational roles of a city as an actor and a platform. While the previous literature has identified the actions that cities can take to foster the CE, most remain at a very conceptual level, and more empirical evidence is needed

(Girard & Nocca, 2019; Lakatos et al., 2021; Isoaho & Valkama, 2024). By bringing cities' operational roles and key actions together in the context of the CE, we provide a more comprehensive way to understand how cities can foster the transition toward CE.

2.2 THE IMPORTANCE OF CITIES FOR CIRCULAR CONSTRUCTION

An unanimously agreed and comprehensive definition of circular construction (Benachio et al., 2020) has yet to be established. One oft-quoted definition provided by Pomponi and Moncaster (2017, p. 711) of the CE in the built environment is '*building that is designed, planned, built, operated, maintained, and deconstructed in a manner consistent with CE principles'*. Based on this definition, Benachio et al. (2020, p. 5) refined the definition of the CE in the construction sector as '*the use of practices, in all stages of the life cycle of a building, to keep the materials as long as possible in a closed loop, to reduce the use of new natural resources in a construction project'*. An essential element of both definitions is the mention of circular practices at different lifecycle stages. On the other hand, Dams et al. (2021, p. 1) explained that '*the concept of circular construction requires that a building should not be merely a static, physically whole entity, but instead should be a changing, evolving combination of functions and processes and be able to adapt to changing societal or functional requirements over long periods of time'*. From our point of view, the need for a combination of processes and actions is interesting, as is the constant development that comes from reacting to external stimuli. Moreover, Ghaffar et al. (2020) observed that '*in circular construction, buildings and infrastructure will be designed according to circular principles*,' bringing in the perspective that circular construction considers more than just buildings. In addition, the EMF (2023) sets out the following three CE principles: to eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature. Based on these definitions, we refer to circular construction as *actions that aim to maintain construction materials, products, buildings, and infrastructure in use and circulation at their highest value by reducing, sharing, reusing, refurbishing, repairing, and recycling in all lifecycle phases*.

Cities are among the key actors in the CE transition in the construction sector, as they are not only major centres of the built environment but also involved in construction projects in one way or another (cf. Campbell-Johnston et al., 2019; Christensen, 2021). For example, cities are pivotal in advancing the construction sector towards the CE as economic hubs. That is, urban areas can achieve cost savings through the reduction, reuse, and recycling of materials while also driving innovation and technological advancements in sustainable building practices (Joensuu et al., 2020; Christensen, 2021). City governments have the authority to implement policies and regulations that promote circular construction, and cities can engage communities to foster a culture of sustainability (Isoaho & Valkama, 2024). Circular construction in cities can significantly mitigate climate change by reducing the greenhouse gas emissions associated with building materials. Overall, cities' influence on resource use, economic activities, policymaking, and community engagement makes them essential in the CE transition. (e.g., Campbell-Johnston et al., 2019; Lakatos et al., 2021; Hürlimann et al., 2022) In addition, cities' (circular) actions are influenced by external policy instruments, providing frameworks, boundary conditions, and guidelines for more sustainable ways of operating. For example, the Environmental Product Declaration (EPD), the revision of the Construction Products Regulation (CPR 2024), along with the Waste Framework Directive (2008/98/EC), Energy Performance of Buildings Directive (EPBD), and the New Circular Economy Action Plan (COM(2020)98), establishes a strong regulatory foundation for circular construction in the EU and driving the transition towards more circular and sustainable ways of operating in the construction sector, and along that providing cities the opportunity utilize them in their own operations.

