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Keeping the Town Clean and the Value Local: A Locally Financed Resource-Recovery Model for Small African Cities

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Abstract
Rapid urbanisation in sub-Saharan Africa is concentrated not only in megacities but in a fast-growing tier of small and secondary cities, where uncollected and openly dumped waste is among the most visible threats to public health and the urban environment. Research and investment have focused on large cities, leaving smaller towns with collection models that they cannot afford to run. This paper reviews completed and documented field experience with community source-separation incentives, community buy-back schemes, rewards-for-recycling logistics, franchised zonal micro-enterprise collection, decentralised composting and city-scale clean-city governance, and distils the lessons that recur across these cases. Building on that evidence, the paper proposes TownLoop, a closed-loop resource-recovery model designed for the conditions of a single small city: micro-zones served by paid community enterprises, a simple two-stream separation at the household, local conversion of the organic majority into compost for nearby farms, a single shared aggregation hub for dry recyclables, and two governance mechanisms that are the paper's main contribution. The first is a local clearing council that verifies recovered quantities and coverage and settles payments on a fixed cycle. The second is a coverage-linked payment formula that ties enterprise income to the share of households reliably served rather than to tonnage alone, aligning private incentives with the public goal of a clean and fully served town. The paper sets out the unit economics and the threshold at which local revenues cover operating cost, the conditions for scaling within a town and across a national network of secondary cities, and a phased eighteen-month pilot with indicators aligned to the clean-cities monitoring framework and Sustainable Development Goal target 11.6.

Keywords: solid waste management; secondary cities; resource recovery; decentralised composting; source separation; community enterprise; clean cities; sub-Saharan Africa

1. Introduction

1.1 The clean-city imperative in rapidly urbanising Africa

Few public services shape the daily experience of an African town as directly as the handling of its waste. When collection works, streets are passable, drains run during the rains, markets are usable and the spread of disease is checked. When it fails, refuse accumulates in gutters and open spaces, blocks drainage and creates breeding sites for the vectors of cholera, malaria and diarrhoeal illness. Solid waste management is therefore not a peripheral municipal chore but a frontline determinant of urban health and dignity (Henry, Yongsheng and Jun, 2006; Marshall and Farahbakhsh, 2013).

The scale of the challenge is rising quickly. Global reviews project that waste generation in low-income cities will roughly double over fifteen to twenty years as populations and incomes grow, with sub-Saharan Africa urbanising faster than any other region (Hoornweg and Bhada-Tata, 2012; UNEP and ISWA, 2015). Spending on collection and disposal already absorbs a large share of municipal budgets in developing countries, and the share is highest where systems are weakest, because uncollected waste imposes downstream costs on drainage, health and the local economy (Guerrero, Maas and Hogland, 2013). Keeping a town clean is, in this sense, an investment rather than a cost, and the case for getting it right grows stronger as cities expand.

1.2 The small-city blind spot in waste research and policy

Most of the empirical literature, and most donor and national investment, concentrates on capital cities and large metropolitan areas. The comparative work that does exist samples predominantly large cities (Wilson, Rodic, Scheinberg, Velis and Alabaster, 2012), and influential reviews draw their case material from the same tier (Hoornweg and Bhada-Tata, 2012). Yet a substantial and rising share of African urban growth is occurring in small and secondary cities of a few tens of thousands to a few hundred thousand residents. These places face the same sanitation imperative with a fraction of the administrative capacity, a thinner tax base, and waste volumes too small to interest the large private contractors that operate in capital cities.

The result is a structural blind spot. The models that have been studied and promoted are largely those of the big city, and they assume conditions that small towns do not have. The next section sets out why those assumptions do not travel. The practical consequence is that many small towns operate no functioning system at all, relying on irregular informal collection and open dumping, which is precisely the pattern that the clean-city agenda seeks to end.

1.3 Aim, contribution and structure

This paper has two aims. The first is to assemble, from completed and documented field experience, the design lessons that recur across the kinds of community-based and decentralised models most relevant to small towns. The second is to propose an integrated model, named TownLoop, that combines these lessons into a single coherent system tuned to the small-city setting, and to specify two governance mechanisms that the existing models lack.

The contribution is therefore both synthetic and design-oriented. Two elements are presented as novel: **(i)** a local clearing council that verifies recovered quantities and household coverage and settles payments to enterprises on a fixed cycle, and **(ii)** a coverage-linked payment formula that rewards enterprises for the share of households reliably served rather than for tonnage alone. The remainder of the paper is organised as follows. Section 2 frames the clean-environment problem in secondary cities. Section 3 reviews completed evaluations and field experience and synthesises what they confirm. Section 4 sets out the TownLoop model. Sections 5 and 6 treat scalability and transferability. Section 7 proposes a pilot and evaluation design. Section 8 discusses novelty, equity, failure modes and the contribution to clean cities, and Section 9 concludes.

2. Clean environments and solid waste in secondary African cities

2.1 Waste generation, the organic majority, and the collection gap

Two features of waste in African towns dominate any sensible design. The first is composition. Characterisation studies across the region report that the largest single fraction by mass is putrescible organic material, principally food and yard waste, commonly between half and three-quarters of the stream, with plastics, paper, glass and metal making up much smaller shares (Miezah, Obiri-Danso, Kádár, Fei-Baffoe and Mensah, 2015; Puopiel, 2010). Figure 1 presents an indicative profile. The organic majority matters because it is heavy, wet and quick to rot, so it drives both the nuisance of uncollected waste and the cost of hauling it, while also being the fraction most amenable to local treatment through composting.

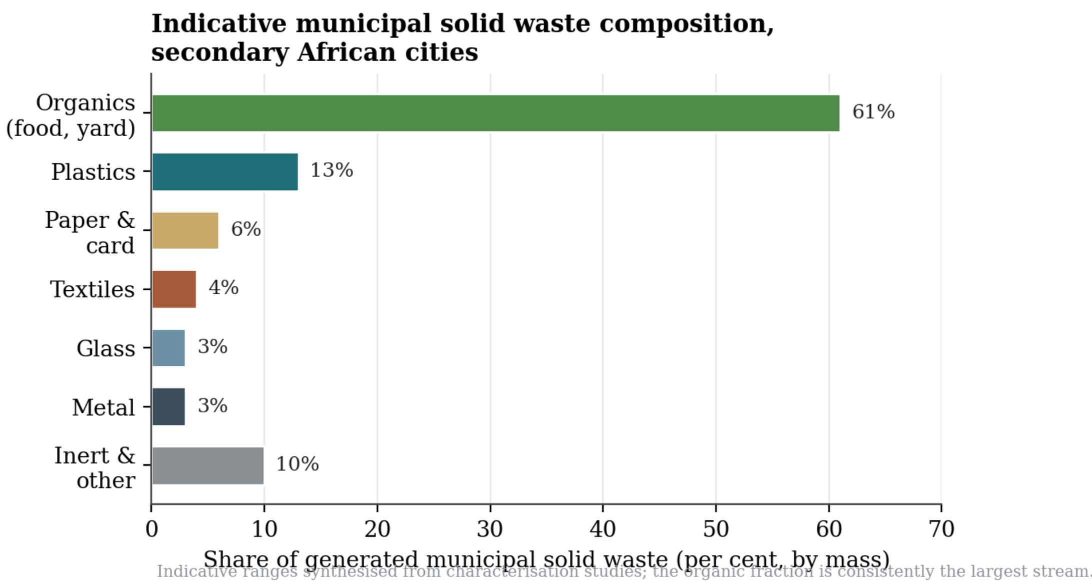

Figure 1. Indicative municipal solid waste composition in secondary African cities. The putrescible organic fraction is consistently the largest stream, which makes its local capture the single most important design lever.

