Strategic Management Insights

Article

Business Model and Carbon Reduction Path of Community-Level Organic Waste Resource Utilization

Yanzhi Li [1,*]

[1] Fujian Zhongren Property Management Co., Ltd., Fuzhou, China
* Correspondence: Yanzhi Li, Fujian Zhongren Property Management Co., Ltd., Fuzhou, China

Abstract: Driven by the goals of carbon emission reduction, zero-waste cities, and grassroots governance modernization, community-level organic waste resource utilization is crucial for improving urban household waste management. Compared with traditional governance models relying on mixed disposal and centralized treatment, community-level utilization emphasizes source separation, on-site reduction, recycling, and multi-stakeholder collaboration. This approach shortens the treatment chain, reduces system costs, and promotes low-carbon transformation. However, organic waste management currently faces challenges, including inadequate front-end and back-end coordination, limited property management capacity, insufficient resident participation, and unclear carbon reduction performance metrics. From the perspective of community governance and green property management collaboration, this article clarifies the practical logic of organic waste resource utilization. It constructs a comprehensive business model integrating government guidance, property management organization, resident participation, professional operation, digital empowerment, and resource return. Furthermore, the study systematically outlines a carbon reduction path focusing on source reduction, optimized collection and transportation, on-site treatment, product substitution, and enhanced management efficiency. Ultimately, community-level organic waste utilization is not merely a technological issue but a systemic project requiring grassroots governance transformation, property service innovation, and the cultivation of green lifestyles. Future efforts must collaboratively transition organic waste management from pilot projects to a normalized, institutionalized, and large-scale approach, emphasizing institutional supply, operational mechanisms, technological platforms, and revenue distribution.

Keywords: community governance; organic waste; business model; carbon reduction; property management; smart sanitation

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1. Introduction

Community-level organic waste resource utilization represents a pivotal approach for enhancing the initial stages of municipal solid waste management systems, fostering recycling practices, and advancing low-carbon transitions. Unlike traditional disposal-oriented methods focused on the end-of-pipe processes, the core value of community-level resource utilization lies in embedding waste governance within the community framework. This approach reconstructs the organic waste management chain through mechanisms such as source separation, property organization, professional operation, and digital empowerment [1, 2]. These mechanisms collectively enable the integration of waste reduction, resource utilization, and low-carbon development into a unified system. Studies have identified that the primary obstacles in community organic waste management are not technological but rather stem from inadequate coordination between the initial and subsequent stages, limited property management capabilities, insufficient resident engagement, and the lack of clear articulation of carbon reduction outcomes. Addressing these challenges necessitates the development of a composite business model that incorporates government guidance, property management organization, resident

participation, professional operation, digital empowerment, and resource recycling. Within this model, the government provides institutional frameworks and ensures public value, property management facilitates front-end organizational activities, residents contribute to effective source separation, professional entities optimize resource conversion rates, and digital platforms offer comprehensive support throughout the process. Furthermore, the sustainability of such projects is determined by the holistic return of benefits. From the perspective of carbon reduction mechanisms, source separation plays a critical role in minimizing emissions. The emission reduction processes span multiple stages, including waste quantity reduction, streamlined collection and transportation, localized or nearby disposal, resource substitution, and refined digital management. These interconnected stages generate a synergistic effect that significantly reduces systemic emissions across the waste management chain.

The resource utilization of community organic waste is not merely an innovative method of waste management but also serves as a fundamental pillar for green community operations, enhanced property services, and modernized grassroots environmental governance. Moving forward, it is essential to establish institutional standards, operational frameworks, and carbon accounting methodologies tailored to community-specific scenarios. Additionally, efforts should be directed toward strengthening the development of digital platforms and performance evaluation systems. Transitioning from isolated pilot projects to large-scale, project-based operations and routine governance will provide consistent and effective support for the green transformation of urban communities. This progression will ensure the integration of sustainable practices into everyday community operations, fostering long-term environmental benefits and contributing to the broader goals of urban ecological modernization [3].

