Sustainable Production and Consumption 30 (2022) 53–63

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc

Governance challenges and opportunities for implementing resource recovery from organic waste streams in urban areas of Latin America: insights from Chía, Colombia

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ARTICLE INFO

Article history:
Received 6 September 2021
Revised 29 October 2021
Accepted 22 November 2021
Available online 25 November 2021

Edited by : Prof. Kuo-Jui Wu

Keywords:
Environmental governance
Circular economy
Resource recovery
Organic waste
Sanitation
Sustainable urban development

ABSTRACT

Across the globe, there is increasing interest in implementing circular approaches to urban sanitation and waste management to mitigate environmental challenges and promote sustainable business opportunities. In Latin America where 80% of the population live in urban areas, there is limited investigation into the enabling factors and governance barriers that are critical to implementing circular economy strategies in urban areas. This paper aims at assessing the governance capacity to implement resource recovery from organic waste streams in the municipality of Chía, Colombia, through applying the Governance Capacity Framework in a participatory process with local stakeholders. The findings highlight the importance of local initiatives for resource recovery that allow experimentation, raise awareness and foster collaboration, as well as mechanisms available for public participation in decision-making processes as enabling factors. Meanwhile, the inadequate monitoring and assessment of environmental strategies and policies, inadequate sharing of information among stakeholders and the relative low awareness of potential benefits of recovering resources from organic waste streams, especially among public sector actors, emerge as key barriers. Beyond Chía, the results provide insights on crucial factors for ensuring sufficient governance capacity in other urban areas in low- and middle-income countries which are considering circular approaches to urban sanitation and waste management. The findings also provide an empirical basis to advance the understanding of the governance conditions necessary for implementing resource recovery from organic waste streams, upon which further applications of the governance capacity framework along with participatory aspects in other similar urban contexts could build.

1. Introduction

Improving the management of urban organic waste streams is a central challenge for sustainable development (Andersson et al., 2020; Corcoran et al., 2010). Population growth, rapid urbanization and industrialization are increasing the quantities of solid waste and wastewater produced globally as well as the demand for food, water, and energy. In many low- and middle-income countries, organic waste streams are not properly managed, hence leading to significant harm to both human and ecosystems health (Dickin et al., 2016; Garcia and You, 2017; Kaza et al., 2018; Strande et al., 2014). These waste streams include the organic fraction of municipal solid waste such as food waste, agricultural and food production waste which includes animal manure, and municipal wastewater plus fecal sludge from on-site sani-

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https://doi.org/10.1016/j.spc.2021.11.025

tation systems. However, recovering and reusing resources such as the nutrients, organic matter, water and energy contained in organic waste streams, supports a transition to a circular economy and contributes to many interlinked Sustainable Development Goals (Andersson et al., 2020; Schroeder et al., 2018). A circular economy (CE) approach seeks to address the challenges associated with linear resource management, to reduce environmental impacts and maximize resource efficiency (Brandão et al., 2020). Resource recovery approaches for waste management and sanitation are key for the transition to a CE as they contribute to water, food and energy security and reduce the demand for raw materials while creating business opportunities along the waste service chain (Andersson et al., 2020; Tsai et al., 2020).

In the context of Latin America, previous work on resource recovery from organic waste has focused on technological developments and business models (Otoo and Drechsel, 2018; Silva-Martínez et al., 2020), and the literature on governance of the circular economy is just emerging. While there is increasing interest in circular economy approaches and sufficient technological advances for resource recovery from organic waste streams, the pace and scale of implementation is still lagging (Rodriguez et al., 2020) which suggests the existence of gaps in governance aspects, including suitable policies, institutional and regulatory frameworks as well as finance structures (Kautto and Lazarevic, 2020). This gives rise to the research question: what are the factors that facilitate or impede the governance capacity to implement circular economy approaches to the management of organic waste streams in urban areas in low- and middle-income countries? This study aims to address the above question through assessing governance capacity to implement resource recovery from organic waste streams in urban areas, with a focus on the municipality of Chía, Colombia.

Governance capacity is understood here as a set of governance conditions to enable effective change in transition towards CE approaches to sanitation and waste management systems. The aim of this paper is not only to identify the barriers and enabling factors for governance of circular approaches to the management of organic waste streams but to describe underlying mechanisms through application of the Governance Capacity Framework (Koop et al., 2017), linked to a broader participatory process. Through the case study, the intention is also to build an empirical basis for understanding the governance conditions necessary for implementing resource recovery from organic waste streams at the urban scale with consideration of local contextual challenges particularly in a Latin American setting. This work therefore contributes novel insights to the CE literature since a significant portion of the body of research on CE so far focuses on the European Union and China (Alnajem et al., 2021; Türkeli et al., 2018).

The rest of this paper is structured as follows: section 2 provides a brief literature review focusing on resource recovery from organic waste streams, the limited scale and pace of implementation of circular organic waste management in Latin America and its linkage to gaps in governance capacity. Section 3 describes the governance capacity framework and the process of applying it to the case study, while section 4 describes the results from the assessment. These results from the case study, the novel contributions of the findings and their implications are discussed in section 5, and then section 6 outlines the main conclusions from our findings and suggests potential areas for further enquiry.

2. Literature review

The transition to a CE has gained traction at local, regional, and global levels across academia, private sector, civil society and policy makers (Alnajem et al., 2021). For instance, the European Commission adopted a circular economy action plan, as part of the European Green Deal (European Commission, 2020). China's Circular Economy Promotion Law came into force in 2009, and a number of other countries have implemented CE strategies or plans (McDowall et al., 2017). Within recent work on transitions to CE, there is limited focus on low- and middle-income countries (Ddiba, 2020), including in Latin America where CE transitions have been under-researched. In this context, the implementation of resource recovery from urban organic waste streams is particularly relevant as 80% of the population in Latin America live in urban and peri–urban areas (UN DESA, 2019). Besides, it is estimated that less than 1% of the organic waste in the region is composted and that just 40% of the wastewater that is collected is treated (Margallo et al., 2019; Rodriguez et al., 2020). This indicates that significant amounts of solid waste are deposited in open dumps and untreated wastewater is discharged to water bodies (Hettiarachchi et al., 2018b; Rodriguez et al., 2020).

