



Living labs supporting circular cities in Morocco: Towards collaborative waste management in Casablanca

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ABSTRACT

This article examines the role of Living Labs in advancing a circular economy approach to waste management in Casablanca. Amid rapid urbanization, intensifies pressure on waste management infrastructure. Living Labs emerge as promising tools to foster collaboration among citizens, local authorities, private operators, and associations. The study reveals that, while economic imperatives primarily drive waste management practices, Living Labs provides a participatory innovation framework that enhances citizen engagement and adapts waste management solutions to local specificities. However, the lack of adequate infrastructure for waste sorting and the challenge of coordinating initiatives hinder the full transition to circular cities. By integrating co-creation and local resource mobilization, this article concludes that Living Labs can contribute to Casablanca's sustainability goals while recommending stronger public policy support to maximize its effectiveness. The methodology used in this study combines secondary data, field observations, and semi-structured interviews with local stakeholders. This approach allows the exploration of collaborative waste management practices and the potential integration of circular city concepts within Casablanca's context.

1. Introduction

The rapid growth of urban areas and the exponential consumption of resources have made waste management a central issue for environmental sustainability. In this context, the circular economy (CE) has emerged as a strategic lever for reducing ecological footprints while optimizing resource use [1,2]. However, despite the promising theoretical framework, implementing CE at an urban level remains complex, faced with the diversity of stakeholders, infrastructural limitations, and local cultural specificities. Originally designed for industrial environments, CE models thus require adaptation to address the realities and challenges of urban territories.

Cities, therefore, provide ideal experimental grounds for testing innovative and sustainable waste management solutions. Initiatives such as Living Labs (LL) create spaces where co-creation and collaborative experimentation can unfold effectively. Initially conceptualized at MIT in the 1990s and strengthened in Europe by the ENoLL network [3], these living laboratories mobilize citizens, businesses, public

institutions, and researchers to develop solutions tailored to local needs [4]. By combining scientific research, citizen participation, and practical applications, LLs embody participatory and place-based innovation, which is particularly relevant to urban circularity and collaborative waste management challenges.

Living Labs distinguishes itself through an experimental governance approach, facilitating decentralized decision-making and empowering local actors to design solutions that fit specific on-the-ground realities [4]. This approach allows cities to move beyond local experimentation to influence urban policies and build frameworks for collaborative governance [5]. Recent studies have highlighted the effectiveness of LLs in adopting circular practices by integrating social justice, sustainability, and participative governance, making innovation accessible and contextually relevant [6,7]. However, integrating LLs into urban strategies presents challenges: complex governance, the need to coordinate a wide range of stakeholders, and the economic viability of projects. Institutional obstacles and a lack of suitable infrastructure also hinder the deployment of circular solutions in certain urban contexts [8].

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Circular Cities (CC) offer a holistic approach to urban sustainability that aligns closely with the principles of Living Labs (LL), especially in fostering systemic changes towards sustainability. Herrador et al. [9] emphasize that CC are not merely a set of practices, but integrated, community-driven systems that engage diverse stakeholders across the urban spectrum. These cities aim to create sustainable, resource-efficient environments where circularity principles are deeply embedded in urban processes, such as waste management, energy flows, and economic activities [10]. The CC model fosters collaboration, crucial for the development of LL, as it inherently encourages participation from local governments, businesses, and citizens to implement solutions that close resource loops [1]. Furthermore, CC leverage the advantages of LL by providing platforms for experimentation and innovation in real-life urban contexts, as demonstrated by the EU's Circular Cities Declaration (CCD), which outlines key principles for scaling circularity in cities [11]. These collaborative, experimental spaces are essential for testing circular economy solutions and ensuring that cities not only reduce waste but also regenerate ecosystems and promote social equity [12]. Thus, the Living Lab approach becomes a pivotal mechanism for ensuring the effective implementation and scaling of circular economy principles within urban settings, making CC more resilient and adaptable to future challenges.

Circular cities represent an evolving model in urban planning, where resource flows are closed, and waste is minimized through systemic changes. This model of urban development is a key component of the circular economy and focuses on reducing consumption, recycling, reusing, and regenerating urban spaces. A circular city functions as a regenerative urban ecosystem where resource loops are closed, and waste is considered obsolete, significantly reducing the city's ecological footprint while enhancing urban resilience and the health of its population [13].

Adopting circular practices in urban settings, such as circular food systems, water recycling, and adaptive reuse of spaces, aligns well with the principles of Living Labs. These labs provide an experimental framework for testing and implementing circular solutions within the urban context, allowing for adaptive learning and innovation in real-world environments. The integration of circular practices in cities requires substantial investment, political support, and active public engagement. Living Labs can play a crucial role in this process by testing circular strategies in urban contexts, fostering collaboration among local stakeholders, and adapting global circular models to specific urban environments [12].

In a metropolis like Casablanca, where rapid urbanization generates over 6000 tons of waste daily, waste management represents a critical environmental challenge. As Morocco's economic capital, Casablanca faces mounting pressures on its infrastructure and must seek innovative solutions to adopt a sustainable city model.

This article examines the potential of Living Labs to strengthen collaborative waste management within the CE framework in Casablanca. Through an analysis of secondary data, field observations, and semi-structured interviews with local stakeholders, this study aims to identify collaborative waste management practices and explore adaptation possibilities for the Casablanca context. The objective is to demonstrate how LLs can contribute to implementing a sustainable waste management model, rooted in local specificities and inspired by international best practices.

To structure our analysis, the article is divided into four main sections. First, we explore Living Labs as central actors in driving urban dynamics towards a circular economy, explaining how they facilitate open innovation and citizen integration into circular processes. Next, we detail the waste management context in Casablanca and outline our data collection methodology, providing an in-depth understanding of local dynamics and the specific challenges facing this territory. The third section presents the study's results, examining how collaborative management aligns with economic goals and how citizen engagement and legitimization of source-separation initiatives encourage participation.

Finally, the discussion focuses on the implications of Living Labs for the development of circular cities, highlighting their advantages and the challenges encountered in their implementation.

2. Literature review: living labs and the urban circular economy

In response to contemporary ecological and economic challenges, the circular economy (CE) emerges as an essential lever for reimagining cities as more sustainable and resilient spaces [14]. By advocating for reduced resource extraction and extending product lifecycles, this model calls for profound transformations in governance, industrial practices, and individual behaviors. In this context, Living Labs (LLs) offer a unique framework for open innovation and active participation, mobilizing citizens, companies, public institutions, and researchers to co-create solutions that address the specific needs of urban territories [15,16]. The figure below illustrates the key stakeholders in a Living Lab and their roles in the co-creation process.

Living Labs are increasingly recognized as key platforms for innovation, particularly in urban settings, where they serve as experimental environments that integrate research and practice. The primary goal is to develop, evaluate, and translate ideas into innovative applications within the Living Lab, in collaboration with relevant stakeholders. The following figure presents the key stages of the Living Lab's process.

This approach underscores the importance of cooperative development and implementation of solutions in a practical, experimental environment [17]. These labs foster a collaborative, co-creative process involving stakeholders from diverse sectors, including local communities, businesses, governments, and academia. Living Labs involve testing new solutions in real-world environments, allowing for dynamic interactions and feedback loops that refine and adapt innovation to local needs [18–20].