2. The Real Challenges of Community-Level Organic Waste Resource Utilization

2.1. Insufficient Connection between Source Separation and Back-End Resource Utilization

Although many communities are currently promoting waste sorting and implementing designated disposal points, the connection between source separation and back-end resource utilization remains a significant challenge. Residents often sort waste inaccurately due to factors such as convenience, time constraints, and insufficient awareness of proper sorting practices. This lack of precision at the front end directly impacts the efficiency and effectiveness of subsequent stages in the waste management process. After initial sorting, the absence of a robust connection between mid-stage collection and back-end processing frequently results in poor sorting quality at the processing stage. For organic waste, inadequate sorting at the source compromises the technological feasibility of resource utilization, leading to increased costs for manual sorting and equipment maintenance. Furthermore, the lack of integrated data sharing among communities, property management entities, sanitation departments, and processing facilities exacerbates these issues [4]. Without timely feedback on sorting quality, waste generation volumes, and processing outcomes, it becomes difficult to establish clear accountability or performance-based incentives among the various stakeholders involved. This disconnect undermines residents' understanding of the importance of waste sorting and prevents property management from setting stable expectations for compliance. Addressing these challenges requires a coordinated approach that integrates technological solutions, public education, and governance reforms to ensure a seamless connection between all stages of the waste management process.

2.2. Traditional Property Management Lacks Sufficient Support for Resource-Based Operations.

In the current framework of community management, property management companies typically undertake responsibilities such as cleaning, landscaping, patrolling, facility maintenance, and maintaining order. However, the operational focus of most property management companies remains limited to "timely collection" of fees and

ensuring cleanliness, without integrating green operational practices into their workflows. This limitation is evident in several critical areas. Firstly, there is a lack of comprehensive understanding regarding the generation patterns, classification quality, and disposal processes of organic waste. Secondly, mechanisms for the effective operation of resource-based facilities, including odor control, safety maintenance, and handling abnormal disposal scenarios, are either absent or underdeveloped [2, 5]. Lastly, there is insufficient design and implementation of community-based disposal scenarios for resource-based products, which hinders the establishment of a closed-loop system connecting front-end waste diversion with back-end resource utilization. Addressing these gaps requires property management companies to undergo a fundamental transformation in their organizational capabilities. This shift involves moving beyond the traditional logic of property services to adopt a green operational framework that prioritizes sustainability and resource efficiency within community-level organic waste management systems.

2.3. Project Construction Outpaces Operational Mechanism Development.

In recent years, the progress in waste sorting and the development of green communities have led to the initiation of community resource utilization pilot projects in certain regions [6]. These projects often involve the deployment of small-scale kitchen waste and green waste crushing or intelligent sorting and disposal equipment. Despite the initial success facilitated by policy support or special funding, a recurring issue has emerged where the focus on construction overshadows the importance of establishing robust operational mechanisms. While equipment and facilities are rapidly made available during the early stages, the transition to routine operations frequently encounters challenges such as unclear assignment of responsibilities, inadequate maintenance protocols, insufficient training for personnel, and a lack of transparency in evaluating benefits. These shortcomings can result in equipment being underutilized, operational inefficiencies, and weakened management practices. Without a standardized operational framework, resource-based governance struggles to scale beyond isolated pilot demonstrations, thereby limiting its potential to contribute effectively to the low-carbon transformation of communities. Addressing these operational gaps is essential for ensuring the long-term success and scalability of such initiatives.

2.4. Lack of Long-Term Incentives for Resident Participation

The foundation of community resource-based governance lies in residents' active participation in source separation and consistent resource allocation. However, practical observations reveal that while initial engagement in such projects is often high, sustained participation tends to decline over time due to participation fatigue. This phenomenon is not necessarily rooted in a lack of environmental awareness but rather in the absence of tangible and immediate benefits. For many residents, the process of sorting requires a significant investment of time and adherence to behavioral constraints, while the advantages of resource recovery are perceived as indirect and delayed public benefits [7]. Without the provision of convenient facilities, timely feedback on the process, and incentives tied to measurable outcomes, maintaining long-term participation becomes challenging. This decline in engagement ultimately disrupts the stability and efficiency of the entire resource recovery chain, highlighting the need for strategies that address these barriers comprehensively.

