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Spatial planning for a popular circular economy

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Abstract

This article argues that a popular circular economy already exists in many world cities, and that this economy can be enhanced through spatial planning. We use Mexico City as a case study, and analyse its popular circular economy, defined as the family micro-businesses which contribute to enhancing the circularity of everyday objects by enabling their reuse, repair, refurbishment or recycling. We first present a panorama of this economy using the Mexican economic census. We complement this analysis by presenting two ethnographic vignettes of practices that also form part of the popular circular economy, beyond what can be observed in the census: the first one illustrates practices of public market workers to avoid food waste, and the second pictures an e-waste informal street market. Taken together, these scales of analysis provide a rich account of the multiple activities that compose Mexico City's popular circular economy. We then compare this phenomenon with the orientation and main strategies of the city's circular economy programme, noting a discrepancy between the two with regards to the scope of action. We conclude that spatial planning tools can foster the already existing popular circular economy, by allocating space for family businesses in all neighbourhoods, and by enhancing social cohesion through the design of quality public spaces and infrastructures.

Keywords

urban sustainability, Mexico city, informal economy, waste management, popular economy

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摘要

本文认为，一种大众循环经济在全球众多城市中已广泛存在，且这种经济模式可通过空间规划得到进一步强化。我们以墨西哥城为例，分析其大众循环经济。这种经济模式被定义为家庭微型企业，它们通过实现日常物品的重复使用、维修、翻新或回收利用，助力提升物品的循环性。我们首先利用墨西哥经济普查数据，对这一经济模式进行了全景式呈现。我们通过呈现两个民族志实践案例来对上述分析加以补充，这些实践同样属于大众循环经济的范畴，且超出了普查数据所能观测的范围：第一个案例说明了公共市场工人避免食物浪费的实践，第二个案例描绘了一个非正规电子废弃物街头市场。综合来看，这些分析尺度为构成墨西哥城大众循环经济的多种活动提供了丰富描述。然后，我们将这种现象与该市循环经济计划的定位和主要策略进行比较，发现两者在行动范围上存在差异。我们的结论是，通过在所有街区为家庭企业分配空间，并设计高质量的公共空间和基础设施来增强社会凝聚力，空间规划工具可以促进已经存在的大众循环经济。

关键词

城市可持续发展、墨西哥城、非正规经济、废弃物管理、大众经济

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Introduction: Spatial planning for circular cities in the Global South

Despite hosting just over half of the global population, cities account for 75% of global energy and natural resource consumption (UNEP, 2013). Transforming urban metabolisms so that they become more circular can reduce the urban demand for primary natural resources. The circular economy proposes to reuse the waste of some economic activity as a resource for another, thus reducing both the generation of waste and the demand for primary natural resources (Mies and Gold, 2021). Achieving circular economy principles in urban systems depends on adequate spatial planning, to ensure that urban space is available for low-(economic-)value circular activities, and to build infrastructures (such as composting sites or grey water systems) that can facilitate circular flows (Williams, 2020).

In this article, we focus on the circularity of urban consumer goods. The waste hierarchy proposes a set of strategies to enhance the efficient use of consumer goods and to reduce the generation of waste (Reike et al., 2018). The most optimum strategy in terms of waste reduction, 'refuse', refers to making a product redundant. Reducing waste can be achieved by designing products that are efficient in their use of materials and that can be intensively used, thus reducing resource needs per use of product. Reuse strategies extend the lifespan of products, including repairing and refurbishing, as well as making unwanted but functional products reach a different user. Recycling refers to extracting valuable materials from a discarded product to give it a new use. Finally, recovering refers to energy recovery. All of those steps prevent disposal in a landfill, which is the least desirable option (De Melo et al., 2022). Although the waste hierarchy suggests that the most favoured options are those at the top of the pyramid (refuse, reduce and reuse), recycling is still the most prevalent strategy in circular economy policies both in the Global North and the Global South (Haswell et al., 2024). Little has been written, in contrast, on how to achieve waste prevention or reuse (Reike et al., 2018).

We use Mexico City as a case study. Documenting cases of the Global South, particularly when they are best practice, helps to promote locally adapted solutions

and south–south learning (Haswell et al., 2024). Mexico City is characterised by a tertiary economy of microbusinesses operating on a spectrum of formality/informality (in terms of government registries, norms compliance, tax payment and working conditions). Recently, attention has been focused on subsistence and/or informal economies as spaces which hold valuable experiences of efficient resource use (an essential component of a circular economy; Brown and McGranahan, 2016; Korsunova et al., 2022).

In this article, we explore the role of spatial planning in enhancing the circularity of consumer goods in the context of a popular economy. In the remainder of this article, we first review the role of spatial planning for circular cities and contrast it with the case of the popular economy. Then, we present the case of Mexico City and the mixed-methods approach needed to characterise its popular circular economy. In the Results section, we show that Mexico City's circular economy is popular, diverse and motivated by economic rationality as well as feelings of care; and that it is unevenly distributed across the city. In the Discussion section, we argue that spatial planning strategies can enhance this circular economy, by allocating space for family businesses in all neighbourhoods, and by enhancing social cohesion through the design of quality public spaces and infrastructures. We conclude by emphasising the role of policy in accompanying and enhancing existing practices of urban dwellers that already enable a circular economy, rather than blindly implementing universal blueprints that can displace such practices.