So far, the focus in the transition to a CE has largely been on technical aspects, such as new processes for recovering resources as well as markets for these products (Brandão et al., 2020; Ddiba, 2020). In addition to technologies however, there is a growing awareness that transitioning to a CE requires adequate governance capacity, including suitable policies, standards, regulations, and finance structures (Kautto and Lazarevic, 2020). Implementing CE approaches often requires challenging existing norms, policies and regulations that are designed for linear systems (Flynn and Hacking, 2019). For instance, the Waste Framework Directive in Europe provides classifications of what a waste product is, and the classification of products such as chicken manure and grape waste as "wastes" rather than by-products limits opportunities for resource recovery (Philp, 2018). Understanding governance challenges, and the capacity for successful transition to a CE therefore requires careful examination (Moreau et al., 2017). Smol et al., 2020 present a circular economy model framework in the European water and wastewater sector to guide implementation of CE principles, cutting across technological, organizational, and societal changes. Kirchherr et al. (2018) describe reasons for limited progress in implementation CE in the European Union and rather than technological barriers, they identify cultural and economic barriers, linked to a lack of government-led interventions to accelerate progress. All this underscores the need to identify and address governance capacity aspects.

To address governance barriers, a range of strategies and policy levers have been proposed. Economic approaches include eliminating subsidies that advantage linear production and incentivizing circular approaches, such as through taxation (Kirchherr et al., 2018; Stahel, 2016). A further barrier is related to limited awareness of CE opportunities and approaches to overcome this can include development of communication campaigns, information networks, and training (Stahel, 2016). Standards are also being promoted as a governance tool for the CE (Flynn and Hacking, 2019).

Colombia, as other countries in Latin America, has an interest in integrating waste management and sanitation into CE approaches to mitigate the environmental and health challenges as well as to increase sustainable business opportunities. This interest is emphasized within recent national strategies (Departamento Nacional de Planeación, 2018a, 2018b; Gobierno de la República de Colombia, 2019). However, there is limited investigation into the enabling factors or governance barriers that are critical to promoting the CE in this context, and hence for translating CE strategies from policy to practice at municipal level. Most of the literature focuses on technological developments (Silva-Martínez et al., 2020; UNEP, 2017a), on how to scale up these solutions from the perspective of business models (Hettiarachchi et al., 2018a; Holland Circular Hotspot, 2021; Otoo and Drechsel, 2018) or on the evaluation of environmental policies (Alzate-Arias et al., 2018; Ochoa, 2018). Furthermore, less attention has been accorded to studying the governance of urban waste management and sanitation practices from a

Table 1
Overview of the dimensions, conditions and indicators that form the Governance Capacity Framework. Each dimension is defined by three conditions and each condition in turn by three indicators (Koop et al., 2017).

Dimensions	Conditions	Indicators
Knowing	1. Awareness	1.1 Community knowledge
		1.2 Local sense of urgency
		1.3 Behavioural internalization
	2. Useful knowledge	2.1 Information availability
		2.2 Information transparency
		2.3 Knowledge cohesion
	3. Continuous learning	3.1 Smart monitoring
		3.2 Evaluation
		3.3 Cross-stakeholder learning
Wanting	4. Stakeholder engagement process	4.1 Stakeholder inclusiveness
		4.2 Protection of core values
		4.3 Progress and variety of options
	5. Management ambition	5.1 Ambitious and realistic management
		5.2 Discourse embedding
		5.3 Policy cohesion
	6. Agents of change	6.1 Entrepreneurial agents
		6.2 Collaborative agents
		6.3 Visionary agents
Enabling	7. Multi-level network potential	7.1 Room to maneuver
		7.2 Clear division of responsibilities
		7.3 Authority
	8. Financial viability	8.1 Affordability
		8.2 Consumer willingness to pay
		8.3 Financial continuation
	9. Implementing capacity	9.1. Policy instruments
		9.2. Statutory compliance
		9.3 Preparedness

cross-sectoral perspective in Latin America. Existing literature that alludes to governance in relation to resource recovery from organic waste is often limited to a single sector e.g. urban water & wastewater (Akhmouch, 2012; Andersson et al., 2020), solid waste management (Hettiarachchi et al., 2018b; Kaza et al., 2018), or fecal sludge management (Moya et al., 2019) with little attention to the linkages between them and the implications for resource management. Obtaining a comprehensive understanding of the potential for CE transition therefore requires knowledge of what governance factors can enable the implementation of resource recovery from organic waste streams, including a cross-sectoral perspective on the local contextual challenges.

3. Methods

3.1. The governance capacity framework

To assess the factors enhancing or limiting the implementation of resource recovery from organic waste streams in Chía, the governance capacity framework (GCF) (Koop et al., 2017) was employed and implemented in a participatory process involving local stakeholders. The GCF is an empirical indicator-based diagnostic approach developed for assessing factors that influence environmental governance in urban contexts. It consists of three dimensions and nine conditions that frame environmental governance and each of the nine conditions is defined by three indicators, making a total of 27 indicators overall (Table 1). The *knowing* dimension refers to the awareness, knowledge and learning processes that stakeholders have about challenges, policies, actions, and strategies in the urban environmental context. The *wanting* dimension refers to the cooperation, commitment and ambitious that stakeholders need to show to find long-term solutions to the urban environmental governance challenges. The *enabling* dimension refers to the network, resources, and tools that stakeholders need to have to make possible changes.

To assess the governance capacity of a city to deal with a specific environmental challenge through the GCF, the 27 indicators need to be scored using a five-point Likert-type scale. The scale indicates the extent to which the capacity of the city to govern the environmental challenge is enabling or limiting. Each of the 27 indicators has a predefined question and a scoring guide that is used to link the empirical data to a relevant score that depicts the level of governance capacity for that particular indicator. This is exemplified in Table 2 for the indicator 5.1. The predefined questions and scoring guides for all indicators are provided in the supplementary material accompanying this article. They are based on previous work by Koop et al. (2017) and Ddiba et al. (2020) and are adapted to the case of Chía.

