Stakeholders' social acceptance of a new organic waste management policy in the city of Florianópolis (Brazil)

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Abstract: Incorrect organic waste management can lead to several environmental and health threats. The literature shows that municipalities are adopting several strategies to reduce the improper disposal of organic waste. In 2019, Florianópolis, Brazil, became the first Brazilian state capital to approve a law on mandatory organic waste separation and composting, the Florianópolis composting law (FCL). Nevertheless, the successful implementation of this new regulation relies on acceptance among urban stakeholders and civil society. The role of social acceptance has not been investigated when dealing with new waste management regulations. To this end, 37 qualitative interviews with local stakeholders were conducted to determine the key factors influencing the acceptance of the FCL by analyzing stakeholders' perceptions of the relevant risks, benefits, hindering and promoting factors. The results show that the law could represent an important first step toward a sustainable municipal solid waste management system; however, several risks may arise in the absence of adequate monitoring systems. These risks are mainly linked to water contamination and health issues due to harmful insect proliferation. Furthermore, even though Florianópolis society seems culturally open, the lack of infrastructure and investments in the city could hinder the effectiveness of the law. Strategies for improving the law's effectiveness should be focused on supporting the existing formal and informal composting initiatives that have become widespread in recent decades. This could lead to a decentralized organic waste management system that empowers local initiatives and reduces the initial costs of implementing new composting systems and increases the separation rates at the household level.

Keywords: Composting; Public Policies; Urban Agriculture; Qualitative Analysis; Social Acceptance

1 Introduction

Inappropriate municipal solid waste management can have a series of negative environmental and social impacts in urban areas, such as greenhouse gas emissions, water pollution, air contamination, unregulated jobs and dangerous working conditions for waste pickers (Menikpura et al., 2013; Cruvinel et al., 2019). We refer to municipal solid waste as all those materials wasted and disposed by residential and businesses sectors (Vergara & Tchobanoglous, 2012; Khan et al., 2022). Creating suitable solid waste management strategies is a relevant issue in the political agendas of many cities. Solid waste can be managed through different systems. Although municipal solid waste is managed in controlled areas or incinerated in several municipalities, in developing contexts, these systems are not yet properly in place, and solid waste is still disposed of in dumps in peri-urban areas (Struk, 2017). The impacts of this are reflected in the health of waste management operators and citizens (Rego et al., 2005). The problems related to solid waste management are mostly perceived in contexts where both the population and per capita waste production are increasing (Guerrero et al., 2013). In many cases, the organic fraction can represent approximately 44% of the total municipal solid waste production, and the issues related to its management can contribute to health and environmental problems (World Bank, 2018; Sharma & Jain, 2020). This is particularly noticeable in contexts where there are still problems related to the inappropriate management of organic waste (Struk, 2017).

Different risks need to be considered when dealing with organic waste management (Wei et al., 2017). First, there may be a series of risks linked to composting. The main risks described in the literature are related to "volatile organic compounds" that are potentially harmful to human health (Nie et al. 2018), fungal and bacterial proliferation, and possible water and soil contamination (Clark et al., 1984; ; Domingo & Nadal, 2009; Mudruňka et al., 2017). These risks ultimately depend on how the composting process is managed. The literature suggests that organic waste contaminated with chemical solvents and low compost aeration increase the amount of volatile organic compounds as well as the risk of water contamination (Sykes et al., 2007; Domingo & Nadal, 2009; Nie et al. 2018).

Organic waste is composed of 70% water, and when it is not correctly separated, it might be contaminated with heavy metals that are present in other types of waste. The leachate that is derived, if not properly isolated from groundwater, can contaminate it (Vodyanitskii, 2016). Further waste management problems are linked to centralized models of waste management, which might result in higher implementation costs, management complexity and logistics costs (Pai el at., 2019; Bruni et al., 2020). To this end, municipalities have begun implementing supporting strategies for proper organic waste management (Bahers & Giacché, 2019).

Recently, the Brazilian city of Florianópolis approved the first law on mandatory organic waste treatment ever approved in a Brazilian state capital (law n°10501/19). The Florianópolis composting law (FCL) particularly focuses on promoting a decentralized composting model and supporting fertilizer provision for urban agriculture. The effectiveness of organic waste management policies relies on correct household separation and correct management by the stakeholders involved in the composting processes (Wolsink & Devilee, 2009; Bernad-Beltrán et al., 2014). This implies strong efforts in terms of investments, institutional commitment, technical requirements, and citizen education (Wolsink, 2010).

The implementation of the new regulations may be hindered by a certain level of resistance. The literature suggests that innovations in waste management regulation may be hindered by the way stakeholders perceive risks and benefits related to that innovation (Zeiss & Atwater, 1987). This can be observed in several examples of environmental and agricultural innovation from renewable energy production to urban agriculture (Wolsink, 2010; Specht et al., 2016b; Prosperi et al., 2019). The literature shows that possible conflicts can derive from different views on correct waste disposal (incineration vs. methanization vs. recycling) determined by stakeholders' beliefs and perceptions (; Wolsink, 2010; Achillas et al., 2011). Furthermore, a lack of economic investments, problems related to spatial management, national and international policies and resistance to change in the habits of waste collection companies have the potential to generate conflict (Wolsink, 2004; Wüstenhagen et al., 2007; Wolsink & Devilee, 2009). Laws on organic waste management represent a significant innovation in vulnerable contexts, and their successful implementation may depend on how these measures are accepted among stakeholders and citizens (Coban et al., 2018; Hoang et al., 2019). The literature also shows that tailoring waste management services to local needs and conditions is a key aspect in achieving effective and affordable waste management strategies (Leal Filho et al., 2016). On the other hand, the lack of municipal policy interventions in developing contexts is a key issue in transitioning toward an improved waste management system (Leal Filho et al., 2016). Despite scholars' consistent attention to the issue of the acceptance of municipal solid waste strategies, how specific policy interventions are socially accepted among stakeholders is still an open question.