While the role of cities in fostering circular construction is recognised, there is a scarcity on the actions identified in previous studies. However, previous studies have identified some actions on how cities can foster circular construction, for example, the maintenance of existing infrastructure reduces the need for new materials, while promoting consumer practices and services aligned with the CE encourages sustainable consumption (e.g., Caragliu et al., 2011; Lakatos et al., 2021; Hauashdh et al., 2022). Land-use planning ensures efficient use of space and resources, and public procurement criteria prioritise sustainable materials and methods (e.g., Turcu & Gillie, 2020; Williams, 2019). By optimising industrial structures, cities can enhance resource efficiency and reduce waste. The use of local renewable resources minimises environmental impact (e.g., Lin & Kao, 2020), and industrial symbiosis allows industries to share resources and by-products (e.g., Joensuu et al., 2020). Establishing eco-industrial parks (EIPs) fosters collaboration and innovation towards sustainability (e.g., Uusikartano et al., 2021). Additionally, the utilisation of industrial waste in building materials and effective demolition and waste management practices ensure that materials are reused and recycled, closing the loop in construction processes (e.g., Joensuu et al., 2020; Lin & Kao, 2020; Junli et al., 2021). Through these actions, cities can significantly contribute to a more sustainable and circular construction sector as well as built environment.

Previous studies are still lacking a more comprehensive understanding on the actions that cities can take in relation to circular construction (Wang et al., 2018; Joensuu et al., 2020; Benachio et al., 2020; Christensen, 2021). Moreover, most of the actions identified for cities to foster

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circularity remain at a rather general level and do not address the operational role of the city. One explanatory factor is that the construction sector is at an early stage of the CE transition and is seeking ways to contribute to it (Adams et al., 2017; Çimen, 2021).

3 METHODOLOGY

In this section, we explain the methodological choices of our qualitative multiple-case study.

3.1 RESEARCH DESIGN AND CASE SELECTION

Our study follows a qualitative case study research strategy, as it enables us to study empirically real-life contexts and obtain in-depth information on real-life phenomena (Yin, 2009), here, of cities', as local governments, circular construction actions. We conducted a multiple-case study of four different circular construction cases engaging cities in Finland. By employing purposeful sampling, we selected four cases from Finland's largest cities: Helsinki, Tampere, and Turku. The aim was to select cases with diverse circular construction characteristics to ensure variation within the data (Palinkas et al., 2015) and thus allow us to identify similarities and differences in how cities foster circular construction.

We chose to study cases from the construction sector in which the city is engaged and which are different in nature. The cases studied are (see Table 1) the construction of an EIP, representing circular business development; the construction of an urban area, representing urban planning; mass coordination, representing construction waste management; and an (EU-funded) research project focusing on reusing old concrete elements, representing innovation towards circularity.

In all the selected cases, cities play important roles, for example, by facilitating, coordinating, supervising, funding, or supporting circular construction innovation, development, and operation. Common to all the cases is the drive to minimise waste and maximise resource efficiency.

Table 1: Case-specific details.

	Description	Background	Circular construction aspects
Case 1	Establishment of an EIP (ECO3)	ECO3 is an EIP located in the Tampere region of Finland. The core of ECO3's bio and circular business activity is companies that develop businesses based on construction waste management, nutrient cycle, the wood-based CE, bioenergy and fuel, and technical cycles. ECO3 is an initiative of the City of Nokia's development company.	ECO3 provides an area reserved for companies engaged in bio- and circular business; therefore, many construction material and waste processing companies are located in the area. The city can deliver its construction waste to ECO3 companies or use secondary construction products that are processed in the area.
Case 2	Development of a CE city district (Hiedanranta)	Hiedanranta is a new city district located in the Tampere region of Finland. It is a former industrial area that the City of Tampere is developing into a new city district based on CE principles.	The city has taken into consideration carbon neutrality and CE principles in planning and building the city district. The carbon neutrality of buildings, recycling of construction materials, excavated soil coordination, space sharing, CE projects, and the piloting and use of digitalisation are all observed in the city district.
Case 3	Circulation of excavated soils (mass coordination)	Finland's main cities (Helsinki region, Turku, and Tampere) are coordinating the excavation of soils to promote the reuse and recycling of infra-construction waste. The aims of the mass coordination are to proactively predict soil mass flows, monitor and guide the design and construction of future applications, and maintain up-to-date data.	The primary function of mass coordination is to direct excavated soils directly from their place of origin to the next destination of use, namely, from one site to another, and to improve soil mass economy and material efficiency. This coordination promotes the reuse of excavated soils; in that sense, CE construction may decrease carbon emissions since excavated soils do not normally need to be transported far.
Case 4	Pilot project of a novel construction approach (reuse of old concrete elements)	ReCreate is a Horizon2020 project addressing circular construction (particularly concrete element reuse) with reuse pilots located in Tampere, Finland.	ReCreate aims to develop the deconstruction of intact precast structural concrete elements from old buildings and their reuse in new buildings. The main objective is to keep concrete in circulation as a high-value product and reduce energy consumption and the carbon footprint compared to virgin production, aggregate recycling, and backfilling.

