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Public-Private Partnerships for the Circular Bio-Economy in the Global South: Lessons Learned

Avinandan Taron, Ayan Majumder, Susanne Bodach and Dzifa Agbefu

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ACRONYMS AND ABBREVIATIONS

APCF	Asia Pacific Carbon Fund
BASA	Bangladesh Association for Social Advancement
BMGF	Bill & Melinda Gates Foundation
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
CAGR	Compound Annual Growth Rate
CBE	Circular Bio-economy
CBO	Community-based Organization
CDD	Consortium for DEWATS Dissemination Society
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
COOCEN	Coopérative Pour La Conservation De L'Environement
DBO	Design-Build-Operate
DBOT	Design-Build-Operate-Transfer
DCC	Dhaka City Corporation
DEWATS	Decentralized Wastewater Treatment System
DTMC	Devanahalli Town Municipal Council
FS	Fecal Sludge
FSM	Fecal Sludge Management
FSTP	Fecal Sludge Treatment Plant
GC	Greenfield Crops
GHG	Greenhouse Gas
HAM	Hybrid Annuity Model
IEC	Information, Education and Communication
JICA	Japan International Cooperation Agency
Kcal	Kilocalorie
KPI	Key Performance Indicator
KSWMIP	Kolkata Solid Waste Management Improvement Project
LCL	Lahore Compost Private Ltd.
LCS	Lowest Cost Solutions
MSW	Municipal Solid Waste
MW	Megawatt
NGO	Nongovernmental Organization
O&M	Operation and Maintenance
PIM	Project Information Memorandum
PMC	Pune Municipal Corporation
PPP	Public Private Partnership
RRR	Resource Recovery and Reuse
SME	Small and Medium scale enterprise
SWOT	Strengths, weaknesses, opportunities, and threats
TPD	Tons per day
ULB	Urban Local Body
WTE	Waste-to-Energy
WWR	Worldwide Recycling
WWTP	Wastewater Treatment Plant

SUMMARY

Circular bio-economy aims at products and services from recovered resources to promote sustainable growth through regenerative practices. It focuses on processing biomass from different waste streams into marketable products such as organic fertilizer and bio-energy.[1] While the 'circular' terminology remains dynamic, processes like organic waste composting and biogas production are established resource recovery and reuse (RRR) mechanisms, which can significantly benefit from private sector participation to link the sanitation and agricultural sectors, improve production efficiency, and enhance the quality of waste services in a standardized way. In developing countries, the private sector can be expected to contribute technical skills, organizational capabilities, marketing expertise and leverage capital inflow. In contrast, the public sector will provide the regulatory framework and help its enforcement, plan public investments, involve and educate stakeholders, and ensure waste supply. A well-organized and technically capable structured mechanism of public-private entity can therefore render a sustainable bio-circular economy.

The present study reviews case studies that implemented public-private partnerships (PPP) in resource recovery and reuse from waste streams with a particular focus on Asia and Africa. Critical factors behind the success and failure of these cases were analyzed. Based on the case studies and literature, recommendations are put forward on how best to use PPPs to promote the circular business model and the key issues to be considered for successful implementation. It focuses on PPP models that recover and reuse the organic fraction from solid waste and fecal sludge, which have received less attention than PPP models for wastewater treatment plants (WWTPs). The review indicates three key barriers to success: (i) waste-related bottlenecks, (ii) limited awareness about RRR products, their market(ing), and waste recycling and (iii) lack of proper institutional frameworks. Municipalities often fail to meet their commitments in the quality and quantity of waste, leading to underperformance of the resource recovery plants. Challenges related to source segregation and collection of waste are frequently cited as one of the primary reasons causing variations in the composition of waste and the quality of the recovered resources. The lack of proper waste source segregation stems from the limited awareness of the citizenry on waste management. Municipalities might not fulfill their mandate to collect segregated waste for resource recovery, or there are competing collection services. These problems are aggravated by bottlenecks in the institutional framework and an absence of well-defined interlinkages between the stakeholders. Prominent examples of unsuitable framework conditions for promoting RRR PPPs include the lack of tipping fees, a dearth of clarity on government assets and statutory commitments, poorly-defined payment mechanisms for using the equipment and machinery owned by the municipality, insufficient marketing, missing sales-oriented key performance indicators (KPI), and short-term contractual models.The process of establishing the PPP can be initiated by any party, including a third party, and should be driven by strong local demand and not predominantly external funding agencies.

Given these recorded barriers to success the study points out mitigation measures which include (i) technical analysis to find the most appropriate technology, (ii) financial assessment to understand the investment and operation costs and assess revenue streams to sustain business, (iii) legal analysis to define the roles and responsibilities of the involved parties and stakeholders and (iv) social and environmental assessment to understand the likely impacts of the project. Apart from these general measures, PPP projects related to RRR can benefit from considering ring-fencing of municipal finance, proper scoping of how to engage with the private sector as well as implementing innovative payment mechanisms such as hybrid annuity or including penalty regulations. Moreover, it is required to establish close monitoring, appropriate procurement mechanisms and due diligence during the project preparation and pre-bid. If possible, such a PPP project should consider scalability during the project preparations and integrate recovery from different waste streams.

Firstly, the project selection and development process of an effective PPP in the RRR market shall be backed by a pre-feasibility assessment pointing out risk allocation, commercial viability assessment as well as financial strategy planning. Secondly, during the procurement, establishing appropriate prequalifying and evaluation criteria for the bidder can facilitate selection from a competent set of private parties experienced in the targeted market of the recovered resources. Contract designing is an essential component outlaying the scope of service and risks with clarity; it should include incentives for service delivery through service level benchmarking and KPIs which go beyond resource recovery and include the reuse, i.e., sold volumes versus the waste collected.

In a PPP, the public sector has a leading role in defining objectives, prioritizing the project criteria, framing the applicable policies and regulations and finalizing the type of PPP to implement. Private sector involvement is crucial in

[1] Organic fertilizer is usually compost based; it is also known by the public as bio-fertilizer, soil conditioner, humus or 'manure'. Bio-energy can refer to biogas or, for example, briquettes made from sawdust, wood chips and/or charcoal.

implementation, sharing the financial risk and engendering technological innovation. An effective PPP formulation, therefore, requires matchmaking of the public and private sector expectations. This study proposes different measures to tackle such expectations using close collaboration between the stakeholders for resource recovery. The public sector's role in promoting circularity is visualizing the present investment needs and introducing efficiency through private sector engagement. The successful involvement of the private sector in the RRR market is critical to close the resource loop and safeguard human and environmental health, which is the overarching objective of sustainable waste management.