Scholars have previously described the role of social acceptance when innovations and new regulations are introduced in sectors such as agriculture, waste management and beyond (Lucke, 1995; Sauer et al., 2005; Schäfer and Keppler, 2013). Consensus on the definition of social acceptance has not been reached yet. Wüstenhagen et al. (2007) refer to social acceptance as the conditions that determine the effective support to technological and societal changes, not exclusively linked to technical factors. Specifically, it refers to individuals' attitudes, social relationships and organizations that are dynamically shaped in learning processes (Wolsink, 2010: 303). Following the approach of Lucke (1995), through the assessment of peoples' willingness to silently accept or actively promote a certain innovation, in combination with the analysis of the elements that they are likely to disapprove of or to protest against, it is possible to extrapolate society's attitude in the future with respect to the innovation that is introduced (Lucke, 1995).

Thus, to examine the emerging needs in this area, this article presents a case study on the social acceptance of a specific policy intervention on urban organic waste composting, the FCL. This regulation represents a novelty in the Brazilian context, and it is a policy intervention specifically for the organic portion of solid waste. The present paper investigates the perceptions of key stakeholders to understand the social acceptance of the new FCL. The aim of this paper is to assess the social acceptance of the FCL by answering the following research questions:

i) What risks and benefits do key stakeholders associate with the FCL?
ii) Which contextual factors do key stakeholders consider most relevant for the successful implementation of the FCL?

The results of this article will help decision-makers from policy and science fields and civil society understand the key factors that influence the social acceptance and successful implementation of the FCL, thus creating an organic waste management model that is most in line with the scope of the FCL. The hindering and promoting factors can include environmental and health issues (Sykes et al., 2007; ; Domingo & Nadal, 2009; Nie et al. 2018), economic and regulatory frameworks (Wolsink, 2004; Wüstenhagen et al., 2007; Wolsink & Devilee, 2009) and cultural aspects (Wolsink & Devilee, 2009; Bernad-Beltrán et al., 2014; Coban et al., 2018; Hoang et al., 2019).

2 Materials and methods

2.1 Theoretical Background

The analytical framework is based on the approach to analyze social acceptance introduced by Specht et al. (2016a) and further developed by Di Fiore et al. (2021). The advanced framework by Di Fiore et al. 2021 defines the dimensions involved in designing municipal regulations regarding environmental management actions. The framework, initially designed for urban agriculture regulations, has been adapted to identify the dimensions and stakeholders that need to be addressed for the analysis.

According to acceptance theory, the process of acceptance depends on the subject, object, and context of that acceptance (Lucke 1995; Specht et al. 2016a). The *subject of acceptance* in this case is all the stakeholders involved in waste management who have knowledge of the law and can potentially impact or be impacted by the law. A sample of stakeholders was selected with the goal of involving experts from each of the municipal solid waste dimensions, as shown in Table 1. The *object of acceptance* is the FCL. The aim is to assess which benefits and risks stakeholders associate with the composting law. These benefits and risks are partially derived from the literature (Sykes et al., 2007; Domingo & Nadal, 2009; Wolsink & Devilee, 2009; Wolsink, 2010; Bernad-Beltrán et al., 2014; Wei et al., 2017; Nie et al. 2018), while others have been included after data analysis through a grounded theory approach (Strauss & Corbin, 1997). The *contextual factors* relate to external factors connected with the law that could hinder or support the implementation of the FCL. Here, these are related to several dimensions assessed in the theoretical framework presented in Di Fiore et al., 2021. Following the framework in Table 1, the aim of this study is to address the acceptance of the composting law within the following dimensions: “Policy-making”, “Legal framework”, “Urban planning”, “Market”, “Cultural background” and “Community organic waste management and urban agriculture”. A further dimension called “Large organic waste production” has been added.

Table 1: The analytical framework for assessing the acceptance of the new composting law. Source: adapted from Di Fiore et al., 2021.

	Assessing perceived risks, perceived benefits, hindering factors and promoting factors of the 2019 Florianopolis composting law						
Dimension	Policy-making 	Legal framework 	Urban planning 	Large OW production 	Market 	Cultural background 	Community organic waste management and urban agriculture 
Stakeholders involved	Local government and decision-makers	Technical and public administration	Public administration and urban planning	Food service, Restaurants, supermarkets, and hotels	Private waste management companies	Environmental education associations and NGOs	Community organic waste management initiatives

2.2 Case study description: State of municipal solid waste management in Brazil

In 2018, 79 million tons of solid waste were generated in Brazil, representing an increase of 1% over the previous year; 92% (72.7 million) of this waste was collected, while approximately 8% was not recorded, so it might have been informally collected or simply not collected (ABRELPE, 2019). A total of 59.5% (43.3 million tons) of the collected solid urban waste was properly disposed of in a controlled environment, representing a small improvement over the previous year (ABRELPE, 2019). Solid waste in Brazil is mainly treated by three systems:

i) Garbage dumps: uncontrolled open-air garbage disposal areas with no drainage systems or gas collection;
ii) Landfills: areas where the waste is covered but there are no drainage or gas collection systems; and
iii) Sanitary landfills: areas where solid waste is stocked, liquid is drained and gases are collected (ABRELPE, 2019).

Even though a national law prohibiting the use of open-air garbage dumps was approved in 2010, the rest of the solid waste (40.5%) was inappropriately dumped by 3001 municipalities (ABRELPE, 2019). This municipal solid waste ends up going to garbage dumps or landfills, which do not have the systems and measures in place that are necessary to protect people's health and the environment from damage and degradation (de Andrade & Ferreira 2011; ABRELPE, 2019). Furthermore, in Brazil, there are relevant differences in terms of solid waste management and treatment. Significant differences emerge when comparing the solid waste treatment strategies in different regions. In terms of recycling initiatives and the proper treatment of waste, southern and southeastern states are the only Brazilian regions that have managed to guarantee the correct treatment of municipal solid waste through landfilling in controlled areas (ABRELPE, 2019).