The second feature is the collection gap. In high-income cities, near-universal collection is the norm; across African cities, reliable collection typically reaches only a portion of residents, and the share falls sharply in smaller and poorer settlements (Wilson, 2007; Hoornweg and Bhada-Tata, 2012; Scheinberg, Wilson and Rodic, 2010b). Figure 2 illustrates the pattern. The households left out are disproportionately poor and peripheral, and it is their waste that ends up in drains and open dumps. Any model that aims at a clean town, rather than at recovering the most valuable materials, must therefore treat coverage of the hardest-to-reach households as a primary objective rather than a by-product.

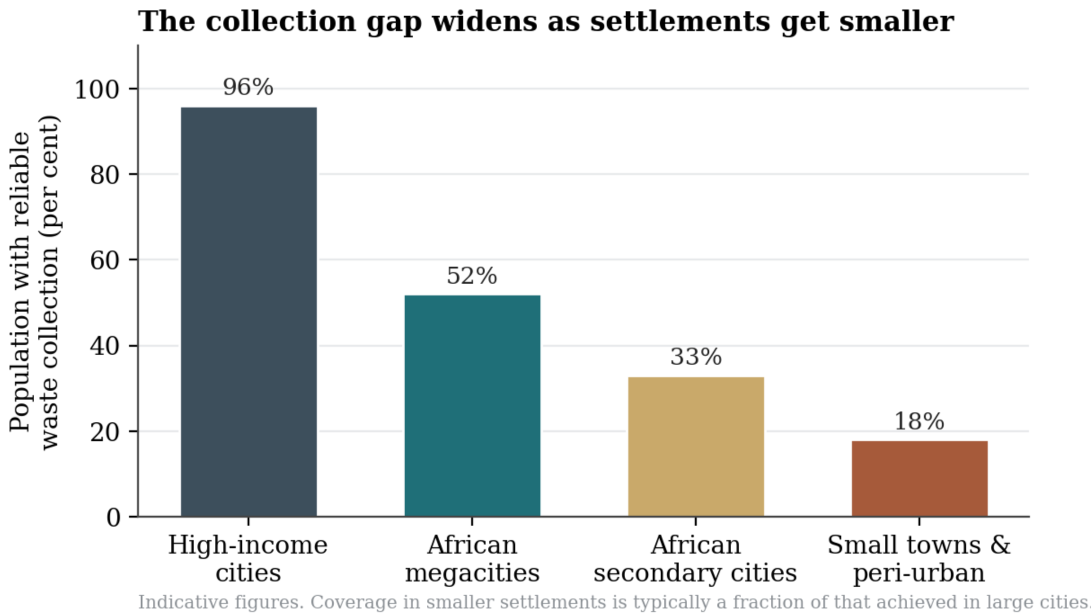

Figure 2. The collection gap widens as settlements get smaller. Reliable coverage in small towns and peri-urban areas is typically a fraction of that achieved in large cities (indicative figures).

2.2 Why megacity collect-and-haul models transfer poorly to small towns

The dominant model in large cities is collect-and-haul: compactor trucks gather mixed waste and transport it to a distant landfill or dumpsite. This model rests on conditions that small towns rarely meet. It depends on capital-intensive fleets whose cost per tonne falls only at high volumes, on paved road networks that allow trucks to reach households, on a disposal site within an economic haul distance, and on a municipal budget able to sustain fuel, maintenance and staffing (Guerrero, Maas and Hogland, 2013; Marshall and Farahbakhsh, 2013). A town of fifty thousand people generates too little waste to use such fleets efficiently, often has unpaved or congested lanes that trucks cannot enter, and seldom has the recurrent budget to keep vehicles running once a donor-funded purchase has depreciated.

Transplanting the collect-and-haul template into a small town therefore tends to fail in a predictable sequence: an initial vehicle grant, a period of service, rising maintenance costs, breakdown, and a return to open dumping. Because the model also discards the organic majority into a dumpsite, it forgoes the one resource the town has in abundance and gains nothing in return. The implication is that small towns need a different architecture, one built around low-capital local collection, local treatment of organics, and shared infrastructure only where scale genuinely helps.

2.3 The clean-cities policy frame: the African Clean Cities Platform, SDG 11.6 and the Waste Wise Cities approach

A supportive policy frame now exists. The 2030 Agenda for Sustainable Development sets target 11.6, to reduce the adverse per-capita environmental impact of cities, including by paying special attention to municipal and other waste management, and its indicator 11.6.1 measures the proportion of municipal solid waste that is collected and managed in controlled facilities (United Nations, 2015). This gives towns a clear, internationally comparable objective: raise the share of waste that is both collected and properly managed.

At the regional level, the African Clean Cities Platform was established in 2017 in Maputo by African governments together with the Government of Japan, the Japan International Cooperation Agency, the United Nations Environment Programme and the United Nations Human Settlements Programme, as a platform for knowledge exchange and cooperation toward the waste-related goals (Ministry of the Environment of Japan and others, 2017). The accompanying Waste Wise Cities approach promotes consistent measurement of collection and controlled management so that cities can benchmark progress against indicator 11.6.1. A model intended for adoption in this environment should therefore produce exactly the quantities these frameworks measure, namely the share of households served and the share of waste managed in controlled facilities, and should report them in a form that municipalities can submit. Section 7 specifies indicators on this basis.

3. Verifiable models with completed evaluations

This section reviews documented field experience from programmes whose operation and results have been reported in enough detail to draw design lessons. The cases were chosen to span the functions a small-town model must perform: motivating households to separate, paying collectors, moving recyclables at low cost, organising collection by area, treating the organic majority, governing a clean city at scale, and bringing informal collectors into a recognised system. The section closes by drawing out what the cases consistently confirm.

3.1 Source-separation incentives evaluated in Tamale, Ghana

Work in the Tamale metropolis in northern Ghana has examined both what the waste stream contains and what would induce households to separate it. Characterisation confirms the regional pattern of a dominant organic fraction and a modest recyclable fraction, and identifies indiscriminate disposal by unserved households as a central problem (Puopiel, 2010; Miezah and others, 2015). Studies of household behaviour find that participation in separation responds strongly to simple, tangible incentives, in particular the provision of free or subsidised separation bins and the assurance of reliable collection, and that residents express clear preferences among monetary and non-monetary incentive options (Oduro-Kwarteng and van Dijk, 2013).

Two lessons carry forward. First, separation is feasible in a small Ghanaian city when the scheme is kept simple and the promised collection actually arrives. Second, the binding constraint is reliability and convenience rather than household willingness in principle. A model should therefore minimise the cognitive load of separation and treat dependable collection as the precondition for participation, not as an optional add-on.

3.2 Community buy-back with digital payment: the Manja Pamodzi experience, Zambia

Manja Pamodzi, meaning hands together, is a community recycling initiative launched in Lusaka in 2015 by Zambian Breweries with partners, in a city where only about a quarter of daily waste was being collected formally. It organises a value chain in which community collectors gather post-consumer packaging and sell it to neighbourhood aggregators, who consolidate and pass material to processors, with collectors paid for what they bring in. Within its first year the programme had recruited several dozen community collectors served by a small number of aggregators, and had recovered cartons and plastics measured in the tens of tonnes, alongside community clean-up days that cleared waste from drains and public spaces (Lusaka Times, 2015). The documented experience confirms that a buy-back chain can mobilise collection and visibly clean neighbourhoods, and that paying collectors promptly and predictably is central to retaining them. Reported difficulties cluster around the aggregator tier: uneven aggregator performance, the cost and unpredictability of transport to processors, and delays in paying collectors. These point to a design need for a dependable settlement function and for shared logistics, both of which the present model addresses directly.