1. INTRODUCTION

1.1. Towards a Circular Bio-economy

Circular bio-economy (CBE) is the production of recoverable biological (waste) resources and the conversion of these resources into high-value-added products, such as food, feed, bio-based products and bioenergy (Gatto et al. 2021). The transition to a bio-based economy with closed resource loops is necessary to ensure resource conservation and sustainable growth for future generations (European Commission 2017). CBE minimizes the depletion of resources, encourages regenerative practices, and stimulates reuse and recycling in a way that adds the highest possible value to the system (Muscat et al. 2021). It focuses on using waste and residues as a valuable resource (UNEP 2016; Stegmann et al. 2020). CBE fosters the sustainable processing of biomass into marketable products (Figure 1) such as organic fertilizers, or energy in the form of fuel, power or heat (Hetemäki et al. 2017; Temmes and Peck 2020; Zabaniotou 2018; Stegmann et al. 2020). As shown by Otoo and Drechsel (2018) resource recovery and reuse (RRR) is no longer about technologies but business models.

The CBE market has substantial economic potential. The size of the waste-to-energy market is estimated at USD 39.8 billion in 2021 (Globenewswire 2022), with a compound annual growth rate (CAGR) of 5.3% (between 2022–28). Similarly, the compost market stands at USD 9.2 billion with a CAGR of 6.8% between 2019–2024 (Globenewswire 2019). The economic potential of resource recovery from fecal sludge (FS) treatment in low-income countries is estimated at USD 5 per person and year (Mallory et al. 2020). Another growing resource for CBE practices is food waste. The economic potential for resource recovery through food waste management is estimated at USD 34.22 billion, with a CAGR of 5.4% between 2020 and 2027 (Grand View Research 2022). Municipalities facing the challenge of urbanization need to plan and envision the safeguarding of citizens' health and environment by taking steps toward appropriate waste management. Investments made in the public utilities for waste can help in realizing economic returns in the long run by capturing the market potential as well as lowering health and environmental risks in future.

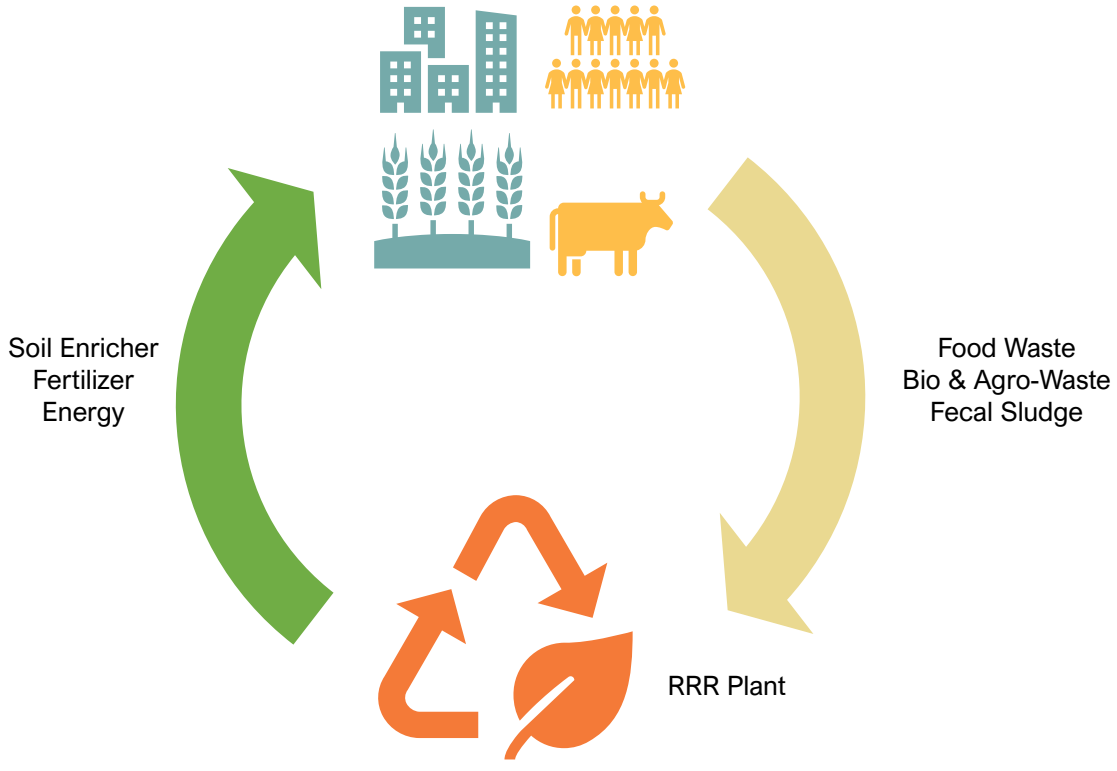

FIGURE 1. RESOURCE RECOVERY AND REUSE (RRR) PLANT IN A CIRCULAR BIO-ECONOMY.

In developing countries, bio-based waste can act as a significant revenue source if managed well, for example, as potential feedstock through various biomass conversion processes (Nizami et al. 2017). The CBE focuses on sustainable resource-efficient biomass valorization in Asia and Africa using an integrated, multi-output product chain. Such optimization must ideally consider each of the three pillars of sustainability: economic, environmental and social (Stegmann et al. 2020; Feleke et al. 2021). Resource recovery and reuse (RRR) practices offer immense potential for improving the return on investment of safely-managed sanitation-waste services in public-private partnerships (Zarei 2020). Nutrients and energy can be recovered from different resources — raw wastewater streams, sewage sludge, fecal sludge and organic solid waste — to create an additional revenue stream (Zhang et al. 2018; Zarei 2020). Promotion of sanitation and waste management in a circular bio-economy through the financing mechanism of PPP is an effective way to convert waste into a resource and render it harmless (Xu et al. 2015).

Many RRR initiatives explore the means to mitigate the impacts of climate change within the waste sector by encouraging waste reduction and recycling and reducing the negative impact on the environment. Opportunities to realize these goals are available via organic fertilizer, energy and water for irrigation and aquaculture. Creating an affordable nutrient-rich organic fertilizer would address possible adverse effects of chemical fertilizers on the environment. In addition, the use of waste-derived briquettes can reduce charcoal and firewood consumption and deforestation.