2.3 State of municipal solid waste management in Florianópolis

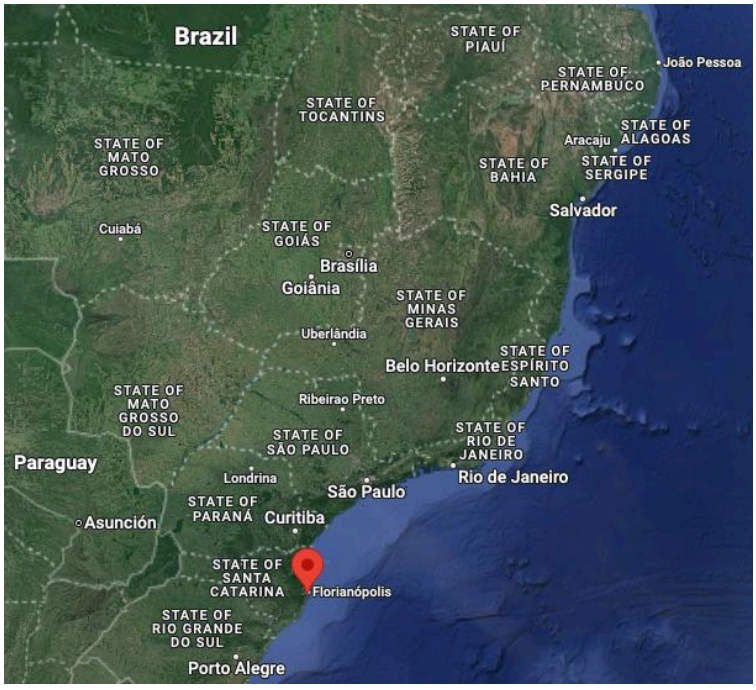

Figure 1: Florianópolis location. Source: Google Maps; 2022.

The state of Santa Catarina is particularly advanced in waste treatment. Santa Catarina's capital, Florianópolis, recently approved the FCL. The aim of the law is the obligatory appropriate disposal

of organic waste through the process of composting and the prohibition of sanitary landfills and incineration (law 10.501/2019). The law, approved in June 2019 through municipal decree 20645/2019, aimed to achieve the composting of 25% of the municipality's organic waste by 2020 and to completely eliminate organic waste incineration and collection in sanitary landfills by 2030. The law established the obligation first among large organic waste producers such as supermarkets, hotels and restaurants. The total investment in the implementation of the FCL, 1 million reals (160 000 euros), came from the National Environmental Fund (Ciclovivo.com.br, 2021). This support helped provide new equipment for organic waste collection, specifically 900 large tanks (70 liters) and 2 million small tanks (30 liters). The municipality of Florianópolis invested an additional 10 million reals (1.6 million euros) in new equipment for waste collection (4 new trucks) (Ciclovivo.com.br, 2021). It is worth mentioning that despite the intention to start implementing the law in 2020, the actual implementation start date was moved to 2021 because of the COVID-19 pandemic. Nonetheless, the approval of this municipal law is particularly relevant considering that organic waste represents, on average, 35% of the total household waste weight produced in Florianópolis (COMCAP, 2019). The rest of the waste is composed of recyclable waste such as plastic, paper, metal and glass (42%) and nonrecyclable material (22%) (see Table 2).

Table 2: Composting and recycling rates from 2018. Source: COMCAP; 2019.

	Total tons collected	**Target amount recycled/composted**	**Actual amount recycled/composted**
Dry recyclable materials (paper, plastic, metal)	90.007 (42%)	21.602 (24%)	12.052 (13%)
Organic waste (household food waste, public garden waste)	73.261 (35%)	18.315 (25%)	3.437 (5%)

2.4 Organic waste management practices and implementation

The law promotes an organic waste management model that supports household composting and decentralized waste management within neighborhoods in small organic waste treatment landfills. It also supports the production of high-quality compost for urban agricultural activities in Florianópolis. The main composting method used in Florianópolis and promoted by the FCL is the one developed by the Federal University of Santa Catarina (UFSC), the "UFSC method". This method consists of composting windrows combined with vertical straw walls (see Figure 1). The organic waste is placed inside the composting windrow and then covered with a layer of straw. A decomposition process is carried out through passive aeration and thermophilic processes (Trivella et al., 2016; Neto & Miller, 2017). These windrows can have several dimensions and applications in the household and on a municipal scale. They can reach up to 3 meters in height and width and 8–10 meters in length. Organic waste is manually collected from 30- to 70-liter tanks and manually discarded into the composting yards. The main advantages of this method lie in its ease of use and low required investment.

Although the implementation of this technology started in 1994, the collection and treatment of organic waste in Florianopolis was not mandatory until the law was put in place. There have been several attempts to support mandatory organic waste collection and treatment since the 1980s. The most successful and long-living organic waste management initiatives have been those started by communities, such as the "Revolução dos Baldinhos", literally meaning "The revolution of the buckets". This project started in 2009 to manage and compost the organic waste produced in the Chico Mendes community, a peripheral community in the continental area of Florianópolis. This project, initiated by the Chico Mendes inhabitants, contributed to the creation of a community vegetable garden and successfully mitigated health issues related to the lack of organic waste management (Abreu & Rover, 2013). Other small composting initiatives have been promoted by local institutions working in environmental and waste management areas, such as those implemented in the Florianópolis Botanical Garden and in *Córrego Grande* Park.

However, these community initiatives have little impact on the treatment of municipal solid waste, and the actual capacity of organic waste treatment in Florianópolis is very low. The total amount of organic waste composted by the municipal company Companhia de Melhoramentos da Capital (COMCAP) in 2019 was 4.019 tons of organic waste, representing just 5.51% of the total amount of organic waste produced in the municipality (COMCAP, 2019). The rest of the waste produced in the city is treated in a sanitary landfill in Biguaçu, 40 km away from Florianópolis, which is managed by a private company (see Figure 2). Composting treatment thus represents a chance to reduce the environmental impact of waste management, reduce waste transportation costs, increase education, and provide an example of good practices for other Brazilian and Latin American cities.

Figure 2: Examples of community waste management initiatives. Visitors are observing the "*Revolução dos Baldinhos*" composting yards (left). A community gardener is preparing compost from the organic waste collected through voluntary collection points (right). Source: Authors.