3.2 DATA GATHERING AND ANALYSIS

Our research data consist of primary and secondary sources (see Table 2). Among the primary data sources are semi-structured interviews and ethnographic observations, while secondary sources include media data, city reports, and web pages.

Table 2: Data types analysed in the study.

Data types	Case 1	Case 2	Case 3	Case 4
Semi-structured interviews	N=2 CEO in a city owned development company (10/2021) Senior university research fellow (11/2021)	N=3 KAM in the consultant company (10/2021) DM in a city-owned company (10/2021) Senior university research fellow (9/2021)	N=3 Mass coordinator in the city (three mass coordinators in different cities) (7-10/2021)	N=3 BDM & PM in a construction company (10/2021) Housing and development manager & PM in city organisation (10/2021) Senior university research fellow (10/2021)
Ethnographic observation	Attending consortium/project meetings, seminars, and site visits focusing on the cases (N=76 ethnographic observation situations)			
Secondary data	Media data, new, web pages, seminar presentations, and city reports and documents focusing on the cases (N=157 secondary sources)			
Abbreviations	CEO =Chief executive officer; KAM = Key account manager; (B)DM = (Business) Development manager; PM = Project manager			

Our abductive research approach focused on identifying comprehensively different actions cities can take to foster circular construction through various data sources. The data analysis was conducted as a thematic analysis. Interviews were recorded, transcribed, and saved to ATLAS.ti data analysis software, where two researchers coded all relevant text excerpts on how cities can contribute to circular construction. Data from observations, minutes, reports, and secondary sources were analysed and saved to Excel and combined with the interview data from ATLAS.ti. In the data analysis, we sought excerpts related to actions taken by cities to foster circular construction either directly or indirectly (by helping other actors) after which all the coded parts were reanalysed and categorised. Lastly, we further analysed our findings by deleting and combining the overlapping results. By using multiple tactics and tools in the data analysis, we gained a comprehensive overview of how cities can foster circular construction through two operational roles (actor and platform). Two researchers collected and analysed the data, which increased the data triangulation and the reliability of the results (Flick, 2004).

4 RESULTS

In this section, we present our multiple-case study's results of the key actions cities can take to foster circular construction and how their operational roles, that is, actor and platform, manifest.

4.1 KEY ACTIONS TAKEN BY CITIES TO FOSTER CIRCULAR CONSTRUCTION

Based on our analysis, we identified that the key actions cities as local governments take to foster circularity in construction occur in four different categories – facilitate collaboration, steer and monitor, develop, and operate (see Table 3). However, the city's governmental role in fostering CE in construction is complex and not always reduceable to easily categorisable actions; rather, actions fall within and between the identified categories. It is also clear that the city may contain different layers and different levels of bodies depending on the size of the city (organisational aspect of the city). In our analysis, we have taken into account that a city may, for example, contain different units (city government, city council, zoning, building control, licensing and permitting, in-house companies owned by the city, etc.) that include individuals whose own perceptions and attitudes affect their decision-making. Overall, a city can be seen as a larger entity, and each city is hence unique, as its list of actions is also strongly influenced by its location, size, and structure and their subsequent impacts (external factors).