Effective and efficient low-cost conversion technology and risk mitigation processes can generate revenue for the CBE value chain by transforming biomass feedstock into valuable products (Tapia et al. 2019). Such technologies include aerobic or anaerobic digestion for compost and biogas production, amongst others. The conversion efficiency of these processes plays an essential role in the economic performance of a technology. For developing countries, composting is a relatively 'low-tech' conversion solution for feedstock, which can remove pathogens as a way of risk mitigation from the final treatment of feedstock (Cofie et al. 2016). Composting can constitute an attractive solution for treating fecal sludge (FS) and provide an opportunity to sanitize it. At the same time, composting ensures the recovery of nutrients and returns them at a low cost to the soil (Moya et al. 2019). Experience from developing countries underscores the several challenges that waste-to-energy technologies face in terms of waste feedstock quantity and quality, emission control, citizen's perceptions as well as other factors, which is discussed in the successive sections.

1.2. Public-Private Partnerships (PPPs) for Scaling Resource Recovery and Reuse (RRR)

While running municipal public utility services, one of the most common issues in developing countries is the techno-commercial feasibility and viability. The urban local bodies (ULBs) depend heavily on household tax (e.g., property taxes) and user fee collection for services such as waste and wastewater. They are also reliant on the general budgetary provision from the state and central governments. However, in many instances, these three means cannot ensure the commercial viability of the system. In many cases, public authorities have not been effectively able to recover the investment, failing to recirculate the potential physical resources back into the system. With increasing urbanization, waste management has become a significant challenge for ULBs and municipalities. Promoting CBE practices in municipal solid waste and fecal sludge management (FSM), particularly resource recovery from the organic waste fraction, is an excellent opportunity to increase the cost recovery of these public utility services. Organic fertilizer for soil amelioration and fertility enrichment as well as recovered energy are broadly understood to be major components which can be derived through a CBE system. Segregated municipal organic waste, agro-industrial (including agricultural) residues and FS are the three major resources with revenue-generating potential. Recovery of valuable materials employing organic composting, co-composting, fecal sludge treatment and waste-to-energy technology can generate substantial revenues if effectively and efficiently implemented. Moreover, resource recovery brings an enormous positive impact on environmental and community health, local economy as well as the resilience to climate change.

The participation of the private sector in scaling RRR solutions in the waste sector using PPP approaches can significantly ameliorate the efficiency and quality of service provision in a standardized way. In developing countries, the private sector can be expected to contribute technical skills, organizational capabilities and flexibility. In contrast, the public sector must strengthen the regulatory framework, control costs, plan investment, educate users, establish and enforce regulations and by-laws and involve producers and consumers. Thus, a well-organized and technically capable public-private entity can render RRR services required to achieve a full circularity. While developing a PPP in the RRR market, the following key issues should be considered:

1. Long-term technical feasibility,
2. Ensuring revenue generation to run the service,
3. Attracting sufficient private sector investment,
4. Inviting the local community to participate actively, and
5. Effectively factorizing a high investment load and loan on assets, etc.

In discussing the PPP framework as an instrument for scaling RRR, it is imperative to understand the key challenges:

In small cities, towns and peri-urban areas of the developing world, the solid and liquid waste in general is not always properly managed, with bio-waste being neither reused nor

recovered. Waste collection rates are low and municipal waste disposal relies heavily on open dumpsites and landfills that are not adequately engineered and do not follow sanitary landfill standards (UNEP 2010; ADB 2011). In most cases the waste is not segregated, leading to lower resource recovery. Due to improper disposal practices, the randomly disposed waste clogs waterbodies which causes flooding. With increasing urbanization, this practice is leading to serious environmental, social and economic concerns (UNEP 2010; Hoornweg and Bhada-Tata 2012). In Asia and Africa, where population density in small cities and peri-urban areas is very high, moving towards resource and energy recovery is a necessity. PPP may help to improve operational efficiency, reduce financial and technical burden on the local government and manage potential risks. It allows for a win-win situation for the government and the private contractor, to obtain valuable economical resource and revenue from solid and liquid waste. However, for a successful RRR business model through a PPP arrangement, the project should aim to achieve at least some of the following objectives (Figure 2):

FIGURE 2. OBJECTIVES FOR A SUCCESSFUL PPP IN THE RRR MARKET.

1. Capturing the potential market,
2. Producing a high-quality end-product for improving crop and soil quality,
3. Technological innovation,
4. Climate change mitigation and resilience,
5. Risk sharing benefit, and
6. Policy level opportunities.

Box 1 describes the above-listed objectives in detail and explains their significance.

Employing resource recovery and reuse (RRR) in the waste value chain does not always leads to huge commercial benefits or high economic prospects. However, it contributes substantially to the environment and social improvements. Other anticipated benefits include improved soil quality and reduced industrial fertilizer use, which are often imported. Moreover, RRR decreases the waste disposal load and, in turn, the amount of waste which goes into the landfill, promoting a shift towards the holistically sustainable model of circular bio-economy (CBE).

The PPP framework can potentially strengthen RRR projects by making the implementation more effective and efficient, a win-win situation for government and private entities. Investment in water and sanitation infrastructure often has lower financial returns when compared to businesses in other sectors (Peterson 2003). Furthermore, typical accounting practices generally overlook the positive externalities of RRR projects, such as avoided disposal costs, reduced soil erosion and climate change mitigation (Oviedo-Ocaña et al. 2016). Other unaccounted cost reductions are linked to reduced energy use and decreased waste incineration, less air and water pollution, and the conservation of natural resources (Abdel-Shafy et al. 2018). Small municipalities suffer and are often short of monetary funds and capacities — they might not have the vision to propagate the social and environmental benefits achievable through a circular economy approach to the general public.

Conceptualizing a PPP model in the RRR market comes with specific challenges. For example, institutional and contractual adjustments between private and public entities might be required to cope with unforeseen political intervention. That might also lead to changes in the project timeline and reallocation of responsibilities. While adopting or replicating success stories, sufficient case-specific due diligence is essential to meet regional and local needs.

This publication brings comprehensive insight into circular bio-economy practices with a particular focus on Asia and Africa. It showcases opportunities for using the PPP framework to effectively recover material and energy resources from bio-waste by involving private entities. Critical factors behind the success and failure of case studies in different regions are also analyzed. Based on the case studies and literature, recommendations are put

forward to use PPPs as an instrument to promote the RRR business model and the key issues to be considered for successful implementation. It focuses on PPP models that recover and reuse the organic fraction from solid waste and fecal sludge, which have received less attention than PPP models for wastewater treatment plants (WWTPs).