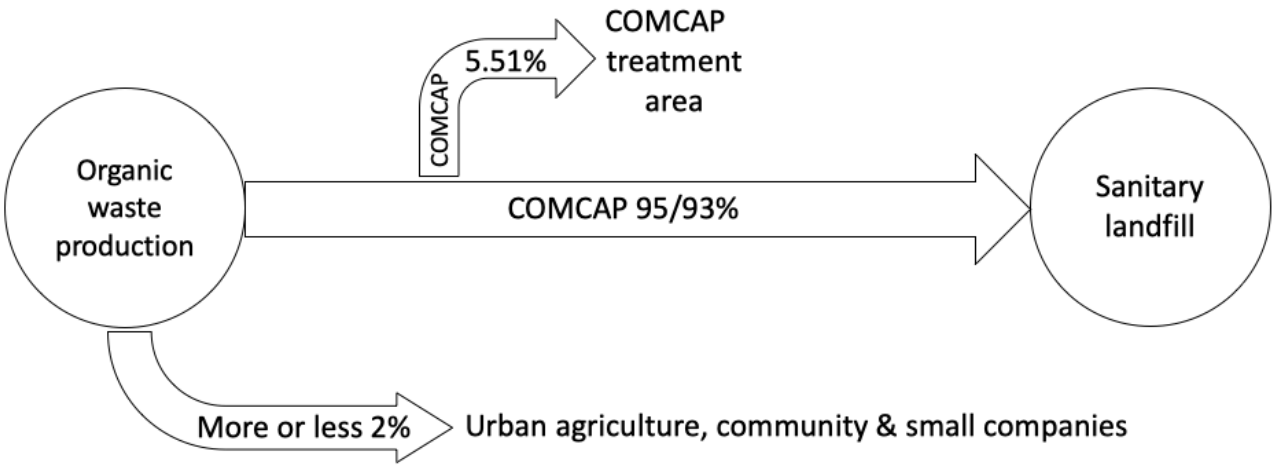

Figure 3: Florianópolis organic waste flow before the FCL. Source: COMCAP, 2019.
The treatment capacity of the community and small companies is estimated based on their average per day treatment capacity = 500 kg/day.

2.5 Selection of waste management stakeholders for the interviews (subjects of acceptance)

The interviews were conducted with 37 relevant stakeholders across several dimensions of organic waste management. Following the established framework, the perceptions of several key stakeholder groups (the subjects of acceptance) were assessed. The first group included members of the government involved in designing the law. Furthermore, COMCAP technical experts and former COMCAP presidents were involved. A further group of stakeholders included employees from COMCAP and public administrators with expertise in health and environmental regulations. To ensure representativeness in the implications of planning, public administration experts on urban geography, urban planning and household projects were interviewed (see Table 3).
Another group of stakeholders was represented by those potentially affected by the FCL, including large producers of organic waste, such as hotels, restaurants and food distribution centers. Private organic waste treatment companies were also involved, including three small companies with a treatment limit of 500 kg of organic waste per day, two representatives of the company managing the main COMCAP composting yard, a representative of a semipublic organic waste treatment company, and a representative of the company managing the sanitary landfill. Environmental education associations were also involved via experts from CEPAGRO, an NGO particularly focused on composting education; a representative of the Zero Waste Movement; and an employee of the environmental education association *Instituto Çarakura*. Finally, stakeholders involved in community waste management initiatives operating vegetable gardens were included.
It is worth mentioning that these stakeholder groups often overlap, particularly in regard to i) environmental education associations, whose workers are often community organic waste management activists, and ii) small organic waste management companies, many of whose employees are former UFSC students who are directly connected with the research activities of the creators of the UFSC method.

Table 3: Interviewed stakeholder and stakeholder groups.

	Policy- and decision-makers	
Policy-making 	**Policy #1**	COMCAP representative
	Policy #2	COMCAP representative
	Policy #3	Member of the city council
	Policy #4	Member of the city council
	Policy #5	COMCAP representative

	Policy #6	COMCAP representative
	Experts in legal frameworks	
Legal Framework 	**Legal_Fr #7**	Expert in health and tropical diseases
	Legal_Fr t #8	COMCAP expert in regulatory aspects
	Legal_Fr #9	COMCAP expert in environmental education
	Legal_Fr #10	Expert in environmental regulation (at state level)
	Legal_Fr #11	COMCAP expert in regulatory aspects
	Legal_Fr #12	Expert in environmental regulation (at municipal level)
	Experts in urban planning	
Urban Planning 	**Plann #13**	Expert in urban geography
	Plann #14	Urban planner
	Plann #15	Urban planner
	Large OW producers	
Large OW Production 	**Prod #16**	Member of the Santa Catarina Supermarkets Association
	Prod #17	Member of the Santa Catarina Hotels Association
	Prod #18	Private restaurant
	Prod #19	Employee in the Florianópolis Food Distribution Center
	Prod #20	Member of the Florianópolis Private Businesses Association
	Prod #21	Member of the Bars, Restaurants and Food Companies Association
	Prod #22	Member of the Santa Catarina Supermarkets Association
	Private companies in OW treatment	
Market 	**Treat #23**	Small treatment company initiator
	Treat #24	Small treatment company initiator
	Treat #25	Small treatment company initiator
	Treat #26	Small treatment company initiator
	Treat #27	Small treatment company employee
	Treat #28	Semipublic treatment company employee
	Treat #29	Sanitary landfill company manager
	Environmental education associations	
Cultural Background 	**Education #30**	CEPAGRO employee
	Education #31	Instituto Çarakura employee
	Education #32	CEPAGRO employee
	Education #33	CEPAGRO employee
	Education #34	Zero Waste Movement activist
	Community OW treatment initiatives & vegetable garden activists	
Community OW Management 	**Community #35**	Participant in a community composting yard
	Community #36	UFSC researcher
	Community #37	Participant in a community composting yard