Unlike traditional laboratories, Living Labs integrates end-users from the earliest stages of the innovation process. As co-innovators, citizens actively contribute to developing and adapting circular practices, particularly in recycling, shared repair, and material reuse. This co-creation process embeds the circular economy into the daily lives of communities, making its benefits tangible and immediate [19,21]. The involvement of users in Living Labs contributes to a deeper understanding of local challenges and opportunities, ensuring that circular economy solutions are grounded in real-world conditions [4].

Living Labs also serve as technological experimentation platforms that support the transition to circular cities. For instance, using emerging technologies such as digital twins, artificial intelligence, and the Internet of Things (IoT) in waste management initiatives enhances waste collection, sorting, and CO₂ emission reduction related to transport and processing operations. These innovations facilitate the integration of circular processes into urban life, boosting material flow efficiency and product traceability [22]. The integration of these technologies is part of the broader trend of using smart city technologies to improve urban sustainability, with circular economy principles at the core.

One of the main strengths of Living Labs lies in its ability to foster synergies among diverse stakeholders and promote inclusive governance. By involving citizens, businesses, local authorities, and NGOs in decision-making processes, these labs ensure that solutions meet the expectations of various stakeholders. The collaborative governance they promote is crucial for CE, enabling stakeholders to tackle resource management and waste reduction challenges [23]. Recent studies emphasize that inclusive governance in Living Labs fosters collective decision-making, which is essential for addressing the systemic challenges of circular economy transitions [6].

Moreover, the local anchoring of Living Labs allows them to adapt CE models to the specificities of each territory. By operating locally, they integrate cultural and socio-economic practices, testing solutions tailored to local infrastructures and behaviors, such as short reuse cycles for sorting and recycling. Thus, Living Labs does not merely apply

universal industrial models but transforms them to fit local practices [24]. In line with this, Williams [12] highlights the importance of adapting circular economy solutions to urban cultural and infrastructural contexts, further reinforcing the relevance of Living Labs in fostering such adaptations.

To expand the literature framework, this article employs a systematic approach to reviewing the state of the art, emphasizing key concepts such as "Living Labs," "circular economy," and "circular cities." The literature review was conducted through a multi-step process that involved searching academic databases, including Scopus and Google Scholar, using a combination of keywords like "Living Labs," "open innovation," "circular economy," "circular cities," and "urban sustainability." The search also included recent publications from top-tier journals and conferences, ensuring the inclusion of the latest advancements and theoretical developments. The review followed an inductive methodology; articles were first selected based on their relevance to the topic and then analyzed using content analysis to identify recurring themes and theoretical approaches. Key articles foundational to understanding Living Labs and circular economies in urban contexts were cross-referenced and synthesized to build a comprehensive theoretical framework. This approach enabled the identification of gaps in the existing literature and highlighted opportunities for further research, especially in applying Living Labs to the context of circular cities and waste management in urban settings.

In line with this approach, circular cities emerge as an essential framework for incorporating circular economy principles into urban planning, highlighting the integration of sustainable practices across various sectors. Circular cities represent a new vision of urban development that focuses on reducing resource consumption and waste while regenerating urban ecosystems. These cities integrate circular economy principles into every aspect of urban life, including waste management, energy use, and infrastructure design. According to Williams [12], circular cities are urban ecosystems where resource loops are closed, waste becomes obsolete, and ecological regeneration is prioritized. Living Labs are crucial in the context of circular cities as they provide a testing ground for circular economy principles, helping to transform urban spaces into sustainable, resource-efficient environments.

This table highlights the various dimensions that make Living Labs essential for promoting the circular economy. They integrate end-users into co-creation, facilitate technology adoption, foster inclusive governance, and adapt to local contexts. Additionally, they play a crucial role in education and awareness, contributing to a collective adoption of circularity principles.

Living Labs position themselves as key platforms for circular economy innovation within cities. By connecting local actors in a real-world experimental setting, they pave the way for more sustainable and resilient cities, where co-created solutions align with communities' specific needs while reinforcing local environmental and social values.

To study the role of Living Labs in the transition to a circular economy, this article adopts a qualitative approach focused on waste management, specifically Municipal Solid Waste (MSW), in the urban context of Casablanca. This methodology delves into the perceptions and practices of the various stakeholders involved, utilizing secondary data analysis, field observations, and semi-structured interviews. The following methodology section will elaborate on the data collection and analysis methods used to understand better the contributions of Living Labs to the transition toward circular cities.

3. Context and research methodology

The shift towards collaborative waste management in Casablanca poses a major challenge within a rapidly urbanizing environment and increasingly stringent environmental goals. Although Morocco has implemented various programs to encourage the circular economy, the application of waste management strategies remains constrained by structural, economic, and sociocultural limitations. This section outlines

the research context, methodology for data collection from key stakeholders, and the analytical approach used to assess the potential of Living Labs as platforms for collaborative waste management in Casablanca.

3.1. Waste management in casablanca

Morocco has developed several strategic programs and plans to balance socio-economic development with environmental preservation while adopting a circular economy approach. Key initiatives include national waste valorization and household waste management programs. Additionally, the government has initiated the transition towards a circular economy. These efforts include a study led by the State Secretariat for Sustainable Development to create a transition strategy by 2030, accompanied by an action plan to accelerate this shift, alongside advocacy and awareness campaigns. Legislative and regulatory drafts have also been introduced to formalize this transformation. However, despite these efforts, results in waste management remain limited, with insufficient outcomes in terms of recycling and waste valorization. While some progress has been made in urban cleaning, household waste management is largely dominated by bulk collection practices without source separation. This lack of initial sorting hinders waste processing, making the process costly and less attractive for private sector players [25].

Achieving an effective transition towards a circular economy requires a systemic shift, involving coordinated mobilization of all stakeholders within each link of the value chain as well as in strategic sectors. This integrated approach is essential to ensure waste management that is both sustainable and aligned with circular economy objectives.

The figure above illustrates the household waste collection method in Casablanca. Despite a few pilot initiatives for source separation, waste collection in Casablanca is predominantly done in bulk, with no systematic source sorting. This approach complicates waste processing, making it costly and less profitable for the private sector.

Additionally, in 2023 alone, our study area, the three provinces/prefectures of Casablanca (Casablanca, Nouaceur, and Mediouna) produced over 6000 tons of daily waste.

This table projects a combined daily waste production of 6031 tons for Casablanca, Nouaceur, and Mediouna, highlighting the growing challenges of waste management. According to estimates by the Casablanca municipality, waste generation in Casablanca alone is expected to reach 2.79 million tons by 2043.

While Morocco is progressing toward a circular economy through various waste management and valorization programs, Casablanca faces significant challenges. Bulk collection without source sorting increases treatment costs and complicates recycling processes. With daily waste production already exceeding 6000 tons in 2023, projections for 2043 underscore the urgent need to develop collaborative waste management strategies that engage all stakeholders. The following section presents our field data collection approach, aiming to analyze the potential role of Living Labs in designing innovative and inclusive solutions that support the transition to a circular city.

3.2. Data collection

To analyze the role of Living Labs in waste management and the transition to circular cities, we focused on the case of Household and Similar Waste (HSW) in Casablanca. This study adopts a qualitative methodology based on multiple data collection methods.