3. Building a Business Model for Community-Level Organic Waste Resource Utilization

The sustainability of community-level organic waste resource utilization is not dependent on the adoption of a single technological solution but rather on the establishment of a comprehensive and sustainable business model. This model integrates the principles of community governance with the operational requirements of environmentally friendly practices. It encompasses a multi-faceted approach that includes government guidance, active involvement of property management organizations, resident participation, professional operational management, digital empowerment, and

the efficient recycling of resources. Such a framework ensures that organic waste is managed in a manner that aligns with both ecological and economic objectives, fostering long-term viability and community engagement [8, 9].

3.1. Government Guidance: Institutional Supply and Public Value Guarantee

Organic waste resource utilization is characterized by its attributes as a public good, making it challenging for enterprises or individual residents to independently bear the costs associated with initial infrastructure investment, institutional design, and community mobilization. Consequently, the government plays a pivotal role in guiding the implementation of this model and ensuring the provision of public value [4]. Community organic waste resource utilization should be integrated into broader initiatives such as the development of waste-free communities, green property evaluations, household waste classification assessments, and grassroots environmental governance performance systems. This integration helps to clarify its policy positioning and align it with national sustainability goals. To alleviate the financial burden on stakeholders, the government can provide support through pilot subsidies, facility upgrades, points-based incentive systems, and recognition of demonstration projects. These measures reduce barriers to participation and encourage broader engagement. Additionally, the establishment of technical and safety standards tailored to community-specific scenarios is essential. These standards should define clear boundaries for processes such as disposal, temporary storage, pretreatment, odor control, and product utilization. By doing so, the government can mitigate potential environmental risks that may arise from excessive project efficiency, ensuring that the benefits of organic waste resource utilization are maximized without compromising environmental safety.

3.2. Property Management Organization: The Core Hub of Front-End Governance

In the community resource-based governance system, property management companies possess significant organizational advantages. These companies, having long been integral to the daily operations of communities, are equipped with resources related to cleaning, landscaping, facility inspections, and resident communication. This enables them to seamlessly integrate resource-based tasks into their existing workflows. Furthermore, their familiarity with community spatial boundaries, public facility layouts, and high-frequency activity scenarios allows for efficient planning of disposal points, collection routes, and equipment operation. Additionally, the relatively stable service relationships they maintain with residents facilitate effective classification guidance, behavioral encouragement, and feedback communication. Consequently, the role of property management companies should extend beyond the passive execution of cleaning tasks to encompass the responsibilities of operational organizers within front-end resource-based governance [8]. By embedding source classification, node maintenance, process coordination, resident mobilization, and result feedback into their service offerings, these organizations can significantly enhance the stability and continuity of community organic waste management systems. This comprehensive approach ensures a more sustainable and efficient governance model for community resources.

3.3. Resident Participation: From Sorting Obligation to Value Co-Creation

Residents play a pivotal role as the primary producers of community organic waste, and their active participation significantly influences the efficiency of back-end waste classification systems. Sustained engagement from residents is essential to ensure the long-term success of waste management initiatives. Beyond traditional methods such as public awareness campaigns and moral encouragement, it is crucial to involve residents in value co-creation processes. For instance, optimizing waste collection facilities by improving the placement of collection points, enhancing signage clarity, and refining collection schedules can help reduce sorting costs and improve convenience. Furthermore, establishing tangible incentive mechanisms, such as points redemption programs, green family recognition initiatives, community honor boards, and displays of environmental achievements, can provide residents with both direct and indirect benefits. These

measures not only foster a sense of accomplishment but also encourage consistent participation. From a governance perspective, the transformation of residents from passive "objects of management cooperation" to active "participants in green living" is fundamental to building a sustainable foundation for environmentally responsible behavior within communities.

3.4. Professional Operation: Enhancing Resource Conversion Efficiency and Market Integration Capabilities

Property management companies possess robust organizational capabilities; however, they require collaboration with professional operators to optimize various aspects of waste management. These include the operation of specialized equipment, meticulous process control, effective odor management, innovative product development, and efficient market absorption strategies. Kitchen waste, for instance, should be processed using methods such as small-scale biodegradation, anaerobic treatment, or co-conversion facilities, tailored to the specific size and environmental characteristics of the community [10]. Similarly, garden and landscaping waste can be effectively utilized through techniques like crushing and covering, substrate processing, and composting. The involvement of professional operators ensures that the community's efforts in front-end waste sorting are transformed into stable and valuable resource outputs. This collaboration not only enhances processing efficiency and reduces technical barriers but also facilitates integration with nearby greening maintenance, landscaping renewal, and agricultural utilization scenarios. Consequently, the project's market-oriented operational capabilities are significantly strengthened, promoting sustainable and efficient resource management.