2.6 Expert interviews

Semistructured interviews with 37 key stakeholders were conducted from April to August 2019. The first set of respondents included local government members who supported the law, and subsequent respondents were reached through a snowball sampling technique. The interviews were conducted face-to-face by the main author. All interviews were conducted in Portuguese and recorded after obtaining the respondent's approval. The meetings took place where the respondents felt comfortable,

usually at their workplace or in a public space. The interviews were conducted following a guideline that divided each interview into four topical sections. The first section was introductory and was meant to help describe the role of the interviewee. The second part was focused on the main perceived benefits and risks associated with the FCL. The third part concerned the assessment of potential contextual conflicts and barriers, and the last part was meant to obtain other relevant stakeholder indications. The interviews lasted approximately 50 minutes each. The interviews were fully transcribed, and data analysis was conducted through the coding software MAXQDA - VERBI Software GmbH; the coding process was performed according to the coding principles proposed by Saldaña (2015). The process consisted of text fragment classification in data units assigned to a series of conceptual categories (codes). The codes were associated with the analytical framework in terms of perceived risks and benefits and hindering and promoting factors. Further codes were added after the first data analysis round. The codes were then analyzed, and different weights were assigned to each code according to its frequency and the weighting that interviewees gave to a specific aspect.

3 Results and discussion

3.1 Object of acceptance

This part of the analysis focuses on assessing the main perceived benefits and risks linked to the FCL, and an overview of the results is displayed in Table 4.

The main benefits associated with the FCL relate to the environment. First, the law increases the possibility of reusing compost as a fertilizer in urban agriculture. A representative of a small organic waste treatment company reported how this material could be considered a resource:

"*Something that used to be [...] waste is now transformed into a resource, into a raw material that can be used locally and transformed"* [Treat #26] (see Table 3).

Another important benefit is avoiding sending organic waste to the sanitary landfill. This reduces water contamination and air pollution and is also related to the ethical dimension of the correct treatment of this material. Finally, some of the environmental benefits include a reduction in the carbon emissions derived from waste collection and transportation. The economic benefits of the FCL are associated with public savings potentially derived from several aspects of the law. The first aspect concerns benefits derived from supporting the local and household treatment of waste. A member of the city council suggested that a large portion of waste management costs are related to transporting this material to the sanitary landfill. He claims that *"by not sending this waste to the sanitary landfill, we save 37 million reals per year for the municipality*" [Policy #3].

Another aspect that needs to be considered is that there is a limit on the amount of waste that a garbage dump can treat. Usually, this limit corresponds to a period of 20 years. Organic waste represents, on average, 35% of the total waste produced in Florianópolis. The law could reduce the workload for the sanitary landfill, as affirmed by a representative of the sanitary landfill management company:

"The law's effectiveness will reduce the amount of organic waste treated in the sanitary landfill, consequently extending the life of the sanitary landfill" [Treat #29].

Other benefits associated with the FCL are social benefits. These social benefits include occupational opportunities from new organic waste treatment companies that can be established as a consequence of the FCL. This was also confirmed by several interviewees, including a representative of one of the environmental education associations: *"Many composting companies will start to come to Florianópolis"* [Education #34].

Furthermore, as the owner of a small organic waste treatment company reported, the FCL can increase citizens' food security and promote a more sustainable food provision model, since "*communities can produce food by themselves that can be easily accessible and that will generate income and improve food security*" [Treat #26].

The law also represents an opportunity to sensitize citizens to waste separation and environmental education and "*can lead more people to be aware of the topic*" [Treat #26]. The last social benefit indicated by the interviewees was the possibility of enhancing the role of community waste management initiative participants and supporting their role as community builders. In particular, past experiences have shown how virtuous community waste management initiatives have enhanced the role of citizens in improving communities' conditions through job creation and citizens' involvement in neighborhood activities. The Revolução Dos Baldinhos is an example of this: "*The Revolução Dos Baldinhos is a solution to several problems. We are talking about garbage, but we are also talking about reducing violence, potentially generating income, and interacting with the community*" [Community #37].

Finally, several stakeholders reported that the FCL ensures the continuity of several existing waste management initiatives and projects. This law establishes a formal commitment to using financial resources from the government to reach the goal of 100% organic waste treatment. This is seen by stakeholders as a positive aspect ensuring the continuity of all small waste management businesses and associations: *"For people working in this field, it is great to have this regulation*" [Treat #24] (see Table 4).

Table 4: Major perceived benefits and risks of the FCL

Major benefits	Major risks
Environmental Benefits • Use of the compost in urban agriculture (cited 47 times) • Environmental impacts (cited 32 times)	**Environmental Risks** • Environmental and water contamination risks (cited 10 times)
Economic Benefits • Reduction in public costs (cited 43 times)	**Economic Risks** • Tax increases for private companies (cited 38 times)
Social Benefits • Job creation (cited 23 times) • Citizen awareness (cited 23 times) • Local organic waste management initiative valorization (cited 17 times)	**Social Risks** • Health issues related to bad management (cited 28 times)

The interviewees noted a series of perceived risks associated with the FCL. One of the most commonly mentioned perceived risks relates to a possible increase in taxes. Citizens and private businesses are afraid that the FCL implies an increase in the annual taxes on waste management, as the representative of one large organic waste producer suggested: "*The government can't create money. It will have to share this cost with society*" [Prod #20].

Stakeholders also reported that composting systems could facilitate tropical insect and rat proliferation and consequently the diseases related to their spread. Technicians are afraid that decomposing organic matter could attract both insects and rats. Leptospirosis outbreaks occurred in 2008 in the continental area of the cities through rat proliferation due to a lack of proper organic waste collection and disposal (Haake & Levett, 2015). The introduction of the UFSC method and the community experience of the "*Revolução dos Baldinhos*" solved the issue. Nonetheless, although the UFSC composting method has been used and tested for 25 years, local experts report that, if not well managed, it can cause harmful insect proliferation. Even though severe accidents have not occurred thus far, organic matter can attract the phlebotomine fly, which is potentially harmful to human beings

(Maroli et al., 2013). "*This insect reproduces in decomposing organic matter*" [Legal_Fr #7]; thus, inappropriate management could increase the risk of insect proliferation.
Some of the perceived risks are related to potential environmental impacts due to water contamination. Even though the UFSC method is not a particularly complex technology, it requires technical knowledge, assistance, maintenance and materials. The limits of composting yards may still be reached, and there is not a clear strategy on how to deal with material scarcity, in particular straw, sawdust and dry foliage: "*I think this method has a certain operative limit…sometimes they [other organic waste treatment activity participants] have had to come here to ask for materials*" [Treat #28]. The lack of these materials is then perceived as potentially increasing the chances of the composting yard being badly managed and thereby increasing the environmental risks, since only these materials guarantee isolation and correct temperature maintenance (see Table 4).

