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DOI
10.1007/978-981-96-6867-0_11

Publication date
2025

Document Version
Final published version

Published in
The Inclusive Circular Economy

Citation (APA)
Schraven, D., de Jong, M., Liu, Z., & Tong, X. (2025). Conclusions. In M. de Jong, D. Schraven, T. Xin, & L. Dong (Eds.), *The Inclusive Circular Economy: Challenges and Opportunities for Urban Innovation* (pp. 213-222). (Urban Sustainability; Vol. Part F980). Springer. https://doi.org/10.1007/978-981-96-6867-0_11

Conclusions

Daan Schraven, Martin de Jong, Zhaowen Liu, and Xin Tong

Abstract This conclusion chapter synthesizes the contributions from the preceding chapters to address the central question of how a city can govern its Urban Waste Management System (UWMS) to achieve circularity and inclusion. By integrating insights from diverse perspectives, we highlight the key principles and strategies that enable cities to transition towards more sustainable and inclusive waste management practices. The synthetic UWMS framework introduced earlier in the book serves as a comprehensive tool for understanding the complex dynamics of circularity and inclusion in urban contexts. This chapter discusses the interconnectedness of governance, policy, technology, and community participation, emphasizing that effective UWMS governance requires a multi-layered approach. It concludes with practical recommendations for policymakers and urban planners, outlining pathways for achieving a circular economy while fostering social equity and inclusion within urban waste systems. Ultimately, it calls for an adaptive, collaborative governance model to ensure long-term sustainability and inclusivity in urban waste management.

Keywords Urban waste management system · CE policies · Transformation

D. Schraven (✉)
Department of Management in the Built Environment, Delft University of Technology, Delft, The Netherlands
e-mail: d.f.j.schraven@tudelft.nl

M. de Jong
Rotterdam School of Management & Erasmus School of Law, Erasmus University Rotterdam, Rotterdam, The Netherlands

Institute for Global Public Policy, Fudan University, Shanghai, China

Smart City Institute, HEC Liège, University of Liège, Liege, Belgium

M. de Jong
e-mail: w.m.jong@law.eur.nl

Z. Liu
Delft University of Technology, Delft, The Netherlands

X. Tong
College of Urban and Environmental Sciences, Peking University, Beijing, China
e-mail: tongxin@urban.pku.edu.cn

M. de Jong et al. (eds.), *The Inclusive Circular Economy*, Urban Sustainability,
https://doi.org/10.1007/978-981-96-6867-0_11

Informal waste pickers or recyclers are often invisible in a city's busy streets. But if one thing has become clear from the various chapters in this book: waste management practices happen organically in all parts of the city, and the informal activities form an integral part of the waste management system, as well as of its aspirations to higher levels of inclusion and circularity. In the theoretical and empirical parts of the book, we took a deep dive into the concepts of inclusion and circularity in urban waste management systems, coming from both the academic literature and real-life cases in the Netherlands and China. With a bird eye's view, the chapters sought to address the main question introduced in the introduction of the book: *How should a city govern the entirety of its urban waste management system such that it achieves inclusive and circular aspirations?*

Each chapter provided an answer to this question and elucidated specific lessons, experiences, and insights. Yet, in a way, a succinct answer to this question helped us synthesize all these individual stories and reviews into a more integrated approach that a city should seek to set up if it wishes to plan its urban waste management system or make changes to its existing system in place.

1 Synthetic Framework for UWMS for Circular Economy Transformation

For this synthesis to be possible, it is important to first sketch the layers of the urban waste management system that have been featured in the topics and cases of the parts A, B, and C. Figure 1 shows these layers as the:

i. properties of separate UWMS components (from Chapter 1);
ii. schemata of boundaries, actors, flows, and indicators of an UWMS (from Chapter 4); and
iii. process methodology for designing inclusive and circular UWMS (from Chapter 4).

First, the smallest layer of the UWMS involves the properties of each separate node in the overall system (i). As adapted from Liu et al. [10], Chapter 1 described that this building block involves a physical facility and set of actors that are involved in the facility, for example through operating or supplying the facility. For example, in a sorting center (physical facility), waste is brought by a transporter and then separated by employees (actors). These actions organize the logistics of the waste travelling through the UWMS from node to node.