In the following section, Chapter 2 – *Lessons learned from the Asian and African RRR market* presents the findings from the analysis of 12 PPP case studies in the RRR market and highlights the major barriers to success. It also suggests mitigation measure to address the barriers and challenges. The third chapter, *The Roadmap for an effective PPP in the RRR Market* outlines key issues to be considered for preparing a PPP on resource recovery and describes how to structure the PPP project effectively. It can be used by municipalities and project advisors as a guideline for developing, preparing and implementing PPPs in the RRR market. Finally, Chapter 4, *Roles of Stakeholders in PPP framework* assesses the PPP stakeholder landscape in the RRR market and discusses the important contributions of each stakeholder for achieving a successful PPP.

BOX 1: KEY OBJECTIVES FOR A SUCCESSFUL RRR BUSINESS MODEL THROUGH A PPP ARRANGEMENT.

Capturing the potential market: Generating revenue through RRR has an enormous market potential in developing countries. The RRR end-product from the household's resources (organic waste, fecal sludge) and agricultural resources such as biomass from agriculture can significantly contribute to the revenue products, which have economical value indeveloping countries. Intervention of private entities can always effectively help to capture this potential market through institutional mechanisms and an effective business framework.

Producing a high-quality end-product for improving crop and soil quality: Soil enricher, organic fertilizer and compost produced from solid waste, co-compost plant or fecal sludge treatment plant (FSTP) can effectively improve crop production and enhance soil quality.

Technological innovation: Research organizations, entrepreneurs, trade organizations and NGOs can be involved and play a significant role in the PPPs for supporting product development, marketing and sales. Knowledge institutions can also enable the provision of technology and expertise.

Climate change mitigation and resilience: Besides the economic revenue, scaling of CBE practices through PPPs will contribute to Greenhouse Gas (GHG) emission reduction in the waste and agriculture sector, helping in substantial environmental benefits, local climate change mitigation and resilience.

Outcome-oriented result: In a well-structured PPP framework, an outcome-oriented result can be achieved with specific, measurable, attainable goals within a particular time frame. The ultimate benefit of the end product lies with the consumers or citizens, thus making the system more convincing and outcome-oriented.

Financial sustainability: Resource recovery from bio-waste generates additional revenue and allows the business model to be more self-sustainable. It also reduces the dependency on public funds.

Risk sharing benefit: The joint efforts of the public and private sectors offer great potential for closing infrastructural development gaps. The PPP provides a framework for the public and private sector partners to build and sustain a medium to long-term relationship of mutual benefit. In a PPP, the role of the private partner is often to become a long-term service provider rather than being an upfront project contractor. It may also combine the responsibilities of designing, building, operating and financing projects to deliver the services needed by the public sector.

Policy level opportunities: Policy gaps in the sector can be jointly turned into opportunities by co-designing effective and efficient PPP ventures. The active involvement of both public and private sector partners is essential in this process. Development partners can provide guidance. The PPP innovation in the RRR market can also be used to improve PPP regulation to empower the public and private stakeholders to engage in a fruitful collaboration.

2. LESSONS LEARNED FROM THE ASIAN AND AFRICAN RRR MARKET

During the last couple of decades, circular bio-economy is being seriously adopted as a potential means of resource recovery in many developing countries. While CBE projects structured through a PPP framework have proven successful in several cases, there are some notable failures as well. The primary reasons for the failure of such projects include:

- Limited market knowledge to optimize revenues,
- Limited management capacity of municipalities,
- Lack of proper institutional framework,
- Inconsistent waste flow information,
- Lack of citizens' awareness on waste segregation.

At the same time, there is evidence of several examples from Asia and Africa with a robust PPP framework which have resulted in technically feasible and commercially viable circular bio-economy projects. Key factors in their successful implementation were:

- Optimizing operational procedure and responsibilities,
- Increased design capacity (economics of scale),
- Advanced know-how of waste flows and nature,
- Inducing small enterprises and entrepreneurs,
- Well-established market linkages,
- Understanding market size and co-finance options
- Strong bonding between public and private entities,
- Performance-oriented PPP contract.

The following section provides an overview of the countries' readiness for PPP in Asia and Africa before analyzing relevant PPP success stories among African and Asian countries. The analysis aimed to identify critical factors for the successful setup, process and operation of plants which use organic municipal waste, agro-waste and fecal sludge for resource recovery. Finally, the lesson learned have been summarized, with some suggested mitigation measures.

2.1 Country's Readiness for PPPs

Asia

Endo and Ram (2021) categorize developing countries in Asia implementing PPPs into (i) PPP mature countries, (ii) intermediate PPP application countries and (iii) PPP less-developed countries (Table 1). The authors observed that developing countries in Asia with higher incomes relative to other countries have better success in implementing PPPs, a trend noted worldwide.

The first group comprises China and India, where the application of PPPs has readily taken off, with the total amount of project investment reaching USD 455 billion, equivalent to 77% of the market share in Asia. The second group includes Indonesia, the Philippines, Thailand and Viet Nam. According to the number of projects, PPPs in these countries are increasingly taken off. However, Group II countries are still in the process

TABLE 1. PUBLIC-PRIVATE PARTNERSHIP (PPP) PROJECTS THAT REACHED FINANCIAL CLOSE IN SELECTED DEVELOPING COUNTRIES IN ASIA (1990–2016).

Country	Number of Projects	Total amount of projects (USD billion)
Group I: PPP mature countries		
India	861	314.0
People's Republic of China	1,052	139.0
Group II: Intermediate PPP application countries		
Indonesia	120	18.6
Philippines	119	56.9
Thailand	150	38.8
Viet Nam	84	16.2
Group III: PPP less-developed countries		
Cambodia	25	3.1
Myanmar	6	1.5

Source: Endo and Ram 2021.

of improving their PPP-related legislation, regulation and institutions to promote extensive deployment. Compared to the first two, Cambodia and Myanmar comprise the less-developed country group with a smaller number of realized projects.

The enabling environment of several countries shows evidence of efforts toward improving the enabling climate for PPPs (Figure 3). Countries like India, China, the Philippines and Thailand receive high scores equivalent to developed countries like Japan and Korea (EIU 2015, 2018). Despite such efforts, countries like the Philippines and Thailand still lag behind the developed world in their application of PPP models because the PPPs are limited to few sectors. To address this gap, development partners have recently started actively pursuing the creation of bankable PPP projects. This is achieved by supporting feasibility studies and bringing all relevant stakeholders together. Consequently, PPP transaction advisory services constitute the top of the agenda of development institutions (Endo and Ram 2021).