3.2 Contextual factors

The third step of the analysis concerns the contextual factors that, according to stakeholders, could hinder or promote the implementation of the FCL.

Table 5: Contextual factors promoting and hindering the FCL

Promoting contextual factors	**Hindering contextual factors**
• Long history and cultural background of composting initiatives (cited 74 times) • Environmental awareness of the society (cited 65 times) • Advanced state of research and technology (cited 53 times) • Supportive legal framework (cited 23 times) • Supportive political framework and institutional commitment (cited 25 times)	• Lack of infrastructure for safe organic waste treatment (cited 78 times) • Lack of citizen acceptance might reduce waste separation rates (cited 59 times) • Spatial issues and tourism can make logistics management more difficult (cited 49 times) • Lack of regulations can hinder the effectiveness of the law (cited 44 times) • Political views and lobbying can delay the implementation of the law (cited 43 times) • Waste management problems derived from conflicts between COMCAP and communities' waste management initiatives (cited 24 times).

The interviews revealed a series of aspects that may promote the successful implementation of the law. Most of these aspects are related to some characteristics of Florianópolis society. This society has been described as particularly open to environmental innovations, and past experiences have affected citizens' awareness of organic waste themes. In particular, the Beija-Flor program in 1986 has "*established roots*" [Legal_Fr #9], as affirmed by one COMCAP employee.
Other promoting factors are linked to the role of the university in the field of organic waste treatment, particularly through the UFSC method. According to stakeholders from the environmental education associations, UFSC "*encourages many professionals who work in the composting area*" [Education

#34]. Furthermore, a good level of experience with the method guarantees a certain level of safety: "*I truly have no worries about handling this method…It is old knowledge*" [Education #31].

Finally, the existing legal framework seems to promote the law. There are several national laws from which the current local and regional organic waste management regulations are derived. The legal framework thus promotes the adoption of local strategies for organic waste treatment and seems to reflect the public agenda of Florianópolis. One treatment company owner referred specifically to the 12305/2010 law: "*The 2010 law, 12305 [...] says that all types of waste must be returned to the production cycle itself. Organic waste is also included*" [Treat #26]. Another supporting decree is the "*'Zero Waste' decree that the city signed saying that the city will be garbage free by 2030*", as noted by a CEPAGRO member [Education #30] (see Table 5).

Stakeholders mentioned different factors that may hinder the successful implementation of the FCL. These factors are related to a lack of technology and resources for waste treatment. The UFSC method is very affordable and easy to use, but "*it is a very rough job because you work with those 50-liter tanks*" [Treat #25].

This aspect, together with the time demands of the UFSC method (depending on the quantity of waste, composting can take up to 6 months), may hinder the effectiveness of the FCL, as confirmed by a COMCAP technical expert: "*Treating huge amounts of waste through […] the UFSC thermophilic process won't be viable. We will need a more accelerated treatment method so that we can treat more waste in a smaller area*" [Policy #6].

One possible solution may be the adoption of new technologies such as biodigesters, but there is not "*any sort of technology like that…in Brazil I don't know about a biodigester for municipal organic waste*", as described by a COMCAP technician [Policy #5].

Another hindering factor may be the refusal of some members of society to change their household waste management habits. An expert on COMCAP regulation affirms that citizens could have difficulties in accepting both a change in their behavior and a possible tax increase: "*I'm sure that […] in 2030 […] we will still have people not doing it*" [Legal_Fr #11]. A representative from COMCAP described Florianópolis as being heavily impacted by daily commuters and tourists coming to the city. These individuals are not as aware of the Florianópolis waste management regulations as other stakeholders are: "*Florianópolis […] is a city where those who study and work in the city do not actually live in the city, but they produce waste [...] they throw their waste in the first place they find […]. Florianópolis is [...] a touristy city; the people who come to the city do not have the same awareness or concern, because the city is not theirs*" [Policy #2]. These two aspects together may hinder the implementation of the FCL, particularly during the tourist season.

Another hindering factor relates to the lack of strict regulations. The interviewed stakeholders said that the law is not particularly strict for two main reasons: i) There are no indications of the fines and measures that are enforced against those who do not comply with the law: "*Unfortunately, due to the lack of regulation, the ways we have today to ensure law compliance are not effective*" [Prod #20]; and ii) there is no clear definition of what constitutes a large organic waste producer: "*The law says that it will start with large producers but does not specify who is considered a large organic waste producer*" [Treat #26].

Furthermore, as one urban planner suggested, the FCL may be hindered by the complexity of the geography in the territory: *"Well…if you think of an island that is 50 km long from north to south, with roads that all end up in the same place (here on the bridge), that is the only way to connect the island to the continental area […] where all the waste is*" [Plann #13]. Other geographical characteristics create several difficulties and cause community isolation: "*In the central area, there are hills that the garbage truck cannot reach, the streets are narrow or so steep … in 'Costa da Lagoa', you can only get there by boat. […] Therefore, we have a very diverse geography, which complicates our waste operations in the area*" [Plann #13].

As one law promoter suggested, political factors can hinder the successful implementation of the FCL. There is a fear of poor administration due to the perception that *"the way politics works is still very bad*", policies are not well applied, and "*possible pressures coming from part of the society*

willing to build a biodigester […] and privatize the waste management system" may collide with the FCL model [Policy #4].

Finally, one factor that was addressed by a community composting operator and reported by other stakeholders is the contrasting views of COMCAP and community waste management initiatives. This leads to organic waste initiative isolation in peripheral areas in terms of public service support, such as "*receiving material or having street cleaning services*" [Community #37]. This consequently intensifies the contrast between the public institutions and peripheral communities.