Conceptual framework

Achieving a circular economy in cities: The role of spatial planning

Local governments are a central actor to foster a circular economy in cities. Their levers for action are diverse, and include public transport planning, adopting building regulations towards the compulsory use of green technologies in new buildings, incentives for local economic innovation towards circularity, as well as education campaigns (Bolger and Doyon, 2019). Particularly important is spatial planning, which allocates space for different activities in the city. Given the low economic value of many circular economy activities (for instance, green urban areas for water infiltration, urban farming or storage for recyclable materials), the market allocation of urban land tends to expel these activities to the urban peripheries. Yet, for optimum environmental performance, these activities ought to occur in urban centres, as close as possible to the areas where urban metabolism is the most dense, to avoid the economic and environmental costs associated with transport (Williams, 2020). This implies that space must be dedicated to managing solid waste (including storage, sorting and reuse activities) where it is produced – including in residential and commercial areas (Bahers and Rutherford, 2024). At the building scale, this entails dedicating appropriate space to waste management activities, such as space for different bins to sort households' recyclable waste (Kakeu-tardy et al., 2023). At the neighbourhood level, this implies dedicating space to activities that may not generate much immediate economic value, such as community composting (Bortolotti et al., 2018) or repair shops (van der Velden, 2021), and that may therefore depend on favourable land-use planning to be accommodated even in areas where land value is high (Williams, 2019).

In parallel, a consideration of space when designing circular economy strategies also entails taking into account the local (social, environmental and territorial) context where such strategies are implemented. Particularly, social cohesion (whether local

actors know each other and are able to collaborate) is necessary for collective action (Ostrom and Ahn, 2003) and is thus a crucial aspect of the potential success of circular economy strategies (Mies and Gold, 2021). For instance, in the well-known case of Kalundborg's industrial symbiosis, trust and reciprocity among local actors were identified as instrumental to the network's success (Doménech and Davies, 2011). In terms of spatial planning, this suggests that neighbourhoods where social cohesion is strong may be more likely to sustain circular economy strategies over time. We explore this possibility with the case of Mexico City's public markets, which are infrastructures that have contributed to strengthening local cohesion in the city's neighbourhoods (Giglia, 2018). Before this, we present the concept of the popular economy to analyse how it may challenge established spatial planning principles for a circular economy.

Popular economies

Popular economies refer to economic activities undertaken by families for their own reproduction and to ensure immediate life necessities (Coraggio, 2020). Such economic activities are embedded in the sphere of social reproduction (Gaiger, 2019), because they rely on family labour and because their economic capital blends with that of the family unit (Sarria-Icaza and Tiribia, 2004). For instance, a shop may operate in part of a family's home. The term 'popular economy' has been used to refer to a broad range of social and economic practices, from local social networks and collective childcare to street begging (Sarria-Icaza and Tiribia, 2004). In this article, we focus on elements of the popular economy that are micro-scale economic activities, providing livelihoods for a family unit, and that are not orientated at the accumulation of capital.

Popular economies are not synonymous with informal economies, but there is an overlap between the two. Popular economies operate on a spectrum of formality/informality, as they comply with some formal institutions and rules (Acuto et al., 2019). For instance, family-owned shops may pay taxes, or offer contracts and social security to their workers. In this article, we circumscribe the term 'informality' to those economic activities that fail to comply with the law (for instance, a street market which does not follow the municipality's land use plan or the city's environmental regulations or the country's tax and labour obligations; Blades et al., 2011), as is the case with the e-waste street market.

Popular economies and sustainability

Most activities causing the contemporary environmental crisis can be attributed to the lifestyle of the world's most affluent population (Wiedmann et al., 2020). In contrast, the global poor's livelihoods not only have a negligible environmental impact but they also often help resolve or avert environmental crises (Martinez-Alier, 2002). The circular economy requires making an efficient use of natural resources by avoiding sending waste to landfill. Coincidentally, activities that make an efficient use of consumer goods by repairing them and repurposing them are characteristic of subsistence economies, and of the livelihoods of populations suffering economic hardships. This is why scholars have noted the existence of a 'necessity-driven circular economy' (Korsunova et al., 2022), resulting in resource-efficient activities that are not necessarily driven by environmental concerns. Although the concept emerged by observing the Global South, these practices also exist in the Global North: Bahers and Rutherford (2024) coined the term 'civic infrastructures of circularity'

to refer to citizens helping each other to repair domestic appliances. Smith and Jehlička (2013) write about the 'quiet sustainability' of Eastern Europe's urban farmers who grow vegetables as much as a money-saving practice as an opportunity to spend quality time with neighbours and children. These examples suggest that urban dwellers around the world engage in economic practices that contribute to resource efficiency, and that they may be driven by environmental consciousness as well as by economic rationality or other motives.