The analysis utilizes secondary data, field observations, and a series of semi-structured interviews with 29 stakeholders of diverse backgrounds. These interviews and observations aim to capture a representative and contextualized view of collaborative waste management practices and the circular economy, taking into account the diversity of perceptions and local actions. Data collection was conducted in two main phases

The first series of semi-structured interviews: This initial phase involved conducting interviews during two scientific events that brought together various stakeholders engaged in the circular economy. The National Colloquium on the Circular Economy and Sustainable Territorial Development, organized by the National School of Business and Management in Oujda on April 27, 2023, and a conference on urban sustainability held on May 30, 2023, in Casablanca. These events enabled interactions with researchers, institutional representatives, and members of civil society interested in circularity dynamics. Insights gathered from these events were enriched by a series of interviews, allowing cross-analysis of perspectives from different profiles.

- The second series of interviews using a "snowball" technique: To obtain additional and diversified perspectives, we employed the snowball technique [26]. Individuals interviewed in the first phase directed us to other stakeholders involved in circular economy initiatives, including social economy actors, innovative project leaders, and association members. This technique broadened the participant panel to include diverse voices representative of the HSW management ecosystem in Greater Casablanca.

The following table summarizes the interview data, divided into two categories of participants: institutional actors and field actors.

This data collection approach enables the capture of diverse perspectives and experiences among actors, while accounting for the unique characteristics of each municipality in Greater Casablanca. By combining field observations, secondary data, and semi-structured interviews, this study provides an in-depth analysis of municipal solid waste management (MSW) practices and the potential integration of Living Labs in advancing circular cities.

The following table summarizes the types of data collected, their sources, descriptions, and their specific relevance for analyzing the potential impact of Living Labs in transitioning towards circular waste management practices in Casablanca.

The semi-structured interviews invited respondents to explore several aspects of collaborative waste management practices. Firstly, participants were asked to share their perceptions of the collaborative innovation enabled by Living Labs, particularly in co-creating solutions tailored to the local context. They then discussed the economic benefits of these practices, such as optimizing collection costs and accessing funding for sustainable initiatives. The discussions also highlighted the importance of incentives, such as value-based pricing, to promote eco-

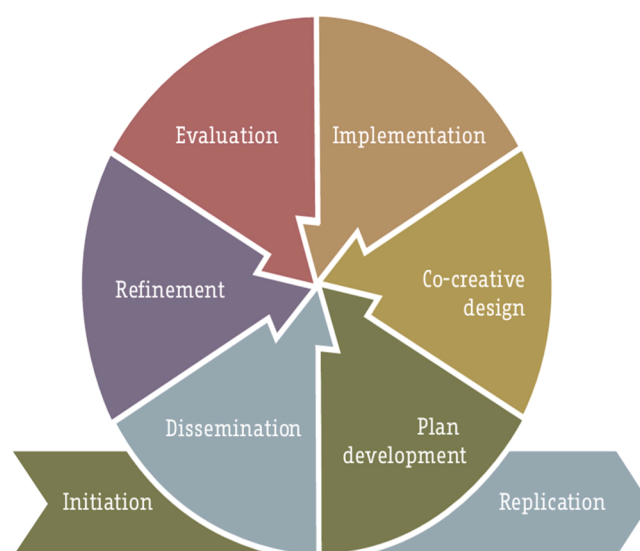


Fig. 2. Key stages of the Living Lab process.
Source: Steen & Bueren, 2017

friendly behaviors and reinforce citizen engagement in waste sorting. The social impact of Living Labs was also addressed, especially their potential to boost the local economy and strengthen social bonds. Lastly, the interviews clarified the respective roles of local authorities and private operators and provided an opportunity to discuss ways to stabilize and sustain circular waste management practices within a framework of collaborative governance.

3.3. Analytical approach

The data analysis followed a three-step process. The first step examined the motivations of local authorities and how these motivations shaped the definition of household waste minimization practices. The second step analyzed how actors who were previously peripheral or external to the field became involved in waste management. The third step focused on efforts to stabilize interactions within the field around management practices. At each stage of analysis, the data were subjected to descriptive codes, which were progressively aggregated to a more abstract level through axial coding [27]. In this way, critical points identified in each interview were grouped to uncover the main themes related to the anticipated and actual evolution of roles among various field actors, as well as the determinants of their behaviors and the actions they undertake about the study's topic (Table 5) [28].

The interviews explored various aspects of collaborative waste management: collaborative innovation through the co-creation of local solutions and citizen engagement, operational efficiency by optimizing costs and seeking funding, and incentivization through pricing to encourage source separation. The social impact was discussed in terms of boosting local employment, and the redefinition of roles focused on the integration of the circular economy by local authorities and private operators. Finally, practice stabilization was addressed, specifically the coordination between stakeholders for sustainable collaboration.

Themes identified in the interviews were then compared across all responses, allowing for cross-comparison and categorization of recurring and unique elements into specific categories and sub-categories. This process involved constant verification through iterative checks with the transcripts, performed using NVivo 12 software, to ensure the accuracy of the analysis with the original data. Lastly, to reinforce the validity of the interpretation, the results were presented to participants [29], whose feedback did not necessitate any substantive adjustments.

This methodology has highlighted the main factors motivating decision-makers to adopt a collaborative waste management approach

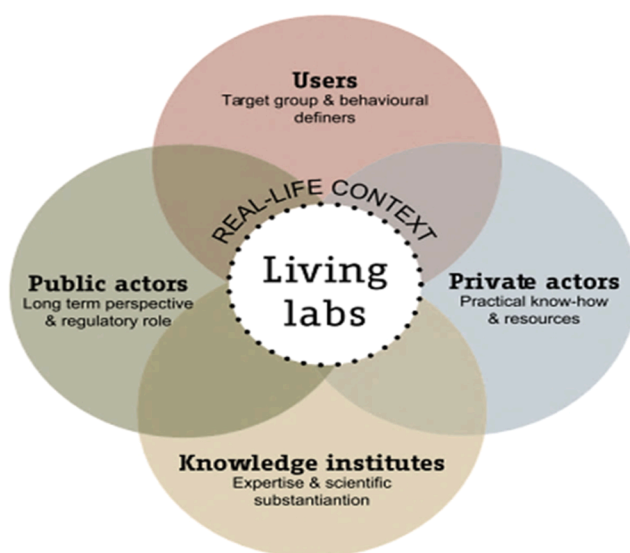


Fig. 1. The Living Lab stakeholders.
Source: Steen & Bueren, 2017



Fig. 3. Household Waste Collection Container in Casablanca.

Source: Authors

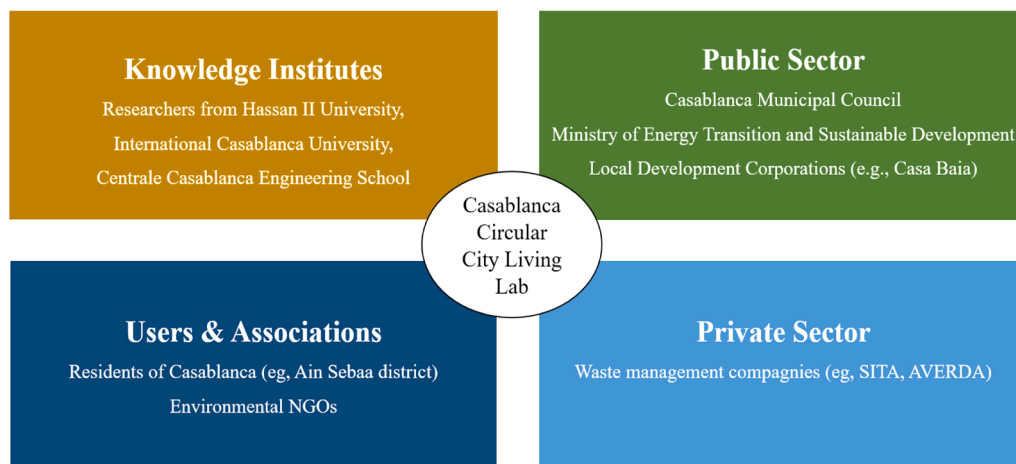


Fig. 4. Proposed Living Lab Stakeholder Model for Circular City Development in Casablanca.