The GCF was selected for this study because it integrates literature on governance and transformation processes including the concepts of governance capacity, adaptive capacity and collaborative governance (Emerson et al., 2012; Gupta et al., 2010; Mees and Driessen, 2011). The transition towards CE and in particular towards resource-oriented sanitation and waste management requires collaboration and cooperation across governance levels and sectors including the environmental, agricultural, energy, health, industrial and infrastructure sectors (Rodriguez et al., 2020; van Leeuwen et al., 2018). The GCF is not a prescriptive framework but it is an evaluation and diagnostic method, and hence can be used for any type of challenge where multi-organizational networks have to collaborate to find common solutions (Koop et al., 2017). The Likert-type scale used in the GCF provides a transparent way of showing what the current governance capacity in a city is like, in contrast to other governance capacity frameworks like Emerson et al. (2012) and Silva et al. (2018). This way of depicting results enables the identification of what the main issues are and what actions can be taken to improve the situation, hence providing for easier communication with various urban stakeholders.

Furthermore, the standardized approach in the GCF addresses potential uncertainties and allows for systematic research in the field of urban environmental governance (Koop et al., 2017). To ensure validity, the GCF uses a triangulation approach that collates evidence from multiple sources; the desk study, the interviews and feedback from stakeholders. Furthermore, the reliability of the approach is ensured through only generating scores based on substantiation in relation to the detailed scoring guide. In this way, the GCF can provide a consistent and reproducible way of generating information and enabling learning and exchange of experiences especially across low- and middle-income urban areas in Latin America where the approach has not been widely used previously (Schreurs et al., 2018). Further details about how the GCF addresses uncertainties in contrast to other governance frameworks are described in Brockhoff et al. (2019) and Rahmasary et al. (2019).

3.2. Assessing governance capacity in Chía

3.2.1. Case description

Chía is a municipality located within Cundinamarca County, a region in the central part of Colombia. It is located about 20 km north of Bogotá. The municipal government is formed by secretariats (the equivalent of municipal departments), which are responsible for different service delivery sectors including public health, environment, and economy (Alcaldía Municipal de Chía, 2015). As of 2015, Chía had about 127,000 inhabitants and this is expected to increase to almost 200,000 inhabitants by the year 2027, largely driven by rural-urban migration according to Alcaldía Municipal de Chía (2015). Like other cities in Colombia and elsewhere in Latin America, Chía has transformed from a rural to an urban area and nowadays its economy is largely driven by the service sector. Most of the farming activities in the municipality have receded, al-

Table 2
Demonstration of the GCF scoring methodology with an example of the predefined question and scoring guide for the indicator 5.1 – Ambitious and realistic management (Adapted from Koop et al. (2017) and Ddiba et al. (2020)).

Predefined question	To what extent are goals for resource- oriented sanitation and waste management systems ambitious and yet realistic (supported by realistic intermittent targets that adequately deal with uncertainties)?
Score	**Description**
++	**Realistic and ambitious strategy** The available policies are based on modern and innovative assessment tools and policy objectives are ambitious. Support is provided by a comprehensive set of intermittent targets, which provide clear and flexible pathways. Assessment tools and scenario analyses identify tipping points that may be found in policy documents.
+	**Long-term ambitious goals** There is a long-term vision that incorporates uncertainty. However, it is not supported by a comprehensive set of short-term targets. Hence, achievements and realistic targets are difficult to measure or estimate. Visions are often found online as an organization's strategy. They often entail a description of resource-oriented sanitation and waste management systems and the need for action.
0	**Confined realistic goals.** There is a confined vision of resource-oriented sanitation and waste management systems. Ambition is mostly focused on improving the current situation where unchanging conditions are assumed, and risk and scenario analyses are lacking.
–	**Short-term goals** Actions and goals mention sustainability objectives. Actions and goals are "quick fixes" mainly, not adhering to a long-term vision or sustainable solutions. Uncertainties and risks are largely unknown.
– –	**Short-term, conflicting goals** Goals consider only contemporary waste and resource challenges, are shortsighted and lack sustainability objectives. Goals are arbitrary and sometimes conflicting, and the character of policy is predominantly reactive.

though there are still fields for livestock and horticultural activities in the surroundings of the municipality (CMGRD, 2015). Population growth and land use change have put pressure on the natural resources of the region. Furthermore, the disposal of solid waste in the area's rivers together with the continuous discharge of non-treated wastewater pollute the water resources and increase the risk of flooding and public sanitary emergencies (CMGRD, 2015).

In Chía, flows of organic waste streams emanate from households, restaurants, local markets, floriculture and public landscaping activities, and the slaughterhouse as they are the main activities generating waste (Mosquera, 2019). The public utility EMSERCHÍA is responsible for waste management and sanitation services (EMSERCHÍA, 2019). Municipal solid waste collection services cover almost 90% of the population (CMGRD, 2015). The organic proportion of solid waste, which is 66% of the waste generated per month, is collected, transported, and disposed of in the regional landfill (Consultoría y Dirección de Proyectos SAS, 2016). To reduce the amount disposed of in the landfill, two resource recovery initiatives have been promoted; the *Circuito Verde* program and the municipal nursery (Alcaldía Municipal de Chía, 2016; Consultoría y Dirección de Proyectos SAS, 2016). The *Circuito Verde* program aims to collect organic waste from households and other waste generators and transport it to private companies that generate compost. In the municipal nursery, liquid and solid fertilizer are made from organic waste coming from the market, domestic septic tanks and the slaughterhouse. This fertilizer is delivered free of charge to farmers in the surrounding areas.

