

*Original Research*

# How Waste Sorting Has Been Implemented in Urban Villages in China. A Co-Production Theory Perspective

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## Abstract

Waste sorting in urban villages is a less developed while important issue in waste management and it is of great importance to environmental sustainability. China is now facing challenges of combating waste sorting while little attention has been paid to these challenges in urban villages. This article aims to add to this knowledge by examining how waste sorting has been implemented in urban villages via a case study of Shenzhen, China. A co-production theory perspective is adopted to explore how actors are engaged in the process of waste sorting and what are the results. The findings suggest coproduction approach is neither a top-down nor bottom-up approach. It is a much more complex process that involves intensive interactions between the government and residents. It concludes that the co-production approach to waste sorting exemplified by urban villages' sustainable development has great significance for general environmental management and policy making in the long term.

**Keywords:** waste sorting, sustainable development, urban villages, co-production

## Introduction

Waste management has always been an important policy agenda of sustainable development around the world. Growing populations alongside urbanization, economic development and increased consumption are accelerating waste generation at concerning pace [1]. Each year, the world generates more than 2 billion tonnes of municipal solid waste. According to the World Bank [2], China has become the world's largest waste producer since 2004. In recent years, the Chinese

government has made great policy efforts in addressing waste sorting problems. In 2020, China declared to increase the integral reuse rate of bulk solid waste to 60 percent by 2025. In particular, there has been a growing concern among the public regarding the potential consequences of waste, hence the need to recycle and reuse the waste has been evident in many metropolises of China [3]. However, it is still in its initial stage and developed unevenly across different regions of China. Given the reality, it is of critical importance to tackle waste problems in order to advance environmental sustainability, inclusive cities and public governance. Therefore, urgent attention should be paid to waste handling and its management [4, 5], both globally and locally.

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Waste sorting as part of environmental management has long been perceived as government-led activities. However, in reality, public services like environmental services could be provided more efficiently through a co-producing approach with the involvement of service recipients [6]. Currently, most studies of waste management are centered on Western countries. In China, most scholarly attention has been paid to large cities such as Shanghai, Beijing etc. Research on this topic is less published related to developing countries and informal settlements, particularly waste management in a complex and hard-to-manage environment. For one thing, it is only recently that piloting compulsory waste sorting is implemented in some urban villages in China. For another thing, urban villages in China are perceived as a closed area where access to these villages can be difficult on certain occasions. Given these considerations, this article is devoted to adding to this knowledge by examining how waste sorting has been implemented in urban villages.

This article attends to exploring how waste sorting has been implemented in urban villages and its potential impact on waste management and environmental sustainability. In order to answer the research question, detailed questions are posed: who are the actors engaged in waste sorting activities and how are they involved in a co-production process of addressing waste sorting problems? The main theoretical argument is that co-production in waste sorting is found to be characterized as a mix of hierarchical and governance arrangements. Further, findings suggest that waste sorting in urban villages has been implemented under conditions generated by a combination of both administrative legacies and innovative practices.

Thus, this paper expected to contribute to the existing literature on environmental management and community governance in three aspects. First, although waste sorting has gained increasing academic attention, few studies have examined waste sorting practices in an informal settlement context. Furthermore, most studies have focused on developed countries while scant research has examined waste sorting in developing countries. Second, existing research have extensively investigated waste sorting from a technical perspective while few studies have examined the mechanism of waste management from a mecro-level perspective. Thus, our study aims to supplement existing research by employing co-production theory, a new theoretical perspective to deeply explore how waste sorting has been implemented in informal settlement. Third, a new model has been articulated to understand the process of waste management.

To answer the research questions, we first analyze the complexity of Chinese urban villages. Next the actors involved in waste sorting are identified and then we explore the mechanism of waste sorting from a co-production perspective through a case study of urban villages in Shenzhen China. The remainder of this article is organized as follows. First, a thorough description

of the context of Chinese urban villages is provided. It outlines the historic and institutional environment of urban villages. The urban/rural circumstance is explained to understand why co-production is adopted as a policy tool in waste management. The next section presents the qualitative study design alongside an introduction of the case under study and its social and economic conditions, followed by an in-depth analysis of waste sorting in urban villages. In conclusion, policy implications are discussed.

## Literature Review and Analytical Framework

### Waste Sorting in Urban Villages

China's rapid urbanization has resulted in urban villages. Along with the urbanization process and land acquisition, some rural villages that used to locate at the urban fringe are now incorporated into urban areas. Although rural villages are geographically within urban administrative boundaries, their rural status means that the construction of buildings can easily bypass urban planning and construction codes [7, 8]. Because it's convenient location and cheap rental price, urban villages have attracted a large number of migrant workers to settle down.

In this study, the term "urban villages" refers to rural villages commonly found within Chinese cities that have been granted urban administrative status during urbanization but have maintained their village-based collective economic organization [9]. Urban villages represent a unique form of community in Chinese society. They differ from urban gated communities and administrative villages in terms of the hukou system, governance structures, land resource management, and public service delivery [10]. Because of China's long-standing urban-rural divide, public goods and services in rural villages had to be self-financed and self-sufficient [11]. Despite recent efforts to integrate these urban villages into urban areas through institutional transformation, provision of public services such as infrastructure, sanitation, and social welfare remains dependent on the community shareholding company (i.e., the former village collective). The integration of these villages into urban areas has not solved the problem of urban-rural disparities or the resulting lack of adequate public services. Therefore, examining waste sorting in urban villages should acknowledge the urban/rural structure and the related circumstances.