The case of Mexico City

Waste management and circular economy policies in Mexico City

Mexico City is a city of 9 million inhabitants (INEGI, 2020).[1] The city government collects over 12,000 tonnes of solid waste daily from households and small businesses (Secretaría del Medio Ambiente del Gobierno de la Ciudad de México, 2024). Since the 2012 closure of the city's last public landfill, solid waste has been sent to private landfills. Different infrastructures have been built to divert waste from landfill, including a 35-hectare compost site and three waste selection plants, where waste is separated to be recycled. In parallel, the cement company CEMEX receives three tonnes of waste daily to be incinerated as a waste-to-energy method (Gallegos-Carrasco and Juvera-Vargas, 2015). Finally, a thermal plant was inaugurated in 2020 to produce artificial charcoal by burning organic waste. Although the amount of solid waste sent to landfill appears to have gradually decreased in the last decade, the exact reduction cannot be calculated, due to a recent change in the government's methodology to estimate waste flows, impeding data comparison pre and post 2020 (EVALUA-CDMX, 2024).

In 2023, the city passed a Law on the Circular Economy, followed by the publication of the Programme for the Circular Economy (2024–2030; Mexico City Government, 2024). Contrary to the pre-existing waste management programmes, this new programme introduces, for the first time, policies related to the early stages of the waste hierarchy, including better product use and manufacture and extending the lifespan of household goods. However, almost half of the strategies are educational campaigns (for instance, workshops to ease local companies' circularity transition). In contrast, few focus on recirculating materials in urban infrastructure (for instance, incorporating recycled materials to fill potholes) or spatial planning (the only ones being building new cycle lanes and creating six spaces for citizens to exchange knowledge and to repair household goods).

The popular economy in Mexico City

Micro-enterprises characterise Mexico City's economy. Thirty per cent of the city's workers are independent workers (INEGI, 2024b), many of whom have created their own businesses. Over 40% of workers are employed in a micro-business, where family labour remains the norm (INEGI, 2024b).

This economy of micro-businesses is characterised by varying levels of regulation and compliance with employment and environmental norms. Within the employment census, over half of the city's workers are considered informal (self-employed, selling their services or receiving a wage without a contract or health insurance). Within this category, over half (28% of the total) of workers labour in the informal sector, defined as economic entities that are not registered as companies, and where household and productive resources are merged (INEGI, 2024b).

Within the informal economy, waste collection, valorisation and recycling activities occur. Firstly, municipal waste collection services depend on the work of approximately 10,000 informal workers who help municipal employees on their collection routes (Espinosa and Parra, 2019). Most of the city's recycling activities are undertaken by *pepenadores* (informal recyclers who open solid waste bags and sort out recyclable materials) and *centros de acopio* (family businesses which buy recyclable waste, process it and sell it to the recycling industry; Guibrunet, 2019a, 2019b).

Methods for empirical research

We combined two complementary methodological approaches to characterise the existing popular circular economy. We first used the economic census to quantitatively and spatially analyse Mexico City's registered shops that engage in the circular economy. We complemented this analysis by exploring other urban activities that cannot be captured by the economic census, as they occur either in informal economic units or in shops which do not primarily engage in circular economy activities. We explored this second research object by providing ethnographic vignettes of two case studies: one of practices to avoid food waste in the city's public markets, and another of an informal electronics (e-waste) market. Combining these two approaches allows us to explore the extent to which a popular circular economy *already exists* in Mexico City. We describe those two methodological approaches in turn.

Analysis of the economic census

We quantified and mapped Mexico City's businesses which undertake activities that divert waste from landfill. We used the National Statistical Directory of Economic Census that is elaborated and regularly updated by the Mexican federal government's statistics agency; the data used is that of November 2024 (INEGI, 2024a). We selected the economic units that report activities related to selling second-hand household items, trade of recyclable materials and reparation of everyday household items (following the waste hierarchy). We then excluded economic units that do not form part of the popular economy (identified as those that hire more than five employees, those that are run by a registered company and those that depend on a large-scale initial investment; see Supplemental Material). We quantified the number of economic units and number of workers for each of these activities. We also mapped those activities and calculated the number of units per inhabitant in each of the city's neighbourhoods.[2]

Ethnographic vignettes

Our first vignette explores practices to avoid food waste in Mexico City's public markets. Fieldwork took place in three markets located in Benito Juárez and Gustavo A Madero municipalities between April 2023 and March 2024. Seventy-one semi-structured interviews were conducted with workers and owners of market shops selling raw or prepared food. The research aimed to document food waste in the markets, as well as workers' strategies to avoid it.

Our second vignette is that of an informal electronics recycling market, in the Renovación neighbourhood, in eastern Mexico City. Originally, this case study traced the trajectories of e-waste (Bunge González, 2024). It explored the processes of revaluation and repurposing, while also delving into the motivations and decision-making processes behind selecting e-waste for different uses. As such, the interviews focused on the origins and destinations of e-waste, as well as the criteria used to determine their value and selection for specific

purposes. Several hours of participant observations were combined with 41 ethnographic and semi-structured interviews conducted between February and November 2022. Interviewees were informal recyclers, including an itinerant scrap trader, domestic recyclers, resellers, repairers and refurbishers and one consumer, though many participants overlapped across multiple roles.

