Agnieszka CIECHELSKA • Marta KUSTERKA-JEFMAŃSKA • Sabina ZAREMBA-WARNKE

MUNICIPAL WASTE MANAGEMENT AS A POLYCENTRIC SYSTEM – THE EXAMPLE OF POLAND

Agnieszka **Ciechelska** (ORCID: 0000-0002-3996-3897)
Marta **Kusterka-Jefmańska** (ORCID: 0000-0002-6773-6157)
Sabina **Zaremba-Warnke** (ORCID: 0000-0002-9005-5763)
– *Wrocław University of Economics and Business*

Correspondence address:
Komandorska Street 118–120, 53-345 Wrocław, Poland
e-mail: agnieszka.ciechelska@ue.wroc.pl

ABSTRACT: In developed countries, the main burden of waste management rests on the organised (formalised) and massive municipal waste management system. The functioning of these systems is regulated by legislation at the local, national, and international levels. At the same time, some waste fractions are entirely or partially excluded from this system (e.g. bulky waste, second-hand clothing, food, green waste, or metals). As in developing countries, they are partially managed through informal undertakings, the organisation of which, including the mode of operation, scale, or spatial coverage, are diversified. The formal system is organised hierarchically and strictly regulated by law. On the other hand, informal activities are governed by terms and conditions or sets of everyday rules. Thus, municipal waste management in developed countries forms a complex mosaic of activities, organisations and institutions that contribute to reducing waste and its nuisance.
The paper aims to determine whether waste management systems in developed countries have the characteristics facilitating the achievement of the benefits resulting from a polycentric management system. The analysis was conducted using the Polish waste management system as an example. For this purpose, a Theoretical Model for the Commons (Carlisle & Gruby, 2019) was used.

KEYWORDS: municipal waste, common good, polycentrism

Introduction

The municipal waste system can be considered to be a common good system, having in mind two aspects of the notion, i.e. (1) classic common pool resource (CPR) and (2) a system in which the common pool resource is the environment, and any actions aimed at reducing the amount of waste or its nuisance are resources conservation actions that protect the resource(Ciechelska, 2021). Waste as CPR has been discussed many a time with regard to developing countries, including Brazil, India, China, or Egypt (Bose & Blore, 1993; Cavé, n.d.; Chaturvedi & Gidwani, 2011; Chen et al., 2018; Pires Negrão, 2014). In contrast, the system of municipal waste as common good in developed countries has been little studied. Unlike in developing countries, efforts are being made in developed countries to get all generated municipal waste covered by a system, which is supposed to ensure safety and efficiency as well as a steady, relatively homogeneous waste stream from which raw materials can be extracted and the waste residue neutralised through technology. In the literature, the formal system is very well described, although not in the context of common good (except for the sharing of facilities). In the common good model, they become frequent and diverse players, undertaking various actions in relation to the common good resources. This group includes not only businesses (including plant owners) and households, but also public sector organisations. In different countries, and even in different regions within one country, these players are organised differently; they are subject to different sanctions and laws, different monitoring obligations, as well as rules and tools for enforcing the established laws. Furthermore, the governance of the system (under the common good model) becomes more complicated as there are parallel centres of power at the international (e.g. EU), bilateral (e.g. waste export/import conditions), national, and local levels, which turn out to be both the originators and background of the players' actions. Similarly, the effects of resources conservation activities can be observed from different perspectives, i.e. taking into account international, local, and individual responsibilities.

The system is regulated at the national and international levels (e.g. at the level of the EU), but its organisation and related regulations are established locally. A similar approach can be observed in many developed countries, although the instruments and the way of cooperating with local residents differ. The system is quite expensive as it requires expenditures on high-tech installations. In addition, several organisations administering the system are also involved. However, apart from the formal system, waste owners (residents) take up different efforts to reduce waste or minimise its nuisance, i.e. resource conservation actions. These activities involve different