3.3 Rewards-for-recycling and low-cost logistics: Wecyclers, Nigeria

Wecyclers, founded in Lagos in 2012, built a household recycling service for low-income neighbourhoods around a fleet of low-cost, locally assembled cargo cycles that collect recyclables door to door, delivering them to neighbourhood sorting and aggregation points (Matheson, 2015). Households that subscribe have material collected on a regular schedule and earn points by weight that are redeemable for goods, with rewards underwritten in part by corporate partners. By the middle of the decade the service reported several thousand subscribed households and recovered material measured in the hundreds of tonnes.

Three design lessons stand out. Low-capital, human-powered logistics can reach dense, poorly accessible neighbourhoods that trucks cannot, at a cost structure a small town can contemplate. A clear per-kilogram reward changes household behaviour. And reliance on external reward funding is a vulnerability: where rewards depend on sponsorship rather than on the value the system itself generates, the model is exposed if that funding pauses. A small-town design should therefore aim to fund its incentives from the value it recovers and from local service fees rather than from open-ended external subsidy.

3.4 Franchised and zonal micro-enterprise collection in Accra, Ghana, and the evaluated reasons for its decline

Accra offers the most instructive cautionary case, because its move to private and franchised collection was studied closely as it unfolded. From the late 1990s the city contracted private firms and assigned them zones, expecting competition and local enterprise to extend coverage. Early assessments found that private collection could match or exceed public service quality in the zones where it operated (Obirih-Opareh and Post, 2002), and that private involvement expanded capacity

(Oteng-Ababio, 2010). Over time, however, the franchised and zonal arrangement underperformed and in places collapsed.

The evaluated reasons are consistent across studies (Post, Broekema and Obirih-Opareh, 2003; Oteng-Ababio, Arguello and Gabbay, 2013; Oduro-Kwarteng and van Dijk, 2013). Cost recovery broke down because user fees were hard to collect, especially in low-income zones, and payments to contractors were irregular and delayed. Monitoring was weak, so service shortfalls went unverified and contractors had little reason to serve unprofitable households. Zones were allocated and altered in ways exposed to political interference, undermining the predictability that enterprises needed to invest. The net effect was a regressive pattern in which profitable high-income zones were served while poor zones were neglected, and the burden of uncollected waste fell on those least able to bear it (Baabereyir, Jewitt and O'Hara, 2012). The Accra experience thus identifies the precise failure points, namely unreliable payment, weak verification and political instability of zoning, that a durable zonal model must engineer against.

3.5 Decentralised composting: the Waste Concern model and its African applications

Because the organic fraction dominates the stream, treating it locally yields the largest single improvement for the least cost. The best-documented template is the Waste Concern community composting model developed in Dhaka, in which source-separated organic waste is collected from a defined neighbourhood and composted at a small decentralised site using simple windrow or box methods, producing a marketable soil amendment sold to farms (Zurbrügg, Drescher, Rytz, Sinha and Enayetullah, 2005). Evaluations describe a configuration that benefits multiple parties at once: the neighbourhood is cleaned, organic waste is diverted from disposal, jobs are created, and farms receive affordable compost, with the sale of compost contributing to the running cost.

The approach has been codified for wider use in low- and middle-income cities, including guidance on siting, process control, product quality and the economics of compost sales (Rothenberger, Zurbrügg, Enayetullah and Sinha, 2006; Hoornweg, Thomas and Otten, 2000). The recurring conditions for success are reliable input of clean separated organics, careful process management to produce a consistent product, and a real market among nearby farmers. The lesson for small African towns, which usually sit close to peri-urban agriculture, is that decentralised composting can convert the town's largest waste problem into a local product and a local revenue stream, provided the organic stream is kept clean at the household.

3.6 City-scale benchmarking: the Kigali, Rwanda experience

Kigali is widely regarded as one of the cleanest cities in Africa, and its experience benchmarks what governance and civic participation can achieve. Several elements combine. A national prohibition on non-biodegradable plastic bags, enacted in 2008 and enforced firmly, removed a major source of persistent litter at source (Republic of Rwanda, 2008). A monthly community work practice mobilises residents for neighbourhood cleaning and maintenance. Household collection is delivered by competing private operators under municipal oversight, and collection fees are set on a sliding scale by income so that cost is shared between government and households. Two transferable principles emerge. First, sustained cleanliness rests on a combination of credible rules, consistent enforcement and genuine community participation, not on equipment alone. Second, an income-graduated fee can finance collection while protecting poorer households, which is directly relevant to the financing of a small-town model. Kigali also illustrates the value of strong local coordination, the role played in the present model by a dedicated clearing and settlement body.

3.7 Informal-sector formalisation: evaluated barriers and success factors

In almost every African town, informal waste pickers and itinerant buyers already recover materials and form the backbone of de facto recycling (Wilson, Velis and Cheeseman, 2006; Nzeadibe, 2009). Studies of efforts to bring this workforce into recognised systems identify both the gains and the pitfalls. The informal sector recovers materials at very low cost and provides livelihoods, so integrating rather than displacing it is the efficient course (Scheinberg, Simpson and Gupt, 2010a; Velis and others, 2012).

Success factors that recur include formal recognition of collectors and a defined role in the chain, reliable and fair payment, access to organised aggregation that lets small quantities reach buyers at a fair price, and protection from being pushed out when a formal scheme arrives (Ezeah, Fazakerley and Roberts, 2013). The barriers are the mirror image: non-recognition, irregular payment, exclusion by capital-intensive contracts, and weak market access for individual collectors (Ezeah and Roberts, 2012). A small-town model should therefore build on the existing informal workforce by recognising it, paying it dependably and giving it shared aggregation, rather than competing with it.

3.8 Synthesis: what the completed evaluations consistently confirm

Read together, the cases point in the same direction. Households will separate and present waste when the scheme is simple and collection is reliable. Low-capital, human-powered or light-vehicle collection suits dense and poorly accessible neighbourhoods. The organic majority is best treated locally through composting, turning the largest problem into a local product. Recyclables need shared aggregation to reach buyers at a worthwhile price. Programmes that depend on open-ended external funding for their incentives are fragile, whereas those that recover value locally are more durable. Above all, the recurring causes of failure are not technical but institutional: unreliable payment, weak verification of service, and instability of the arrangements that assign work. Table 1 summarises the cases and the lesson each contributes.

Case	Function illustrated	Lesson carried into the model
Tamale, Ghana	Source-separation incentives	Keep separation simple and make collection dependable; convenience and reliability, not willingness, are the binding constraint.
Manja Pamodzi, Zambia	Community buy-back chain	Buy-back mobilises collection and cleans streets, but needs prompt settlement and shared transport to sustain the aggregator tier.
Wecyclers, Nigeria	Rewards and low-cost logistics	Cargo cycles reach dense areas cheaply and rewards change behaviour; fund incentives from recovered value, not open-ended subsidy.
Accra, Ghana	Franchised zonal collection	Zoning works only with reliable payment, real verification and politically stable assignment; their absence drives collapse and inequity.
Waste Concern model	Decentralised composting	Local composting diverts the organic majority and creates a saleable product, given clean inputs and a nearby farm market.
Kigali, Rwanda	Clean-city governance	Credible rules, enforcement, civic participation and income-graduated fees sustain cleanliness beyond equipment.
Informal-sector studies	Formalisation	Recognise, pay and aggregate for existing collectors rather than displacing them.