For both cases of fieldwork, ethical protocols were followed, in accordance with our university's guidelines, to ensure the free, prior and informed consent of individuals to take part in the study. The purpose and process of the research was explained to potential participants and verbal consent was gained to conduct and record the interviews, which were later transcribed for analysis.

Recommendations for spatial planning

We answer the second research question (how can spatial planning foster the popular circular economy?) by critically reflecting on two main sources of data: first, the unequal spatial distribution of popular circular economies across the city; and second, the experiences of shop owners and e-waste workers collected through fieldwork. This reflection is presented in the discussion section.

Results

Quantitative and spatial characterisation of Mexico City's popular circular economy

The circular economy is widespread in Mexico City, as 30,789 economic units (7% of total units) contribute to activities of reuse, repairing and recycling (Supplemental Material). A total of 97% of these economic units form part of the popular economy (Table 1), which amounts to an estimated 68,000 workers. This suggests that over 1% of Mexico City's active population engages in the popular circular economy.

Most of the economic units that compose the popular circular economy perform activities of repair and refurbishment of diverse household items. Car repairs are the most common, followed by the repair and refurbishment of electronics, appliances and miscellaneous household goods (clothes, shoes, furniture, glasses, knives, etc.).

Second-hand shops are the second most common type of shop. These enhance the reuse of everyday objects through finding them new owners when in disuse. Recycling shops buy recyclable household waste such as tin cans, cardboard or plastic bottles. After a process of sorting, cleaning and accumulation, these materials are sold to the recycling industry.

Finally, there are renting services for household goods such as clothes (commonly rented for formal events such as weddings or graduation ceremonies), party equipment (tables and chairs, tableware) and electrical appliances. These allow households to not own items that they rarely use, thus contributing to reducing overall consumption and waste.

Renting services (reduce), second-hand shops (reuse) and recycling shops (recycle) are unevenly distributed in the city, as most neighbourhoods do not have one of these shops (Figure 1). This can be explained by the fact that proximity may be less crucial in using these shops (for instance, one may call a company to rent party equipment, including furniture and silverware, and this company will bring the equipment using their own vehicle). In contrast, few neighbourhoods do not have any repair shop. This suggests that most households in the city live in proximity to a shop that may repair their mobile phone, blender or bike.

Circular economy practices in the informal economy and other shops

In addition to those shops registered in the census and presented in the previous

Table 1. Number of shops that compose the popular circular economy.

Type of circular economy	Activity	Number of units
Reduce	**Reduce total**	**772**
	Appliances and electronics renting service	8
	Clothes renting service	109
	Other renting services	97
	Party equipment renting services	558
Reuse	**Reuse (second-hand shops) total**	**1,521**
Repair/refurbish	Repair/refurbish total	23,715
	Appliances repair	1,123
	Bike repair	690
	Car repair	13,855
	Electronics repair	2,590
	Furniture repair	773
	Motorcycle repair	926
	Other repairs[a]	2,481
	Shoe repair	1277
Recycle	**Recycle total**	**1,245**
	Glass recycling	33
	Metals recycling	552
	Other/mixed recycling	104
	Paper and cardboard recycling	291
	Plastics recycling	265
Total		**27,253**

[a]'Other repairs' include clothes, watches, knives and glasses, among other things.

paragraphs, other practices occur within the popular economy that also compose the city's circular economy. We present two vignettes that act as examples of a broader diversity of practices.

Vignette 1. Reduce and reuse: Food waste prevention practices in public markets. Mexico City's 329 public markets are emblematic of the city's popular economy (Figure 2(a)). Built in the 1960s and 1970s to ensure access to affordable everyday goods for the city's residents, they are filled with family shops selling food and other basic goods. They are a space of daily encounters for workers and local residents, and as such they have become symbols of local identities (Giglia, 2018). Nowadays, they receive 17% of the city's households' food budget, more than what is spent in supermarkets (Bracamontes Nájera and Guibrunet, n.d.).

Although not traditionally considered as circular economy workers, food sellers in public markets appear, through our interviews, to reduce the city's food waste. Food waste is common in the markets, mostly of fresh produce (fruits and vegetables) due to recent heat waves (fridges being uncommon in markets). In parallel, many shop owners find it difficult to buy the right number of products that will sell before they go off – this excess inventory is identified as another common cause of food waste.

When confronted with food products that are about to go off and have not yet sold, shop owners employ a range of strategies to avoid food waste. First, they may provide a discount for such products. They may also freeze the products or cook them to then sell as prepared food. For instance, it is common for fruit sellers to make fruit salads out of ripened fruit so that it may sell more quickly.