Only about 85% of the population have access to the sewerage network (Sánchez, 2015), while others use on-site sanitation systems like latrines and septic tanks which are often not properly maintained (CMGRD, 2015). There is a local wastewater treatment plant, but it treats only about 37% of the collected wastewater and its efficiency is below 50% (CMGRD, 2015). The sludge produced from the plant is manually extracted and buried around the facilities while the untreated wastewater is discharged directly into the rivers (CMGRD, 2015). The construction of a new plant is almost complete (El Periódico de Chía, 2020; Sánchez, 2015), and it is expected that it will lead to an increase in the quantity of treated wastewater.

The existence of some resource recovery initiatives in Chía shows that there is an interest in improving waste management and sanitation through the implementation of CE approaches and some of these are referenced in the Solid Waste Local Management Plan and the Sanitation and Discharge Management Plan (Consultoría y Dirección de Proyectos SAS, 2016; Sánchez, 2015). However, challenges with their implementation at scale remain and linear waste management seems to prevail in the municipality (Universidad El Bosque, 2017), as is the case elsewhere in urban areas of Latin America (Rúa-Restrepo et al., 2019). This makes Chía a relevant case for understanding the barriers and driving factors for the uptake of resource recovery from organic waste streams in urban contexts in Latin America .

3.2.2. Assessment process

Pre-assessment activities. The overall process, as illustrated in Fig. 1, started with participatory pre-assessment activities including an inception workshop, a focus group discussion, twelve scoping interviews and visits to the municipal nursery, wastewater treatment plant and on-site septic tank systems in various residential areas. These activities altogether involved stakeholders from the sanitation and waste management sectors in Chía and Cundinamarca County, with the aim of refining the scope and boundaries

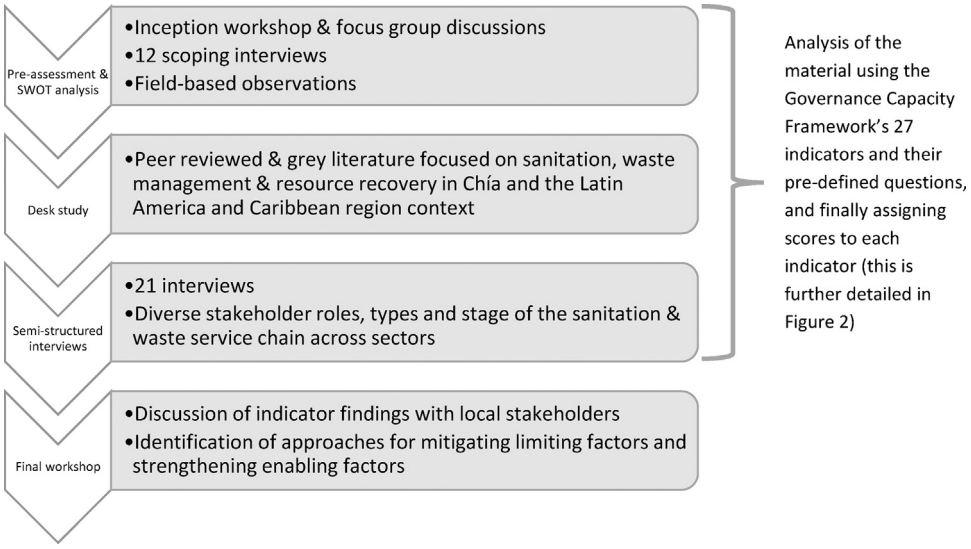

Fig. 1. Overview of this study's methodological process for assessing governance capacity in Chía, Colombia.

of the study, and the overall mapping of key organic waste streams and more relevant stakeholders in the municipality. The inception workshop also involved a preliminary SWOT analysis to collectively identify the general *strengths, weaknesses, opportunities and threats* connected to integrating resource recovery into the waste management and sanitation systems of the municipality.

The predefined questions and scoring guide of the GCF were then adapted to the Chía context and this was followed by a desk-based review. The review provided a preliminary evaluation of the governance capacity in Chía, and it included previous studies in which the GCF had been applied, peer-reviewed and gray literature as well as local, regional, and national regulatory documents linked to sanitation, waste management and resource recovery in Colombia and Latin America. Most of the literature was obtained from online sources, and it supplemented the information obtained from the earlier pre-assessment activities. An overview of the documents reviewed for the desk study is provided in the supplementary material accompanying this article.

Stakeholder mapping and interviews. With the information collected during the pre-assessment activities, local stakeholders were mapped and categorized according to their roles, types, and functions in the various stages of the sanitation and waste management chain. The stakeholders identified included regional and local public authorities, entrepreneurs of small, medium, and large companies, waste pickers associations, representatives of research institutes, and ordinary citizens. Based on the stakeholder mapping activities, potential interviewees were selected through a combination of purposive and snowball sampling (Hibberts et al., 2012), with the aim of obtaining a diverse set of interviewees with representation from every stakeholder category. It was also aimed that each of the 27 GCF indicators should be discussed by at least three or four different interviewees. Eventually, a total of 21 stakeholders agreed to participate in interviews.

The detailed categorization of stakeholder roles, types, and stages of the sanitation and waste management chain, the entities represented in each category and the number of interviewees in each category are provided in the supplementary material accompanying this article. The interviews were conducted face to face and in Spanish, usually at the workplace of the interviewee. Each interview lasted between 20 and 90 min. They were semi-structured, guided by the GCF predefined questions along with follow-up questions to target specific indicators or to gain further clarifications. Each interviewee who agreed to participate in the interviews indicated their consent by signing an informed consent form and all interviews were recorded in audio except for one interviewee who declined to do so.

Analysis and feedback. Information from the interviews was transcribed manually and coded according to the GCF indicators. To guarantee the respondents' anonymity, a coding system was applied to refer to each of the interviewees, from CH001 to CH021. This information together with that obtained during the pre-assessment activities and the desk review was analyzed and summarized according to the predefined question for each indicator. After that, scores based on the Likert-type scale were assigned to the indicators based on how the summary of findings related to the specific scoring guide for each indicator, first by one author and then together with the rest of the co-author team as illustrated in Fig. 2.