Compared with the urban gated communities, due to its unique governance structure, population structure, spatial layout, and infrastructure and public facilities, urban villages face great difficulties in waste sorting, such as lack of supervision, the shortage of funds etc. Thus, they represent a unique and clear divergence from the regular approach to public service delivery in urban communities, which helps build the empirical basis for our case study. It contributes to the theoretical debate

surrounding the implications of waste management and policy making in the complex governance context of urban villages.

### Co-Production in Waste Sorting: a Renewed Perspective

The term “co-production”, which emerged in the 1970s, refers to urban services provided and supported by individuals belonging to more than one organization [12]. For example, public organizations were viewed as lacking the capacity to solve new problems, which resulted in reduced citizen participation [13-15]. This idea meant a shift in the focus from organizational forms to collaborative arrangements for governance [16]. It can be seen as a new governance tool that embraces both professionals and people who use services. Although the definition of co-production varies, the central theme is the improvement of public services through the active engagement of both government and citizens in individual and collective forms. For instance, the experience of dining in a restaurant is influenced by a number of factors, such as food quality, surroundings, and service attitude. Thus, the outcome is not always tangible and cannot be captured by a single determinant. Since co-production can occur in a wide range of activities, in this article, we use the definition from Nabatchi, Sancino, and Sicilia [17], which defines co-production from a broad perspective: it can occur in any phase of the public service cycle when state actors and lay actors work together to produce benefits. To address complex governance issues, it is equally necessary to consider the context in which problems occur. This links to our research questions, surrounding the role that actors play in waste sorting, and how the co-production approach is implemented in such context.

Although co-production in waste management is receiving an increased attention [18], less is known about how co-production actually works in real life waste management. According to prior research, co-production takes place between actors engaged in the process of public service provision based on direct interaction. In particular, it occurs when actors directly interact with each other in a mutually beneficial manner. Thus, a co-production approach could be applied in understanding waste management and explain how public organizations engage residents in waste sorting. Based on existing literature, co-production has the potential to generate positive outcomes in terms of efficiency, citizen satisfaction, effectiveness etc. [19, 20]. The upsurge of application of co-production in public services has further suggested that capacities of residents can potentially improve the outcomes of public services, in which the role of individuals is altering significantly. In waste management, co-production has the potential to provide a pathway that connects the government and residents through joint efforts. Through co-produced arrangements, it can be arguably indicated that substantial contribution could be made to improve

the life outcomes of residents. Given few studies have provided solid evidence in this regard, a more in-depth exploration is required.

The potential benefits of co-production are associated with producing more quality services at lower costs [21]. This is critical for waste management because the government is aspiring to address waste problems and hence to improve the overall environment. Under a co-production approach, waste management can be perceived as a joint process in which different actors could potentially shape the outcome of waste sorting. Unlike regular service delivery [22], waste sorting requires the cooperation of all involved actors and it is highly dependent on their attitude and behavior which could fundamentally influence the result. Given the above considerations, this article is centralized in understanding how waste sorting has been implemented in urban villages by applying a co-production approach. Based on a review of literature, we propose that co-production in urban villages embraces distinct features involving both administrative traditions and service innovation elements.

### Analytical Framework

According to co-production theory, efforts contributed by more than one actor are likely to produce positive outcomes in public service delivery. More recently, co-production has been employed in service areas including education, childcare, healthcare [23, 24]. As practices have witnessed greater involvement of service users and communities, it is necessary to find out how co-production has been implemented and what are the results/outcomes of it. The analytical framework of this study is articulated based on the above explained theory of co-production. The focus has been on the process of waste management in informal settlements. Co-production requires inputs from each actor, which has been pointed out by existing research [25, 26]. It is assumed that actors, inputs/resources and the process are critical factors that impact the outcome of waste sorting. Despite existing discussion on the potential benefits of co-production, it is crucial to further explore the mechanism of waste management in a particular context. Fig. 1 presents the analytical framework of this study.

Based on the analytical framework, coproduction is theoretically understood from three main dimensions: actors, inputs/resources and process. Actors refer to those who are involved in the process of waste sorting and their respective roles in this process. Inputs/resources can be assets, human resources, skills and financial resources which are put into coproduction.

According to coproduction theory, the process is critical if outcomes are to be examined. In this study, the process of waste sorting is primarily interpreted as the mechanism of coproduction. In other words, how coproduction works in real life. Coproduction involves intense interaction between professionals and citizens.

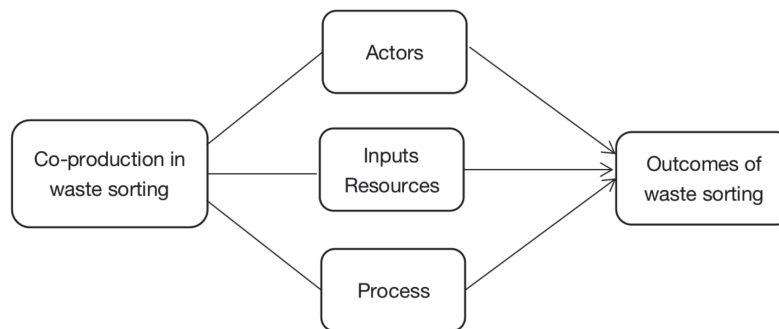


Fig. 1. The analytical framework.