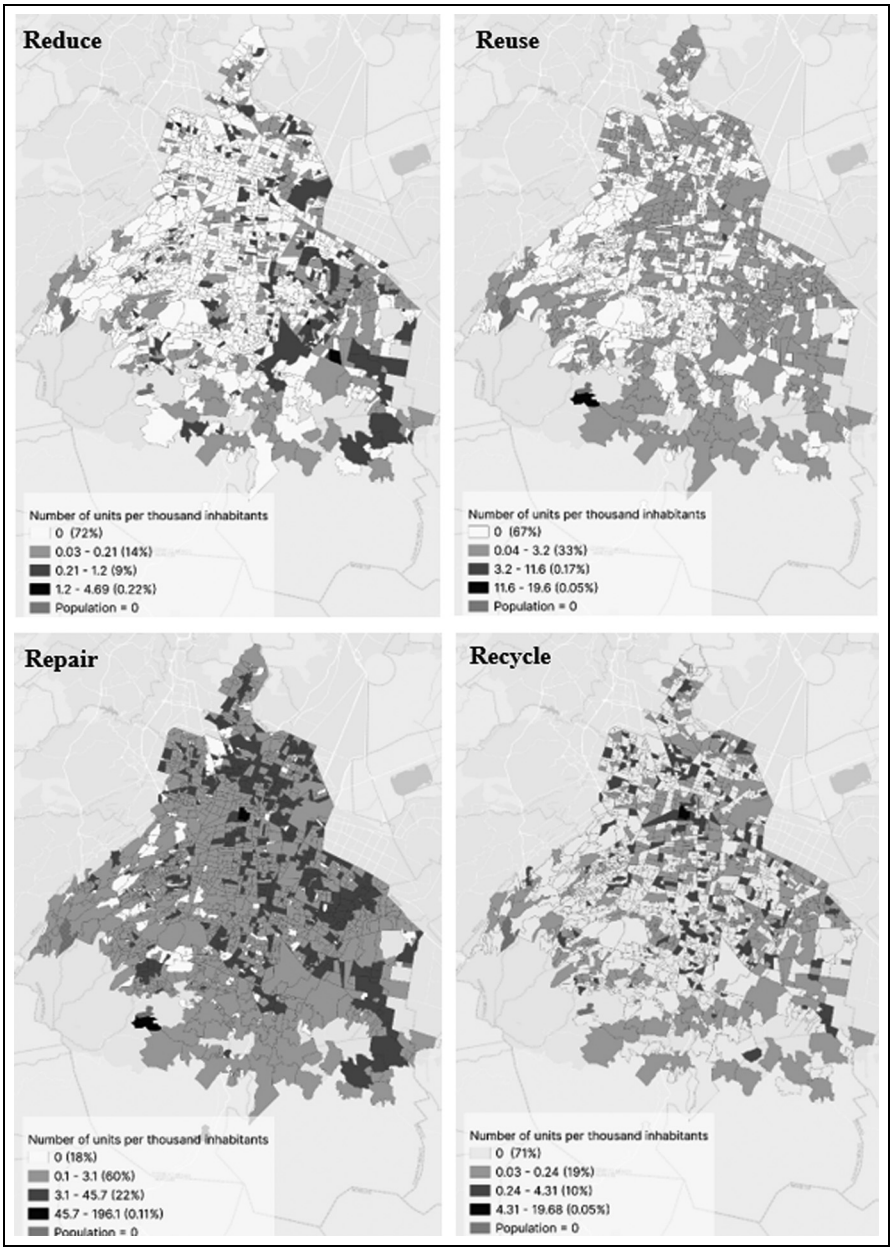

Figure 1. Spatial distribution of the popular circular economy in Mexico City.
Source: Authors' elaboration with data from INEGI (2020, 2024a).

Butchers also produce patties for burgers out of the meat that has not sold. At times, the food is also offered at a discounted price to the markets' cafeterias and restaurants for them to use in their daily menu. Shop owners also often bring their products home to share

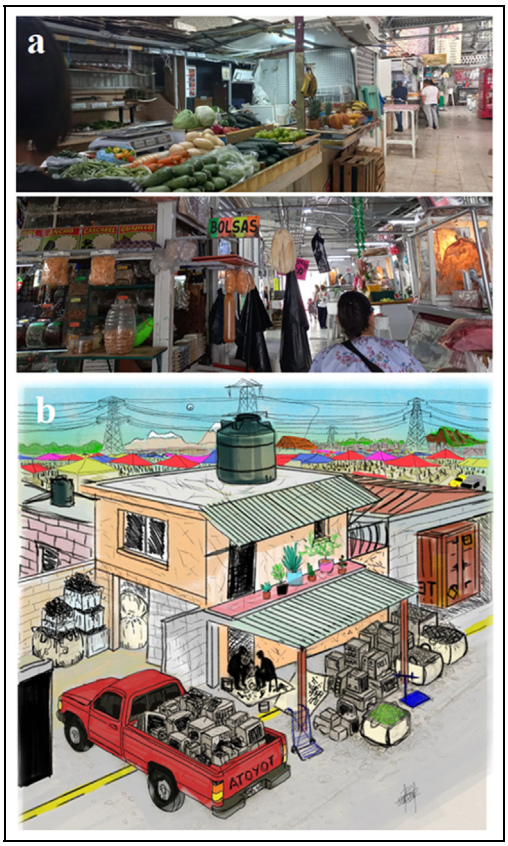

Figure 2. A public market (a) and a home-based recycling workshop in Renovación (b).
Picture credits: Clara P Orozco Pérez (a) and Emilio Bunge González (b).