Second, multiple nodes make up the entire UWMS (ii). In this system, the waste logistics are managed through the dynamics between the components. Yet, for the UWMS to function, Chapter 4 pointed to the importance of the urban context in which an UWMS operates. This includes the description of the system boundaries, actors, flows and indicators. For example, a city could wish to collect all the waste in its city boundaries (boundaries) and would have several collection points (actors)

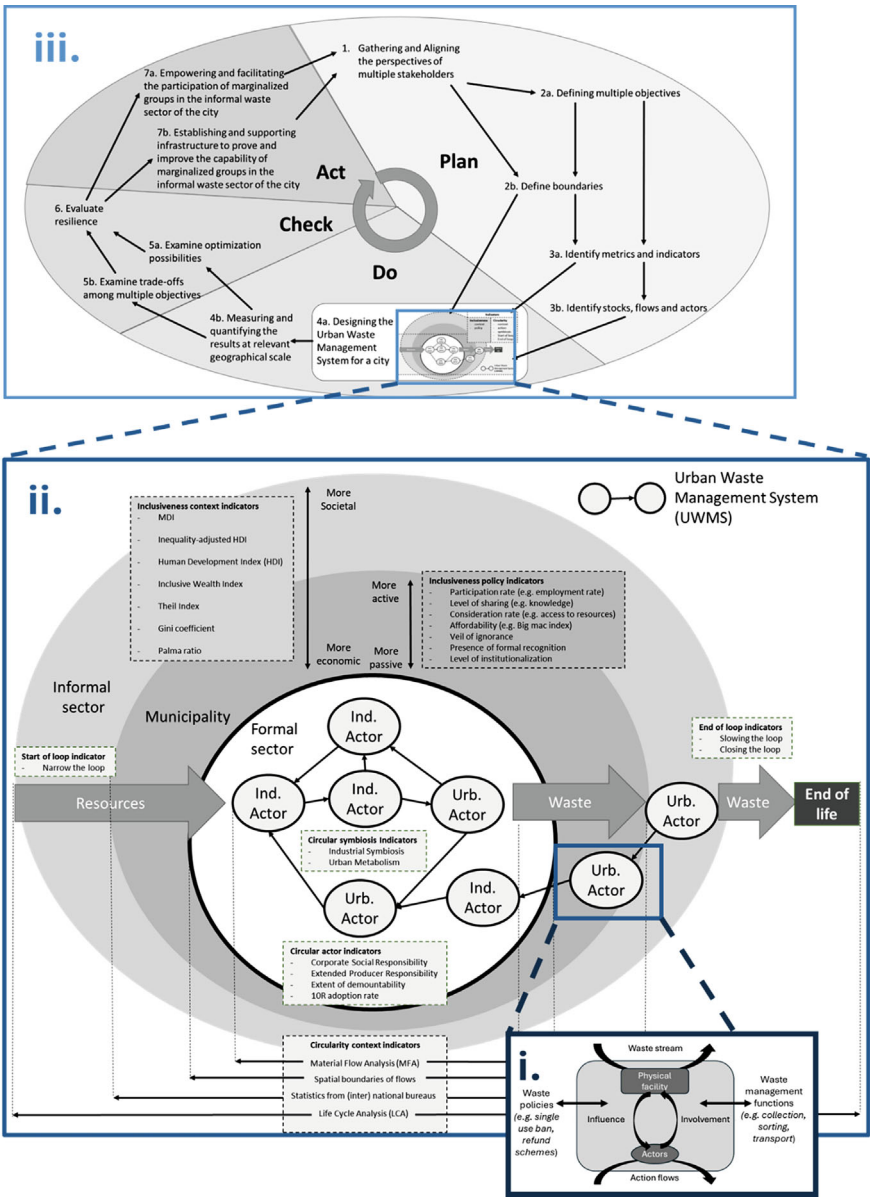

Fig. 1 Layers of an UWMS

where it separates municipal solid waste by paper, plastics, and biowaste (flows) and measures the extent that this is recycled and reused (indicators). Details of all these aspects make up the UWMS design.

Third, a city does not develop its UWMS out of nothing but requires a process methodology (iii). Chapter 4 describes that such a procedure should define and redefine the UWMS, its function for the city and its aspirations (e.g. inclusion and circularity). The process is introduced as a cyclical process, where relevant events for the city ignite mechanisms that attune the UWMS to citizens' needs.

2 Design UWMS for Inclusion and Circularity

The theoretical underpinnings in part A did not only help to create a framework for the UWMS (Chapter 4), but also concluded with propositions as to how the UWMS should be designed for inclusion and circularity.