The actions in the first category, ***facilitate collaboration***, are linked to the systemic nature of the CE as well as to the fact that cities, as built environments, link actors. Thus, the city has a critical role to play in facilitating, supporting, and maintaining cooperation between actors and stakeholders (i.e., between actors but also within the city organisation) to enable actions fostering the CE. The second category, ***steer and monitor***, focuses on the opportunities offered by the city's obligations. Actions in this category are taken as part of the city's responsibilities and obligations and seek, in particular, to understand how cities' duties can be used to foster the CE transition. The third category, ***develop***, focuses on the opportunities for the city to be involved in innovation and development projects as either an active driver or a participant/enabler. The actions in the last category, ***operate***, focus on different ways a city can actively contribute to fostering circularity in the construction sector within the city area and more generally in society. Actions in this category are not mandatory for cities but can be critical in promoting the CE transition. In addition, the actions in this category can most strongly intersect with the characteristics of the other categories. Table 3 presents the categories and their descriptions.

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Table 3: Categorisation of the key actions cities can take to foster circular construction.

Category	Description	Key actions identified
Facilitate collaboration	Actions stemming from the systemic nature of the CE and the fact that cities, as built environment, are hotspots for actors to operate and collaborate.	- Participate in CE actions and projects to promote the adoption of circular solutions, products, and services - Support the sharing economy to facilitate the uptake of circular solutions - Foster and maintain public–private partnerships to enhance the implementation of circular solutions, products, and services - Enable platforms for collaboration and the development of innovative circular solutions - Pilot initiatives to promote circular solutions, products, and services - Collaborate with research institutions to increase understanding and implementation of circular solutions, products, and services - Join networks to share best practices and enhance understanding of circular solutions, products, services, and implementation
Steer and monitor	Actions stemming from the city's responsibilities and obligations, i.e., how to utilise cities' duties to foster the CE.	- Align city policy and strategy with circular and sustainability objectives to support the transition towards CE - Establish acquisition and CE procurement criteria to promote circular solutions in city projects and create markets for them - Make city investments to support the transition towards CE - Building control services (supervision) supporting circular projects and solutions - Align licensing and permits with CE objectives for new projects focusing on circular principles
Develop	Actions stemming from the city's involvement in innovation and development towards the CE.	- Develop an EIP to enhance material efficiency and collaboration - Utilize city-owned land to develop areas for CE (city as a landowner) - Planning and zoning of different areas that supports the transition towards CE - Market and commercialize CE to create markets for circular solutions, products, and services - Participate in developing national CE tools to understand the impact and comparability of circular solutions - Develop and coordinate regional databases and platforms to use collected data in decision-making supporting CE - Recruit, educate, and train staff to increase the city's competence in circular solutions and implementation - Use research and survey results to create circular concepts and plans - Align city-owned companies with the city's circular objectives
Operate	Actions stemming from the non-mandatory opportunities and possibilities to foster circularity that are open to cities.	- Align city properties and assets with CE objectives - Use voluntary agreements (e.g., Green deals) to support CE transition - Implement knowledge-based management from research and surveys to enhance CE actions - Use existing calculation methods (e.g., LCA, carbon footprint) to compare CE solutions - Coordinate processes within the city and with other organizations to support the transition towards CE

Facilitate collaboration: A city can play a vital role in advancing the CE in the construction sector through different facilitating actions. First, by participating in, facilitating, and contributing to regional and national CE roadmaps and strategies, a city can align its policies and practices in collaboration with other cities and the government to best respect the CE principles (*Case 1*). A city can also enable and accelerate the sharing economy, for example, by promoting the more efficient use of common spaces and buildings and by creating platforms for industrial symbioses and the more efficient use of material and energy flows between companies (*Cases 1 and 2*). Moreover, a city can facilitate cooperation and innovation among different actors and stakeholders, such as by establishing an EIP for bio and CE companies, cooperating with research institutes to gain data for urban development, and developing information exchanges and best practices between different cities (*Cases 1, 2, 3, and 4*). A city can also support areas where landmasses and recycled materials can be stored and processed and provide financing and enabling functions for pilot projects supporting circular construction (*Cases 1, 2, 3, and 4*). Furthermore, a city can build a brand and raise awareness of the benefits and opportunities of the CE in the construction sector by organising and participating in CE competitions, seminars, events, and conferences nationally and internationally (*Cases 1 and 2*). By doing so, a city can help facilitate the systemic transition to the CE in the built environment.