Feedback on the assessment of the 27 indicators was obtained in a final workshop organized after the interviews and the analysis. The workshop involved the interviewees and other stakeholders who had participated in the pre-assessment activities. During this workshop, the participants discussed how to address the identified governance challenges, by strengthening the enabling governance factors and sketching out strategies to enable upscaling of resource-oriented sanitation and waste management in Chía and Cundinamarca.

4. Results

4.1. Assessment of the governance capacity

The assessment revealed that the capacity of Chía to govern the implementation of resource-oriented sanitation and waste management is relatively low, as shown in Fig. 3. The low scores of indicators *2.1 Information availability, 3.1 Smart monitoring* and *3.2 Evaluation* highlight important barriers for the implementation of resource recovery from organic waste streams. On the other hand, the relatively high scores of indicators *6.1. Entrepreneurial agents, 6.2 Collaborative agents* and *8.1 Affordability* reveal enablers for the implementation of resource recovery approaches.

An overview of the factors enhancing or limiting governance capacity to implement resource recovery of organic waste streams that emerged in Chía is shown in Table 3, while a narrative with

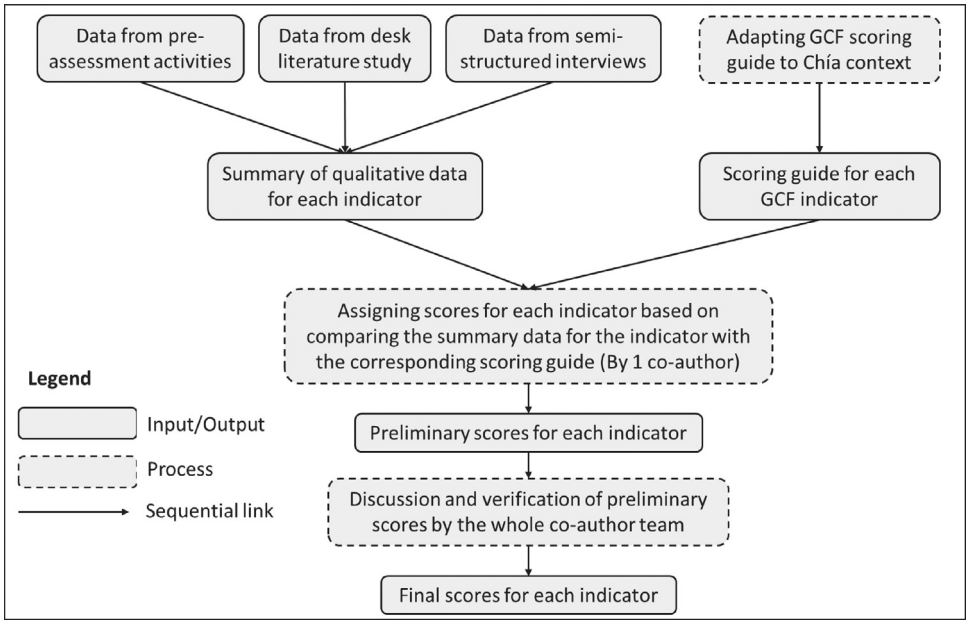

Fig. 2. Overview of the procedure for analysing and generating scores for each GCF indicator in the Chía case study.

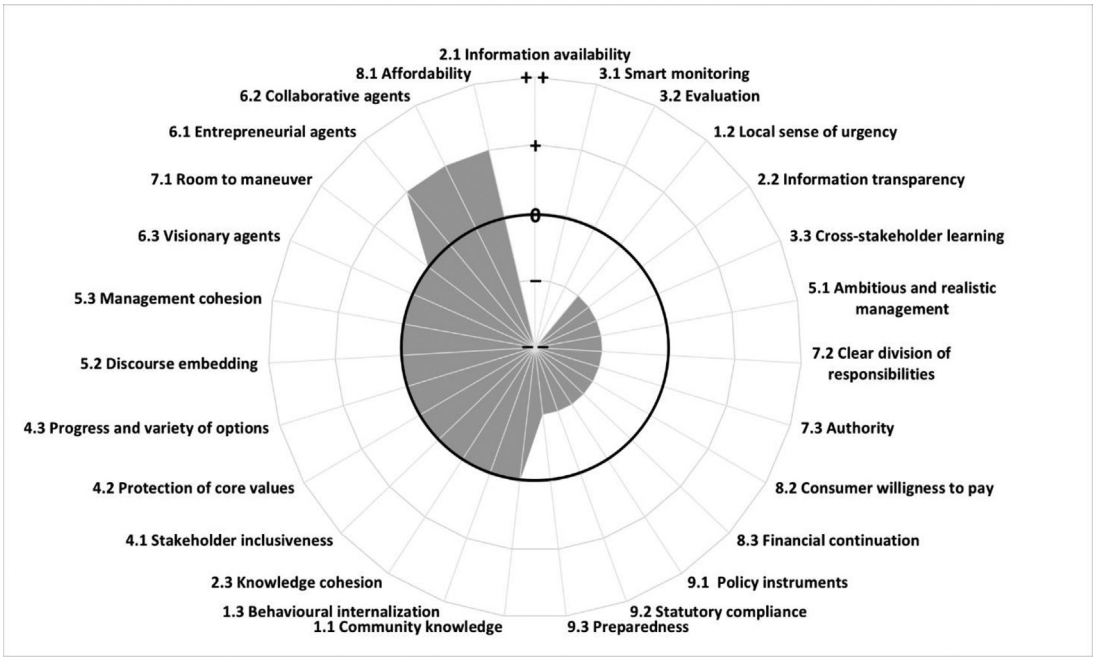

Fig. 3. Governance capacity assessment of Chía. The 27 indicators are arranged clockwise in the diagram from the most limiting (– –) to the most enabling (++) (García Aguilar, 2020).

further details on the factors and substantiation of the indicator scores is provided in the supplementary material accompanying this paper.

4.2. Actions and strategies to enhance governance capacity

During the final workshop, some actions and strategies were identified by local stakeholders as priorities that can potentially address the barriers revealed in the governance assessment and enhance the overall governance capacity of Chía to implement resource-oriented sanitation and waste management systems. These actions and strategies are outlined in Table 4, categorized according to the three dimensions of the GCF.