Source: Authors

in Greater Casablanca. It also sheds light on the nature of actions undertaken to actualize this approach by identifying obstacles and levers in its implementation. The analysis, ultimately, focuses on the potential contribution of Living Labs to the transition towards circular cities, setting the stage for a detailed presentation of the study's findings.

4. Results

To analyze the dynamics of waste management in Morocco, this results section examines the current collaborative approach to managing Municipal Solid Waste (MSW) in Casablanca, with a focus on the economic motivations driving this approach. Despite legislative aspirations towards a circular economy, collaborative practices remain strongly influenced by profitability objectives, with priority given to cost reduction and the maximization of available resources.

4.1. Collaborative management driven by economic interests

The collaborative management of household waste in Morocco diverges significantly from the priorities outlined in legislation oriented towards a circular economy. This divergence stems from a realignment of collaborative management practices around the primary interests of the sector's central actors, particularly local authorities and national private operators. In the realm of Municipal Solid Waste (MSW), practices related to the circular economy are primarily motivated by economic objectives, focusing on creating and sharing value around waste and reducing processing costs.

This economic logic permeates all stages of the transition towards a circular economy. It manifests in decision-making processes, operational practices, the resources and tools mobilized, and the performance indicators monitored. These priorities are confirmed both by interviews with sector actors and secondary data, revealing that the current

Table 1
Contributions of Living Labs to the circular economy.

Dimensions	Description	Practices
Stakeholder Mobilization	Integration of citizens, businesses, institutions, and researchers from the early stages of the innovation process [15].	Enables co-creation of solutions adapted to local needs, embedding the circular economy into everyday urban practices.
Emerging Technologies	Use of technologies such as digital twins, AI, and IoT to optimize waste and resource flow management [22].	Improves waste collection and processing efficiency, and reduces CO ₂ emissions, reinforcing the integration of circularity in cities.
Collaborative Governance	Promotes inclusive governance by involving citizens, businesses, and local authorities [23].	Addresses the expectations of diverse stakeholders and overcomes systemic challenges related to resource management and waste infrastructure.
Local Anchoring	Tailoring CE models to the cultural and socio-economic specifics of territories, with short reuse circuits [24].	Specific sorting models, and valorization of local materials.

Source: Authors.

approach remains grounded in a profitability logic rather than a collaborative ecological transformation, as the legislative framework advocates.

Interviews reveal that the shift towards collaborative household waste management is primarily driven by economic imperatives. In the context of Morocco's advanced regionalization, the financial autonomy of local authorities, although essential for local development, also imposes significant constraints. With the increased transfer of responsibilities, local authorities must now manage their own financial resources, which requires them to maximize revenue generation and optimize fund utilization. However, the limits of their resources, exacerbated by the prolonged effects of the economic crisis and the COVID-19 pandemic, restrict their capacity to independently finance waste management projects.

Facing these budgetary pressures, local authorities are turning towards collaborative management, integrating external partners such as private operators, associations, and civil society to share responsibilities and costs. This approach allows them not only to offset financial shortcomings but also to access expertise and additional funding mechanisms. In this sense, collaborative waste management emerges as a response to the constraints of financial autonomy and serves as a lever to ensure the sustainability and effectiveness of local actions, while also strengthening territorial governance and stakeholder engagement.

The interview excerpts highlight how economic constraints and the demands of financial autonomy are guiding Moroccan municipalities toward collaborative waste management. The involvement of private actors and associations has become an essential lever to overcome budget limitations and enhance waste management efficiency, distributing costs and responsibilities among diverse partners.

Collaborative waste management, driven by economic constraints and financial autonomy requirements, requires not only coordination among different partners but also efforts to legitimize the approach, building buy-in from users and stakeholders alike. Local authorities play a key role in promoting this collaborative approach, needing to convince

both citizens and sector stakeholders of the relevance and value of new waste management practices.

4.2. Raising awareness and citizen engagement to legitimize collaborative waste management

To legitimize collaborative waste management, local authorities, especially in Casablanca, focus on two main areas: promoting source separation of waste and encouraging eco-responsible behavior. These awareness-raising actions aim to mobilize citizens around waste sorting by making the practice accessible and fostering a sense of individual responsibility, essential for sustainable waste management.

One of the main challenges of this initiative is turning source separation into a collective habit. Local authorities organize awareness campaigns to explain the importance of separating recyclable waste from other waste at the point of collection. In May 2022, the Mayor of Casablanca launched a pilot operation for sorting household waste at source in the Ain Sebaa district, with the goal of eventually extending this initiative to the entire metropolis. She stated: "For this program's launch, we have chosen one residence per district and provided it with dedicated sorting bins. Each household will now have two separate bins: one for household waste and another, provided by the city, for plastics, glass, cardboard, and other recyclable items." In addition to installing these bins, the initiative includes a public awareness campaign on the importance of selective sorting. This effort aims to encourage participation in sorting by demonstrating the concrete impact of citizen involvement on sustainable waste management.

In this context, a Casablanca Municipal Council representative underscored the importance of citizen engagement in the success of these initiatives: "We've observed that much of the success in waste management hinges on citizen involvement in sorting. Without clear and regular awareness efforts, source separation initiatives risk going unheeded. That's why we're investing in local campaigns to explain the importance of separating recyclables from other waste, helping people realize their significant role in the process." These local campaigns aim to embed sorting practices into citizens' daily routines, reinforcing their understanding of their essential contribution to the success of

Table 3
Profile of interview participants.

Category	Number of Participants	Profile of Actors
Institutional Actors	13	- 4 staff members from the Ministry of Energy Transition and Sustainable Development - 5 representatives from national environmental protection associations - 2 consultants from consulting and research firms - 2 representatives from Casablanca's municipal council
Field Actors	16	- Managers within the solid waste division in the municipalities of Casablanca, Nouaceur, and Mediouna - Collaborators within the local development companies (LDC) Casa Baia - Staff from waste management companies operating in Casablanca (Sita, Averda)

Source: Authors.

Table 2
Waste Production by Provinces/Prefectures in Casablanca.

Province/Prefecture	2023	2030	2043	Total (t)	Annual Average (t)	Daily Average (t)
Casablanca	1.195.621	1.383.889	1.815.700	32.360.317	1.618.016	4.432,92
Nouaceur	177.267	282.018	667.989	7.989.338	399.467	1.094,43
Mediouna	81.591	129.805	307.457	3.677.272	183.864	503,74
Total	1.454.479	1.795.712	2.791.146	44.026.927	2.201.346	6.031

Source: Casablanca Municipality.

Table 4
Data collected and its use for analysis.