Steer and monitor: A city can foster the CE in the construction sector through different steering and monitoring actions. By implementing circular construction policies in its roadmaps and strategies, a city can set a clear vision and direction for the transition to a more sustainable and resource-efficient built environment (*Cases 1, 2, and 3*). A city can also define CE criteria for more sustainable procurement and acquisition and use its purchasing power to create markets and new business opportunities in line with circular construction (*Cases 1, 2, and 3*). For example, a city may increase the use of recycled materials, such as in infrastructure projects, by adopting special procurement criteria and mass coordination (*Cases 2 and 3*). A city can also take into account CE criteria in land donation and plot allocation and encourage the development of circular buildings and neighbourhoods (*Cases 2 and 4*). Moreover, a city government needs to be committed to developing circular practices over the long term and provide support and incentives for companies to develop their own CE actions (*Cases 1, 2, and 3*). In addition, the city can implement circular policies and regulations, such as considering the principles of the CE and the reduction and recycling of waste in construction and demolition permits and environmental permits and licensing as well as promoting and enabling circular design and construction practices through construction supervision (*Cases 1, 2, 3, and 4*). By adopting more circular ways of steering and monitoring, the city can harness the potential of circularity and benefit from circular construction in terms of reducing carbon footprint, saving energy, enhancing durability and longevity, and increasing economic value. By doing so, a city can enable and promote CE innovation and contribute to a more resilient and sustainable urban environment.

Develop: A city can foster circular construction by implementing various actions related to development that aim to reduce the environmental impact and resource consumption of the construction sector. One such action is to develop an EIP, which is a planned area where businesses cooperate to optimise the use of materials, energy, and water and minimise waste and emissions (*Case 1*). A city can act as a landowner and planner to facilitate the development of EIPs, city districts, and areas in accordance with CE principles to foster circular construction (*Cases 1, 2, and 3*). Moreover, a city can use sustainable zoning to allocate areas for land and resource recycling where materials from demolition and renovation projects can be collected, sorted, and reused or recycled (*Case 3*). A city can also improve the engagement of different actors and stakeholders, such as developers, contractors, architects, and customers, by developing guidelines to ensure the benefits of circular construction are realised and advising on the best practices of successful projects (*Cases 1, 2, and 3*). Cities can contribute to and participate in the development of national CE calculation tools and methods, which can help measure and monitor the circularity performance of buildings and materials (*Cases 1, 2, 3, and 4*). In addition, cities can develop and coordinate regional and national databases and platforms to share collected CE data for regional and national use and develop operating models to collect and use CE data in decision-making and planning and maintain these models by compiling databases (*Cases 1, 2, and 3*). However, the city organisations must have sufficient knowledge of the CE and sustainable decision-making, which is why a city can also recruit CE experts into its organisations and develop its internal CE knowledge and expertise through education and training (*Cases 1, 2, and 3*). Furthermore, a city can conduct its own surveys and engage in concept building to support circular construction, such as assessing the carbon neutrality or CE potential of districts and neighbourhoods (*Cases 1 and 2*). Besides carrying out their own surveys, cities can participate in research projects and utilise the research data gained in their own urban development, such as by identifying the barriers and enablers of circular construction and testing new circular products, services, and solutions. In addition, a city can establish or support companies that foster the CE, such as those that offer product-as-a-service, sharing platforms, or product life extension models (*Cases 1, 2, and 4*). By coordinating its internal processes, such as mass coordination, land use, and construction supervision, a city can ensure the effective implementation of circular construction actions.