with their families and give away products to regular customers: 'I try not to waste food because it costs me, so if it doesn't sell, I take it home to eat it. If not, I also give it to my customers.' Some interviewees also reported giving away the products 'to those who most need it' (rather than to their own customers): 'you try to help people and you simply give it away'. Finally, food is also given away to customers or passerby who own animals (mainly chickens) to be used as feed. Some butchers also report selling remains to intermediaries who work in the agroindustry to be used in gelatine and pet food production: 'actually, the term "waste" is not real here, because we have a client who buys this waste and uses it. I mean, all the chicken and its parts, the fat, the skin, everything is used'.

Most shop owners report using at least one of these strategies. Yet, their motivations vary. Some of these practices (for instance, selling food at a discounted price) make economic sense and are common across any types of food shops, including supermarkets or other chain stores. Others, however, are less often encountered in food shops but were common in the market. For instance, many shop owners reported preferring to have little stock to explicitly avoid food waste, even if that implies a reduction in overall sales. Bringing food home is also a common practice in the market, which is uncommon or even prohibited in larger chain stores. Finally, shop owners commonly give food away, either to customers or to passerby in need. Market workers have often worked for many years in the same market and know not only the local residents but also their economic conditions, particular food needs (for instance, if they own animals) or temporary hardships.

These practices, which emerge in food markets but are uncommon in supermarkets, are the result of the markets' physical, social and historical specificities. The dense networks of small shops (sometimes over 100 of them) that compose a public market foster a sense of solidarity across shop owners and workers – who often have to collaborate to solve local issues. Having a diversity of shop types also increases the probability that one's waste (for instance, fruit that is about to go off) can be used in another shop (for instance, a restaurant that will make fruit juice to accompany lunch). The fact that most workers are also the owners of their businesses gives them relatively more freedom to dispose of the food in diverse ways (such as bringing food home or giving it away) that are typically forbidden in chain

stores. The reduction of food waste that is achieved through these local social connections and diffuse practices, invisible in food waste databases, forms part of a popular circular economy that depends on local social cohesion, a diversity of economic activities and a custom of making efficient use of resources which is common in family shops.

Vignette 2. Repair, refurbish, remanufacture, recycle: e-waste recycling in the Renovaciœn neighbourhood. Originally built on the outskirts of a landfill which closed in the 1980s, the Renovación neighbourhood (in the municipality of Iztapalapa) has been transformed by three generations of waste workers into a cluster for the reuse, repair, refurbishment and recycling of all kinds of electronic appliances, including mobile phones and computers (Figure 2(b)). The home-based disassembly of e-waste has seen a notable increase in the last 15 years, dominating the daily landscape and the mediatic representation of the zone. Today, the neighbourhood holds a firm position within the city, national and international trade of e-waste, exporting tens of tonnes of printed circuit boards to the USA and China every year (Smith and Cota, 2016). It is one of various clusters of informal recycling throughout the city.

Bordering the neighbourhood, a permanent street market called *Tianguis de Las Torres* specialises in the sale of discarded goods. Home-based recyclers from the Renovación neighbourhood supply the market with e-waste from across city. The e-waste is sold according to the waste hierarchy, allowing its remaining value to be captured by a variety of buyers, either as a second-hand item or as pieces for repair or refurbishment, before being auctioned or dismantled to recycle its materials (mostly copper and printed circuit boards). At least once a week, recyclers first attempt to sell the items at a higher price than that of their metals alone, hoping to make some extra income. These goods are typically sold under the ambiguous and all-inclusive label of 'cháchara', implying a limited awareness of their quality and functionality, as many sellers don't bother testing the devices. As a result, haggling is common. Buyers face the risk of purchasing non-functioning items, but they may also score significant bargains. As a reseller explains:

> I once got a DVD screen […] for 30 pesos. I'm selling it on Facebook for 1500. That's the game – you lose some, win some. There's stuff here you'd never expect to work – and then when you check … 'Whoa! No way, it works'.

If items remain unsold after two days, they are either auctioned off or broken down for materials, depending on their metal content and the seller's available storage space. 'Things that we don't sell get recycled – we break them down. Like computer parts, hard drives, anything that doesn't go. It all gets dismantled', a seller states.

Once in the market, e-waste enters an ecosystem of second-hand consumers, resellers, repairers and refurbishers. There are two types of resellers. Generalists resell auctioned lots of unsorted goods, with any leftovers either re-auctioned or set aside for dismantling. Specialists seek bargains on specific items like car radios or screens, which they later sell at a higher price after testing and reclassifying them as functional.