Coproduction of waste sorting is influenced by four critical factors and strategies: knowledge transfer, commitment, facilities, and supervision. Coproduction of waste sorting requires professional environmental protection knowledge. A knowledge transfer occurs when a member of a network is influenced by the experience and skills of another [27]. Commitment strategies include verbal commitment or the signature of an individual or collective behavioral contract, in waste sorting in order to obtain long term behavioral changes [28]. The availability of waste sorting facilities and convenient waste management services is likely to encourage residents to sort their waste [29]. Lastly, supervision is increasingly used in developing countries to provide guidance and monitor residents' behavior while sorting waste [30].

Apart from the process, it is essential to investigate the outcomes of waste sorting. In this regard, outcome information is important as it indicates whether or not coproduction of waste sorting is achieving the desired outcomes for society. Often, the outcomes of waste sorting can be viewed as a result of quality and citizens' satisfaction. In this study, the term "life advancement" is used to refer to coproduction as a means of improving quality of life [31]. The satisfaction of citizens with this process is essential for encouraging them to continue sorting waste [32]. An increase in citizen satisfaction can result in more efficient waste management. In addition, a green lifestyle involves eco-friendly consumption and habits. This refers to a way of living that involves considering the adverse effects on the environment of one's daily activities and of the meaningful narrative that guides that consideration [33]. Moreover, the purpose of promoting waste sorting at the community level is to protect the environment in a sustainable manner. In the long term, efficient waste sorting is expected to result in significant environmental improvements.

## Method and Data

### Case Study

The qualitative research design facilitates an in-depth investigation of the research topic [34]. In this

study, we use a single case design, which is commonly used for testing, building, or applying theories. An advantage of analyzing one case is that it can verify, challenge, or extend existing theories by investigating propositions or uncovering other possible relationships between concepts. Using the single case design can also enable researchers to gain a deeper understanding of the phenomenon by collecting data from multiple sources and understanding the context in which it occurred. Despite these, the single case method has one limitation: its results are difficult to generalize to a large sample size [35].

Shenzhen is chosen for the research for three reasons. First, the city is one of the first batches of national waste sorting pilots and have accumulated rich experiences in implementing waste sorting policies. Second, the city is built on rural villages that now constitute the rural/urban fringe, there are various urban villages scattering around the city that accommodate more than half of the total population [36]. Third, as Shenzhen is in China's first Special Economic Zone, the city administrators are granted considerable autonomy and have played a leading role in national institutional innovation. Therefore, the city of Shenzhen is a suitable location for an in-depth and exploratory study.

The empirical case is waste sorting in Xinwei village, a typical urban village in Shenzhen. The case has been chosen for two reasons: first, Xinwei village has been chosen as a pilot village for waste sorting. Second, the practice in Xinwei village has generated positive outcomes, which made it suitable to investigate the puzzle of how urban villages effectively address waste problems in complex governance environment. Based on these considerations, we are able to answer the research question.

### Data Collection and Analysis

The data were collected from three main sources: interviews, documents, and participant observations. The fieldwork was conducted between 2019 and 2021. Follow-up field visits were conducted in 2022 and 2023 in order to trace the progress of waste sorting in Xinwei village with the purpose of obtaining a comprehensive picture of this practice. With the urban villages operating

as closed systems, it is challenging for outsiders to acquire all the relevant data. To ensure the credibility of the data collected, interviews, documents, and participant observations were triangulated. The authors observed the waste sorting behavior of residents in the centralized waste collection point. Documents provide a contextual understanding to guide the interviews and interpret the interview responses [37]. These documents mainly refer to village chronicles that are preserved by the village committee. The participant observations can help establish the empirical base of waste sorting in urban villages. By combining the two data sources, the interview data allows us to comprehend more thorough and detailed practices of waste management in the urban village. More specifically, documentary data contain published documents including operational plans, reports and internal documents. Copies of published regulations and policies are helpful for us to understand the waste management of urban villages. We also gathered agenda notes, meeting records, and other unpublished administrative documents to supplement our data sources.

We conducted 28 semi-structured interviews with community leaders, residents, volunteers, merchants, landlords and scholars (see Table 1). A snowball referral method was used to identify eligible interviewees. The interviews were in depth and ranged from 60 min to 90 min in length. Those interview questions were mainly concerned with the overall implementation of waste management in this village in terms of the policy background, perspectives of actors, initiatives carried out and prospects for further steps. In addition to interviews with involved actors, we also had discussions with some scholars who are experts in this field so that they can provide rich and in-depth knowledge regarding this matter. Utilizing multiple sources have enabled us to gain vivid experiences regarding the implementation of waste sorting.

In the subsequent data analysis, a coding system was designed to ensure credible interpretations of the empirical material [38]. A multistep process was used in data analysis to implement thematic coding procedures [39]. To begin with, open coding is performed by carefully reading each transcription and reviewing it. After the initial codes are generated, they are categorized under two broad categories: “processes”

and “outcomes”. Second, all codes are validated and reviewed through merging or cleaning. The last step is to define and name the validated themes under each stage. Each step of the process is essential to ensure the accuracy of the data analysis. Finally, we interpret the data to draw conclusions from the results.