Operate: A city can foster the CE in the construction sector through different actions and modes of operation. On its own properties, a city may support the recovery and reuse of materials, products, and elements (*Cases 1 and 2*). This can reduce the demand for new materials and extend the lifespan of existing ones as well as lower the environmental impact of demolition and disposal. On the other hand, through voluntary agreements, a city can participate in Green Deals to foster the CE in various domains, such as construction, waste management, and mobility (*Cases 1, 2, and 3*). Green Deals can help a city share best practices, access funding, and create a supportive regulatory framework for the CE. Additionally, the transition towards more circular actions can generate profits and savings for the city by enabling it to use recovered and recycled materials more efficiently and instead of virgin raw materials (*Case 3*). This can lower the costs of procurement, transportation, and disposal and reduce the dependency on external suppliers and vulnerability to price fluctuations. Furthermore, a city can use the services and products produced in the EIP as well as the industrial symbiosis for public–private partnership to support the development and implementation of innovative solutions for urban challenges (*Case 1*). The EIP can provide a city with access to cutting-edge technologies, expertise, and networks that can help foster the CE in the construction sector. As well as operating in circular projects as an active member or by offering the project ground for development, a city can benefit by co-developing new solutions, creating new business opportunities, and enhancing public–private partnerships (*Cases 1, 2, and 4*). Moreover, in a city-level context, data (e.g., information on material flows, waste generation, energy consumption, carbon emissions, and economic indicators) are generated that can be used in decision-making on the implementation of circular actions, for example, planning how to handle the material flows in the area (*Cases 1, 2, and 3*). Thus, it is important that the city can collect, process, analyse, and maintain CE data. These data can be used to monitor and evaluate the progress and impact of the city's CE actions as well as to communicate and engage with various actors and stakeholders, such as citizens, businesses, and policymakers. In addition, calculation tools and metrics, such as LCA and carbon footprint calculations, can be used in decision-making, evaluating the overall sustainability of a project, comparing different options and scenarios, identifying hotspots and improvement areas, and optimising the environmental performance of construction projects. By taking these actions, a city can foster the CE in the construction sector and contribute to the global goals of climate action, resource efficiency, and social inclusion.

4.2 CITIES' OPERATIONAL ROLES IN FOSTERING CIRCULAR CONSTRUCTION

In this study, we focused on the two operational roles through which a city can foster circular construction – the city as an actor and the city as a platform. As shown by the findings on the key actions cities can take, a city can be an active actor, for example, in planning city districts, funding CE projects, establishing new companies focusing on developing areas and districts as well in line with CE principles, educating their own staff, recruiting CE professionals, and operating EIPs. In addition, a city can apply CE criteria in procurement and thus actively

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foster circular construction and markets for circular solutions and products. On the other hand, as a platform, a city can facilitate industrial symbiosis and enable the circulation of construction materials. It can also offer (e.g., through plot donation and zoning) areas and spaces to other organisations to test and pilot new circular construction solutions (e.g., sustainable dismantling, forms of the sharing economy, or new construction methods). Such a policy will enable the sharing economy for citizens and companies and integrate CE principles into roadmaps and politics, both as cities' own roadmaps and as policies setting targets for circular construction (although the operational side often requires close cooperation with companies and other stakeholders). Finally, such strategies will allow cities to contribute to regional and national-level CE projects, for example, by streamlining bureaucracy. Thus, based on our analysis, we have compiled the dynamism of cities fostering circular construction into Figure 1. This serves as a starting point to understand how cities can foster the CE in the construction sector in each unique case.

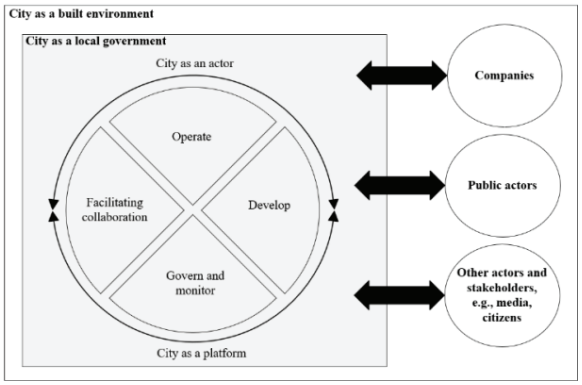

Figure 1: Cities fostering circular construction in collaboration with others.

In *case 1*, the establishment of an EIP, the city took various actions to foster circular construction at different stages in the process of setting up the EIP. The city can be seen as an actor because it has a central role in land use planning, environmental permitting, infrastructure building, concept building, and facilitating the operation within the area. However, the city can be seen as a platform as well since it also provides an area where companies can jointly develop bio and CE businesses and create new industrial symbioses.