With the definition and characteristics of a circular city, Chapter 2 established several cornerstones on how circularity needs to be understood in the context of an UWMS. As the hard system boundaries contradict the idea of exchanging waste and resources between cities [2, 14], the actors other than from government and industry filled the gap for the circular city in the transnational networks for resources recovery and recycling [12, 16–18].

More specifically, Chapter 3 revealed six dimensions of an inclusive city which can be tied to the UWMS for higher circularity (Fig. 1, ii), namely: the spatial inclusion (e.g. the sites and areas of UWMS in the city), social inclusion (e.g. affordability of services), political inclusion (e.g. level of institutionalization), economic inclusion (e.g. inclusive wealth index), environmental inclusion (e.g. life cycle analysis), and cultural inclusion (e.g. participation rate). It is important to deliberately consider the informal activities for their role and effectiveness in achieving societal goals through reshaping the circular value chains [9, 13].

Besides the identification of design elements of the UWMS (Fig. 1, ii), inclusion and circularity can be designed with systematic processes as shown in Chapter 4 (Fig. 1, iii). With operational monitoring techniques, five types of circularity indicators were identified: actor indicators (e.g. extended producer responsibility), context indicators (e.g. material flow analysis at city scale), symbiosis indicators (e.g. urban metabolism), start of loop and end of loop indicators (e.g. narrowing and slowing the loop), combined with 2 inclusion indicators: policy indicators (e.g. level of sharing) and context indicators (e.g. Theil index). If an UWMS deploys these circularity and inclusion aspects effectively, it can make the UWMS regenerative for urban prosperity and solidarity [1, 4, 7, 15].

3 Building Links Between Locales in a Separated World

The empirical insights from policy to practices (part B) did not only provide practical lessons for policy makers within specific case-contexts, but also offered more generic insights on various layers of the UWMS (Fig. 1, iii).

The transition of an UWMS into a circular and more resilient system is a challenge both locally and globally. Chapter 5 and 6 included an overview over the history of waste management in both the Dutch and Chinese contexts. The local evolutions generally take shape as a cyclical process reaching activities at different levels (Fig. 1, iii).

Compared to the spontaneous evolution of an UWMS in Dutch cities, the Chinese government is more active in issuing new CE policies, with experimental implementation through demonstration projects. A combination of hierarchical control measures and innovation-pushes (pilots and demonstration projects) characterize the circular city initiatives in China, while North American and European governments typically couple innovation policy with economic policy [5, 8]. These combinatorial policy structures show the direct and indirect effects that the CE policies have on the local UWMS contexts, which have a different position in the transnational recycling chains.

The development of an UWMS in Beijing and its relationship with changes in the informal recycling sector since 1970s illustrated the transformation process in urban development. Chapter 7 demonstrated how direct changes were more quickly implemented, but that although indirect effects took longer to generate impact, these eventually overhauled direct policy intentions when this impact did emerge (Fig. 1, iii). The story of Beijing showcased the tensions between a top-down policy to become a zero-waste city and the migrant recyclers that struggle to survive in a city that they work for. It provided evidence of the undeniable importance of social inclusion in the circular economy at the city level. The chapter stipulated that decisions should: (a) go beyond direct changes, like physical deployment of recycling or disposal facilities; (b) collaborate between authorities and verbal and non-verbal stakeholders under mutual understanding; and (c) set it as a community-based system where verbal and non-verbal stakeholders are designed to have a share.

4 Empirical Insights from Practices to Policies

The empirical insights from practices to policies (part C) did not only provide practical lessons for policy makers within specific case-contexts, but also highlighted more generic insights from various layers of the UWMS (Fig. 1, i).

The Waste Journey, an innovative tool demonstrated in Chapter 8, shows the method to capture the waste management practices in a circular economy specifically incorporating the social dimension. The method allowed the authors to identify barriers and opportunities from the stakeholder interactions in waste handling, and

finding their motivations for making decisions, overseeing its journey implications with both quantitative and qualitative data about waste management at the smallest scale (Fig. 1, i).

Chapter 9 focused on the practice of post-consumer recycling and the emerging business models in this realm facilitated by Chinese players through internet technology. The chapter shows how the CE policy of Extended Producer Responsibilities (EPR) resulted in the indirect change of emergent business models in the recycling sector as a response to government interventions [6, 11]. It turned out that practices may respond to policies in unanticipated ways, and thereby made a case for proper inclusion strategies in CE policies, also to learn about potential responses and closing the gap between the governments and informal sector stakeholders [3, 19]. Currently, new business models still rely on government subsidies. The diverse ways in which new business models connect the EPR system to production chains and the UWMS (Fig. 1, ii), sometimes create new actors in that system (Fig. 1, i).