### The Policy Context

In 2000, Shenzhen began to implement the domestic waste sorting, which is among the first batches of cities to pilot waste sorting in China. It is a government-initiated project and citizen participation has been scarce during the process of experimentation. In 2018, Shenzhen relaunched waste sorting practices and issued the Regulations of Shenzhen Special Economic Zone on Domestic Waste Sorting. A central theme of the Regulations is that all residents are required to participate in waste sorting and it also emphasizes the residents’ responsibilities and obligations.

The case conducted in this research is Xinwei village, a typical urban village chosen by the municipal government to experiment pilot waste sorting. When waste sorting was initiated in June 2019, the village had a registered population of 9985, 3995 households, and a land area of 88,000 square kilometers. Just like other urban villages, most of the residents are migrant renters. Due to a lack of a sense of belonging and ownership, these people pay little attention to the local environment and waste sorting [40]. Also, there were few regulations that proved effective, consequently the development and construction of the 175 private housing in Xinwei village was out of control and its physical environment turned to be highly densified and overcrowding. Locals call these houses ‘shaking-hand buildings’ or ‘kissing buildings’ because you can shake hands or kiss your neighbors in the next block through the windows [41]. Further, sanitation facilities, such as trash cans and garbage removal vehicle were in shortage. Thus, urban villages like these have always been criticized by academics and the media as “backward” and “dirty-messy-bad” places (zang-luan-cha) [42]. Inside urban villages, you can see that trash cans are everywhere in the alleys and are often piled up, which may not be cleaned in time. Different from gated communities, there are numerous shops, restaurants and wet markets inside

Table 1. Interview content.

Interviewees	No.	Role	Main questions asked
Community leaders	6	Coordinator, Supervisor	– the policy background of WM – the overall management of WM
Residents	15	Participant	– how much do you know about WM – why participated in WM
Scholars	7	Experts	– what is your take on WM in this village – what are the policy lessons

Abbreviations: WM = waste management

the village that generated large amount of kitchen waste [43]. Therefore, to motivate migrant tenants and small merchants to do waste separation is a tough challenge for the municipal government.

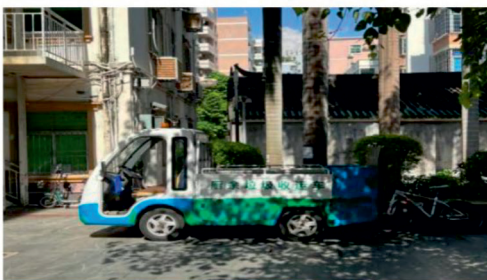
### Results

#### Actors and Inputs

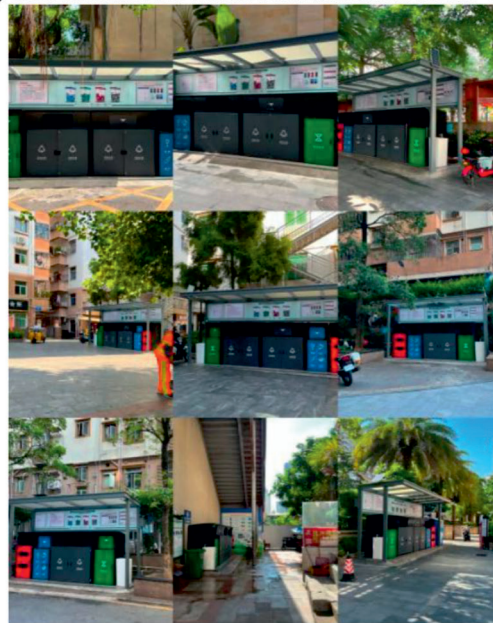
Waste sorting requires coproduced efforts of both government and citizens in different ways [44]. In the case of Xinwei village, waste sorting is carried out through joint efforts of residents, tenants, landlords,

merchants, community leaders, volunteers etc. Fig. 2 presents the initiatives of waste sorting in Xinwei village. In order to effectively implement this project, Xinwei village has devoted a variety of resources including funding, personnel, land, knowledge, facilities etc. According to recent statistics, all merchants are involved in kitchen waste sorting in this village and 70% of the residents participate in waste sorting [45]. Various actors, including residents, volunteers, community leaders, merchants, cleaners, etc., are involved in the waste sorting that formed a coproduction approach in Xinwei village. In general, actors play their own part in promoting waste sorting efforts during the process of coproduction. For example, residents are responsible

a) Kitchen waste collection vehicle



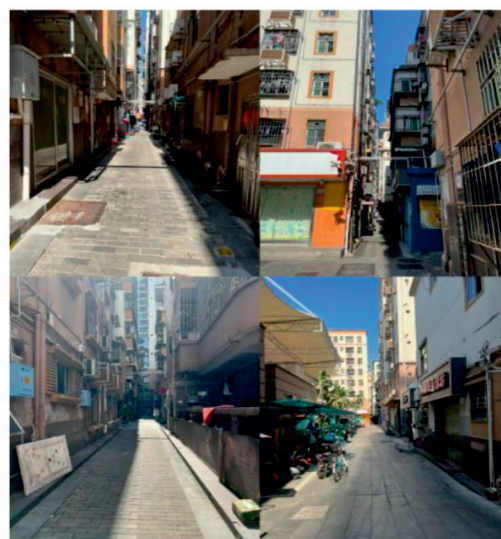
c) The centralized waste collection site in the village



b) The demonstration site of kitchen waste utilization



d) Instructions for waste sorting inside village



e) The overall environment after pilot waste sorting

Fig. 2. Initiatives of waste sorting in Xinwei Village.

for collecting their own waste and throwing them to designated places. Tenants, landlords and merchants are also involved in collecting the waste produced and in setting good examples of collaborating with residents in waste sorting. Community leaders are active participants of coproduction since they are responsible for explaining policies and guiding residents in terms of how to sort waste, where to throw waste and when. They are also actively involved in organizing community activities and in educating residents regarding waste sorting knowledge and skills. There are also volunteers who voluntarily participated in waste sorting and in helping community leaders with sorting-related activities.