In *case 2*, the city focused on building an entire circular city district (Hiedanranta) according to CE principles. Doing so required the city to have extensive knowledge and expertise from a wide range of areas since a circular city district seeks to maximise its use of CE solutions and methods. From the perspective of circular construction, the city can be thought of as playing the roles of both actor and platform. The Hiedanranta city district is being constructed with a deliberate emphasis on all aspects of the CE, including in the construction itself. Since the city developed the idea and proposed its implementation, it has played a central actor role in the project, especially in the planning and construction phases. At the same time, however, it can be seen as a platform, as it has offered an area where a circular city district can be piloted and tested, and citizens can inhabit a built environment while engaging in circular practices such as the sharing economy.

In *case 3*, the circulation of excavated soils, the cities focus on mass coordination as their internal function. The involved cities aim to promote the recycling of landfill, concrete and brick aggregate, and demolition materials by planning and coordinating demolition and new construction projects so that resources obtained in one project are efficiently used in another. Since the city is responsible for the operation of mass coordination, it plays an active and key role in its success. Therefore, the city's role in actions to foster circular construction in case 3 is principally that of an actor.

Lastly, in *case 4*, a city participates in a pilot project focusing on a novel construction approach, and its role is to take actions that enable and streamline the process. This pilot project focuses on concrete element reuse, an almost completely new method for all the actors involved. The city is involved in the development of the process whereby precast concrete elements can be reused, learning how to enable this and determining what it can do to facilitate this reuse. Consequently, the city's actions revolve around supporting the reuse of precast concrete elements. To ensure the smooth operation of the process, the city is discovering how the new approach will be implemented. Therefore, the city's role in fostering circular construction in case 4 is principally that of a platform.

However, we found that dividing cities' actions to foster circular construction according to their operational roles is not the most meaningful outcome of this role division. Rather, it is more valuable to understand what is gained from the different features of the operational roles taken in each action, that is, understanding that actions can have very different effects depending on how they are implemented and that actions can be approached in more depth by delving into their mechanism and logic. Indeed, it is crucial to understand which role the city is perceived to be playing at any given time (especially within the city but also by other actors) to reflect on which actions are optimal in fostering the CE in the current situation. It is also worth noting that the same action can have characteristics of both the roles played by a city, largely depending on the situation and desired outcome. Thus, there is no absolute division between the actions taken when the city is playing the operational role of an actor and those taken when it is acting as a platform.

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5 DISCUSSION AND CONCLUSIONS

In this section, we synthesise our key findings and provide our theoretical and practical contributions as well as our study's limitations and ideas for future research.

5.1 KEY FINDINGS

Cities, as local governments, are complex entities that have internal duties as well as possibilities to foster circular construction through their departments, governmental inputs, and in-house companies. However, as cities also support and interconnect companies, organisations, and citizens, through which they have a large impact on circular decisions, products, and services. Overall, cities have a major role in creating markets for the circular construction.

Focusing on the key actions taken by cities to foster the CE in construction, we identified a total of 26 actions categorised into four different categories, *facilitate collaboration, steer and monitor, develop, and operate,* a city can take to foster circular construction. In addition, analysing these actions enabled us to delve into two operational roles played by the city, the city as an actor and the city as a platform, through which the actions were implemented. However, the outcome is affected by the situation (e.g., what action is considered; how the action is implemented) and its consequent constraints, as well as by other actors in the industry (such as companies, stakeholders, and authorities). Overall, the city's circular construction actions are a summation of all the actions presented in the study. Each case presents a unique combination of these actions, which is why our results provide an excellent starting point for thinking in different situations and suitable combination of actions on how a city can foster circular construction.

However, the division of the city's role into actor and/or platform is not absolute, as the city almost always has identifiable characteristics of both roles, which may vary according to the point of view and the situation. Our study also reveals that when the city acts as an actor, it can itself take concrete actions to foster circular construction. In contrast, when it acts as a platform, its actions are more directed to enabling and supporting other actors' circular construction actions. Moreover, our analysis indicates that the scale of the case under consideration notably affects the role of the city: in large-scale projects, the city's role as actor and platform is more easily identifiable, while in more focused and smaller projects, its role is often identified as that of either an actor or a platform. Although our study identified a wide range of actions that cities could take to contribute to circular construction, they require the desire to operate in a circular manner to gain the full potential of CE.