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waste fractions, vary in scope and scale, and vary in their degree of formalisation. Whether the waste finds its way into the system, is managed otherwise, or is directed to the environment depends on the individual decisions of individual waste generators (households). Therefore, international and global waste problems result from the aggregation of individual actions and decisions. While making a global agreement, which would cover all these individual situations, takes time and a great deal of work, the construction of fair and effective global instruments seems unlikely anytime soon (Ostrom, 2012). That is why particular countries or groups of countries, such as the European Union, implement their policies in this regard, which they then operationalise at the local level. Various measures are also taken to reduce the amount of waste or its nuisance by waste generators themselves. Thus, by reducing the amount or nuisance of waste, the entities benefit on different scales, ranging from the individual to the global (Ostrom, 2012). Therefore, concerning municipal waste management, we can speak of a polycentric system.

Polycentrism

Polycentrism is a concept widely discussed and studied in the works of Vincent and Elinor Ostrom. It denotes a complex form of government with multiple decision-making centres with a certain degree of autonomy (Aligica et al., 2012). It is a common phenomenon, especially concerning the environmental resources management system. Decision-making centres in a polycentric system may operate at different levels, such as local, national, international, or transnational, being simultaneous, subject to legislation at these different levels, sometimes at several in parallel (the phenomenon of overlapping centres (E. Ostrom, 2010b; Paavola, 2016). At the same time, they must exhibit some level of coordination in their activities by considering one another in terms of competitiveness, conflict resolution, or cooperation (V. Ostrom et al., 1961). Polycentric systems function as a governance alternative to centralisation, decentralisation, and community-based governance. Polycentric systems are neither worse nor better than them (V. Ostrom et al., 1961).

Ostrom's works examine polycentrism, considering the metropolitan area governance, characterised by a multiplicity of overlapping decision-making units. Suppose such an organisation operates based on the market economy. In that case, such a system of governance can produce comparably greater efficiency in the production and delivery of public goods and services than if the government was responsible for it, e.g. responsiveness. At the same time, decision-making centres can act coherently and predictably as they consider one another in their decision-making processes (V. Ostrom et al., 1961). Therefore, polycentric systems can provide the following benefits:

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- increased efficiency,
- fewer susceptibility errors generated by the whole system,
- mutual learning,
- taking into account human limitations of information processing,
- consideration of the scale diversity,
- consideration of the existence of multiple objectives in resources management,
- recognition of the diversity of human interests and values associated with most complex natural resource systems (Folke, 2007; Heikkila et al., 2018; McGinnis & Walker, 2010; E. Ostrom, 2010b).

Polycentrism in the management of the common good can, furthermore, provide better access to local knowledge, better contextualisation of policies, reduced risk that a resource will cease to function across the region due to multiple opportunities for policy experimentation, better information transfer through overlap, and increased capacity for adaptive management (Heikkila et al., 2018). However, it is impossible to point to ideal examples of polycentric systems or a set of characteristics that determine such a system. All systems are more or less polycentric (Tiffen & Mortimore, 1994).

Research method

The theoretical model of a polycentric resources management system used for the analysis makes it possible to show the benefits of using such a system if it exhibits specific characteristics. These relationships were initially studied by Ostrom (McGinnis & Ostrom, 2014; E. Ostrom, 2006; V. Ostrom et al., 1961), and the model was later extended and modified by Gruby (Carlisle & Gruby, 2019). Ostrom identifies three features of the system that determine the occurrence of certain benefits. Gruby reduces them to two but still distinguishes supporting conditions that increase the likelihood of occurrence of a given benefit. This model does not fully explain the success of a given resource system as it prevents the multiplicity and interplay of factors that can contribute to such a success. It focuses only on the institutional features of the system. In the model, institutions are understood broadly, i.e. as formal and informal, including organisations, rules, standards, and strategies that structure human interactions (McGinnis & Ostrom, 2014). The model distinguishes the following benefits:

- increased adaptability of the system to social and environmental changes,
- possibility of good institutional fit for resources conservation in complex natural systems,
- reduced institutional failures and resource losses due to the redundancy of players and variability or redundancy of management institutions (Marshall, 2009; Van Kamp et al., 2003).