African countries

In Africa, five countries account for more than 50% of all successful PPP activity from 2008 to 2018: South Africa, Morocco, Nigeria, Egypt and Ghana. Other countries have multiple PPPs in] the pipeline, e.g., Burkina Faso with 20 projects and Botswana with 8 (Terry 2020). Although 33 of the 54 total African countries have PPP policies in place, limited experience in structuring and procurement of PPPs is a significant bottleneck for implementation. Sectors like energy, transport and ICT account for the majority of PPP investments, while less than 5% of the total amount between 1999 and 2019 was observed to be invested in water, sewage and solid waste management (Dauskardt and Ganguly 2020).

Compared to developing Asia, African countries are less ready for the deployment of PPP models. South Africa has with 71 by far the highest scoring for an enabling PPP environment. It is followed by Morocco, Kenya and Egypt, which score above 50 (see Figure 4). PPPs are seen as an essential element to fill the gap for infrastructure investment in the coming years. Africa's infrastructure investments need financing of up to USD 170 billion a year by 2025, with a financing gap of USD 68 to USD 108 billion a year which could be filled by the private sector (Terry 2020).

2.2 Key Barriers and Factors of Success

Significant infrastructure investments in developing countries are successfully utilizing PPP models; they have further attracted private investment in the waste sector at a limited scale. For upscaling investments, it is critical to learn from the failures. As a result, this study analyzed 12 PPP cases in the RRR sector from Asia and Africa (see Table 2)[2] and identified key barriers that can be considered as lessons learned for establishing successful PPPs. These barriers are further described in the next section.

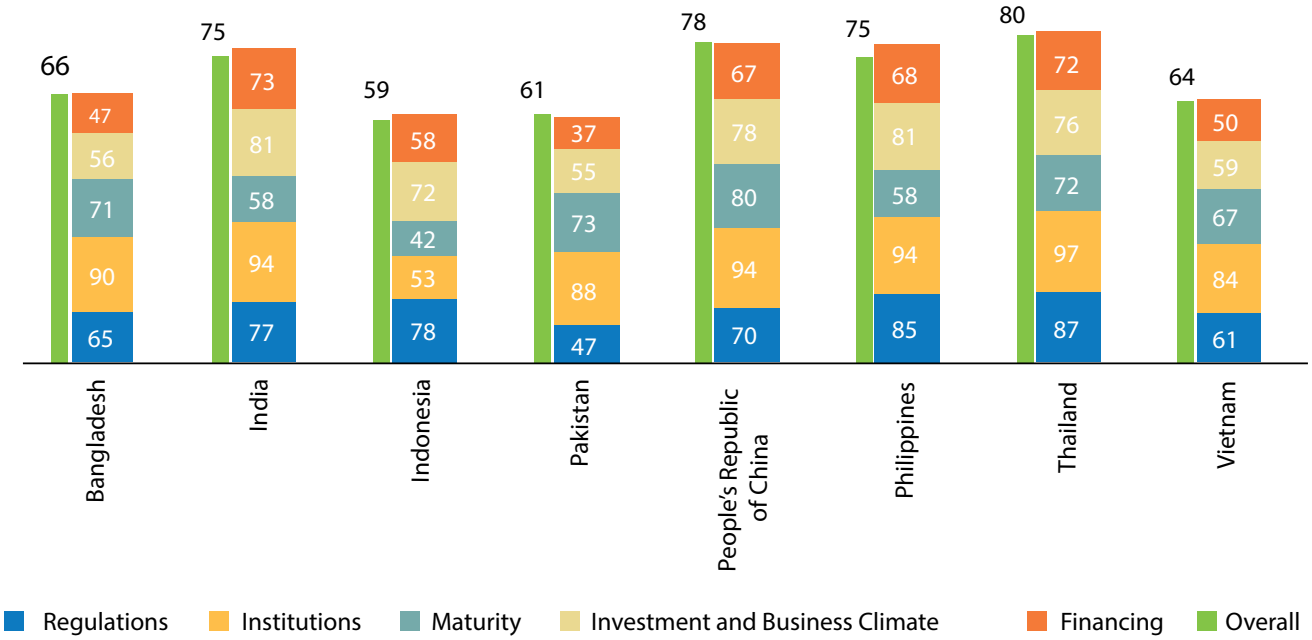

FIGURE 3. COUNTRY SCORING OF THE ENABLING ENVIRONMENT FOR INFRASTRUCTURE-RELATED PPPs IN SELECTED ASIAN COUNTRIES, 2019.

Note: The higher the score, the better the enabling environment for PPPs.

[2] The detailed description of the case studies is presented in the Annex.