3.3 Discussion: Social acceptance of the FCL

This study presents an innovative approach to waste management analysis through the analysis of stakeholders' social acceptance of a specific and novel regulation in the Brazilian context. This analysis allows us to identify the risks and benefits of the FCL, and it particularly responds to the needs that emerged in the literature in finding an analytical approach capable of illustrating stakeholders' perceptions and providing policy suggestions. The results of this study help to add new elements to the concepts that influence the acceptance of waste management regulations.

The interview results show that the major perceived benefits associated with the FCL are mainly environmental and social. The former includes a potential reduction in the ecological footprint of organic waste transportation and treatment. Although such benefits are in line with what has been reported in the literature (Zeiss & Atwater, 1987; Sikora 1998; Larney et al., 2006), Florianópolis stakeholders consider the agronomic use of compost for household and community vegetable gardens to be the main environmental benefit. This is particularly relevant for enhancing the relationship between urban agriculture and organic waste management systems (Cofie et al., 2006).

The perceived economic benefits of the FCL include avoiding sanitary landfill use and a reduction in public expenditures. Cost reduction, which is context-related, is debated in the literature. From the perspective of waste treatment, composting does not always come with public cost reductions over landfill disposal (Renkow & Rubin, 1998). The prices of waste recycling and composting vary according to several economic variables, such as the local market prices for labor, capital, fuel, and disposal fees (Bohm et al., 2010). On the other hand, when environmental and educational aspects are included in the cost analysis, composting can lead to public cost reductions (Farrell & Jones, 2009; Mu et al., 2017). It is worth mentioning that, according to the latest data available for Florianopolis, the costs per ton of municipal organic waste have been reduced from 180.59 R$ in 2020 to 156.81 R$ in 2021 (CHAMADA PÚBLICA N°. 591/SMA/DSLC/2021). Nevertheless, to what extent this cost reduction is due to the FCL and how this affects households is not yet possible to estimate.

The social benefits mentioned in the interviews are particularly linked to specific characteristics of Florianópolis associated with new job opportunities and the empowerment of marginalized communities. This could be of particular importance since, in the context of Florianópolis, initiatives such as the Revolução Dos Baldinhos have a positive impact on community well-being. Furthermore, these kinds of initiatives can serve as an example of good practices for similar contexts both in Brazil and other countries. The benefits mentioned by the stakeholders seem to be closely connected to the contextual tradition of urban farming and community waste management initiatives, which are prominent characteristics of the Florianópolis waste management context.

Stakeholders' major concerns relate to tax increases. This is a common perceived risk when public policies on waste management are approved (Wüstenhagen et al., 2007; Wolsink, 2010). Nevertheless, it is worth mentioning that the law itself does not mention or require a tax increase, and FCL proponents have mentioned possible tax incentives that could be provided to those who compost

their organic waste and direct payments to small community initiatives for organic waste treatment. The main preoccupation with tax increases comes from private businesses and large waste producers. This may be a problem for some citizens but can also inhibit the successful implementation of the law itself due to possible rejection from the population. On the other hand, some scholars have reported that taxations based on weight have several limitations since they tend to penalize the recovery of the heaviest fractions, such as the organic fraction, without considering the amount of space and environmental impact that each fraction has (Cossu & Masi, 2013).

The second most mentioned perceived risk was health issues. Disease vector proliferation with composting methods similar to the UFSC method has already been reported in the literature (Mudruňka et al., 2017; Haug, 2018). Poor composting yard management could also lead to environmental risks such as groundwater contamination. Organic waste is more than 70% water. Thus, heavy rain or the absence of any efficient drainage system can increase the chances of groundwater contamination (Korboulewsky et al., 2002; Wei et al., 2017). On the other hand, these negative externalities appear only when composting yard management is inappropriate. The institutions involved in Florianópolis environmental management reported composting guidelines for composting yard implementers (FAPESC, 2017), and no severe accidents have been reported in relation to the UFSC method.

Several promoting contextual factors emerged through the interviews. These factors relate to the cultural background of Florianópolis. The city has a well-established network of institutions and associations working on the theme of organic waste management. This network is mainly represented by the university where the UFSC method was studied and developed. Environmental education associations operating in the territory for several years have also played an important role in citizens' education. Furthermore, stakeholders describe Florianópolis civil society as particularly sensitive to environmental issues. This, together with a proactive political view and the absence of particular legal or urban planning boundaries, can support the successful implementation of the FCL.

Additionally, several hindering factors emerged from the analysis of the contextual aspects. The lack of clear guidelines regarding operational implementation could delay the initiation of the FCL. The lack of technical requirements and economic resources could hinder COMCAP's effective collection and treatment of waste. Other aspects that could hinder the success of the law relate to the lack of cooperation between the several small composting initiatives in marginalized areas and COMCAP's management. The lack of technical assistance in terms of waste collection and treatment in peripheral areas could compromise the implementation of the law and increase social conflict. A comparison of the main acceptance elements that emerged in the study with those mentioned in the literature is shown in Annex II.

3.4 Practical and policy implications of the study

These case study results show that the new FCL can have a series of implications for policy-makers at the local level. The first aspects that need to be addressed to overcome the main barriers to the new regulation are related to tax increases. Shifting from a weight-based to a volume-based taxation system is a possible solution when dealing with organic waste, and evidence from an Italian case study confirms the potentiality of this solution (Cossu & Masi, 2013). Other case studies considered the introduction of a "Pay-As-You-Throw" tax as a viable solution for both reducing costs for citizens and increasing recycling rates (Pfister & Matthys 2022). Solutions to reduce the risks of tax increases for the organic fraction should consider finding the correct frequency of weekly collection for households and private company activities to optimize transportation costs and reduce the burden for citizens in keeping their organic fraction in their household (Choe & Fraser, 1999).