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On the other hand, the following features and conditions were distinguished as conducive to the occurrence of the benefits mentioned above in polycentric natural resources systems:

1. Overlapping decision-making centres – favourable conditions include that decision-making centres are organisationally distinct; they operate at different levels and in different jurisdictions, and the scope of their authority and jurisdiction overlaps with the boundaries of the environmental problem.
2. Decision-making centres include others in their actions through cooperation, competition, conflict and conflict resolution mechanisms. Supportive conditions comprise the fact that the rules and standards structure the actions taken in the system. Decision-making centres are interconnected; they participate in mediation and learning processes and apply accountability mechanisms for decisions and conflict resolution mechanisms (Carlisle & Gruby, 2019). The relationship between the characteristics of a shared resources system and the benefits of this type of management is shown in Figure 1.

The institutions in a polycentric system can be divided into decision-making centres and supporting institutions. According to the SES Ostrom model, they are Collective Players. Decision-making centres are only those entities that independently create sets of standards and rules in a given area (McGinnis, 2011). They are most often identified with government bodies at various levels and self-organising communities of the resources users; however, they can also be formal and informal institutions with different ownership and organisational structures, which exert strong influence on policy or provide important technical and/or financial support, but do not formally exercise authority. Supporting institutions, on the other hand, make their competencies (e.g. scientific and practical knowledge, organisational, technical or social skills) available to decision-making centres, increasing the effectiveness of the system. Cooperation between decision-making and supporting centres can be permanent or periodic; they can merge or cooperate in different ways.

The diversity of institutions present in the system (with regard to geography, different scales of operation, different organisational forms, subject to different jurisdictions, standards, and rules) facilitates better and faster adaptation to changes than in centralised systems (Folke et al., 2005; Oakerson & Parks, 2011). This is particularly important in natural resources systems, where changes are often rapid and non-linear (A. Poteete, 2012; Sovacool et al., 2017). The diversity of institutions makes them more durable as they better take into account the characteristics of the particular natural resources system they deal with (Folke et al., 2007). In such systems, players do not pursue a single and consistent policy, but take advantage of the diver-

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Attribute	Enabling Condition	Advantage		
		Enhanced Adaptive Capacity	Good Institutional Fit	Risk Mitigation/ Redundancy
Multiple,overlapping decision-making centers with some degree of autonomy		X	X	X
	Decision-making centers employ diverse institutions	X	X	X
	Decision-making centers existat different levels and across political jurisdictions		X	X
	The jurisdiction or scope of authority of decision-making centers is coterminous with the boundaries of the problem being addressed		X	
Choosing to act in ways that take account of others through processes of cooperation, competition,conflict, and conflict resolution		X	X	
	Generally applicable rules and norms structure actions and behaviors within the system	X		
	Decision-making centers participate in cross-scale linkages or other mechanisms for deliberation and learning	X	X	
	Mechanisms for accountability exist within the governance system	X		
	A variety of formal and informal mechanisms for conflict resolution exist within the system	X		

Figure 1. Theoretical Model of a Functional Polycentric Governance System for the Commons

Source: Carlisle & Gruby, 2019.

sity of principles and standards that guide institutions, choosing those that are most effective. Alternatively, however, there is no optimal set of standards and rules to guarantee success, so each institution is more or less effective (E. Ostrom, 1999). Institutional fit can consist of adapting institutions to the temporal, spatial and functional characteristics of the ecosystem or adapting to the social system – to the value system, beliefs, or psychological needs of a given social group (Folke et al., 2005). For the effective operation of a polycentric system, it is not the number of institutions in the system that is important, but the existence of multiple opportunities that the players take advantage of when taking actions to preserve the resource. Hence, frequent overlapping of institutions is possible, as well as:

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- better flow and access to information, including about the activities that ensure the success of the system (Marshall, 2009) and learning, as a result,
- considerable autonomy of institutions (actual rather than formal (Marshall, 2015)) and lack of central coordination of their activities (E. Ostrom, 2010b).