Data Types	Sources	Description	Usefulness for our study
Primary	Interviews	13 interviews with institutional actors (lasting 30 to 120 min), recorded and transcribed, totaling about 120 pages	Provides insights into circular economy regulations, anticipated impacts, and perceived limitations in municipal waste management.
	Interviews	16 interviews with field actors (lasting 40 to 90 min each), all recorded except one, for which notes were taken; approximately 310 pages transcribed.	Offers information on how field actors are adopting collaborative waste management practices.
	Observation	Participation in a conference (6 h) and a colloquium (8 h) involving various stakeholders in the waste sector, including local authorities and private operators.	Provides an understanding of the feasibility of establishing a Living Lab for collaborative waste management.
	Observation	Visit to the “Casa-Baia” Local Development Corporation, including discussions with service managers.	Provides information on the household waste management process, its challenges, and opportunities from the perspective of local operators.
	Observation	Visit to the Casablanca landfill site.	Offers insights into current landfill practices for household waste and identifies potential improvements within a circular framework.
Secondary	National-level documentation	Publications from the Ministry of Energy Transition and Sustainable Development, the Economic, Social, and Environmental Council, etc.	Provides an official regulatory framework, legal objectives, and national data relevant for understanding the regulatory context of the studied areas.
	Documentation from studied territories	Publications from the Casablanca Municipal Council.	Provides specific local perspectives and objectives, allowing for contextualization of challenges and strategies deployed for circular economy initiatives in Casablanca.

Source: Authors.

collaborative initiatives.

Additionally, local authorities strive to increase points of contact with the public, engaging schools, neighborhood associations, and local businesses to build collective awareness around waste management. A manager in the solid waste division of Nouaceur municipality explained: “Our goal is to create a collective consciousness. We have implemented awareness activities in schools, neighborhood associations, and even local businesses. If every citizen understands why and how to sort, it greatly simplifies the work of waste management services and improves collection efficiency.” This awareness effort broadens public understanding and reinforces the coherence of sorting practices at the local level.

Simultaneously, associations play a crucial role in highlighting eco-

Table 5
Data structure.

First-Order Category	Second-Order Theme	Theoretical Dimension
Collaborative Innovation	Co-creation of solutions adapted to local contexts Active participation of citizens and local actors	Development of context-specific practices Stakeholder engagement in CE
Operational Efficiency	Collaborative management optimizes collection and processing costs Cost reduction and access to funding for sustainable initiatives	Theory of practice according to local needs Economic model aligned with CE
Sensibilisation et responsabilisation	Awareness promotes sorting at the source Citizen participation encourages eco-responsible behaviors	Legitimization of sorting practices Legitimization of collaborative management practices
Social and Territorial Impact	Waste management boosts local employment Differentiated collection supports the local economy	Strengthening of social and economic bonds Legitimization of local actors
Redefinition of Stakeholder Roles	Local authorities as drivers of CE integration Private operators contribute to waste valorization	Role distribution within CE Role segmentation and stabilization
Practice Stabilization	Coordination between local authorities, citizens, and private operators	Stabilization of interactions and collaboration

Source: Authors.

responsible behaviors by demonstrating the direct benefits of these actions to citizens. A collaborator from a national environmental protection association shared: “Citizens often don’t see the impact of their daily actions. Our role as an association is to make this visible. We participate in awareness projects to show that waste sorting has a direct effect on the environment and, more broadly, on the quality of life in their neighborhoods. The more people understand the importance of their actions, the more invested they feel and the more willing they are to collaborate.” This testimonial emphasizes the shift from individual behaviors to collective engagement, essential for the success of sorting initiatives.

In short, these awareness-raising and citizen engagement actions form a foundation for legitimizing collaborative waste management practices. By recognizing each citizen as a key actor within the management system, local authorities reinforce social acceptance of collaborative initiatives and foster a transition to waste management that is both sustainable and inclusive. This legitimization process thus relies on collective mobilization, where each participant, particularly citizens, understands their role and responsibility in the waste management chain.

4.3. The living lab: an organizational approach for sustainable, collaborative waste management

Collaborative waste management, inspired by the Living Lab model, profoundly reshapes the field of Household and Similar Waste (HSW) in Morocco. This approach broadens the range of actors involved, redefines their roles, and reorganizes coordination methods, creating a dynamic where co-creation and local innovation play central roles. Through interviews, several themes emerged, illustrating how this organizational model promotes not only efficiency but also the transition to circular urban practices.

In this context, the role of the user becomes crucial. They act as a moderator and differentiator of waste flows, influencing the overall quantity of HSW through purchasing behavior and, most importantly, through the quality of source separation. Previously a passive participant, the user now becomes a key player in selective collection. A collaborator at Sita, a waste management company in Casablanca,

Table 6

Excerpts from interviews illustrating economic constraints and the shift toward collaborative waste management.

Stakeholder Profile	Interview Excerpt
Casablanca Municipal Council Representative	"With the new financial responsibilities we must assume under advanced regionalization, it has become clear that our resources alone are insufficient. Waste management is particularly costly, and without the involvement of private and community actors, we simply could not meet the growing demands for collection and treatment services."
Collaborator at "Casa-Baia" Local Development Corporation,	Local Development Corporation are now required to work closely with local authorities and other partners to share financial and operational burdens. We had to explore partnerships with the private sector to benefit from their technical skills and financial capacity, especially in the post-pandemic context where budgets are very tight."
Collaborator at the Ministry of Energy Transition and Sustainable Development	"Financial autonomy has indeed given local authorities greater freedom, but it also compels them to rely on collaborative management to offset costs. We see that they are actively seeking partnerships with private companies and associations to fill funding gaps, particularly in waste management projects where collection and treatment costs are constantly rising."
Consultant at a Consulting Firm	"Many local authorities today find themselves with expanded responsibilities but without the corresponding resources. In the context of waste management, this forces them to think collaboratively to share costs and risks with external partners, in order to maintain a level of service that meets the needs of the population."
Collaborator at Sita, a Waste Management Company in Casablanca	"The management model we are implementing with local authorities is based on a sharing of costs and responsibilities. Local authorities can no longer bear the expenses of sustainable waste management alone; we step in to provide technical expertise and operational efficiency, but this requires shared financial commitment."
Representative from a National Environmental Protection Association	"The financial constraints faced by local authorities are increasingly apparent. We have been asked to offer our support and ideas to optimize waste management, especially in underserved neighborhoods. This collaborative approach is a direct response to budgetary limits, but it also paves the way for better citizen inclusion in local projects."

Source: Authors.

shared: "More and more initiatives come from local associations and residents themselves, sometimes without direct involvement from the municipality. Residents play a key role in sorting and awareness-raising activities, creating a ripple effect within their communities." This transformation of the user into an engaged and informed actor within the Living Lab framework facilitates the legitimization of collaborative waste management, essential for the transition to a local circular economy.

At the same time, local authorities act as integrators, orchestrating an ecosystem of diverse actors involved throughout the HSW management chain. They mobilize a variety of resources, both local and national, to support sorting, collection, and recovery initiatives in partnership with associations, social enterprises, and private operators. A representative of the Casablanca Municipal Council illustrated this

dynamic: "By bringing all actors together around a shared project, we realized that many were working individually. Today, with clearly defined partnerships, we manage to federate and coordinate efforts effectively." This testimonial highlights the importance of a collaborative and unifying approach, essential to the Living Lab model, which maximizes local resources and skills for common objectives.