Current studies have argued that waste sorting and management are not solely perceived as a technical problem, but a social issue involving proper environmental knowledge and individual behavioral change [46]. Apparently, doing waste sorting well is not an overnight task. This involves changing the environmental behavior and habits of residents [47]. Besides the trash facilitates, propaganda and education play a vital role in improving the pro-environment behavior of residents and gaining the professional knowledge of waste sorting and environmental protection. In urban villages, behavior change is even more challenging because many residents are less-educated and thus pay little attention to environmental protection. However, waste sorting is a project that requires residents' intrinsic motivation to participate in and to cooperate with other actors.

The Co-Production Process: Commitment, Physical Facilities, Knowledge Transfer and Supervision

When Xinwei Village first started to promote waste sorting, residents and merchants did not cooperate, as

expected. They would subconsciously compare their community themselves with other non-pilot ones which waste sorting was not a must, believing that separating waste was burdensome. In fact, urban villages can generate several types of waste. Among them, kitchen waste is one type that deserves special attention. Residents in urban villages generally do not cook as they work far away from the village and thus produce less kitchen waste. However, there are about 65 small restaurants and shops inside the village that present great challenges to waste management. If the kitchen waste is mixed with sundries, it will bring great damage to the waste disposal system. If merchants do not differentiate between kitchen waste and other garbage, then the kitchen waste mixed with sundries will not become fertilizer, and hence waste sorting becomes inevitably a critical task for the local government. Fig. 3 presents the mechanism of co-production in waste sorting.

Commitment

Since a large number of tenants in urban villages mobilize a lot, it proved to be an effective approach to training tenants to sort waste through their landlords. Landlords are urged to make use of the opportunity when tenants apply for video access cards to publicize waste sorting and require tenants to sign the commitment document to participate in waste sorting. In addition, merchants, such as supermarkets, restaurants, meat and vegetables stores, and fruit shops, which produce not only kitchen waste but also peel and vegetable waste in urban villages, signed a commitment letter to participate in waste sorting.

With regard to the technique of waste sorting, signing the commitment letter proved to be an effective way to promote a green lifestyle among residents.

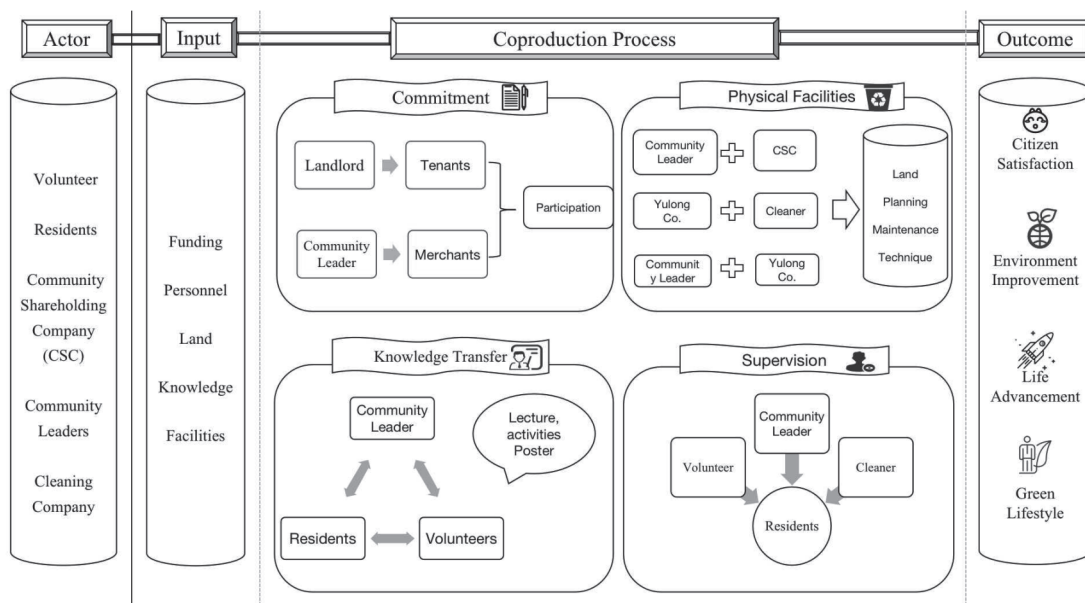


Fig. 3. The mechanism of co-production in waste sorting.

When signing the waste sorting commitment letter, the basic knowledge of garbage classification was popularized, which strengthened the awareness of environmental protection of residents and other involved actors in this village. Moreover, the community has also put-up posters on the waste sorting in each residential building in the village, together with guidelines of waste sorting put up at each centralized waste collection point. Community leaders are also engaged in learning the knowledge of waste sorting and then apply the knowledge learned to organizing community activities. The merchants are encouraged to participate in the professional training of waste sorting as well. Residents and merchants are also mobilized to jointly shoot a flash mob propaganda video on waste sorting in Xinwei village. In addition, slogans can be seen everywhere with a theme of advocating residents' green lifestyle and waste sorting. Thus, commitment of residents in waste sorting has strengthened and a supportive atmosphere is formed in the Xinwei village.