At the same time, independent decision-making centres can cooperate, compete, be in conflict or resolve it (E. Ostrom, 1999). Cooperation allows for greater capacity to act or outsource some tasks to more competent entities. In turn, the close spatial proximity of decision-making centres promotes competition, which contributes to the exchange of information. However, intense competition can reduce cooperation (A. R. Poteete & Ostrom, 2004); hence the need of developing effective conflict resolution and accountability mechanisms for decision-makers.

Polycentric waste management system in Poland

The Polish system of municipal waste management is similar to systems operating in developed countries. It can be regarded as a system of the common good, where the resource is the environment, and all activities aimed at reducing nuisance and minimising waste are activities that conserve the resource. In this context, a formal system and informal activities can be distinguished in the waste management system (Ciechelska, 2021). The formal system is based on municipal waste management systems. Their formalisation is intended to ensure the efficiency of these systems by ensuring the continuity of relatively homogeneous waste streams for treatment facilities. To this end, municipalities (or their associations) organise a method for collecting waste from waste generators, divided into mixed waste and individual fractions destined for recovery and recycling. The waste is then sent to processing plants, where individual fractions are separated from both mixed waste and selectively collected waste. These fractions are then covered by the recycling (material or energy) or management processes. Only residual waste goes to landfills.

The rules for the organisation of these systems by municipalities derive from national regulations, and these, in turn are subordinated to the EU regulations and the goals of a closed-loop economy (Ciechelska, 2017). However, municipalities and their associations have a certain autonomy in establishing rules and principles that constitute local laws (Agovino et al., 2021). They adapt them to local conditions (e.g. frequency of waste collection), to principles and values adhered to by local residents (e.g. labelling of bags with improperly sorted waste), and to adopted methods of communication (e.g. an official delivers information personally to homes). In setting local regula-

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tions, municipalities may consult with residents and sometimes with waste collection and processing contractors selected by tender.

Municipalities can cooperate with other neighbouring or distant municipalities, similar or with different characteristics (e.g. urban and rural, but located in the mountains) in the collaborative organisation, management, or operation of the waste management system. In addition, they can use the expertise of advisory centres (including experts, universities, or industry associations). Several players are involved in the operation of formal systems, i.e.:

- transport companies and plant owners,
- operators-companies involved in the operation of treatment facilities,
- operators and companies involved in the process of waste treatment and disposal facilities, companies involved in the management of the system (including monitoring, sanctions, etc.),
- authorities with its agencies operating at the local, national or EU level, sometimes acting based on multilateral agreements, thus increasing their reach,
- institutions that organise and are responsible for the efficiency of the system, i.e. a local authority with separate organisational units or business entities established for this purpose,
- contractors – companies engaged in waste collection and transport, waste trade (including for recycling), recycling, and waste recovery (Munguía-López et al., 2020),
- recovery organisations – monitoring and "certification" of proper waste handling,
- waste owners and generators, i.e. households, housing cooperatives, or housing communities,
- research centres and constructors of installations, for example,
- industry associations (e.g. city associations, directors' associations, etc.).

In parallel with the formal system, a number of informal activities are being developed, undertaken by residents – waste generators, such as:

- zero waste movements, promoting and implementing activities that reduce waste generation,
- the backyard and community composters for the bio and food fractions used by local livestock farmers, community refrigerators, online platforms for selling food with short shelf life (stores and restaurants are the bidders), or charitable organisations (Lazell, 2016),
- online exchange and sales platforms for bulky waste and electrical and electronic equipment, "Garbage truck is on its way" information platforms; inter-neighbourhood and family exchanges; inter-neighbourhood displays of second-hand goods, roadshows and flea markets, charities, Repair Café",

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- for the second-hand clothing fraction – donation to clothing stores accepting second-hand clothing, circular boutiques, inter-household exchanges with varying degrees of familiarity, online platforms and stationary places for buying and exchanging second-hand clothing, charity stores, charitable organisations, campaign collections, such as the Noble Gift project (Degenstein et al., 2021),
- metals and paper fractions – appropriated by local collectors for resale to return and buy-back centres (now less and less popular due to increasingly difficult access to the waste and decreasing profitability) (Porras Bulla et al., 2021; Rendon et al., 2021).