Table 1. Documented cases and the design lesson each contributes.

4. The TownLoop model

4.1 Design principles and the closed-loop, clean-environment objective

TownLoop translates the synthesis above into a single system for one small city. Its objective is stated deliberately as a clean and fully served town rather than as a recycling rate, because the public-health gains come from collecting everyone's waste and managing it properly, not from recovering the most valuable materials from a subset of households. Four principles follow. The system should be low in capital and local in operation. It should treat the organic majority where it falls. It should retain the value it recovers inside the town economy. And it should make the institutional functions that caused failure elsewhere, namely payment, verification and the assignment of work, explicit and dependable.

The architecture is a closed loop, shown in Figure 3. Households present two streams to paid micro-zone enterprises. The organic stream goes to decentralised composting sites and on to peri-urban farms, returning nutrients to local soils. The dry stream goes to a single town aggregation hub and on to off-takers, retaining material value locally. A clearing council sits at the centre, verifying quantities and coverage and settling payments to the enterprises. The two elements drawn in the centre and described in Sections 4.6 and 4.7 are the model's novel contribution.

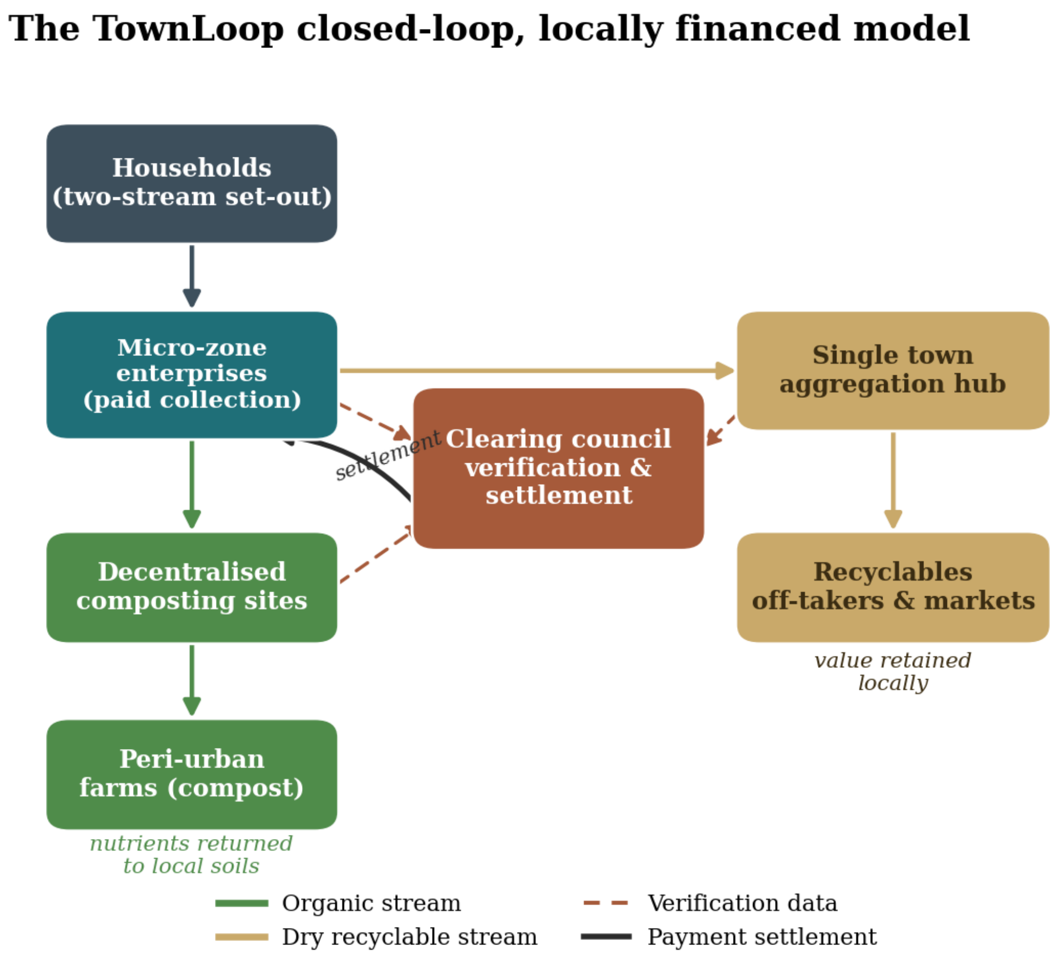

Figure 3. The TownLoop closed-loop, locally financed model. Two household streams flow to local treatment and to a shared hub; a clearing council verifies quantities and coverage and settles payments, and value is retained within the town.

4.2 Micro-zones and paid community enterprises

The town is divided into micro-zones, each comprising on the order of eight hundred to fifteen hundred households, sized so that a small team can serve every household on a regular schedule using handcarts or a light cargo tricycle. Each micro-zone is served by a community enterprise, which may be a cooperative formed from existing informal collectors, recognising and building on the workforce already present rather than displacing it (Velis and others, 2012; Scheinberg, Simpson and Gupt, 2010a). The enterprise is paid for service under the formula in Section 4.7 and is the single accountable party for coverage in its zone.

This design takes the strength of the Accra franchised model, namely local enterprise responsible for a defined area, while engineering against its failure points. Zone boundaries are fixed for the duration of an agreement to give enterprises the stability to invest, removing the political volatility that undermined Accra (Post and others, 2003). Capital requirements are deliberately low, following the Wecyclers logic that human-powered and light logistics reach dense lanes cheaply (Matheson, 2015).

4.3 Two-stream source separation

Households separate waste into only two streams: a wet stream of food and garden organics, and a dry stream containing recyclables and residual material. The choice of a binary split is deliberate. Multi-stream separation raises the effort and knowledge required of households and depresses participation, whereas a single wet and dry distinction is intuitive and robust, which the Tamale experience suggests is decisive for compliance (Oduro-Kwarteng and van Dijk, 2013). Figure 4 shows the household interface. Because organics are the largest fraction, capturing the wet stream cleanly is what makes local composting possible and is the principal lever on both cleanliness and diversion.

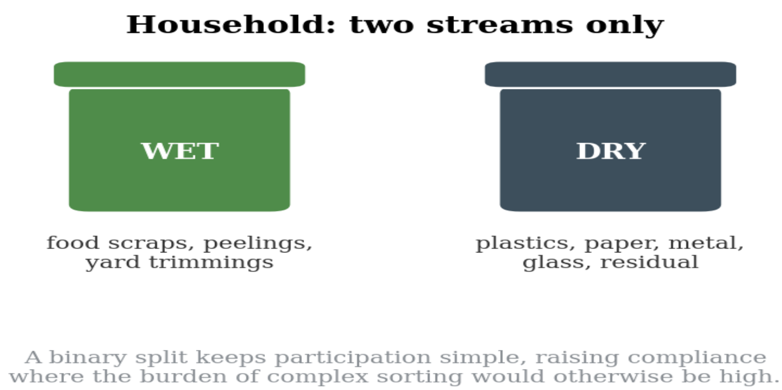

Figure 4. Two-stream source separation at the household. A binary wet and dry split keeps participation simple, which the evidence indicates is decisive for compliance.