5. Discussion

5.1. The potential to scale up local initiatives for resource recovery from organic waste streams

The existence of local companies such as *GreenFuel, BioAmbientar, Ecocracking* and *Ecociclus* in Chía and Cundinamarca indicates the presence of agents of change (Condition 6) that are committed to innovating and creating precedence for resource recovery from organic waste streams. The initiatives by these entrepreneurs create a basis for building local knowledge and experience as well as raising awareness about resource recovery and the circular economy. Increasing awareness amongst local stakeholders can lead to

Table 3
Overview of the factors enhancing and limiting governance capacity to implement resource recovery of organic waste streams in Chía.

Factors enhancing governance capacity to implement resource recovery of organic waste streams	Factors limiting governance capacity to implement resource recovery from organic waste streams
Local entrepreneurs have established many successful initiatives for resource recovery from organic waste streams e.g. the companies GreenFuel, BioAmbientar, Ecocracking, Biolodos and Ecociclus (indicator 6.1). Local initiatives for resource recovery have led to increasing awareness about the potential of resource recovery from organic waste (indicator 1.1, 1.3). There are collaborations and public-private partnerships that have emerged for implementing resource recovery from organic waste streams at local and county level, e.g. Circuito Verde and the Cajicá composting program (indicator 6.2). Training activities and events linked to sanitation and waste management provide local stakeholders with opportunities for collaboration and knowledge exchange e.g. the EMSERCHÍA waste picker training initiative (indicator 4.1, 6.2). Chía has a high coverage of sanitation and municipal waste collection services including in the low-income areas of the city, in part due to public financing initiatives (indicator 8.1). Resource recovery products are available and affordable for Chía residents e.g. the fertilizer produced within the municipal nursery which is delivered free of charge to interested farmers (indicator 8.1). Chía has mechanisms for promoting citizen participation in decision-making e.g. the Citizen Participation Office and the multiple *Juntas de Acción Comunal* neighbourhood associations (indicator 4.1). At national level, there are strategies for circular economy that include targets for increasing resource recovery from organic waste streams (indicator 5.1).	Relatively low availability of information from public institutions in Chía to promote the implementation of resource recovery from organic waste streams (condition 2). Information gap regarding the quantities, types, sources and final destinations of solid and liquid organic waste in Chía (indicator 2.1). Transparency and access to environmental information is generally limited due to bureaucracy (indicator 2.2). Relatively low awareness of the environmental, social and economic benefits of implementing resource recovery from organic waste streams within the public sector, except for solid waste recycling (condition 1). A general perception within the public sector that implementing resource recovery entails more costs than benefits (indicator 8.2). Insufficient monitoring and follow-up of environmental strategies and their implementation at the local and regional level (indicator 3.1, 3.2) Data from the available initiatives for monitoring waste generation, collection and recycling is not widely shared (indicator 3.3) Responsibilities for sanitation, waste management and resource recovery are fragmented across different sectors even at the local level in Chía (Indicator 7.2) and hence no specific institution taking lead in strategies for implementing resource-oriented sanitation and waste management (indicator 7.3). The absence of long-term strategies for resource recovery at the local level in Chía makes implementation dependent on the political will of officials in short election cycles (indicator 5.1, 7.3). Municipal resources are focused on investing in infrastructure for waste collection and sewerage, with little consideration for potential resource recovery aspects downstream (indicator 5.1, condition 8). Many private sector actors perceive investing in resource-oriented sanitation and waste management as a risk, given the insufficient national and local public funding for CE initiatives (indicator 8.3).

Table 4
Actions and strategies identified by local stakeholders to enhance the governance capacity to implement resource recovery from organic waste streams in Chía.

Dimension	Actions and strategies to enhance governance capacity
Knowing	Promote education, awareness, and training activities for all relevant stakeholders with emphasis on the municipal authorities and citizens, focusing on the environmental, social and economic benefits of resource recovery and on implementing and complying with the current regulations for waste management and sanitation (condition 1). Establish systems for monitoring the quantities and characterization of waste generated at local level and for assessing the performance of the existing resource recovery initiatives (condition 3) Improve access to public information, including on public investments and expenditure for waste management, sanitation and resource recovery initiatives (indicator 2.1, 2.2)
Wanting	Integrate resource recovery as a key concept in the local urban planning around which to develop initiatives and projects that link and deliver benefits to multiple sectors including public health, agriculture, energy and infrastructure (indicator 5.1). Consider developing areas to scale up the current resource recovery activities with a long-term vision aimed at transforming all the organic waste generated in Chía into resource recovery products (condition 5). Aim at developing long-term urban planning strategies that are less vulnerable to being influenced by short-term political cycles (indicator 6.3). Promote collaborations between the municipal authorities and local universities to increase research on the planning and implementation of resource recovery initiatives (indicator 4.3, indicator 6.2).
Enabling	Allocate resources to build infrastructure for resource recovery processes and to promote energy generation from waste (indicator 8.3). Create the right incentives for waste generators to practice source separation of organic and inorganic waste (condition 9). Reduce the requirements and bureaucracy needed to establish public-private partnerships (condition 7).

learning and action (Velenturf and Jopson, 2019) hence fostering implementation of resource recovery actions. Although it is not guaranteed, this increased awareness about resource recovery can contribute towards increasing the demand and the market available for resource recovery products and services (Otoo and Drechsel, 2018; Russell et al., 2020). The presence of multiple local resource recovery initiatives also forms a crucial ground for experimentation which is necessary in building a comprehensive understanding of the benefits and potential of the circular economy (Russell et al., 2020), given that most of the negative externalities associated with the prevailing model of disposing off organic waste streams at landfills or as effluent in watercourses are not well acknowledged (Otoo and Drechsel, 2018).