Within those mentioned formal and informal resources conservation activities, decision-making centres can include:

- centres of power, with agencies at the EU, national, and local levels,
- system operators setting the rules for the system (how to organise the waste treatment system in the region and how to use available facilities),
- waste generators, i.e. households and housing cooperatives and communities,
- enterprises intermediating in the trade of second-hand goods (online platforms),
- charity and aid organisations,
- informal social groups (e.g. Repair Café or a Facebook group "Garbage truck is on its way") as well as family and friend groups participating in the second-hand goods trade,
- art collectives and individual artists,
- farms using their own and collected food and bio waste from other generators.

They are assisted by consulting and research centres, such as universities and experts, local governments, and various professional forums, associations, and NGOs.

Informal resource conservation activities can be permanent or action-based. Participating players may act individually or cooperate in groups with varying degrees of involvement and frequency. The players (individual and collective) form a very diverse mosaic of different institutions in terms of organisation (Pieroni et al., 2020), ownership, and the ways the activities are carried out.

Conclusions

The multiplicity of diverse decision-making and advisory centres makes it possible to classify the municipal waste management system as a polycentric system. In addition, the hierarchical nature of the organisation and regulations (especially the formal system) indicates that it is a well-anchored

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system (Ostrom). Decision-making centres vary in their form of organisation; they include enterprises, public entities, social groups, NGOs, and even households. Some were established by law (e.g. regional waste treatment facilities), other were created as a result of the existing law and system (second-hand stores), and still, others are the result of community initiatives (e.g. Repair Café). Formal and informal activities are carried out at different spatial scales and jurisdictions, for example:

- Participation of households, municipalities and their associations in the formal system – spatial scope: local; the scale of operation: local.
- Waste treatment, recycling, recovery and marketing companies – spatial scope: regional to international; the scale of operation: local to global.
- Power centres – spatial scope: local to international; the scale of operation: local to global.
- Second-hand goods brokering companies (Vinted, Allegro) – spatial scope: local to international; the scale of operation: local to global.
- Households exchanging things with family, neighbours and friends (in different ways), e.g. inter-neighbourhood displays of second-hand goods, roadshows and flea markets, or Repair Cafés – spatial scope: local; the scale of operation: local.
- Charities, upcycling and recycling businesses – spatial scope: local to international; the scale of operation: local to international.
- Local farms – spatial scope: local; the scale of operation: local.

The development of technology has enabled wide and widespread access to various types of waste of varying value (e.g. designer clothing), which were produced at a considerable distance from the place of their appropriation. Thus, the scale of waste trading and the carbon footprint associated with its transport has increased significantly, including internationally (e.g. Vinted). Technology has also contributed significantly to the development of information-sharing and learning processes. These processes have traditionally been part of the formal system and have been implemented through various information exchange fora, such as conferences, consultations, bilateral and international cooperation, and industry associations. An example can be the regular conferences organised for the entire waste industry by Abrys, a publisher of trade journals, with speakers representing various decision-making and consulting centres. Another indicator is the opportunity to participate in public consultations in changing legislation, which is one of the ways to mediate and develop a legal consensus. Participants in informal activities, thanks to the opportunity to exchange experiences and opinions (through influencers, for example) and to learn, as well as thanks to social media, could leverage their scale of activity. They form various types of social groups, where they exchange information (e.g. The garbage truck is on its way) and promote various ideas that favour resources conservation activities, e.g. zero

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waste; still, however, they can express their opinions with regard to the formal system, its players and ways of conducting resources conservation activities, e.g. through the possibility of online, anonymous submission of comments and requests to the municipality.

Different types of resource conservation activities are subject to formal and informal regulations, which often include accountability mechanisms for decision-makers and conflict resolution mechanisms. Relatively thoroughly and transparently, these issues are resolved in the formal system. Every institution operating in this system, regardless of the level at which it operates, is subject to regulations. Regulations describe the type and manner of its activities; hence, the ability of the formal system to adapt to a changing situation is limited. In addition, legal regulations are well-anchored, but they are tailored to the national scale. They regulate the principles of operation of specific institutions, e.g. legal regulations on the operation of municipalities in the organisation of the waste management system cover only the national and local level. However, they are subordinated to the overarching objective of the EU policies and the circular economy goals.