To lower the barrier further, the model provides separation bins or bags as an entry incentive, mirroring the single most-preferred incentive reported in Tamale. The enterprise collects the wet stream frequently enough to prevent odour and the dry stream on a regular schedule, and a clean wet stream is treated as a condition of the compost market downstream.

4.4 Local organics to compost to farms

The wet stream is processed at decentralised composting sites located within or close to the micro-zones, following the Waste Concern template of small windrow or box composting sized to neighbourhood input (Zurbrügg and others, 2005; Rothenberger and others, 2006). Keeping sites small and local minimises transport, the cost that most often defeats organic diversion, and places

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the work where labour is available. The output is a soil amendment sold to peri-urban farms that typically surround small African towns, closing the nutrient loop and generating revenue that helps fund the system. Diverting the organic majority from open dumps in this way also avoids the greenhouse-gas emissions that decomposing waste would otherwise release, a recognised co-benefit of improved waste management in Africa (Couth and Trois, 2010).

Two operational disciplines determine success, both identified in the composting literature. Inputs must be kept clean, which is why the wet and dry split and frequent organic collection matter. And the process must be managed to yield a consistent product, since farm demand depends on predictable quality (Hoornweg and others, 2000). The compost market is developed deliberately as part of the model rather than assumed, with the aggregation hub supporting marketing to farms.

4.5 The single town aggregation hub

Dry recyclables from all micro-zones are consolidated at a single shared aggregation hub for the town. Individual zones, and individual informal collectors, generate quantities too small to attract buyers at a fair price; the early Manja Pamodzi experience, in which dozens of collectors depended on only a handful of aggregators, illustrates how thin this tier can be (Lusaka Times, 2015). A single hub reaches the volume at which off-takers will buy on reasonable terms, performs basic sorting and baling, and provides one transparent point of sale. Concentrating this function in one shared facility, rather than duplicating it across zones, is where genuine scale economy exists in a small town, and is the counterpart to keeping composting decentralised.

The hub also houses the marketing of compost to farms and serves as the physical point at which the clearing council weighs and records material, linking the operational and governance layers. Siting the hub on an accessible route, with space for sorting and temporary storage, is the main fixed-capital decision in the model.

4.6 The clearing council: verification and settlement (novel)

The first novel element addresses the institutional failure that recurs across the cases, namely that enterprises were not paid reliably and that service was not verified. TownLoop establishes a local clearing council: a small standing body whose two functions are to verify and to settle. Its membership brings together the municipality, representatives of the micro-zone enterprises, the hub operator, a compost or farm off-taker representative, and community representatives, so that the parties whose claims must be reconciled sit at the same table.

Verification combines simple, low-cost measurement with light audit. Material is weighed and logged at the hub and at composting sites, and coverage is checked against the household roster of each zone through periodic spot checks and a community feedback channel. Settlement then follows a fixed cycle: on each settlement date the council reconciles the verified quantities and coverage against the payment formula and authorises payment to each enterprise from the pooled revenue. The design borrows, in a deliberate sense, the logic of a financial clearing house, in which an independent body nets and settles obligations among many parties on a predictable schedule so that none has to trust another directly. Three properties result that the reviewed programmes lacked:

- **Timely, predictable payment.** A fixed settlement cycle removes the irregular and delayed payment that drove the Accra collapse, and supports the aggregator tier that proved to be the thin point in early Manja Pamodzi (Post and others, 2003; Lusaka Times, 2015).
- **Independent verification.** Quantities and coverage are checked by a body that is not the paying municipality alone, which addresses the weak monitoring identified in Accra (Oteng-Ababio and others, 2013).
- **Transparent dispute resolution.** A standing multi-stakeholder forum gives enterprises and households a route to contest errors, building the trust on which voluntary participation depends.

The council is intentionally lightweight, suited to a small town's capacity, and its records are precisely the quantities the clean-cities frameworks ask cities to report, linking governance to monitoring (Section 7.3).

4.7 The coverage-linked payment formula (novel)

The second novel element determines how much each enterprise is paid, and is the mechanism that aligns private incentives with the public objective of a clean, fully served town. A payment rule based on tonnage alone, as in pure buy-back schemes, rewards enterprises for capturing the heaviest and most valuable waste and gives them no reason to serve the last, poorest and least productive households. That is precisely the logic that produced the regressive neglect of poor zones in Accra (Baabereyir and others, 2012). TownLoop instead ties the core of enterprise income to coverage, the verified share of households in the zone that are reliably served, with material value as a secondary component.

In its simplest form the periodic payment to an enterprise is:

$$\boldsymbol{Payment = B \times C \times Q \ + \ s \times V}$$

where B is a base service payment per zone, C is the verified coverage rate (the share of registered households reliably served), Q is a quality factor reflecting separation cleanliness and schedule adherence, V is the market value of recyclables and compost attributable to the zone, and s is the share of that value passed to the enterprise. The coverage term is the dominant driver of income, so an enterprise maximises its payment by serving every household, including the hard-to-reach, rather than by cherry-picking high-value waste. The quality factor protects the downstream compost and recyclable markets by rewarding clean separation. The value-share term preserves the proven motivating power of a per-unit reward without letting it override coverage. Table 2 sets out the components and the behaviour each is designed to produce.

Term	Meaning	Intended behaviour
B	Base service payment per zone	Covers the fixed cost of operating a zone and makes service viable before any material is sold.
C	Verified coverage rate (share of households reliably served)	Dominant income driver; rewards serving every household, including the poorest and most peripheral.
Q	Quality factor (separation cleanliness, schedule adherence)	Protects compost and recyclable markets by rewarding clean, on-time service.
$s \times V$	Enterprise share of recovered material value	Retains the motivating power of a per-unit reward without overriding the coverage objective.

Table 2. Components of the coverage-linked payment formula and the behaviour each is designed to produce.

Figure 5 contrasts the two payment logics. Under a tonnage-only rule, payment rises quickly as easy, high-yield waste is captured and then flattens, so there is little reward for serving the final households; under the coverage-linked rule, payment keeps rising with coverage, so the enterprise is paid most for serving everyone. The financing of the formula is local by design. The pooled revenue that the council settles from is built from three local sources: an income-graduated household service fee, on the Kigali principle that protects poorer residents (Republic of Rwanda, 2008, and the income-scaled fees described in Section 3.6); the sale of recyclables and compost; and a modest municipal contribution toward the coverage component, which is the part of the service that is a public good rather than a private transaction. Section 5.2 examines when these sources cover cost.

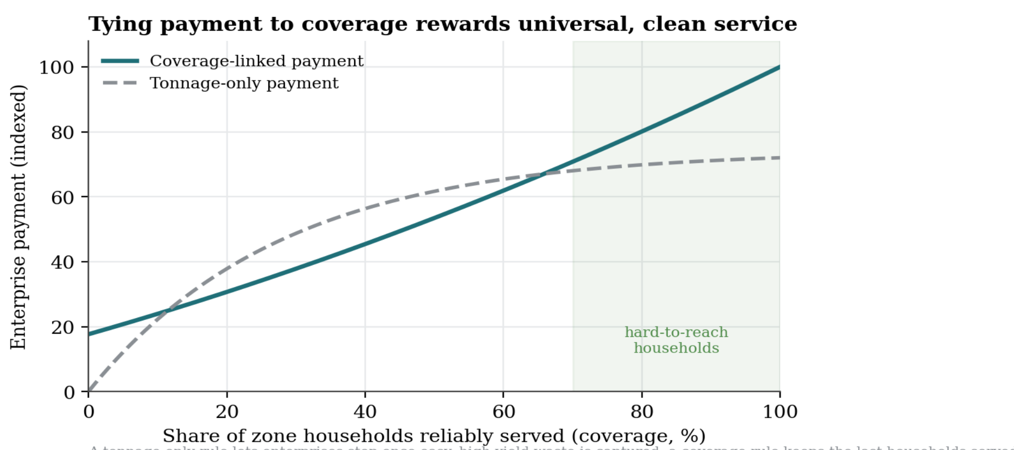

Figure 5. Tying payment to coverage rewards universal service. A tonnage-only rule lets enterprises stop once high-yield waste is captured; the coverage-linked rule keeps the last households served.