3.5. Digital Empowerment: Forming a Closed-Loop Data System Throughout the Process

Digital platforms play a pivotal role in resource recovery projects, serving not merely as tools for recording information but as essential mechanisms for connecting stakeholders and enhancing governance processes. Through smart sanitation systems or advanced property management platforms, it becomes possible to monitor and analyze various aspects of waste management, including resident waste disposal behaviors, sorting quality, organic waste generation, collection frequency, equipment operational status, collection routes, and operational plans. Additionally, these systems enable the compilation of statistics related to resource recovery product output, usage patterns, and cost savings, while providing visual representations of waste reduction, pollution mitigation, and carbon footprint minimization. The fundamental value of digital empowerment lies in its ability to transition management practices from being experience-based to refined and systematic, thereby facilitating the scalability of pilot projects into replicable operations [11]. Comprehensive data traceability is indispensable for ensuring the effective implementation of revenue distribution, performance evaluations, and policy support within the business model, ultimately driving sustainable development in resource recovery initiatives.

3.6. Resource Recycling: Building a Comprehensive Revenue Structure

The advantages of implementing organic waste recycling at the community level extend far beyond the direct revenue generated from product sales. A more holistic approach involves constructing a comprehensive revenue structure that integrates multiple dimensions of value creation. This includes, first, the significant reduction in costs associated with waste collection and final disposal due to effective waste minimization. Second, recycled products such as organic fertilizers, mulch, and soil amendments can serve as substitutes for traditional materials used in community greening and public space maintenance, thereby reducing expenditure in these areas. Third, enhanced green property services can elevate community satisfaction and strengthen brand influence, fostering a positive reputation for the property management entity. Lastly, external benefits such as green demonstration certifications, performance-based rewards, and favorable evaluations in low-carbon projects further contribute to the

overall value. By designing institutional mechanisms that channel these benefits back into property management operations and community public services, the system can achieve long-term sustainability and resilience.

4. Carbon Reduction Pathways for Community-Level Organic Waste Resource Utilization

4.1. Source Separation and Reduction to Lower End-of-Life Emission Pressure

When organic waste is introduced into a mixed waste management system, it often disrupts the efficiency of incineration processes and significantly contributes to greenhouse gas emissions during landfill operations [12]. Kitchen waste, characterized by its high moisture content, diminishes the calorific value of combustible waste streams, thereby increasing the auxiliary energy required for effective incineration. Furthermore, when such waste is deposited in landfills, it undergoes anaerobic decomposition, leading to the production of high-temperature gases such as methane, a potent greenhouse gas. Implementing community-level source separation of organic waste is a critical strategy to address these challenges. By removing organic components at the source, the purity of materials designated for resource recovery is enhanced, and the volume of waste entering high-emission disposal systems is substantially reduced. This approach represents a foundational step in achieving meaningful carbon reduction and improving overall waste management efficiency.

4.2. Compressing the Collection and Transportation Chain to Reduce Transportation Energy Consumption

Traditional centralized collection and transportation methods often involve extensive transportation radii and frequent collection schedules, leading to elevated costs and energy consumption. This is particularly problematic for organic waste, which typically has high moisture content and low economic value, making its transportation both inefficient and resource-intensive. By implementing community-level resource recovery strategies, such as on-site waste treatment, coordinated regional processing, and optimized route scheduling, transportation distances can be significantly reduced [13]. These measures also minimize empty vehicle transfers and redundant operations, thereby lowering fuel consumption and associated carbon emissions. Such approaches are especially effective in densely populated residential areas with substantial waste generation, where they can achieve notable reductions in emissions and operational inefficiencies, contributing to more sustainable waste management practices.