Meanwhile, municipalities, and cross-border municipalities, in particular, point out that, in their case, it could be reasonable to create a cross-border waste system. They may undertake bilateral cooperation in this regard, but no provisions reflect the cross-border nature of the problem. The situation is also similar concerning informal activities. Individual modes of operation are regulated by various types of regulations (e.g. the neighbourhood exchanges regulations or the Allegro regulations). However, they do not address the problems of the worsening waste situation resulting from their development. Formal laws do not regulate this issue, either. As a result, waste can quite freely transgress national borders through informal activities and increase the spatial scope of negative impacts. Correspondingly, the literature confirms that most often, there is a lack of adequate regulations of the operation of decision-making centres regarding cross-border areas (E. Ostrom, 2010a).

Liability control mechanisms in the formal system have a hierarchical arrangement and result from legally imposed obligations subordinated – on the one hand –to the establishment and operation of effective municipal waste management systems and – on the other hand – the achievement of circular economy goals in the form of appropriate recycling rate levels. They are tailored to the specifics of individual decision-making centres. Furthermore, these regulations include specific monitoring rules and sanctions for failure to meet obligations. Despite these regulations, numerous pathologies are observed in this area, such as fires of stored waste, import of waste from Western European countries, or illegal landfills. Accountability mechanisms fail regarding plant operators and power centres, and households, as numer-

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Attribute	Enabling Condition	Advantage		
		Enhanced Adaptive Capacity	Good Institutional Fit	Risk Mitigation/ Redundancy
Multiple,overlapping decision-making centers with some degree of autonomy		×	×	×
	Decision-making centers employ diverse institutions	×	×	×
	Decision-making centers existat different levels and across political jurisdictions		×	×
	The jurisdiction or scope of authority of decision-making centers is coterminous with the boundaries of the problem being addressed		-	
Choosing to act in ways that take account of others through processes of cooperation, competition,conflict, and conflict resolution		×	×	
	Generally applicable rules and norms structure actions and behaviors within the system	×		
	Decision-making centers participate in cross-scale linkages or other mechanisms for deliberation and learning	×	×	
	Mechanisms for accountability exist within the governance system	–		
	A variety of formal and informal mechanisms for conflict resolution exist within the system	×		

Figure 2. Model of a Functional Polycentric Governance System for the Commons in Poland

ous cases of abandonment of municipal waste in public places, such as forests, are observed. This is illustrated in Figure 2.

As a result of existing regulations at the EU level, waste management systems in developed countries are pretty similar to the Polish system. There are numerous and diverse decision-making centres operating at different levels, on different scales, and within different jurisdictions. However, as in Poland, the scope of institutions does not always coincide with the scope of the existing regulations, especially in a cross-border context. Hence, it can be concluded that municipal waste management systems in developed countries, operating as polycentric systems, show increased adaptability and lower environmental risk. In contrast, the good institutional fit is limited due to the partial matching of the scope of authority of decision-making centres with the scope of the problem.

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Indeed, decision-making centres in Poland and developed countries consider other centres when making decisions within the formal and informal systems. Examples include information-sharing platforms, experience-sharing fora, social media, or speeches delivered by influencers. Decision-making centres are reciprocal, although they may operate on different scales. Their operation may be regulated in various formal and informal ways, expressing slightly different rules and standards. Thus, Poland's and developed countries' municipal waste management systems shall demonstrate an excellent institutional fit and increased adaptability, limited by imperfect accountability mechanisms. With that said, different developed countries show differences in accountability, sanctions, and enforcement, so the level of benefits from the latter feature of the system may vary from country to country.

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The contribution of the authors

Agnieszka Ciechelska – 70% (conception, literature review, analysis and conclusions).

Marta Kusterka-Jefmańska – 15% (e.g. literature review, conclusions).

Sabina Zaremba-Warnke – 15% (literature review, conclusions).

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