The existing collaborations and public private partnerships among stakeholders that are running initiatives like *Circuito Verde* in Chía, also demonstrate the potential for scaling up resource re-

covery initiatives. Collaboration among stakeholders is essential for realizing resource recovery initiatives especially in multi-sectoral contexts (Ddiba et al., 2020). Scaling up these local initiatives for resource recovery can be an important step towards making significant contributions to local, national, and global strategies for the circular economy and for sustainable development. Colombia's national strategies for the circular economy and the implementation of sustainable development goals have targets for resource recovery from organic waste (Departamento Nacional de Planeación, 2018a; Gobierno de la República de Colombia, 2019) and the potential impact of resource recovery initiatives on sustainable development has been explored in the literature (Otoo and Drechsel, 2018; Schroeder et al., 2018). Tools for resource value mapping (e.g. Ddiba et al. 2021) could also be used to visualize the potential and benefits of resource recovery at scale and demonstrate how it can strengthen the local natural resource base and the local economy through green businesses.

At the same time, the existing resource recovery initiatives in Chía manifest challenges with regards to the insufficient institutional and economic support rendered, especially from the public sector (indicator 6.1, condition 8). This is in addition to the relatively low sense of urgency and management ambition at a municipal level, despite the evidence that strategic support and visionary policies articulated at a local level are crucial for catalyzing resource recovery initiatives (Ddiba et al., 2020). While it may not be clear why exactly there was insufficient support, it is nevertheless important that local public authorities explore how to provide incentives and funds for entrepreneurs in a circular economy context, especially in early stages (Alonso-Almeida et al., 2021; Zerbinati and Souitaris, 2005). Such support is necessary as reiterated in Table 4, even when it is acknowledged that some initiatives will fail given that progress towards sustainability is a complex endeavor and failures and other unexpected outcomes can still result in important lessons (Bolger and Doyon, 2019; Russell et al., 2020).

5.2. The public sector as an enabler and facilitator of resource recovery initiatives

Implementing resource recovery from organic waste streams requires cross-sectoral collaboration (Ddiba et al., 2020). Local public authorities have crucial roles to play in promoting and implementing resource recovery initiatives (Guest et al., 2009; Gutberlet, 2015). This can occur through public-private partnerships as done by the municipal authorities of Cajicá in Cundinamarca County who implemented a composting program in collaboration with a private company, subsequently receiving recognition for it from the United Nations Environment Program (UNEP, 2017b). This approach implies a change of perspectives that begins by seeing public authorities as a facilitator rather than a barrier, as is normally seen by some private sector actors and citizens (Agyemang et al., 2019).

Public sector stakeholders can also create policies and strategies that provide visionary targets for those engaged in resource recovery (Ddiba et al., 2020). This is already seen in Colombia with the national strategies that include targets for resource recovery from organic waste streams as well as municipal plans in Chía. It then follows that local regulations should have incentives that align with those targets so as to avoid incoherencies in policy implementation (Domenech and Bahn-Walkowiak, 2019). It is also important to identify and clarify the roles and responsibilities among the local public authorities that work along the whole sanitation and waste management chain, especially the ones that are linked to the resource-recovery stage so that it is clear who is accountable for what (Guest et al., 2009; Mees et al., 2014; Otoo and Drechsel, 2018).

5.3. Embedding the governance capacity framework in a participatory process to create knowledge and trigger local action

This study advances the use of the GCF, through embedding it in a participatory process and demonstrating its applicability to serve as an entry point for discussing how to overcome local governance barriers. In comparison with other studies where the GCF has been applied before (e.g. Brockhoff et al., 2019; Madonsela et al., 2019; Šteflová et al., 2018), this study involved more participatory stages with local stakeholders in the form of pre-assessment activities and a post-assessment workshop. The participation of stakeholders since the first stage of the process influenced the scope and boundaries of the study. The stakeholders took part in the identification and definition of the organic waste streams, the identification of other relevant actors and the preliminary SWOT analysis, all of which served as input to frame the desk study and the interviews that were conducted later. Finally, the strategies identified to enhance governance capacity by local stakeholders during the final workshop demonstrated how in order to ensure effective implementation after a governance capacity assessment, actions and strategies need to be charted by local stakeholders.

The participatory process served as a platform to create and strengthen connections among local stakeholders with an interest in sustainable approaches for resource recovery and who can push forward these strategies in Chía. Previous studies on governance and resource recovery highlight the importance of stakeholder involvement and the creation of partnerships throughout the process, from planning to implementation (Rodriguez et al., 2020). For example, Moya et al. (2019) emphasize the importance of involving public sector stakeholders, Hettiarachchi et al. (2018b) highlight private sector engagement while Silveti and Andersson (2019) stress the need to incorporate the informal sector, which is present in many stages of the sanitation and waste management chain in the Latin America and Caribbean region. All this echoes the importance of collaboration, stakeholder engagement and public participation which is emphasized across the governance literature (Kooiman and Jentoft, 2009; Pahl-Wostl, 2009) and also within CE in multi-sectoral contexts (Abreu and Ceglia, 2018; Moreau et al., 2017).

The connections created among local stakeholders could also be a foundation for deeper cross-sectoral knowledge exchange, given the varying levels of knowledge about resource recovery from organic waste streams among local stakeholders in Chía as revealed in the findings. The knowledge and experience built from existing resource recovery initiatives should be shared widely, to enable the entire municipality to learn from their insights and to contribute diverse perspectives to decision-making processes (Montwedi et al., 2021). With the current situation whereby each stakeholder largely keeps their information to themselves, there is a risk that cross-stakeholder learning does not take place and lessons from previous experiences are lost. Exchange of knowledge and information can build trust among stakeholders and trigger triple-loop learning (Johannessen et al., 2019), whereby outcomes build governance capacity in a broader sense across a social ecosystem.