Social enterprises and associations also play a leading role in this Living Lab organization. Their proximity to users and expertise strengthen sorting practices and facilitate the integration of specific waste streams, such as bio-waste, often overlooked by traditional operators for profitability reasons. A collaborator at SDL Casa Baia noted: "We have established partnerships with social and solidarity economy actors to implement targeted collection focused on recovery, with performance objectives." This partnership enables local authorities to adopt a sustainable and inclusive approach by integrating non-traditional actors into waste management, aligned with the principles of a circular economy.

Finally, traditional private operators, although primarily positioned downstream, are adapting their services to meet the new demands of the collaborative field. They contribute by financing equipment and optimizing collection logistics, bringing essential expertise to the municipalities. Through multi-party contracts, they participate in an expanded governance structure, where performance indicators now include reuse and carbon footprint reduction targets, while integrating social enterprises and solidarity actors into their processes.

This table presents a Living Lab model tailored to the specificities of waste management. It summarizes the roles, resources, positioning, targeted waste flows, and objectives of each category of actors in a Living Lab for collaborative waste management. Local authorities play a central coordinating role, ensuring the integration of various actors in the waste management chain, while users, private operators, and associations or civil society representatives contribute specific roles that support the ecological, economic, and social dimensions of the Living Lab model, aiming for sustainable and inclusive waste management.

Based on our fieldwork and analysis, we propose a context-specific model of a Living Lab tailored to the urban circular economy transition in Casablanca. The figure below summarizes the roles and synergies among the key stakeholder groups involved (Figs. 1-4), (Tables 1-7).

The collaboration among key local actors—including academic institutions, municipal authorities, private waste management companies, and resident associations—who co-develops and implement circular solutions adapted to the specific socio-environmental challenges of Casablanca.

In sum, the Living Lab model promotes collaborative waste management by reshaping the organization of the household and similar waste (HHSW) field through co-creation and collective mobilization. This model embodies a sustainable approach, where each actor—from users to private operators, actively contributes to minimizing waste, allowing local authorities to make successful strides toward circular cities. The next section discusses these observations, analyzing their implications for circular city development and the sustainable implementation of the Living Lab model.

5. Discussion

This study reveals the critical role of Living Labs (LLs) in fostering collaborative waste management and advancing the transition to circular cities (CCs), particularly within the urban context of Casablanca. The interviews and data analysis findings highlight the multifaceted challenges and opportunities in integrating circular economy principles into urban settings and the vital contribution of LLs in this process.

The shift from traditional waste management models towards more collaborative, resource-efficient systems is at the core of this discussion. The results suggest that economic imperatives remain the primary driver of waste management in Casablanca, with local authorities struggling to balance their responsibilities within the constraints of financial

Table 7

Categories of stakeholders and their roles in a collaborative waste management living lab.

Category of Stakeholders	Role	Own Resources	Positioning	Flows	Objectives
Users	Moderation and differentiation of waste flows through sorting and purchasing behavior	- Cognitive and behavioral resources to ensure quality sorting - Social influence to encourage eco-responsible behaviors	- Prevention by minimizing waste generated - Collection through careful and differentiated sorting	All types of flows, influenced by consumption and sorting habits	- Economic: cost reduction related to waste generation - Social: contribution to a clean and healthy environment - Ecological: reducing environmental footprint through sorting
Municipalities	Integration and coordination of local and national resources	- Democratic legitimacy to unify stakeholders - Legal responsibility to ensure compliance - Territorial expertise and resource management skills	All stages of the chain: prevention, collection, sorting, recovery, and final management	All flows and stakeholders, with an integrated and territorial approach	- Compliance with regulatory requirements - Balancing public finances and budget optimization - Territorial dynamism through sustainable and collaborative waste management
National Operators	Routing, recovery of flows, and logistical optimization	- Investment capacity and shared financial risk - Technical and logistical expertise - Infrastructure and advanced technologies for waste processing	- Advanced collection and recovery - Flow optimization within a profitable framework	All flows, specializing in large-scale collection and treatment	- Financial profitability and cost optimization - Contribution to sustainability goals through efficient collection and treatment
Associations and Civil Society	Moderation and aggregation of specific non-profitable flows, citizen awareness, and mobilization	- Legitimacy in job creation and social engagement - Control over specific secondary flows - Proximity to users to educate and influence sorting practices	- Prevention and awareness-raising - Alternative collection for specific flows - Reuse and material recovery	Specific, low-volume, or low-profit flows, such as organic waste and secondary material flows	- Creation of sustainable local jobs - Strengthening community engagement - Contribution to the circular economy through reuse and waste flow reduction

Source: Authors.

autonomy. As one municipal council representative pointed out, the high waste management costs have forced authorities to seek external partnerships with private operators and civil society to share the financial burden and access additional expertise and funding. This aligns with the broader findings from the literature that emphasize the need for a collaborative approach to overcome resource limitations and ensure the long-term sustainability of waste management systems [4,30].

Furthermore, the results indicate that LLs offer an effective governance model for addressing these challenges by involving a diverse range of stakeholders—citizens, businesses, local authorities, and NGOs—early in the decision-making and co-creation process. Including local communities as active participants in waste management, particularly through initiatives like source separation and recycling, is crucial for legitimizing these practices. The study finds that user participation in LLs helps optimize waste flows, strengthens social bonds, and encourages eco-responsible behaviors. This participatory process is essential for fostering a sense of ownership and responsibility among citizens, ultimately contributing to the success of collaborative waste management systems.

The integration of technological innovations, such as digital twins, artificial intelligence (AI), and the Internet of Things (IoT), also emerged as a key factor in optimizing waste management practices. These technologies enable real-time monitoring and more efficient sorting and recycling processes, which are essential for transitioning to circular systems. The findings support the idea that, as discussed by Amenta et al. [22], the use of smart city technologies within LLs enhances the scalability of circular practices and contributes to the overall sustainability of urban environments. The ability of LLs to provide experimental platforms for testing and refining these technologies is an important feature that bridges the gap between theoretical concepts and practical applications in urban contexts [12].

While the results demonstrate promising advancements in collaborative waste management, several barriers remain. The lack of infrastructure to support source separation and the fragmented governance structure within Casablanca pose significant challenges to fully implementing circular economy models. This finding resonates with Cuomo et al. [31], who highlighted that infrastructure deficiencies and coordination issues between stakeholders can hinder the effective deployment of circular solutions in urban areas. To address these gaps, the study suggests that further investment in infrastructure and stronger

coordination among stakeholders is necessary to ensure the sustainability and scalability of circular practices in the city.

Moreover, the findings underscore the importance of local context in shaping the implementation of circular economy principles. As noted by Williams [12], adapting global circular economy models to local cultural and socio-economic practices is essential for their success. The case of Casablanca illustrates this need for contextualization, with stakeholders acknowledging the importance of tailoring circular strategies to the specific characteristics of the city and its residents. LLs, by operating at the local level and integrating cultural and social considerations, provide a framework for testing and adapting circular solutions that align with the unique needs of urban communities.

The findings highlight the pivotal role of Living Labs in fostering collaborative, sustainable waste management in Casablanca. By facilitating the co-creation of solutions, integrating emerging technologies, and promoting citizen engagement, LLs provide an effective mechanism for implementing circular economy practices in urban settings. However, the successful adoption of these practices requires overcoming governance and infrastructural challenges, as well as strengthening the coordination among stakeholders. This study contributes to the growing body of knowledge on circular cities and Living Labs, offering valuable insights into how these models can be adapted and scaled to meet the sustainability challenges of rapidly urbanizing cities like Casablanca.