5.2 THEORETICAL CONTRIBUTIONS AND PRACTICAL IMPLICATIONS

In particular, our study contributes to the literature streams on circular cities (e.g., Prendeville et al., 2018; Petit-Boix & Leipod, 2018; Wang et al., 2018; Girard & Nocca, 2019; Christensen, 2021; Paiho et al., 2021; Williams, 2021) and circular construction (e.g., Adams et al., 2017; Benachio et al., 2020; Çimen, 2021) by linking them and deepening the understanding of cities' impact on the construction sector in the context of the CE and providing a list of actions that cities can take to foster circular construction with empirical examples. In addition, our view of the operational roles of cities, that is, as an actor (Acuto et al., 2020) and as aplatform (Tukiainen et al., 2015; Anttiroiko, 2016; Bollier, 2016; Haveri & Anttiroiko, 2021), in fostering circularity complements the discussion of the roles of cities and public actors in the CE transition (von Malmborg, 2004; Frantzeskaki et al., 2016; Kronsell & Mukhtar-Landgren, 2018; Uusikartano et al., 2020; 2021) by providing an overarching starting point for understanding these role(s) in relation to actions and how actions can relate to different roles depending on the situation. In addition, our study provides a comprehensive empirical-based categorisation of key actions taken by cities to foster circular construction and implement their own circular strategies. Thus, it answers the need identified in previous studies on circular cities, circular construction, and the CE in general for more empirical-based evidence on the actions promoting the CE (e.g., Adams et al., 2017; Paiho et al., 2021).

Our study's practical implications are twofold. It deepens cities' understanding of how to foster the CE in the construction sector through different key actions and operational roles. It also reveals how cities can help other actors in the construction sector to understand the impact of cities in the CE transition. Our research provides guidance on how to engage cities and how cities can contribute to fostering the CE in construction projects and the built environment. City organisations and cities' in-house company managers, in particular, are given an overview of how a city can foster and contribute to the development of circular construction. More understanding of cities' different operational roles is provided, guiding cities to develop circular construction more holistically. Practically, our results provide a comprehensive categorisation of the key actions cities can take to foster circular construction to eliminate waste and pollution, better enhance the circulation of products and materials (at their highest value), and regenerate nature. Thus, our results help not only city organisations but also various actors in the construction sector (i.e., companies and other stakeholders) more comprehensively reach circularity and sustainability objectives. In addition, our study provides examples for city organisations of situations in which different key actions can be applied through our empirical multiple-case study setting.

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5.3 LIMITATIONS AND FURTHER RESEARCH

Based on our methodological choices and research setting, our study has some limitations. To gain a comprehensive understanding of cities' key actions and operational roles, we focused on easily accessible cases from the Finnish context, making our qualitative multiple-case study geographically limited. Thus, future research initiatives could expand the geographical focus and undertake a regional comparison of how cities' circular construction actions converge and differ.

Moreover, although we selected four different cases for our multiple-case study, all of which are linked to circular construction engaging cities, other cases may reveal certain key actions that did not emerge in our study. This realisation is, naturally, influenced by the increased understanding of circular actions taken by cities, companies, and stakeholders. Consequently, future studies could look at other circular construction cases and determine how the actions and roles identified in this study emerge and whether new actions can be identified.

Cities, as local governments, have numerous opportunities to take independent action (internally) but also collaborate with various actors and stakeholders (externally) to drive the transition toward CE. Our research serves as a strong foundation for examining ecosystem revenue—identifying key partners for cities and understanding how they should collaborate to unlock the full potential of circular construction. Future cities will not be mere centralised and rule-driven bodies that only decide on strictly city-related issues; rather, they will be enablers and facilitators of innovations and CE business through collaboration. Thus, cities will not only operate in isolation. Therefore, more information is needed about a city's different actions and roles over time and how they develop in collaboration with other actors.

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