Finally, the most critical aspect that must be addressed in the coming years is the variety of visions of the waste management model. On the one hand, a centralized model of organic waste management

that concentrates all the resources in biodigester technology could surely represent a viable solution in terms of energy efficiency, but it requires significant investment from the community or private sector. This solution would not abide by the principles of the FCL and would not valorize the existing small composting initiatives started over the last few decades. A decentralized model using the UFSC method is supported by those promoting the law, small composting initiatives such as Revolução dos Baldinhos, and small private companies. Although it does not treat organic waste as efficiently as a biodigester, the use of the UFSC method is already widespread throughout the city and would not require large investments for increased implementation. Case studies have already shown the potential positive impact that a widespread organic waste management treatment strategy can have on organic fertilizer production (Barboza et al., 2011). As shown in other case studies, a decentralized model can also be an effective solution for increasing the rate of composting by limiting the investment required to reach the FCL objectives (Pai et al., 2019). This is particularly important for Brazilian cities where municipal solid waste is managed at the local level; thus, it requires tailored local solutions. Federal regulation also favors smaller activities with less than 500 kg/day of waste treatment rather than larger activities (FAPESC, 2017). From an administrative point of view, municipal solid waste is managed by COMCAP, which is formally recognized as an "*Autarquia*" (Diário Oficial Eletrônico do Município de Florianópolis, Edição N° 1983). This means that COMCAP is an independent actor within the boundaries of the municipality of Florianopolis. Thus, the municipality of Florianopolis has the capacity to select and adapt the strategy that best suits the needs of the city and its surroundings. The adoption of decentralized composting models, as foreseen in the FCL, has several implications and critical aspects that local stakeholders have to consider.

First, it is recognized in the literature that the decentralization of municipal solid waste is a practical way to reduce logistic costs by taking advantage of existing logistics implemented in small communities, as shown in case studies in Bangladesh (Zurbrügg et al., 2005). Cost reduction is also linked to the capacity of subtracting workload from the sanitary landfill, as emerged in the interviews, which is also confirmed in the literature in other case studies in North America (Platt et al., 2014). These case studies also suggest that a decentralized model of organic waste management can be a valid alternative for solving organic waste management issues in contexts with limited investment capacity (Zurbrügg et al., 2005; Platt et al., 2014). This is confirmed in other case studies where decentralized models have proven to be effective in increasing citizens' willingness to cooperate, supporting a circular economy approach and increasing the waste separation rate without increasing the risks of harmful environmental and health conditions (Comesaña et al., 2017; Manu et al., 2019). On the other hand, policy-makers should be aware of potential problems related to odor and leachate floods in streets when waste collection is not performed on a frequent basis (Sakarika et al., 2019). Nonetheless, the composting model adopted in Florianopolis is already well known and implemented in households, vegetable gardens, universities, municipal parks, small private companies, and community initiatives for organic waste treatment. Guidelines for its correct management have been developed by universities, and developing a decentralized model will reduce the size needed for a composting yard, thus also reducing the risks ensuing from the composting yard (; FAPESC, 2017; Oliveira et al., 2017).

Finally, the decentralized model is advisable to support capacity building and the empowerment of marginalized communities. The literature validates the path by which the FCL decentralizes organic waste management composting yards (Bruni et al., 2020). The Florianopolis case also shows that despite the lack of substantial investment, small community initiatives and businesses have already managed to compost almost half the organic waste treated by COMCAP (see Figure 2). In addition to the low investment needed, the main advantages of this model derive from its participatory approach and ease of use. This model empowers local communities' capacity building and can support job creation, environmental education, community building and well-being in marginalized areas. Enhancing the role of existing initiatives by mapping them and involving them in the codesign of regulations will also avoid the potential conflicts that might emerge between waste management

stakeholders. This will increase the levels of consensus between stakeholders in supporting a circular economy approach to organic waste management.

3.5 Study limitations and outlook for future studies

Even though the present paper empirically tests an analytical framework that has several potential applications, improvements in its application can help overcome some of the study limitations. First, the main limitation of this study is its qualitative nature and non-representativeness due to the small sample size and inability to report the perceived benefits of the civil society. Future studies analyzing citizens' attitudes toward household waste management should be developed to obtain a broader and more complete description of the social acceptance of the FCL. Moreover, the social acceptance approach should be integrated with an analysis based on the creation of different scenarios of waste management according to the solutions that stakeholders report. In this case, a cost-efficiency scenario comparing a decentralized model and the implementation of a biodigester can support the formulation of more concrete solutions and policy suggestions. Finally, this study leaves room for future analysis of the relationship that has emerged between waste management and urban agriculture. The influence of these activities on the waste management system and on household waste management habits should be considered a key aspect to better understand the role that urban agriculture can play both as an awareness-raising activity and as an absorber of fertilizer produced through local composting. This analysis will contribute to understanding how circular approaches to waste management should be supported.

4 Conclusion

The present work analyzes the acceptance of the first composting law ever approved in a Brazilian state capital. This study helps identify critical aspects of the FCL that constrain the implementation of an efficient organic waste management system through the novel lens of social acceptance. This work provides a description of the risks and benefits associated with the FCL, as well as its main hindering and promoting factors. The results show that the decentralized model proposed in the FCL has several perceived benefits, but potential risks and hindering factors were still reported in the interviews and need to be considered. Although all stakeholders agree that Florianópolis society is particularly aware of environmental issues, the UFSC method is a well-known composting method, and biodigester adoption does not seem to be feasible in the short term, some of the respondents still foresaw potential conflicts regarding composting activities. Most of the concerns were voiced by technical experts in regard to the safety of the composting method proposed in the FCL. This is a debated aspect that will require further dialogue between policy-makers and stakeholders in the coming years to guarantee safety and ensure that the law's objectives are achieved.

This Florianópolis case study shows that organic waste management plays a vital role in urban system sustainability, and such management goes beyond the mere aspects related to correct waste treatment. This case study suggests that a decentralized model of organic waste management can be a valid alternative for solving organic waste management issues in contexts with limited investment capacity. Furthermore, it also reveals that this model can support capacity building and the empowerment of marginalized communities. Finally, this case study suggests that similar regulations should start by mapping and involving initiatives that are already active in waste management. They should be involved in the codesign of regulations to avoid conflicts and reach levels of consensus between stakeholders that do not share the same vision.

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