6. Conclusion

This article explored the potential of Living Labs (LLs) to facilitate the transition to sustainable waste management within the framework of a circular economy in Morocco, specifically focusing on the case study of Casablanca. The findings of the study underline that while Morocco's legislative frameworks advocate for environmental sustainability, waste management practices in Casablanca remain largely driven by economic considerations. Local authorities, faced with limited resources, have been compelled to adopt a collaborative approach involving private partners and civil society actors. This strategy, though economically motivated, has allowed for broader stakeholder involvement, improving the efficiency and sustainability of waste management initiatives.

Living Labs, as platforms for open innovation and co-creation, play a crucial role in this collaborative approach by bringing together citizens, businesses, institutions, and researchers. These labs create spaces for

experimentation and the development of tailored solutions that take into account the unique socio-economic and cultural characteristics of local communities. This approach ensures that waste management solutions are contextually relevant, while also fostering citizen engagement and ownership of circular economy practices. The study particularly emphasizes the significant roles played by users and civil society in embedding waste sorting and reuse practices within the urban fabric.

However, the study also identifies several barriers that hinder the full realization of the potential of Living Labs in Casablanca. Institutional challenges, inadequate infrastructure for source separation, and difficulties in coordinating actions among various stakeholders remain significant obstacles. These issues slow the adoption of circular economy practices and prevent the scaling of successful initiatives. To overcome these barriers, the study argues that it is essential to strengthen coordination between public policies and local initiatives and invest in the infrastructure necessary to support circular practices.

In summary, while the Living Lab model holds significant promise for advancing circular cities in Morocco, sustaining this approach requires concerted efforts to address infrastructural gaps, encourage deeper citizen participation, and foster inclusive governance. Casablanca, with its dynamic urban environment, has the potential to become a leading example of circular urban management in Morocco. However, this will depend on the ability of local authorities and their partners to address the contextual challenges identified in this study, ultimately creating an integrated, sustainable governance framework that supports the long-term success of circular economy initiatives.

6.1. Ethical statement

Review and approval by an ethics committee was not needed for this

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.sftr.2025.100868](https://doi.org/10.1016/j.sftr.2025.100868).

Appendix 1: Interview Guide

General Objective:

The objective of this interview guide is to gather perspectives on collaborative waste management and the transition towards a circular economy in Casablanca, with a particular focus on the role of Living Labs. This guide is structured around three main themes: collaborative innovation, operational efficiency, social impacts of waste management, and the evolution of stakeholders' roles in waste management.

Introduction (General Context)

1. Can you briefly describe your role and your organization's involvement in waste management in Casablanca?
2. What is your perspective on the importance of waste management in the transition to a circular economy in Casablanca?

Collaborative Innovation in Waste Management

1. To what extent do you believe collaboration between different stakeholders (citizens, local authorities, private companies, associations) is essential for sustainable waste management in Casablanca?
2. Have you observed any co-creation practices in waste management? If so, can you provide an example where successful collaboration occurred among stakeholders?
3. What role do you think Living Labs can play in waste management in Casablanca? Have you ever worked in a Living Lab or with an actor in this model?
4. How do you think citizens' involvement (as key actors in waste management) can be strengthened to improve waste sorting and recycling?

Operational Efficiency and Costs

1. Is waste management in Casablanca primarily influenced by economic objectives? How does cost reduction and optimizing processes affect waste management strategies?
2. How does collaboration with private operators and associations help you better manage the costs associated with waste collection and processing?
3. Are there any financial mechanisms or specific partnerships that facilitate the transition to circular waste management in Casablanca?
4. In your opinion, what are the main economic challenges in implementing a circular economy in waste management in Casablanca?

study because it did not involve collecting sensitive personal data, medical or invasive procedures, or activities posing any risk to participants. The research relied exclusively on interviews conducted within the context of professional activities and observations of publicly accessible processes. Participation in the interviews was entirely voluntary, and all participants were informed about the study's objectives and consented to participate. This ethical statement adheres to the publishing ethics guidelines set forth by Sustainable Futures.

CRediT authorship contribution statement

Soufiane Elbroumi: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Data curation, Conceptualization. **Maha Assaad Idrissi:** Writing – review & editing, Resources, Methodology, Investigation. **Hicham Eddahmouny:** Validation, Supervision, Project administration, Data curation, Conceptualization. **Mohammed Chaaouan:** Visualization, Resources, Investigation, Data curation.

Declaration of competing interest

The authors of the manuscript titled "*Living Labs Supporting Circular Cities in Morocco: Towards Collaborative Waste Management in Casablanca*" declare that there are no conflicts of interest regarding the publication of this paper. All authors have approved the manuscript for submission, have contributed to its research and development, and have no financial or personal relationships that could inappropriately influence or bias the work presented in this paper.

Social and Territorial Impacts of Waste Management

1. What role do waste management initiatives play in improving quality of life in Casablanca?
2. Have you observed improvements in local employment and community involvement as a result of collaborative waste management initiatives?
3. What social opportunities arise from collaborative waste management and involving local actors in these initiatives?
4. How can the Living Lab model help increase social responsibility regarding waste management in Casablanca?

Evolution of Stakeholders' Roles in Waste Management

1. What are the roles and responsibilities of local authorities, private operators, and associations in waste management in Casablanca?
2. Have you observed any changes in the responsibilities of actors over time? How has the transition to a circular economy influenced these changes?
3. In your opinion, what are the main synergies that need to be established between the various stakeholders to improve waste management in Casablanca?

Conclusion

1. What challenges do you see for the establishment of a circular and inclusive waste management system in Casablanca?
2. In your opinion, what are the key steps needed to strengthen collaboration and efficiency in waste management in Casablanca?

Appendix 2: Excerpts from interview transcripts

Stakeholder Profile	Interview Excerpt	Main Theme
Casablanca Municipal Council Representative	"Waste management is a major challenge for our municipality. Our resources are limited, which is why we are seeking to collaborate with private companies and local associations to overcome budget constraints."	<i>Collaborative Management</i>
Environmental Protection Association Collaborator	"Citizens are often reluctant to sort waste. Our role as an association is to raise awareness and show them the direct impact of their actions on the environment."	<i>Citizen Engagement and Awareness</i>
Private Waste Management Company Manager	"We have noticed that a collaborative approach reduces our operating costs. Partnerships with the municipality and associations have helped structure waste collection and sorting better."	<i>Operational Efficiency and Collaboration</i>
Energy Transition and Sustainable Development Consultant	"The Living Lab model is interesting because it integrates all actors, from public authorities to citizens, through co-creation. This model can truly accelerate the transition to a circular economy."	<i>Living Lab Role</i>
Local Development Corporation Collaborator (Casa Baia)	"By collaborating with local authorities and other actors, we've improved organic waste collection and recycling, which is essential for our sustainable development model."	<i>Local Actor Roles</i>
Ministry of Energy Transition and Sustainable Development Representative	"We have implemented awareness programs, but citizen engagement remains a key challenge. The Living Lab model could help test more locally adapted solutions."	<i>Collaborative Innovations</i>

Data availability

No data was used for the research described in the article.