5. Scalability

5.1 Within-town scaling: from pilot zones to full coverage

Within a town, the model scales by replication of a standard unit, the micro-zone with its enterprise, rather than by enlarging a single operation. A pilot begins with a small number of contiguous zones that share one composting site and feed the single hub, which allows the operating routines, the verification method and the settlement cycle to be tested at low risk. Additional zones are then added on the same template, each a near-identical copy of the last, until the town is fully covered. Because the unit is small and standardised, scaling up is mostly a matter of repetition and training rather than of redesign, and the marginal zone draws on hub and composting infrastructure that already exists.

5.2 Unit economics and the financial-sustainability threshold

Financial sustainability turns on a simple relationship between scale and cost. The hub, and to a lesser extent the composting sites, carry fixed costs that are spread over however many households the system serves. At low coverage, the fixed cost per household is high and local revenue may not cover it; as coverage rises, the fixed cost per household falls, until total local revenue, from service fees, material sales, compost sales and the municipal coverage contribution, meets and then exceeds operating cost. Figure 6 illustrates this threshold. The practical implication reinforces the coverage-linked formula: serving more households is not only the public-health objective but also the route to financial viability, because it is what spreads the fixed costs.

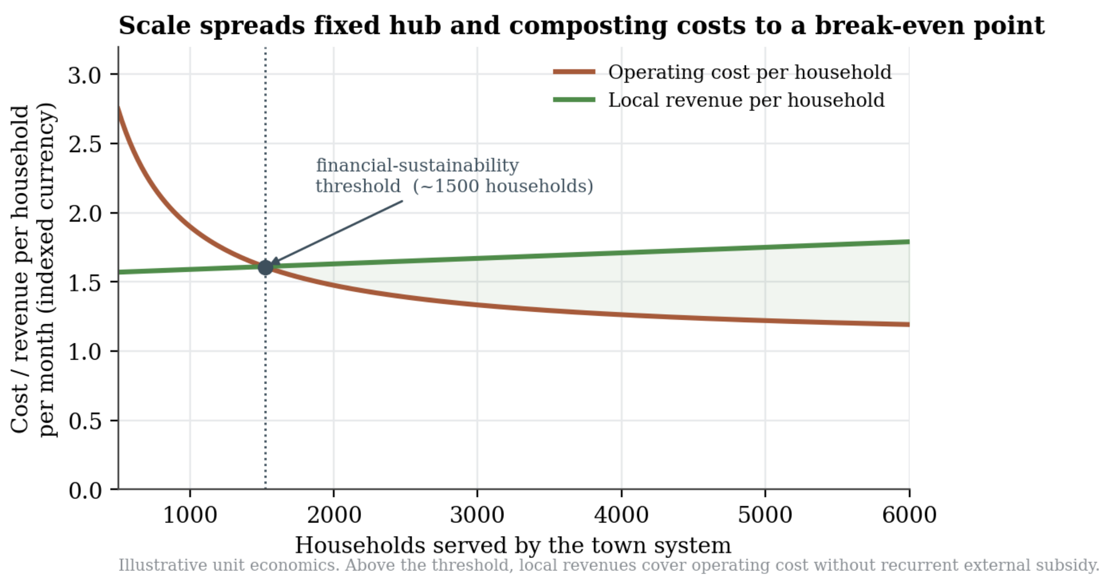

Figure 6. Scale spreads fixed hub and composting costs to a break-even point. Above the threshold, local revenues cover operating cost without recurrent external subsidy (illustrative unit economics).

Designing toward this threshold distinguishes TownLoop from programmes that depended on external reward funding, the vulnerability noted for sponsorship-based rewards in Section 3.3. The aim is not to maximise revenue but to cross the threshold at which the town's own resources sustain a clean environment, so that external funds, if used at all, support setup rather than recurrent operation.

5.3 Network scaling across a country's secondary cities

Beyond a single town, the model scales as a network. Each town runs its own loop, but a shared national or regional platform provides what individual small towns cannot efficiently provide alone: standard clearing and settlement protocols, training and certification for enterprises and composting operators, a common monitoring format aligned to the clean-cities indicators, and, importantly, aggregated off-take. Figure 7 depicts this hub-and-spoke arrangement. By pooling the recyclable output of many towns, the platform can negotiate with buyers from a position of scale that no single small town commands, while leaving operation and value local. This network layer is the natural point of connection to the African Clean Cities Platform and to national clean-city campaigns, discussed in Section 6.3.

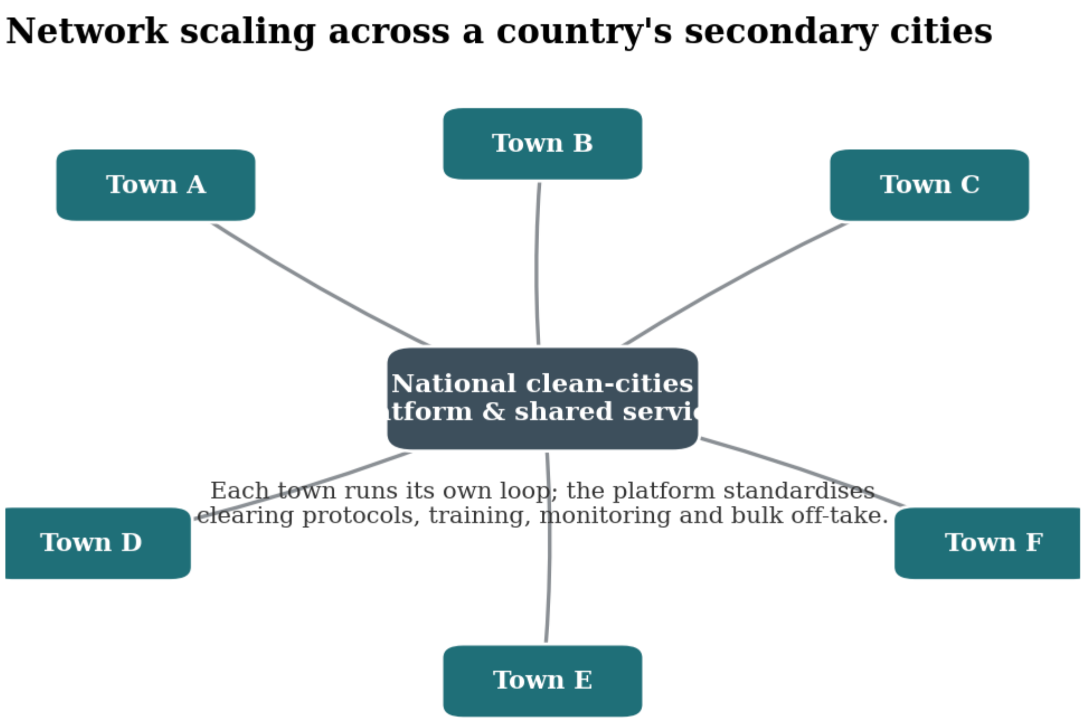

Figure 7. Network scaling across a country's secondary cities. Each town runs its own loop; a shared platform standardises clearing protocols, training, monitoring and bulk off-take.