#### *Physical Facilities*

Waste sorting requires not only commitment, but also physical facilities to ensure the implementation of such project. At the beginning, the site of trash cans has caused conflicts and tension between residents and merchants. Also, the indiscriminate dumping of garbage has made the surroundings dirty and messy. No one wants trash cans near their homes. "We do not do garbage separation, garbage is just thrown away, flies fly everywhere, and cockroaches crawl all over the place in hot days", described by one resident in this village. In order to motivate the residents to engage in waste sorting, the top priority of community leaders is to co-create a pleasant and clean physical environment of sorting waste with other members of the community. Generally speaking, the selection of waste dumping location should be in a sheltered position to avoid the smell of waste blowing in the wind. It also needs to be placed in an open area to avoid crowding when residents gather to do dumping waste.

The village shareholding committee, the *de facto* owner of the village land, played an important role in site selection and the planning of new sanitation facilities. The community leaders then coordinated with Xinwei Industrial Co., Ltd. to vacate six parking lots and build centralized dumping points for garbage. Based on the habits and feedback of residents, the trash cans scattered in the village were removed, and they are now replaced with seventeen centralized waste sorting and collection points, one special garbage (used furniture/New Year flowers) collection point, two waste fabric recycling bins, and one kitchen waste recycling demonstration point. The distribution map of the waste collection points is also posted at the entrance of each building so that residents can quickly find it. With coproduced efforts, the cleaning companies and

cleaners work together to keep the facilities clean and tidy. Because there are many residents and restaurants in urban villages, the cleaning company ensures that the garbage can will be cleaned when it is nearly full in order to keep the environment clean. Each cleaner is responsible for managing two trash points. The job is to ensure that the collection points, the inner and outer walls of the trash can, the lid and the staving off the trash can are kept clean all the time. The rearranged centralized waste collection points and the maintenance of sanitation facilities have not only improved the overall environment of Xinwei village, but have also increased the willingness and motivation of residents to participate in waste sorting. For instance, a centralized waste sorting site was set up in an area where a large number of restaurants are located in the village. At first, these restaurant owners objected, fearing that the stench from the trash could affect their business. However, with joint efforts of the community, the surrounding owners and residents consciously put the kitchen waste into the kitchen waste bin.

"Although there is a dumping point just outside the door, the bins are cleaned many times a day and removed in time. There is almost no smell, so there is no concern about the trash cans and I can still operate my business as usual." (Interview with a fast-food restaurant owner)

#### *Knowledge Transfer*

Developing the commitment to waste sorting is the first step. To realize the commitment of involved actors, a variety of training and environmental education activities are initiated among residents. To encourage more households and merchants to engage in waste sorting, community leaders, volunteers, cleaning companies, village shareholding company and residents have established a co-production arrangement that promotes a wide range of services on waste sorting, including designing pamphlets and brochures, holding public lectures, training and education activities, and upgrading sanitation facilities. Considering that some residents in urban villages have a relatively low level of education, the community tries to make it easy and clear to understand when compiling guidelines of the sorting and separating of household waste and making indicators of the distribution of facilities for sorting household waste. Based upon the efforts of publicizing the general knowledge of waste sorting at the early stage, the community decided to further enhance the awareness of waste sorting of residents and hence sustain their waste sorting behavior. A role model strategy [48] is also adopted by the community to promote household waste sorting in Xinwei village. Some residents who actively participate in community activities have become activists in waste sorting through training. Then, it is expected that more residents would be influenced by their behavior through social networks and norms.



### *Supervision*

Since April 2020, Xinwei village has arranged a team of supervisors to supervise 17 collection points in the village every night from 7 p.m. to 9 p.m. The supervisor team consists of volunteers, university students from Shenzhen Polytechnic and students from Liuxiangdong Primary School. Every day, supervisors guide volunteers to help residents with garbage sorting on a regular basis, one hour in the morning and one hour in the evening. At other times, the cleaners will also conduct a secondary inspection of the residents' garbage. If some residents have trouble in waste sorting, the supervisor would help them to separate the waste. From April 2020 to October 2020, they have supervised a total of 165 days.

"At the beginning, we explained the requirements of waste sorting to the residents in detail, and we knock on doors to educate people about waste sorting, and let them know how to separate the waste. With the joint efforts of the community and volunteers, now the residents know how to separate waste." (Interview with a village supervisor)

### The Outcomes of Waste Sorting

Consequently, by processing, the waste can be used as a biological organic fertilizer like marine fishery supplements and this can maximize the extent of resource utilization. In this way, the recycled waste produces 150 kilograms of fertilizer every day. Based on our field visit in August 2022, we observe that Xinwei village is trying to use waste sorting as a long-term mechanism for environmental governance since the experimentation of waste sorting. During this revisit, it is found that the 17 waste sorting collection points were kept very clean and tidy (see Fig. 2). Garbage could hardly be found inside the village. Our interviews have shown that most residents are able to separate waste successfully in continuous waste sorting, even though some residents do not. Continuous practices have made the environment comfortable and clean. No smell, no noise.