References

- [1] S. Prendeville, E. Cherim, N. Bocken, Circular cities: mapping six cities in transition, *Environmental Innovation and Societal Transitions* 26 (2018) 171–194, <https://doi.org/10.1016/j.eist.2017.03.002>.
- [2] J. Williams, Circular cities: planning for circular development in European cities, *European Planning Studies* 31 (1) (2022) 14–35, <https://doi.org/10.1080/09654313.2022.2060707>.
- [3] P. Ballon, J. Pierson, S. Delaere, Test and experimentation platforms for broadband innovation: examining European practice, in: *Proceedings of the 16th European Regional Conference by the International Telecommunications Society (ITS)*, Porto, Portugal, 2005.
- [4] M. Westerlund, S. Leminen, Managing the challenges of becoming an open innovation company: experiences from Living Labs, *Technology Innovation Management Review* 1 (1) (2011).
- [5] F. Cuomo, S. Ravazzi, F. Savini, L. Bertolini, Transformative Urban Living Labs: towards a circular economy in Amsterdam and Turin, *Sustainability* 12 (18) (2020) 7651, <https://doi.org/10.3390/su12187651>.
- [6] A. Engez, S. Leminen, L. Aarikka-Stenroos, Urban Living Lab as a circular economy ecosystem: advancing environmental sustainability through economic value, material, and knowledge flows, *Sustainability* 13 (5) (2021) 2811, <https://doi.org/10.3390/su13052811>.
- [7] Santonen, T., Creazzo, L., Griffon, A., Bódi, Z., & Aversano, P. (2017). *Cities As Living Labs – Increasing the Impact of Investment in the Circular Economy For Sustainable Cities*. Brussels: European Commission.
- [8] F. Cuomo, N. Lambiase, A. Castagna, Living lab on sharing and circular economy: the case of Turin, *Health Informatics J* 27 (1) (2021) 1460458220987278, <https://doi.org/10.1177/1460458220987278>.
- [9] Herrador, M., de Jong, W., Nasu, K., & Granrath, L. (2023). Shaping a circular cities declaration for Japan: going beyond the European Union case study. Available at SSRN 4588476.
- [10] A. Coskun, J. Metta, Y. Bakırhoğlu, D. Çay, K. Bachus, Make it a circular city: experiences and challenges from European cities striving for sustainability through promoting circular making, *Resources, Conservation and Recycling*, 185 (2022) 106495, <https://doi.org/10.1016/j.resconrec.2022.106495>.
- [11] A. Bortolotti, G.C. Verga, A.Z. Khan, Which circularity for urban design and planning? A compass to navigate circular economy research knowledge and methods, *Planning Practice & Research* (2023), <https://doi.org/10.1080/02697459.2023.2262128>.
- [12] J. Williams, Circular cities: what are the benefits of Circular development? *Sustainability* 13 (10) (2021) 5725, <https://doi.org/10.3390/su13105725>.
- [13] J. Williams, Circular cities, *Urban Studies* 56 (13) (2019) 2746–2762, <https://doi.org/10.1177/0042098018806133>.
- [14] P. Ghisellini, C. Cialani, S. Ulgiati, A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems, *J Clean Prod* (2016) 11–32.
- [15] T. Santonen, Circular economy and Living labs: a multiple case study, in: *ISPIIM Conference Proceedings* (pp. 1–16). The International Society for Professional Innovation Management (ISPIIM), 2020.
- [16] K. Steen, E. van Bueren, Urban Living Labs: a living Lab way of working towards a circular products initiative in the EU View Project Circular Area Development Binckhorst-the Hague View Project, *ResearchGate* (2017). <https://www.researchgate.net/publication/318109901>.
- [17] A. Berkemeier, L. Kühnel, D. Dürigen, H. Hoffmann, H. Zeidler, A.C. Bullinger, A. Wagenführ, SAMSax—An innovative living lab for the advancement of a circular economy through additive manufacturing technologies, *Sustainability* 16 (2) (2024) 823, <https://doi.org/10.3390/su16020823>.
- [18] C. Innella, G. Ansanelli, G. Barberio, C. Brunori, F. Cappellaro, R. Civita, G. Fiorentino, E. Mancuso, R. Pentassuglia, L. Sciubba, A. Zucaro, A methodological framework for the implementation of urban living lab on circular economy co-design activities, *Frontiers in Sustainable Cities* 6 (2024), <https://doi.org/10.3389/frsc.2024.1400914>.
- [19] C. Innella, G. Barberio, C. Brunori, F. Cappellaro, A.R. Ceddia, R. Civita, L. Sciubba, Experimenting urban living lab methodology on circular economy co-design activities in some Italian urban territories, *Frontiers in Sustainable Cities* 6 (2024) 1406834, <https://doi.org/10.1007/s43615-021-00011-6>.
- [20] C. Innella, G. Ansanelli, G. Barberio, C. Brunori, F. Cappellaro, R. Civita, A. Zucaro, A methodological framework for the implementation of urban living lab on circular

- economy co-design activities, *Frontiers in Sustainable Cities* 6 (2024) 1400914, <https://doi.org/10.3389/frsc.2024.1400914>.
- [21] D.H. Florez Ayala, A. Alberton, A. Ersoy, Urban living labs: pathways of sustainability transitions towards innovative city systems from a circular economy perspective, *Sustainability* 14 (16) (2022) 9831, <https://doi.org/10.3390/su14169831>.
- [22] L. Amenta, A. Attademo, H. Remøy, G. Berruti, M. Cerreta, E. Formato, M. Palestino, M. Russo, Managing the transition towards circular metabolism: living labs as a Co-creation approach, *Urban Planning* 4 (3) (2019) 5–18, <https://doi.org/10.17645/up.v4i3.2170>.
- [23] E.S. Lakatos, L.A. Birgovan, A. Szilagy, V. Koval, A.B. Karshowsky, The role of living-labs in cities' transition to a circular economy, *Innovative economics and management* 10 (2) (2023) 271–279.
- [24] A. Obersteg, A. Arlati, J. Knieling, Making cities circular: experiences from the living lab Hamburg-Altona, *European spatial research and policy* 27 (2) (2020) 59–77, <https://doi.org/10.18778/1231-1952.27.2.05>.
- [25] Conseil Économique, Social et Environnemental (CESE). Intégration des principes de l'économie circulaire aux traitements des déchets ménagers et des eaux usées, 2022. Auto-saisine.
- [26] P. Biernacki, D. Waldorf, Snowball sampling : problems and techniques of chain referral sampling, *Sociol Methods Res* 10 (2) (1981) 141–163.
- [27] J.M. Corbin, A. Strauss, Grounded theory research : procedures, canons, and evaluative criteria, *Qualitative sociology* 13 (1) (1990) 3–21.
- [28] Coffey, A. ; Atkinson, P. (1996). Making Sense of Quali Tative Data : Complementary Research Strategies. Sage Publications, Inc.
- [29] Lincoln, Y.S & Guba, E.G. (1985). Naturalistic Inquiry. Sage.
- [30] S. Leminen, M. Rajahonka, M. Westerlund, M. Hossain, Collaborative innovation for sustainability in Nordic cities, *J Clean Prod* 328 (2021) 129549, <https://doi.org/10.1016/j.jclepro.2021.129549>.
- [31] F. Cuomo, Urban Living lab: an experimental Co-production tool to foster the circular economy, *Soc Sci* 11 (6) (2022) 260, <https://doi.org/10.3390/socsci11060260>.