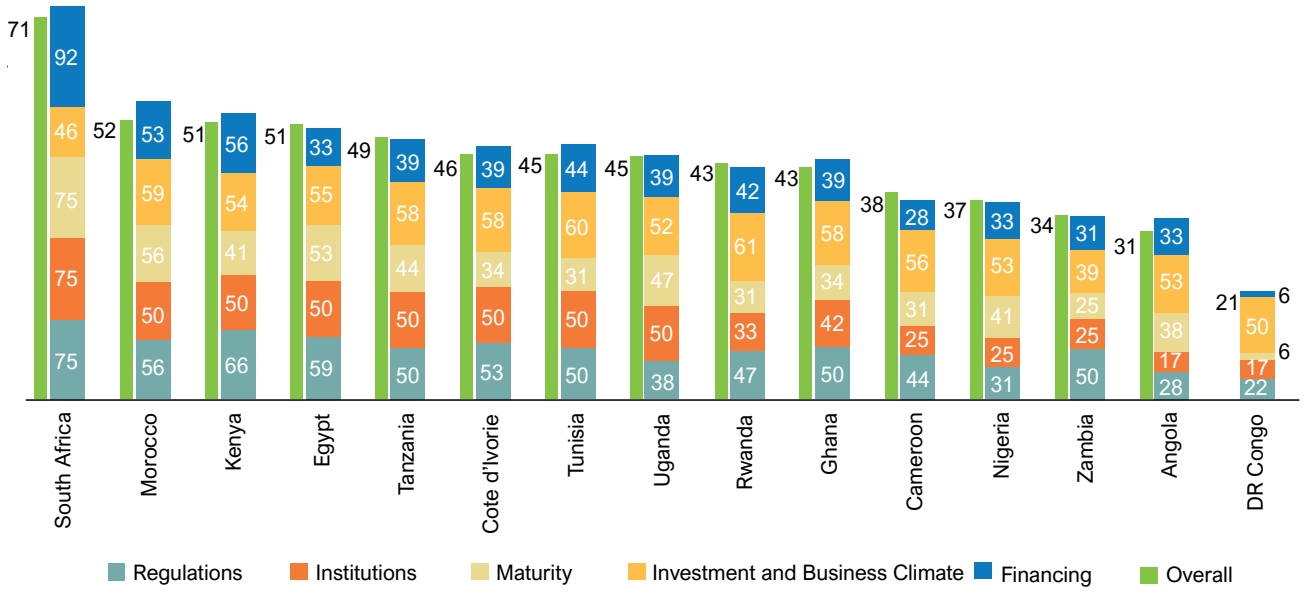

FIGURE 4. COUNTRY SCORING OF THE ENABLING ENVIRONMENT FOR INFRASTRUCTURE-RELATED PPPs IN SELECTED AFRICAN COUNTRIES, 2019.

Note: The higher the score, the better the enabling environment for PPPs.

2.2.1. Input-related Bottlenecks

Not meeting the committed quantity of waste

The analyzed cases[3] offer evidence that resource recovery plants cannot achieve the expected treatment performance when the plant does not receive the waste as per the design capacity. In most of the resource recovery plants[4], the municipality guarantees feedstock supply, but there can be competing services for the same waste affecting the supply like in the case of Somanya, Ghana. The urban local bodies (ULBs) should provide realistic information on the committed waste quantity (as provided in the bid document) since this is a crucial factor for the optimal operation of the plant. Adequate delivery of biomass feedstock enhances the capacity utilization of RRR businesses. If the RRR businesses financed through PPPs cannot access regular feedstock, it is difficult to ensure the seamless conversion to high-value-added products. Eventually, less waste input will result in lower end-product quantity (soil enricher, bio-fertilizer, compost or electricity), which might further impact the project's financial viability. During the project planning and feasibility analysis, municipalities must also consider possible competition for feedstock by different RRR projects.

Poor segregation and substantial variation in the composition of waste

Resource recovery from municipal solid waste largely depends upon the adequate segregation of organic waste and inorganic waste from the waste stream. Inefficient, or an absence of, waste segregation at source leads to mixing up dry and wet waste and other inorganic waste. Poor waste segregation eventually tends to affect the performance of the recovery process. For example, a calorific value of organic waste below 1,000 kcal/kg with high moisture content cannot support the effective combustion process in a waste-to-energy plant. The Nashik waste-to-energy (WTE) plant is operating at 40% of its operational design capacity, due to issues of the quality and quantity of waste supply and segregation (Bhushan and Sambyal 2018). Gianyar composting plant in Temesi, Indonesia, also operates below its financial feasibility due to the absence of source segregation — the private entity needs to outsource segregation activity, which accounts for 42% of their total annual operational costs.

2.2.2. Limited Awareness about Waste Recycling and RRR Production Services

Limited educational activities and a lack of awareness

Insufficient awareness creation or absence of promotional drive towards waste segregation or the possible use of recovered material can factor into the failure of PPP projects. An integrated plan to communicate, consult and involve stakeholders from the community is required for the RRR plant to well-function. Information, education and communication (IEC) activities for citizens, SMEs, authorities and employees are crucial during the early stage of the PPP project. As mentioned earlier, waste segregation is vital for the optimal operation of the plant. Hence, sensitizing the community (i.e., the primary waste generators) is essential and should continue beyond an initial campaign.

[3] E.g., Tema Fortifier compost plant in Ghana, KSWMIP compost plants and Nashik waste-to-energy plant in India.
[4] Including fecal sludge treatment plant (FSTP), compost plant, biomethanation and waste-to-energy plant.

TABLE 2. OVERVIEW OF ANALYZED CASE STUDIES FROM ASIA AND AFRICA.

Plant details (Feedstock type and output, scale)	PPP model and tenure	Challenges and achievements
Somanya fortifer compost and briquette plant, Somanya, Yilo Krobo, Ghana		
• *Fortifer*™ compost and pellets produced from fecal sludge and organic solid waste • 5,000 cubic meters (m^3) of fecal sludge and 300 tons of organic waste per year	Service and management contract for 20 years between Jekora Ventures Limited and Yilo Krobo Municipality Assembly	⊖ Unexpected feedstock competition ⊖ Operating under-capacity ⊖ Unable to reach break-even and over-reliance on continuous external financial support for repairs etc. ⊕ Strong links to clients able to absorb compost and briquettes
Large-scale composting plant, Bulta, Bangladesh		
• Compost from organic municipal solid waste (including market waste) • 75–100 tons per day (TPD)	PPP between Worldwide Recycling (WWR) Bio Fertilizer Bangladesh Ltd.[5] and Dhaka City corporation. Service contract for waste collection. Design, Build and Operate contract for the compost plant.	⊕ Successful marketing strategy ⊕ PPP Model replicated in 27 cities of Bangladesh
Matara compost plant, Matara, Sri Lanka		
• Compost and fuel pellets produced from municipal solid waste • 300–400 tons of organic waste every per month	Service and management contract for 7 years between Matara municipality and Green Crops (GC)	⊕ Strong institutional linkages with clarity in operational and financial aspects ⊕ Suitable marketing strategy
Lahore compost plant, Lahore, Pakistan		
• Compost produced from municipal solid waste • 1000 tons per day of mixed waste collected	Build-Operate-Transfer model for 25 years between Lahore Compost Ltd. (part of Saif Group of Companies) and city district government Lahore (CDG)	⊖ Technological barriers ⊖ Lack of technical expertise, ⊖ Poor marketing strategies
Integrated solid waste management with compost and waste-to-energy recovery in Pune, India		
• Municipal waste to energy (used for street lighting)	PPP contract for service and management (renewable every 5 years) between Pune Municipal Corporation (PMC) and consortium of SWaCH (an NGO) and Mailhem Engineers Pvt Ltd., for management of waste to produce biogas, electricity and bio-sludge.	⊕ Proper planning by PMC towards utilization of waste ⊕ Cost recovery ⊕ Strong institutional linkages with defined roles and responsibilities
Briquettes from solid waste in Kigali, Rwanda		
• Briquettes produced from municipal solid waste • 1,500 tons of briquettes sold since 2018	PPP between the Kigali City Council and Coopérative Pour La Conservation De L'Environement (COOCEN) – build, operate and own briquette plant; service contract for waste collection	⊕ Suitable marketing strategy (briquettes used as fuel in schools, prisons and factories) ⊕ Provision of land from public sector ⊕ Sufficient waste available

(Continued)

[5] A joint venture company of Waste Concern in association with its Dutch partners - World Wide Recycling B.V, FMO Bank and High Tide Worldwide B.V.