### *Citizen Satisfaction*

Based on our field visit and interviews, a majority of residents expressed their satisfaction towards the result of waste sorting. The results have suggested that better designed initiatives are more likely to receive the support of involved actors especially residents living in the community. Furthermore, residents who are better informed are more likely to participate in environmentally friendly activities. Existing literature has discussed the importance of public participation in waste management [49] and our results support this argument. The practice of waste sorting in Xinwei village has the potential to generate some critical lessons for improving citizen satisfaction, an important path toward sustainable waste management.

"Of course I am very satisfied. The community has done a lot of work, such as print brochures and recruit volunteers. They also have a good working attitude when doing publicity and we are happy to cooperate with them." (Interview with a shopper)

### Environment Improvement

According to the data obtained from the interview, Xinwei village has achieved certain results through waste sorting. The garbage is no longer thrown at will, the villages and lanes are kept clean and tidy. Sorting the waste correctly is of great importance to the environment and climate. On the one hand, some waste can be recycled and reused, so as to greatly save the use of raw materials and energy. On the other hand, it can also reduce the amount of waste dumped in the landfill, thus extending the service life of the landfill and reducing the cost of treatment.

"I have lived here for nearly ten years; I can say that the environment of the village has been improved a lot. Before, garbage was everywhere and, in a mess, but now it is very clean and there is no bad smell." (Interview with a resident)

### *Life Advancement*

Waste sorting is not a one-off activity, rather a long-term project that will benefit both individuals and communities. From a resident point of view, the before and after reflection has been a case-in-point that waste sorting has improved the living conditions in the village. For one thing, one could hardly find any garbage on the road; for another thing, residents are gradually changing their behavior, which a big step toward healthy and sustainable living. The results have shown that residents become more aware of the consequences of waste pollution, thus have started thinking about the long-term impact of waste sorting.

"In the past, I didn't think so much about throwing garbage. Now through waste sorting, I have also learned some knowledge of waste disposal, and know that if the waste is not sorted, it will have a bad impact on the environment. Although our generation may not, it will affect future generations." (Interview with a tenant)

### *Green Lifestyle*

After the implementation of the waste separation practices, the residents involved in the study expressed that they will reduce unnecessary waste and seriously consider living a more environmentally friendly life. In doing so, they are determined to develop a sense of responsibility of protecting the environment, which will benefit not only themselves, but also the community as the whole by practicing green lifestyle. In the long term, the positive spillover effects of pro-environmental behaviors are expected to encourage residents to form subsequent pro-environmental behaviors, which will

undoubtedly contribute to the green and sustainable development of the whole society.

“In my family’s daily life, we have become more conscious of environmental protection after learning how to do it after learning waste sorting. When my kids buy stuff, they sometimes pay attention to which packaging is more eco-friendly.” (Interview with a resident with two children)

## Discussions

Encouraging citizens to participate in environmental governance is an important theoretical and practical issue. Without the cooperation and participation of citizens, it is difficult for the government and the market to provide effective and sustainable services to promote environmentally sustainable development [17]. The findings of this paper contributed to the theoretical discussions on coproduction and offer several policy implications for community environmental governance.

### Theoretical Discussions

By examining waste sorting practices in an urban village from a coproduction perspective, this paper extends the discussion of the concept of coproduction in an informal settlement context. Compared with formal communities, the environmental management and sustainable development in informal settlement settings are far more complex [7]. In urban villages, there are many actors involved in dualistic governance structure, so it is challenging to coordinate the responsibilities and actions of these subjects to provide public services in addressing community environmental issues. Additionally, the residents of the village in the city are primarily tenants, thus how to motivate this group with high mobility to participate in community waste sorting activity is another challenge. Most of the western literatures on coproduction are based on the voluntary role of citizens or citizen-led coproduction. This case highlights that co-production approach is neither a top-down nor bottom-up approach. Instead, we found that it is a much more complex process that involves intensive interactions between governments and residents. Concerning the unique circumstance of urban villages, there exists some historical administrative obstacles that could be overcome through co-production arrangements. During the establishment of waste sorting facilities and site evacuation, community shareholding company plays an irreplaceable role in coordinating and communicating with residents. Additionally, the newly established community committee has made great efforts in educating residents and businesses regarding the importance of waste sorting. From the perspective of environmental management, the analysis has indicated the necessity of bearing in mind the context that shapes co-production under the dualistic structure.

Thus, our findings contribute to a growing knowledge of theory development that co-production could also work in a broader context involving both administrative processes and innovation of environmental management. Furthermore, features of co-production in urban villages were manifested in the transition to urban life involving some critical changes in individual lifestyles and the building of sustainable community. These changes demonstrate the profound reestablishment of environmental management system in urban villages in China.

The implementation of waste sorting in urban villages has enabled actors to play a role in co-production of environmental management. The engagement of the community workstation, village shareholding company, volunteers, merchants and individual residents has created new space for sustainable development within urban administration in China. Our case study has also reflected the efforts and the capacity of involved actors to generate balancing strategies in implementing down-to-earth ideas to improve the environment. The co-production in waste sorting in urban villages thereby challenges traditional administrative structures, with market tools and shared opportunities being created to develop more broad-based and inclusive public policies. Therefore, the improvement of community environment occurred in broadening participation and implementing co-production with ideas that mainly targeted residents’ needs and requirements.