On the customer side, repairers not only hunt for cheap spare parts among the discarded items, always with a multimeter in hand, but also offer repair services right in the market. Many are also refurbishers, combining working components from various broken devices, such as mobile phones or LED screens, to create functioning products for sale. Final consumers browse for reusable hardware like phone chargers, speakers, hairdryers or electric fans, as well as second-hand phones and affordable repair services.

A particular subset of these shoppers are collectors, who search for rare and vintage items like old video game consoles.

Interviewees mentioned a variety of motivations to engage in such work. Domestic recyclers seek a complementary income, while resellers and refurbishers see it as a way of making a living among bargain opportunities: 'you get money out of everything, whatever you don't sell, [you can disassemble and] sell the printed circuit board'. Repairers and refurbishers are moved by lowering supply costs and enhancing their profit margins; 'that's the difference', a screen repairer explains: 'parts are more expensive at the original stores; this piece [the LEDs he is extracting from a screen] costs over a 1000 pesos there but here we get it for 200'. Customers are driven by necessity and the opportunity to save money, as well as by recreation, thrill and speculation on the future value of an object.

Despite its successes in recovering metals and other pieces from electronics that can be reused or repurposed, and repairing others to give them a new life, the market has adverse environmental impacts, such as the improper disposal of toxic waste. Yet, compliance with Mexico City's environmental norms for waste traders and recyclers is impossible for most of the neighbourhoods' workers. The administrative and economic costs of registering as a company and paying tax, as well as complying with health and safety standards, are major hinderances for workers to formalising their activity. As such, they are escaping the traditional policy realm, including that of the circular economy.

Discussion

A popular circular economy already exists in Mexico City

A popular circular economy is thriving in Mexico City. Over 27,000 shops enable the reuse, repair, refurbishment and recycling of everyday household objects. In addition, many other informal workers and practices contribute to the circular economy, as the cases of the e-waste informal market and of the public markets illustrate. The efficient use of materials and the ability to repair and refurbish have already been identified as characteristic of subsistence activities in other contexts (Brown and McGranahan, 2016); it is therefore not surprising that Mexico City's popular economy adopts circularity principles. However, these activities cannot be explained fully through the lens of economic rationality. In the public markets, the strategies employed by workers to avoid food waste do not always result in an economic benefit. Rather, they are also motivated by workers' sense of care, particularly towards other workers and local residents. Indeed, a sense of care towards others and the environment, as well as affective relationships, have been found to be strong determinants of circular practices in different contexts (Morrow and Davies, 2022; Tölg and Fuentes, 2024). Mexico City's circular economy programme, which favours educational campaigns to foster the circular economy, may thus be inefficient as it fails to acknowledge and foster citizens' and workers' existing motivations to contribute to a circular economy.

Spatial planning can help foster the popular circular economy

Spatial planning has enabled Mexico City's popular circular economy in two main ways.

Firstly, one challenge that is noted in the international literature for the implementation of circular economy activities in urban areas is their low economic value in comparison with other activities (Williams, 2019). In contrast, in Mexico City, these activities are widespread and distributed throughout the city (with the exception of upper-income

residential areas). They operate within the popular economy and without government support, meaning that they are economically viable, unlike what is generally suggested in the circular economy literature (Bono et al., 2024). This suggests that Mexico City's land-use planning which has favoured mixed-use neighbourhoods, combined with a tacit tolerance of informal economic activities that are undertaken both in residential buildings and public space, are enabling factors for the circular economy to develop. In contrast, new neighbourhoods in peri-urban areas tend to be designed as single-use, residential spaces, where small family shops are inexistent and dependence on large commercial centres becomes the norm (Capron and Esquivel-Hernández, 2016; Janoschka, 2005) – our research shows that such developments impede the implementation of low-value activities such as repair shops in new neighbourhoods. Indeed, popular economies depend on the planning of mixed-use neighbourhoods to thrive (Nohn, 2011), whether through the inclusion of commercial units in residential neighbourhoods or the tolerance for home-based work (Lall et al., 2025). The case of Renovación's informal market, which has developed as a specialised cluster of e-waste repair and refurbishment, holds another lesson for spatial planning. It shows that the skills needed to make a more efficient use of electronics do not depend on large-scale investments or the creation of eco-industrial parks. Indeed, they have developed in public space, through generations of waste pickers learning and teaching each other. Rather, the role of spatial planners, in this case, is to provide adequate infrastructure to avoid the adverse environmental impacts that these activities currently produce (mostly, the uncontrolled disposal of non-recyclable and toxic waste). This can be done by designing flexible and multi-purpose public space (Dias, 2016).