TABLE 2. OVERVIEW OF ANALYZED CASE STUDIES FROM ASIA AND AFRICA. (CONTINUED)

Devanahalli fecal sludge treatment plant and the co-compost unit, Karnataka, India		
• Co-composting and biogas[6] produced from fecal sludge	Service and management contract for 2-year between Devanahalli Town Municipal Council (DTMC) and CDD (NGO)	⊖ Operating under-capacity ⊕ Participation of citizens for approval of plant location ⊕ Good institutional linkages ⊕ Marketing facility for the product
Co-composting plant Sakhipur, Bangladesh		
• Co-composting from organic solid waste, dried fecal sludge and sawdust	Sakhipur municipality, WaterAid Bangladesh, Bangladesh Association for Social Advancement (BASA) and Department for Agricultural Extension	⊕ Proper planning by the municipality toward waste utilization, suitable marketing strategies, cost recovery
Kolkata Solid Waste Management Improvement Project, India		
• Compost from municipal solid waste	Six municipalities of Kolkata Metropolitan Area and private parties (consortium between SENES[7] and Yachiyo Eng. Co. Ltd.)	Initially: ⊖ Low management capacity of the municipality ⊖ Improper waste separation ⊖ Low awareness of the residents ⊖ Inefficient market linkages Later: ⊕ Institutional strengthening ⊕ Awareness campaigns ⊕ Training/capacity building of the municipality
Gianyar composting plant, Temesi, Indonesia		
• Compost produced from municipal solid waste • 60 tons of waste per day	Local Municipal council and consortium formed by Rotary Club of Bali Ubud, Yayasan Bali Fokus amd Yayasan Gelombang Udara Segar (GUS)	⊖ Low financial viability ⊖ Lack of waste segregation results into increasing costs ⊖ Absence of tipping fees
Tema compost plant, Ghana		
• Compost and pellets produced from fecal sludge and organic solid waste	Service contract management for 25 years between Jekora Ventures Limited (JVL) and Tema Metropolitan Assembly (TMA)	⊖ Operating under-capacity due to land rights issues ⊖ Weak marketing strategies ⊕ Strong research support ⊖ Insufficient space for drying beds and composting heap for scaling
Waste to energy plant at Timarpur, New Delhi, India		
• Energy produced from mixed waste • 300 tons per day of mixed waste	*First*: Ministry of Non-Conventional Energy Sources (MNES) and Volund Miljotecknik Ltd. of Denmark *Later*: Build, own, operate and transfer for 25 years between Infrastructure Leasing & Financial Services (IL&FS) and the Municipal Corporation of Delhi	⊖ Cumbersome institutional arrangements with changing operational plans ⊖ Lower waste quality leading to technical issues and higher operational costs

[6] Mostly used within plant premises.
[7] Presently merged with Archadis.

Similarly, operational health and safety are required for workers associated with waste collection and transportation. The municipalities involved in the waste recovery should aim to understand the environmental, social and sustainability perspective of using recovered material or energy over and above the project's commercial viability. Limited capacity on structuring the bid and the lack of vision at the municipal level can often lead to the project's failure. Additionally, budgetary constraints to engage professional transaction advisory agencies can contribute to the failure of the PPP project.

In the Okhla waste-to-energy plant, Delhi, the usage of organic waste as feedstock could not support the combustion because a high proportion of plastics, paper and cardboard was included for the incinerators to function. These are precisely the materials that the informal sector recycles. Delhi's waste pickers recognized this threat to their livelihoods and began agitating against the project, holding multiple rallies and demanding for local and national authorities to halt the project. Furthermore, there have been public protests against the emissions and air pollution generated from the plant.

In contrast, the fecal sludge treatment plant (FSTP) in Devanhalli is a good example where sensitization of different stakeholders and awareness is helping to better operate the plant. This FSTP runs on a self-sustainable commercial mode. A transparent, well-defined institutional framework among the stakeholders, with clear commitments on operational aspects and revenues, has been a vital parameter in the success of this plant. During the project development process, the gaps in Devanahalli residents' behaviors were identified, basis which an education and awareness campaign was implemented. This community engagement initiative has been implemented parallel to the FSTP construction and operations. Furthermore, local farmers were incentivized to use the FSTP by-products. The community engagement strategy was fine-tuned based on local requirements. A similar community sensitization in Dhaka led to waste segregation at source and ensured the efficient production of quality compost by the composting plant operator Waste Concern.

In certain cases where there is a lack of capacity and skill to manage such PPP projects, capacity building and skill development programs need to be incorporated even after the project is deemed feasible. For example, the Lahore compost plant in Pakistan faced technological challenges at the initiation. Since this was the first commercial attempt, the private entity lacked technical expertise and was unaware of available after-sales support on the equipment. They contacted several composting companies around the world to get benefit from their experience; they also visited a few composting plants in Europe, India and the United States to discuss issues involved in the manufacturing, marketing and utilization of compost. In addition, the Lahore Compost Private Ltd. (LCL) staff underwent training to handle the composting machinery by the supplier, allowing them to manage the existing facility with success (Masood et al. 2014).

Limited knowledge and planning towards the end-product and service

PPPs should be structured and planned towards the end-product or end-service using outcome indicators beyond merely design and technology selection, but also for reuse/sales. Some of these possible indicators are, for example, the quality and quantity of sold manure, generated electricity, environmental compliances or emissions. Experience shows that the focus on input-based factors often leads to inefficient resource recovery or even complete technology failure. Defining technology specifications may act as a constraint for innovation and competition.

In Timarpur, for instance, a 3.75 MW power plant was installed to treat 300 tons of municipal solid waste daily. The plant conducted trial operations for 21 days before shutting down due to the poor quality of the incoming waste. It required waste with a net calorific value of at least 1462.5 kcal/kg, but the supplied waste's calorific value was between 600–700 kcal/kg. Plant operators tried to supplement the combustion with diesel fuel, but without success. Subsequently, the project remained non-functional and was demolished 3 years after construction. This incident supports the fact that thermal treatment of municipal solid waste is not feasible for waste with a low calorific value. Limited knowledge and improper planning might fail the desired RRR end-product or service.