### Policy Implications

The policy implications of this article could shed light on the application of co-production in solving complex issues in environmental management. The Xinwei experimentation of waste sorting has the potential of helping local authorities understand the necessity of establishing joint efforts in waste management. Thus, it is critical for policy-makers and public managers to use their knowledge, skills, and judgment to design, activate, and implement co-production activities [50]. However, problems may also occur due to incompatible motives across different actors and competing values when working together. These problems could further pose challenges to environmental management, particularly when the governance mechanism does not effectively respond to those raised issues. To strengthen the sustainability of urban villages, it is critical to nurture the participation space in which affluent community residents are able to contribute. As the nationwide campaign continues [51], the Chinese government has put more efforts to solve serious environmental problems. This is an important lesson learned not only applicable to urban village management, but could also be transferable to environmental management in formal settlements. Thus, utilizing co-production may serve as an important tool for local authorities to address diverse perspectives to improve the environment of the community. To make this point a bit further,

the utilization of information during the process of co-production also plays an important role in influencing people's attitude to waste management [52]. Crucial lessons generated from the article also point towards better planning and designing waste sorting as an important dimension of environmental management and they are socially constructed within the complex and dynamic context of co-production for desirable service outcomes [53].

With the rapid development of urbanization, more and more local governments have implemented market-oriented tools to address waste problems [54]. The reasons are twofold. For one thing, the overall workload of waste sorting management has exceeded the bearing limit of some government departments. For another thing, waste sorting requires coproduced efforts of various actors. In other words, if citizens do not cooperate, it would be very difficult to implement waste sorting measures. Therefore, it is imperative for the local government to adopt the co-production approach to waste sorting management. Compared with government-dominated approach, the strategy of co-production has advantages including collaborative work, effective management and mutual understanding. In the process of co-production, the role of residents are not passive recipients of public services, instead, they are coproducers and supervisors of themselves. This approach can not only effectively supplement the role of the government in waste sorting management, but also enhance trust between residents and the government.

Main policy insights and suggestions generated from this study are:

- Implementing co-production arrangements in waste sorting has the advantage of engaging both the government and residents for the improvement of environment and urban governance. For example, in Xinwei, co-production between the government and citizens has recycled 4500 kg of kitchen waste, 130 kg of glass, 20 kg of cloth waste, 1500 kg of used furniture, 1.5 kg of lamps and 0.6 kg of batteries every day. Thus, it is necessary to further strengthen the co-production base in future policy making for waste management.
- Waste sorting requires the collaborative efforts of different parties. In Xinwei village, volunteers worked with the community shareholding company to help educate villagers on the importance of waste sorting, while the community shareholding company helped to allocate resources and work with the local government on policy implementation. A coproduced waste management system established by these parties can not only improve waste sorting effectiveness, but also motivate and inspire residents to contribute in a positive way.
- The adoption of co-production in waste sorting has enabled both the government and residents to make an effort at different stages of waste sorting. In this case, the government provides infrastructure and technical support, while residents participate

in sorting and transportation. This includes collecting and recycling waste, producing public goods and organizing resources for the betterment of the community. In other words, each party has a role to play which enables them to perform their duties.

- To further implement co-production for sustainable waste sorting, it is encouraged to strengthen the knowledge base of the public for the purpose of developing good waste sorting habits and promoting green lifestyle. For example, by increasing public awareness of the importance of waste sorting and providing educational materials about how to properly sort different types of waste, residents can be empowered to contribute to more sustainable waste sorting practices. In the meantime, it is worth noting that the co-production behaviors of residents are affected by various factors including government instruments, peer pressure, and policy incentives etc.

As argued by previous research, collaboration between individuals and the government in decision-making could produce positive outcomes in terms of good health, productivity and urban governance [55]. In contrast to some developed countries, the co-production approach to waste sorting in developing countries like China is still new and the implementation process of this mode could vary among different regions and cities. For instance, the successful model in this case relies on the active role of community and volunteers played in promoting environmental awareness and education. Thus, it is necessary to further examine the similarities and differences in terms of the standardization, procedure and evaluation of waste sorting in order to promote sustainable lifestyle and healthy development of environmental management in the long run.

## Conclusions

This article has primarily examined how waste sorting has been implemented in Chinese urban villages through co-production arrangements and who were involved in this process. It is among the few that examines waste sorting in urban villages through an in-depth case study. We challenged the assumption that co-production was most initiated from a bottom-up approach. By analyzing the process of waste sorting in urban villages, we argue that the approach of co-production was implemented as a governing strategy that requires a level of craft to solve wicked public problems and the experimentation of waste sorting in urban villages is a typical example. Unlike most Western countries in which co-production is implemented through citizen-led or voluntary action, the historic context and unique process of urbanization have significantly shaped the governance space in Chinese urban villages as well as the approach to waste management.

Further, it is enacted as a balanced choice involving collaborative efforts to produce innovative means

in solving social problems. Furthermore, this strategy has encouraged multiple efforts from ordinary people to participate in community activities, and this move has strengthened the co-production base in urban village governance, particularly in sustainable waste management. The findings of our research change the stereotypes of previous perspectives regarding urban villages in waste management system in China. This article has some limitations. First, the number of cases examined is relatively small. Second, the scope of our research is limited since it is practically impossible for us to access all relevant data. Future studies are expected to incorporate more elements such as longitudinal analysis to examine waste sorting. Broader generalizations are also needed on articulating waste management system by conducting more cross-case and cross-region studies.

### Ethical Statement

This study did not involve human or animal participants, material, or data.

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### Conflict of Interest

The authors declare no conflict of interest.

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