4.3. On-Site or Nearby Treatment Reduces Systemic Emission Losses

The characteristics of organic waste emphasize the importance of addressing treatment processes as early and as close to the source as possible. This approach significantly enhances the ability to control environmental risks while simultaneously reducing treatment costs. By establishing treatment facilities at the community or regional level, organic waste can undergo degradation, crushing, composting, or pretreatment within a short timeframe. This minimizes the adverse effects associated with prolonged storage, such as increased emissions from putrefaction, challenges in odor management, and the complexities of leachate treatment. Furthermore, compared to centralized treatment methods requiring long-distance transportation, on-site or nearby treatment reduces the compression of the treatment chain, thereby lowering systemic emission losses and improving overall efficiency in waste management systems.

4.4. Indirect Emission Reduction through Resource-Based Products Replacing External Inputs

Organic waste recycling products play a significant role in the sustainable maintenance of community green spaces, flower beds, tree pits, and public landscapes. These products can effectively replace conventional chemical fertilizers, potting soil, mulch materials, and other gardening supplies. The production, packaging, and transportation of such external inputs are energy-intensive processes that contribute to carbon emissions. By substituting these with resource-based products derived from

organic waste, communities can achieve a dual benefit: reducing waste emissions and minimizing pollution-related carbon emissions from the upstream supply chain [5]. Furthermore, if a substantial proportion of the maintenance needs for community green spaces can be met locally, the indirect emission reduction effect will be amplified, fostering a more sustainable and environmentally friendly urban ecosystem.

4.5. Digitalized Precision Management Amplifies Synergistic Emission Reduction Effects

In numerous governance projects, inefficiencies in management often serve as an overlooked contributor to emissions [13]. For instance, scenarios such as idle equipment, redundant personnel inspections, poorly planned routes, and inconsistent operational frequencies can collectively result in unnecessary energy and resource consumption. By leveraging digital platforms, it becomes possible to dynamically gather and analyze data related to community waste generation patterns, the operational status of facilities, and detailed management activities. This enables precise control over critical factors such as waste disposal schedules, collection frequencies, equipment maintenance, and resource allocation. Such optimization minimizes avoidable management losses. Although the immediate impact of these measures on emission reductions may not always be evident, their cumulative benefits over time are substantial. Furthermore, these practices can be effectively scaled and replicated across multiple communities, amplifying their long-term value in achieving sustainable development goals.

5. Conclusion

Community-level organic waste resource utilization represents a pivotal strategy for advancing domestic waste management systems toward front-end transformation, recycling, and low-carbon development. Unlike traditional end-of-pipe treatment methods, its significance lies in shifting the focus of waste management to the community level, thereby reconstructing the organic waste management chain. This is achieved through mechanisms such as source separation, property management organization, professional operation, and digital empowerment, which collectively enable a unified approach to waste reduction, resource recovery, and carbon emission mitigation. The study highlights that current challenges in community organic waste management are not rooted in technological limitations but rather stem from insufficient coordination between front-end and back-end processes, inadequate property management capabilities, unstable resident participation mechanisms, and the lack of clear metrics for carbon reduction performance. To address these issues, a composite business model comprising "government guidance---property management organization---resident participation---professional operation---digital empowerment---resource return" must be established. In this model, the government provides institutional support and ensures public value, property management organizes front-end scenarios, residents contribute through source separation, professional entities enhance resource conversion efficiency, digital platforms offer comprehensive process support, and the sustainability of the project is determined by the cumulative return of benefits. From the perspective of carbon emission reduction mechanisms, community-level resource utilization can significantly lower systemic emissions through strategies such as source reduction, shortened collection and transportation chains, localized treatment, substitution of resource products, and refined digital management. These strategies collectively generate a cumulative emission reduction effect, making community organic waste resource utilization a critical tool for promoting green operations, optimizing property services, and modernizing grassroots environmental governance. Future efforts should focus on improving institutional standards, operational mechanisms, and carbon accounting methods to better align with community-specific scenarios. Additionally, enhancing digital platforms and performance expression capabilities will be essential for scaling resource utilization from pilot projects to widespread implementation and transitioning from project-based initiatives to routine practices. These advancements will provide more sustainable and

effective support for the green transformation of urban communities, ensuring long-term environmental and social benefits.

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