Including informal sector practices adds more value to CE interventions than just technically oriented CE policies. Chapter 10 took the urban village of Gangxia in Shenzhen, China, as a case study, where a small-scaled recovery sector of air conditioners co-exists with formal enterprises. The informal recovery activities enhance the network strength, circular capabilities, and service value for the local low-income groups. The community developed quite effective business continuity and pursued circular practices although national or local policies largely ignored their practices, showing that better inclusion of human relationships in formal regulatory requirements could vastly improve the contribution of indirect changes to directed intentions in CE policies in UWMS (Fig. 1, iii).

5 In Sum

How should a city govern its UWMS to match its inclusive and circular aspirations? Fig. 1 offers an initial layered connection between CE policies (Fig. 1, iii), the designed UWMS (Fig. 1, ii) and the individual waste management practices (Fig. 1, i). Figure 2 shows how each chapter contributes to answering this key question with case materials elaborating the synthetic framework for UWMS (Fig. 1). Below we explain the linkages between the framework parts and the chapter contributions.

Figure 1 (i) represents the small-scale individual acting parts of the overall UWMS. Chapter 9 showed that new policies (EPR) can create new actors that operate as functional links within the UWMS. Yet, it also underscores the importance of livelihoods and formal recognition for stakeholders that populate the informal sector. Chapter 10 even highlighted the existence of informal sector practices that were unconnected with the UWMS. Being linked up basically refers to the recognition, stimulation and protection of informal sector practices by official policies.

How can a city pay heed to and learn from the practices in its intended intervening landscape of activities? On this note, Chapter 8 contributed the Waste Journey method, which offered methods of inquiry to follow waste along its management