6. Transferability

6.1 Enabling conditions and contextual prerequisites

TownLoop is designed for portability, but it is not context-free. Several enabling conditions should be present or developable before adoption. There must be demand for compost within an economic distance, which for most small African towns is met by surrounding peri-urban agriculture but should be confirmed. There must be at least one accessible off-taker for dry recyclables, whether a local processor or, through the network, an aggregated buyer. There must be a minimum of municipal willingness to recognise the enterprises, host the clearing council and make a modest coverage contribution. And there must be a means of recording quantities and authorising payment on a fixed cycle, which can be a simple ledger maintained by the council or a basic electronic record, without requiring sophisticated infrastructure.

Where these conditions are weak, they can often be built as part of setup, for instance by developing the farm market for compost in parallel with the composting sites. Where they are absent and cannot be developed, in particular where no compost market exists, the model's central logic of local organic diversion would need rethinking, and adopters should treat the prerequisite check as a gate rather than a formality.

6.2 Adapting to differences in waste composition, density and market access

Three contextual variables call for adaptation. Where the organic share is even higher than the regional norm, the composting capacity and the wet-stream collection frequency are scaled up accordingly, and the case for local treatment strengthens. Where settlement density is high, human-powered collection over short distances is efficient and zone sizes can be generous; where density is low or the town is spread out, zones are smaller in household terms or a light motorised tricycle replaces the handcart, trading some capital cost for reach. Where market access for recyclables is poor, the model leans more heavily on the network's aggregated off-take and on the compost revenue, and may treat low-value dry materials as residual rather than forcing an uneconomic recyclables operation. The standard unit stays the same; the parameters move.

6.3 Fit with the African Clean Cities Platform and national clean-city campaigns

The model is built to fit the prevailing policy architecture rather than to sit beside it. Its objective, a higher share of households served and of waste managed in controlled facilities, is exactly indicator 11.6.1 of the Sustainable Development Goals (United Nations, 2015), and the clearing council generates these figures as a routine by-product of settlement. This makes a TownLoop town a ready contributor to the measurement that the African Clean Cities Platform and the Waste Wise Cities approach promote (Ministry of the Environment of Japan and others, 2017). National clean-city campaigns, of the kind exemplified by Rwanda's combination of rules, enforcement and civic participation (Republic of Rwanda, 2008), provide the political backing and the norm-setting that the model's household participation depends on. TownLoop can therefore be presented to national and regional bodies not as a competing scheme but as an operational template for delivering the clean-city goals they already hold.

7. A proposed pilot and evaluation design

7.1 Site-selection criteria for a secondary-city pilot

A credible pilot should be sited where the model's logic can be fairly tested and the enabling conditions are present. Table 3 sets out the selection criteria. The intent is to choose a town that is representative of the secondary-city tier rather than exceptional, so that a successful pilot is informative for replication.

Criterion	What to look for
Population scale	A small or secondary city, broadly tens of thousands to a few hundred thousand residents, representative of the tier the model targets.
Waste composition	A dominant organic fraction confirmed by a short characterisation, so that local composting is the right lever.
Compost market	Peri-urban farming within an economic distance, with farmers willing to buy or trial compost.
Recyclable off-take	At least one reachable buyer or processor, or access to aggregated off-take through the network.
Municipal commitment	Willingness to recognise enterprises, host the clearing council and make a modest coverage contribution.
Existing collectors	An identifiable informal workforce that can be recognised and organised into enterprises.
Baseline measurability	Feasible to establish current coverage and disposal so that change can be measured against indicator 11.6.1.

Table 3. Site-selection criteria for a secondary-city pilot.

7.2 Phased rollout (about 18 months)

The pilot proceeds in overlapping phases over roughly eighteen months, shown in Figure 8. The first phase establishes the baseline and forms the clearing council, including agreeing the payment parameters and the verification method. The second introduces two-stream separation and paid collection in a small set of pilot zones, with composting sites and farm off-take arrangements brought on shortly after so that the wet stream has somewhere to go. The aggregation hub and recyclable off-take contracts follow once enough zones are producing material to justify them. Scale-up to full town coverage occupies the second half of the period, replicating the proven unit.

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Monitoring aligned to the clean-cities indicators runs throughout, from baseline onward, so that change is captured as it happens rather than reconstructed afterward.

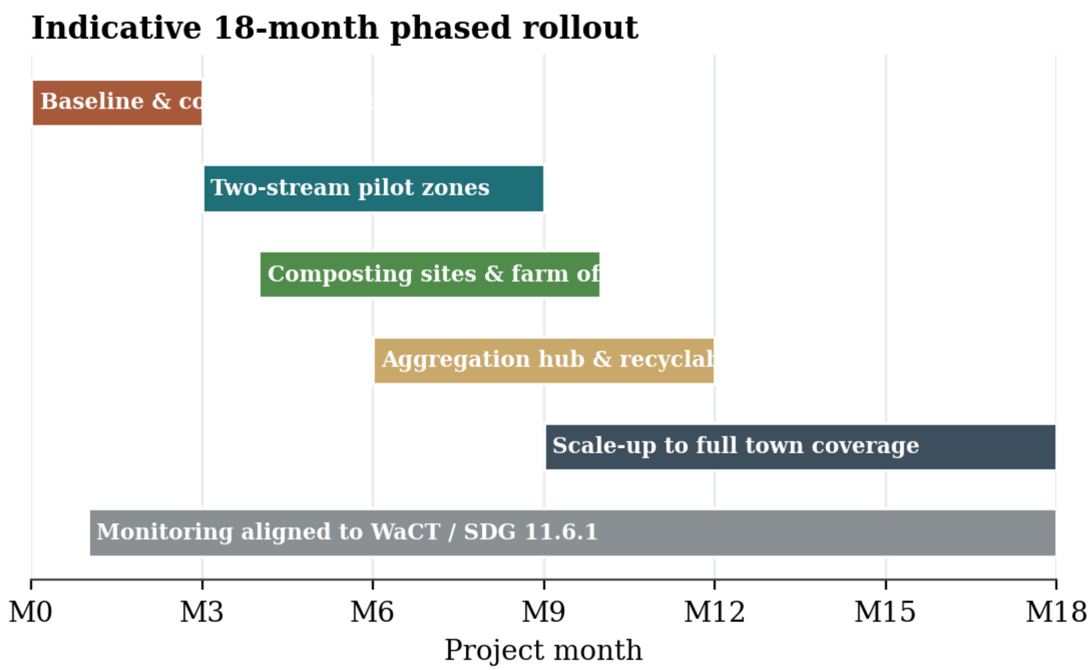

Figure 8. Indicative eighteen-month phased rollout. Composting capacity is brought on close behind the first separation zones so the wet stream has an outlet, and monitoring runs from the baseline onward.

7.3 Indicators aligned to the Waste Wise Cities approach and SDG 11.6.1

Evaluation uses indicators that the clean-cities frameworks already define, so that results are comparable and submittable. The headline indicator is the share of municipal solid waste collected and managed in controlled facilities, which is indicator 11.6.1 (United Nations, 2015). Around it sit operational indicators that the clearing council records as part of settlement, together with outcome and sustainability measures. Table 4 lists them. Because these quantities are generated by the council's routine verification, monitoring imposes little additional burden, and the same records serve both payment and reporting.