5.4. Limitations

The pre-assessment activities and the interviews revealed that stakeholders were more aware about resource recovery from solid waste but not wastewater and other waste streams from sanitation systems. The variability in stakeholders' level of knowledge and awareness can be a challenge to validity of the GCF approach, hence the importance of triangulating between the desk study, the interviews and feedback from stakeholders (Koop et al., 2017) to

address any uncertainties in the assessment process. Furthermore, the focus groups and workshops provided an opportunity for local stakeholders to be exposed to other options for resource recovery from organic waste streams and to discuss them in the context of Chía. In this regard, using the GCF in a broader participatory process can be a starting point for improving governance and building the capacity of local stakeholders to effectively participate in urban planning processes through increased awareness and relevant knowledge.

At the same time however, there are some limitations to the participatory approach to the GCF. Participatory activities require more investment of time and resources in comparison to having an approach that is only limited to interviews. The outcomes of any participatory process are also dependent on the availability of relevant stakeholders to engage in the process. In this sense, the timing of the process is critical since ongoing events in a local context can severely limit the availability of some stakeholders e.g. as described by Madonsela et al. (2019) during the Cape Town water crisis of 2017. In the present study, half the interviewees represented stakeholders from the public sector and hence there could be an inherent bias towards the perspectives of the public sector in the findings. However, the interviewees are also residents of the municipality who are impacted by the state of the sanitation and waste management services, and the assumption could be made that their interview responses partly reflect the diverse lived experiences of their day-to-day lives. This again highlights the strength of the GCF approach in triangulating between various sources of evidence of which the interviews are just one part.

Furthermore, the relevance of the insights gained from a participatory GCF approach is influenced by whether the governance capacity assessment process can be linked to an ongoing governance process in a local context so that there is a direct path to impact through acting on the results. This can be a challenge in instances where there are no local stakeholders with explicit responsibility and mandate for fostering the implementation of resource recovery from organic waste streams. However, if the participatory GCF approach can be embedded in cyclical governance processes, it can be useful as a monitoring tool (Rahmasary et al., 2019) to track the development of indicators as governance capacity evolves over time. These factors could be relevant for future research in this area, including how to determine relevant stakeholders to have overall responsibility for monitoring how governance capacity evolves and the implications for resource recovery from waste, and how to effectively integrate insights from governance capacity assessment into local urban planning processes.

6. Conclusions

This study aimed to identify the barriers and enabling factors for implementing resource recovery from organic waste streams through an assessment of the governance capacity in the municipality of Chía, Colombia using the Governance Capacity Framework linked to a broader participatory process. The results revealed that key factors enabling the implementation of resource recovery from organic waste streams include the presence of local entrepreneurs that are implementing resource recovery initiatives and raising awareness about the circular economy within Chía, and the existing collaborations across stakeholders through public-private partnerships and training activities for resource recovery. The relatively high coverage of access to sanitation and waste collection services and the mechanisms that are available for public participation in decision-making processes via the Citizen Participation Office and neighbourhood associations are also important enabling factors.

On the other hand, there were several barriers for further implementation of resource recovery from organic waste streams. This included the inadequate sharing of information about resource recovery among stakeholders and the relative low awareness of potential benefits of recovering resources from organic waste streams especially among public sector actors. Further, the inadequate monitoring and assessment systems and insufficient institutional support for resource recovery initiatives run by entrepreneurs, as well as the fragmented policies and responsibilities for resource recovery were identified as barriers. Finally, the absence of a long-term vision outlining specific stakeholders to take responsibility for spearheading resource recovery strategies in the long term, emerged as a gap to be addressed.

These findings can serve as input to address barriers within the practical implementation of the goals that are included in the national and local plans and strategies for organic waste reuse and wastewater treatment e.g. the Solid Waste Local Management Plan of Chía and the National Strategy for Circular Economy in Colombia. Furthermore, this study provides a cross-sectoral perspective of the governance of urban waste management and sanitation practices in Latin America and the linkages between resources like waste, water, nutrients and energy which are connected to multiple sectors.

Beyond Chía, this work provides insights on crucial factors for ensuring sufficient governance capacity in other urban areas in low- and middle-income countries which are considering circular approaches to urban sanitation and waste management. Among others, these factors include the importance of local initiatives for resource recovery for experimentation, fostering collaboration and cross-sectoral learning, the need to build knowledge among local stakeholders to catalyze informed decision-making and actions, and the crucial role of public sector actors as facilitators for the implementation of resource recovery initiatives.

The GCF approach which was used in this study along with a participatory process, proved to be a useful tool not only for analysis of the local governance capacity but also as an approach for raising awareness about resource recovery from organic waste streams and the factors necessary for facilitating implementation. To that end, it can be a useful tool to consider for towns and cities that are interested in exploring resource recovery from organic waste streams. Further applications of the governance capacity framework along with participatory aspects in other cities could contribute towards building a broad empirical basis for understanding the governance conditions necessary for implementing circular economy approaches, as well as provide insights for how to effectively integrate the lessons into urban planning processes.

Funding sources

Funding for this work was provided by El Bosque University [Grant No. PCI 2017–9544]; the Swedish Research Council Formas through the UrbanCircle project [Grant No. 2017–00268]; and the Swedish International Development Cooperation Agency (Sida), through core support to Stockholm Environment Institute for the SEI Initiative on Sustainable Sanitation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Mónica García Aguilar: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Juan Felipe Jaramillo:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing –

original draft, Writing – review & editing. **Daniel Ddiba:** Conceptualization, Data curation, Funding acquisition, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Diana Carolina Páez:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing. **Hector Rueda:** Data curation, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing. **Kim Andersson:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. **Sarah Dickin:** Conceptualization, Funding acquisition, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Data statement

A list of the documents reviewed for the desk study, the stakeholders and their categorization as well as the predefined questions and scoring guides for all indicators are provided in the supplementary material accompanying this article.

Acknowledgments

This paper is based upon a master's thesis done by García Aguilar (2020). We would like to acknowledge the respondents and key informants who participated in the study, and the support from the Secretariat of Environment in Chía. We acknowledge the methodological support for this work provided by Stef Koop (KWR) and the critical feedback on the work provided by Alin Kadfak (SLU), Lise Byskov Herslund (UCPH), as well as Göran Finnveden and Elisabeth Ekener (KTH).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.spc.2021.11.025.

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