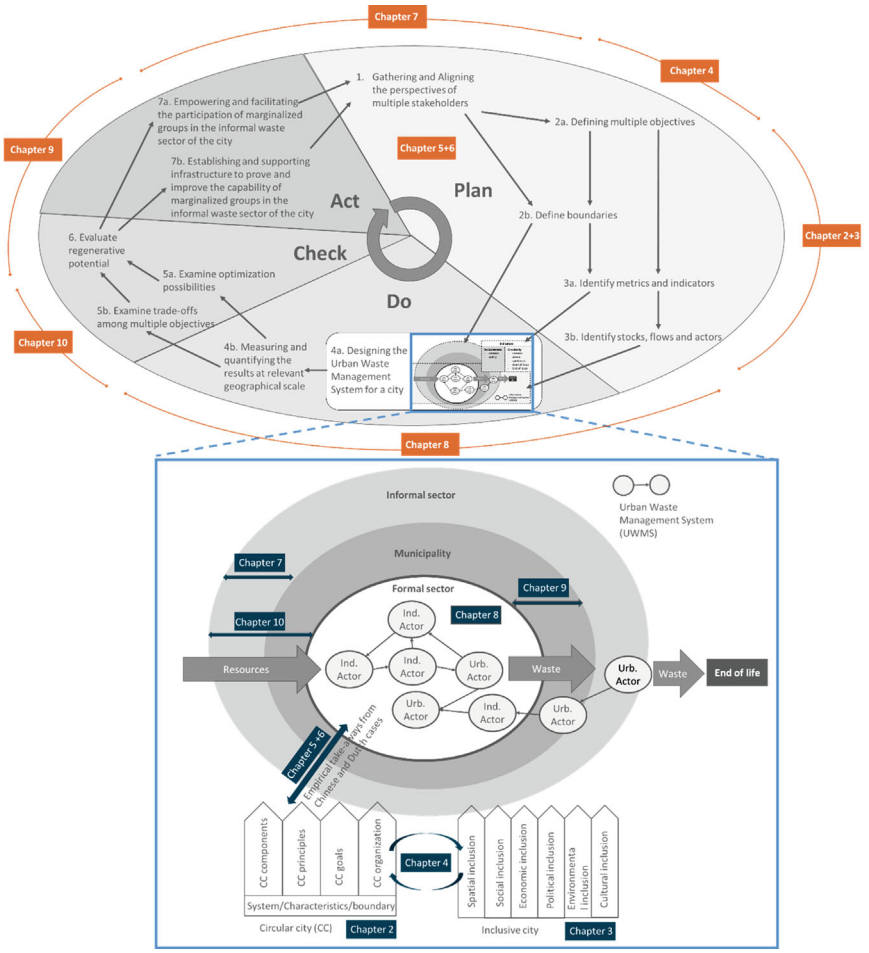

Fig. 2 Mapping of chapter relationships throughout the book

handling path by actors and learning about their motivations to perform their function in the chain. The method demonstrates what makes individual actors tick, and how their actions either stall or facilitate the overall achievement of circular or inclusive aspirations in the UWMS. An important consideration here is the importance of the enduring livelihood needs of the actors, as well as the requirements for the maintenance and upkeep of their human contributions to the inclusive and circular UWMS system. Sketching business models and the role government action plays in securing them can be a means to inform policy makers of relevant needs at the level of waste handling practices, how actors are and can be preserved, boosted or empowered as contributing members of the UWMS.

Figure 1 (ii) shows how multiple individual actors make up the city's overall UWMS. It also shows the role of the city, and the indicators for certain circularity

and inclusion targets that it can direct its policy toward. Tying the various roles of the various chapters in the book together, Chapter 8 offered a means to analyze the middle of the UWMS system and its underlying dynamics of the actors and facilities. At this layer, data flowing from such an analysis can reveal a null benchmark from where improvements can be made. Chapters 9 and 10 earmarked the actors and facilities that function as curbing mechanisms to bring discarded waste back into the UWMS for another chance at life. Chapter 6 and 7 showed how a city can expand its inclusion of informal sectors, and thereby incorporate actors and facilities into its policy making that support the circular lifeline. Chapters 5 and 6 illustrated the power-fields that are imposed on the city to dictate how local CE policy making should adopt certain national CE policy requirements. The challenge for cities was mainly in the realm of making effective pushback to national blind spots that overlook contributing members in the informal sector realm. Chapter 2, 3 and 4 underscored how the philosophies of circular and inclusive cities can act as a guide for this, if merged into an inclusive circular UWMS.

Figure 1 (iii) represents the cycle of information collection and decision making at the urban scale shaping the UWMS in its actual form. Chapter 5 illustrated how this operates in the Netherlands, using transition management, how the plan to check the cycle may occur over long periods. In other countries, the same line of thought will lead to different structures and different recommendations for reconfiguring elements and relations. On the Plan component of the cycle, Chapter 2 and 3 offer ways to think about the goals of the city in terms of inclusion and circularity, and how these can be pursued. On the Do component of the cycle, Chapter 8 reveals how the Waste Journey method could be deployed to benchmark the current UWMS by following the waste movements and discovering key actors, and then by analyzing the achievement of those activities to the policy goals. On the Check component of the cycle, Chapter 10 points out how evaluation of the performance of the system in place should recognize the challenges that occur at the individual components, and how the evaluation needs to be reflexive rather than simply following the measurement of outlined indicators only, at least if it is really to evaluate the informal parts of the UWMS. On the Act component of the cycle, Chapter 9 reveals in the case study how the participation of informal actors in the formal regulatory framework should inform changes to a next cycle of policy making to increase the effectiveness of these actors in enhancing their levels of inclusivity and circularity. Chapter 7 reinforces the cyclicality of the framework, with suggestions as to how the informal sector can be made part of such a next cycle, in its long-term case study of the informal recycling sector in Beijing.

Cities have ever-growing footprints in resource consumption burdening the planet. It calls for the transformation towards a circular city worldwide with actions at different locales. The transnational flows of products continue in the end-of-life stage for reuse, recycling and recovery, which complicate the circular value chain in the global production and consumption network. The inclusive circularity is not only locally embedded, but also globally oriented.

Although the modelling approach developed and presented in this book and summarized in this concluding chapter is general in nature and potentially universal

in its applicability, it needs to be practically fleshed out and specified for each individual city case. Policymakers and analysts in different urban contexts deal with different types and compositions of waste flows, face different practical problems, have different actor constellations and are embedded within different institutional structures and contractual arrangements. The result is that they can apply the conceptual modelling approach, but each must go through it 'with their own specific data input'. They can also draw lessons from each other provided they do not slavishly copy each other's policies but examine which policy solutions work elsewhere, how their own situation diverges from their example and then account for those differences in their adoption of new goals and instruments.

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