Indicator	Definition	Source
Controlled management share (SDG 11.6.1)	Share of generated waste collected and managed in controlled facilities (composting sites, hub, sanctioned disposal).	Council records; baseline survey
Household coverage rate	Share of registered households reliably served, by zone and town-wide.	Council verification (C term)

Organic diversion	Tonnes of organics composted as a share of organics generated.	Composting-site weighbridge logs
Recyclables recovered	Tonnes of dry recyclables sold through the hub.	Hub sales records
Compost sold to farms	Tonnes of compost sold and number of farm buyers.	Hub marketing records
Cost recovery ratio	Local revenue as a share of operating cost (the threshold of Section 5.2).	Council financial settlement
Enterprise livelihoods	Number of collectors engaged and their earnings.	Council payment records
Environmental cleanliness	Reduction in open dumping and blocked drains, by periodic observation.	Spot audits; community reports

Table 4. Evaluation indicators aligned to the Waste Wise Cities approach and SDG indicator 11.6.1.

8. Discussion

8.1 Novelty and prior art

Each component of TownLoop has precedent. Paid zonal enterprises resemble the Accra franchises; two-stream separation with incentives follows the Tamale evidence; buy-back and per-unit rewards echo Manja Pamodzi and Wecyclers; decentralised composting is the Waste Concern model; income-graduated fees and civic governance recall Kigali; and building on informal collectors is the consensus of the formalisation literature. The novelty lies not in any single part but in the integration, and specifically in two governance mechanisms that the prior models did not combine. Figure 9 summarises how the proposed model draws together strengths that earlier approaches held only in part.

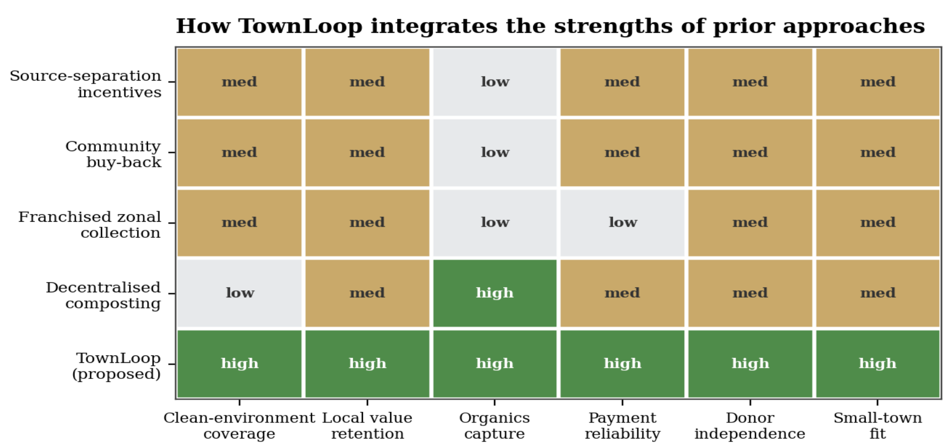

Figure 9. How TownLoop integrates the strengths of prior approaches across the dimensions that matter for a clean, locally financed small-town system (qualitative assessment).

The first novel mechanism is the local clearing council, which makes verification and settlement an explicit, independent and scheduled function rather than an informal afterthought. The reviewed programmes failed or strained precisely where this function was missing. The second is the coverage-linked payment formula, which inverts the usual incentive of buy-back and franchise schemes by paying most for serving everyone rather than for capturing the most valuable waste. Together these mechanisms convert a clean and fully served town from an aspiration into the outcome that the system's own incentives and procedures produce. To the author's knowledge, this particular combination, a coverage-linked payment rule settled by a local clearing council within a closed organic-and-recyclable loop designed for a single small city, has not previously been proposed in this form.

8.2 Equity and the coverage mechanism

Equity is built into the model through the same mechanism that drives its public-health value. The documented inequity of earlier schemes, in which profitable zones were served and poor zones neglected, followed directly from paying for tonnage and value (Baabereyir and others, 2012; Oteng-Ababio and others, 2013). By making verified coverage the dominant term in enterprise income, TownLoop pays most for serving the households that a value-based rule would abandon, which are typically the poorest. The income-graduated service fee reinforces this by protecting poorer residents on the payment side, following the Kigali principle. Equity here is not a separate programme bolted on but a property of the incentive structure, which is more likely to endure than equity that depends on goodwill.

8.3 Failure modes and safeguards: the franchise-collapse cautionary case

The Accra franchise collapse is the clearest warning the literature offers, and the model is designed against its specific failure modes (Post and others, 2003; Oteng-Ababio and others, 2013). Table 5 maps each documented failure to the safeguard that answers it. The honest caution is that safeguards reduce risk rather than remove it. The clearing council depends on the integrity of its members and on the municipality honouring its modest contribution; the compost loop depends on a real and sustained farm market; and household participation depends on collection remaining reliable. These dependencies are why Section 6.1 treats the enabling conditions as a gate and why the pilot in Section 7 is phased to test each assumption before the town commits fully.

Documented failure mode (Accra and others)	TownLoop safeguard
Irregular and delayed payment to collectors	Clearing council settles on a fixed cycle from pooled revenue.
Weak verification of service	Independent council verification of quantities and coverage, with spot audits.

Politically unstable zone assignment	Zone boundaries fixed for the term of the agreement.
Neglect of unprofitable poor households	Coverage-linked payment makes serving every household the income-maximising choice.
Broken cost recovery and fee collection	Income-graduated fees plus material and compost revenue plus municipal coverage contribution, designed toward a break-even threshold.
Dependence on external reward funding	Incentives funded from locally recovered value rather than open-ended subsidy.

Table 5. Documented failure modes and the safeguards built into the model.

8.4 Contribution to clean, healthy cities

The ultimate test of the model is not its recycling rate but whether it keeps a town clean and its people healthier. By prioritising coverage, treating the organic majority that drives nuisance and disease, and removing the institutional weaknesses that caused earlier schemes to lapse back into open dumping, TownLoop is oriented squarely at the clean-environment outcome that the Sustainable Development Goals and the African Clean Cities Platform pursue. Its further claim is that it does so on a town's own resources, keeping both the waste and its value local, which is what gives a small city a reason to sustain the system after any external support ends.

9. Conclusion

Small and secondary African cities have been served poorly by a waste-management literature and a financing model built for large cities. The collect-and-haul template they inherit is too capital-intensive, too dependent on infrastructure they lack, and wasteful of the organic majority that is their largest stream. Yet the field record contains, scattered across separate programmes, most of the pieces of a better answer: simple separation with reliable collection, low-capital local logistics, decentralised composting that turns organics into a local product, shared aggregation for recyclables, civic governance, and the integration of existing informal collectors.

TownLoop assembles these pieces into a single closed-loop system for one small city and adds the two mechanisms the record shows were missing. A local clearing council makes verification and settlement explicit, independent and timely, answering the institutional failures that sank earlier schemes. A coverage-linked payment formula aligns the income of community enterprises with the public goal of serving every household, so that cleanliness and equity are produced by the system's own incentives rather than hoped for. The model is designed to reach a financial-sustainability threshold on local revenue, to scale by replication within a town and as a network across a country's secondary cities, and to report exactly the indicators the clean-cities frameworks measure. The natural next step is the phased pilot set out in Section 7, through which the model's assumptions, above all the durability of the compost market and the integrity of the settlement function, can be tested in a representative town before wider adoption.

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Conflicts of interest
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