Secondly, successful examples of circular economy networks depend on the existence of social capital (including shared values, trust and solidarity) among local actors (Doménech and Davies, 2011; Mies and Gold, 2021). Local cohesion and a sense of place can also foster practices of care towards others and the environment (Mattern, 2018). Spatial planning has a key role to play in this regard: feelings of care are more easily materialised into practices of care if the built environment provides the resources, space and infrastructure to care for others; this can be done, for instance, by building community centres, allowing for the collective use of abandoned spaces or designing inclusive public space (Morrow and Parker, 2020; Power and Williams, 2020). In the case of Mexico City's markets, it is because market workers know the local residents and their specific needs that they have multiple outlets to give away food that is about to be wasted and to ensure its most optimum use. These social ties depend on historic spatial planning decisions to incorporate public markets in the centre of each of the city's neighbourhoods, which are composed of small units that are adequate for family shops. The mix of uses that is present in the market also ensures its success with local residents (and therefore its low turnover of shop owners) and that one's waste can easily be imagined as another's resource. Recent planning decisions in Mexico City, however, have favoured the regeneration and vertical densification of its neighbourhoods, which have led to a gentrification process where popular shops are gradually replaced by international chain stores (Aguayo-Ayala, 2016; Aquino-Illescas and Aguilar-Martínez, 2022). Whether these trends are displacing shops engaged in the popular circular economy remains to be seen. However, it has already been established that these planning decisions have led

to the gradual loss of local social cohesion through the abrupt displacement of local residents and economic activities (Delgadillo, 2016).

Conclusion

The everyday practices of ordinary people are rarely taken seriously in sustainability studies (Jehlička et al., 2023). Experts have notoriously failed to understand the contributions to an efficient use of resources, and to the conservation of nature, that citizens *already make*, without being prompted to do so by educational campaigns or economic incentives (Martinez-Alier, 2002). This has led to a focus on sustainability solutions that depend on technological innovation and obscure or displace the practices of ordinary citizens that already contribute to a sustainable use of materials (Hagbert et al., 2020). This is especially common in the waste management sector, where informal repair and reuse economies are being sidelined by the implementation of rigid and capital-intensive recycling schemes (Davis and Garb, 2019; Reddy, 2015; Tong et al., 2015). In the Global South, this phenomenon is aggravated by the common dependence on expertise and investments from the Global North, which are often driven by motivations of economic gain, a situation which can resemble neocolonialism disguised as sustainability (Dunlap and Arce, 2022; Shapiro-Garza, 2013). Building theory from the Global South can be a way to shed light on existing practices and paradigms such as the capacity to repair (Bhan, 2019), and to better value their contribution to the circular economy.

The case of Mexico City is paradigmatic of this phenomenon. The city's popular economy is already making an efficient use of resources through diverse practices to reuse, repair and recycle food and household goods. These activities are both undertaken as an economically viable livelihood, and as a practice of care. Ironically, these activities are put at risk by the government itself, in two main ways. Firstly, the city's prohibitive posture towards informal street vending, materialised in the design of exclusive public spaces (Hayden, 2021; Martínez, 2016), may disrupt existing clusters of circularity and local cohesion. Secondly, the circular economy programme may displace existing circularity practices. For instance, the programme proposes to extract food that is about to be wasted in markets to send it either to subsidised cafeterias or, if it is no longer edible, to be used as animal feed in the city's zoos. Yet, as seen in our research, most of such food in markets is not currently thrown away, as it is eaten by local workers and neighbours in need. The city's strategy would therefore displace an already functioning practice that not only reduces food waste but also contributes to local social cohesion and food security.

Our research suggests that city governments can accompany and enhance the existing popular circular economy using spatial planning tools. Ensuring that all neighbourhoods have affordable housing and a mix of land uses, including commercial units that can host microbusinesses, can provide the necessary space for repair-and-reuse shops to settle. Secondly, avoiding disrupting local social cohesion, for instance when authorising the building of large-scale housing or commercial centres devoid of public space, is another important, even though diffuse, role of spatial planners.

Designing public policies that foster the circular economy requires knowing how the circular economy *actually* works in any local context. In the case of Mexico City, it takes the form of a popular circular economy that is diverse in its activities and its levels of formalisation. Documenting these practices is an important task for researchers to provide insights to policy makers, and in particular spatial planners, to achieve an ever-growing (popular) circular economy in cities.

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Ethical considerations

Ethics approval is not required at the National Autonomous University of Mexico (where this research was conducted). An ethical protocol was designed for the empirical research, in accordance with our university's guidelines.

Consent to participate

The protocol ensured the free, prior and informed consent of individuals to take part in the study. The purpose and process of the research was explained to potential participants and verbal consent was gained to conduct and record the interviews.

Authors' contributions

LG designed the research project and its methodology and supervised the fieldwork. MHMR collected, systematised and analysed census data and produced the associated graphs and maps. EBG conducted fieldwork in the e-waste informal market. CPOP, VARV and DTP conducted fieldwork on food waste in public markets. VARV also analysed the city's Circular Economy Programme. All authors contributed equally to writing the manuscript.

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Data availability statement

The interview data will not be made available to respect participants' anonymity. The census database can be made available upon request to the corresponding author.

Supplemental material

Supplemental material for this article is available online.

Notes

1. In this article we refer to Mexico City without including its metropolitan area, which boasts a population of over 21 million.
2. To determine the spatial demarcation of the city's neighbourhoods, we used the city's 'colonias' (Mexico City Government, 2023). Each neighbourhood has an average of 50 hectares (the smallest being 0.1 ha and the largest 1186 ha) and 5986 inhabitants (between 0 and 36,159).

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