In contrast, evidence from Pune city shows that proper technology selection makes resource recovery PPP projects feasible. Pune Municipal Corporation has established a PPP venture for decentralized waste processing plants dedicated to composting, biomethanation and waste-to-energy. Finally, biomethanation technology of organic waste was selected due to the low calorific value, with 16 decentralized plants set up across the city. A biomethane-to-electricity plant was constructed by Goa State Waste Management Corporation and the private company Hindustan Waste Treatment Pvt. Ltd. to treat 40 tons of wet waste and produce up to 0.3 MW of electricity (Rao et al. 2018).

Another example is Ghana's Somanya compost plant which can be made operational according to the design capacity. This requires an increase in area of the current composting platform within the plant. The increased composting platform is necessary for two reasons: (i) the high mass reduction during composting, and (ii) the plant uses food waste for compost production; the composting duration of food waste is 17–21 weeks, higher than the baseline projection of 14 weeks. It is estimated that reaching the design capacity by expanding the composting platform would help the plant break even, due to the verified market demand for the compost produced at the plant. These cases indicate that

due diligence and technology selection is crucial to ensure the project's technical viability.

The importance of marketing strategies and market linkages

A well-established market environment reduces transaction costs between the private sector and the government, thereby facilitating the adoption of PPP (Pan et al. 2020). Pan et al. (2020) note good governance and strong market demand to be powerful factors for PPP adoption. A well-developed market environment for the end products of resource recovery stimulates the PPP adoption. However, the market is often unknown and has to be explored. The partnership should be clear on the related responsibilities to better understand market stratification and develop client-oriented marketing strategies.

There has been ample evidence that a weak market (understanding) is a significant constraint for composting plants. Lahore's compost plant faced revenue generation problems because of its poor marketing strategy. During the concession agreement, however, City District Government Lahore (CDGL) agreed to purchase compost for the city's parks, gardens and municipal campuses. This has helped develop the composting product market and improve the prospects for investment returns.

Marketing strategies adopted by Waste Concern in Bangladesh have also been found to boost business revenues. Waste Concern faces a strong buyer power as they mainly sell their compost to price-setting private chemical fertilizer companies which rebrand and sell the compost product. This model is an excellent example of a win-win partnership between key players. It has been instrumental in attracting large amounts of foreign direct investment (FDI) in organic composting. Private entities need to strategize marketing based on the underlying market conditions. To illustrate, while there is a demand for compost among the mango farmers in Somanya, Ghana, this demand is seasonal. Such existing market conditions should be identified at the business planning stage, according to which mitigation measures should be developed.

An instance of good market linkage which helped the operation of a PPP producing briquettes from solid waste is visible in Rwanda. The Kigali City Council provided seven hectares of land to the private entity COOCEN to produce briquettes from organic solid waste. COOCEN is the sole supplier of fuel briquettes to 16 prisons in the country. The payback period for this project has been only 3 years; the gross profit margin is 42%. Notably, COOCEN anticipated an increase in briquette demand due to the rising price of charcoal coupled with the government policy to protect the environment and promote alternative sources of energy (Adam-Bradford and Gebrezgabher 2018). Thus, there is an excellent opportunity for upscaling the plant in the future.

2.2.3 Barriers to Regulatory and Institutional Mechanisms

Lack of proper institutional framework

The absence of well-defined interlinkages among the PPP stakeholders and institutions involved in the RRR service chain results in poor resource recovery. Consequently, the PPP framework must ensure functional coordination between all respective parties or contractors. According to the literature, PPP projects in waste management and RRR are relatively slow due to inefficient institutions, limited governance and weak market linkages (Chatri et al. 2012; Pan et al. 2020). A good institutional environment and other market factors will attract private sector actors for the PPP project, increase private sector profits and temper stakeholder conflicts (Tan and Zhao 2019; Yang et al. 2013). Moreover, the effectiveness of the resource recovery PPP project is principally dependent upon performance at each stage. The key performance indicators (KPI) at each stage of waste management and RRR can help ensure performance and reach the optimal resource recovery potential. In Sri Lanka, the Western Province Waste Authority defined their KPI as the ratio between compost actually sold and potential compost production per month, ranking all their stations according to their performance to not only identify those needing support but also to generate peer-pressure.

A private sector example is Greenfield Crops (GC) which revived the compost business in Matara, Sri Lanka, by adopting a better institutional framework. Initially, the RRR business was not financially feasible, and was contingent on government funds. It has now been revived through a PPP agreement for a period of 7 years. GC started satellite compost stations closer to local markets to minimize transportation costs for waste collection for the municipality and distribution of compost products. Its compost is sold at a flat price exclusive of the transportation fee. This PPP has saved the municipal council a significant amount of money which hitherto was used in operating the composting business as it was incurring losses. According to the agreement, the composting facility and equipment are owned by the municipality, and GC would pay a service fee per month for using the facilities and equipment. In turn, the city paid tipping fees to GC for handling waste, the other source of revenue (Otoo et al. 2018). Hence, the private sector cannot ignore institutional arrangements when delivering public services. It is the government's responsibility to create a favorable institutional framework which enables the development and implementation of PPP (Harvey 2005).

In the compost plant at Bulta, Bangladesh, Waste Concern maintains good relationships with Dhaka City Corporation, private enterprises and community-based organizations (CBOs) to optimize the allocation of resources and activities. This reduces the risks associated with high capital investments, assuring a large market for their end product (Otoo and Hope 2018).

Incentive structures and mechanism

It often seems challenging to attract new private companies to operate in the waste sector. Despite proposed subsidies, it may remain difficult to encourage investments in the sanitation sector. In Ghana, for example, most companies which respond to government's calls for scaling up RRR business initiatives are waste management companies. They are already used to dealing with waste, with waste collection activities in place — any recycling or reuse activity offers an opportunity to reduce waste volumes and save costs, e.g., for transport, dumping, and landfilling, with the advantage of eventually expanding their business horizon. Compost sales are not their primary interest if they can rely on tipping fees. Therefore, they are not necessarily repelled by the prospect of (at least initially) 'limited' potential for generating additional revenue. Private technical firms are at times attracted to such initiatives primarily for the opportunity to test and validate their technologies, without interest in actual compost marketing. The design of effective incentive mechanisms like tipping fees is crucial for boosting the revenues of private entities entering such partnerships. In the case of compost plants, the compost generated through resource recovery does not fetch immediate revenue unless marketed and tailored as per user demand. Tipping fees provided to the private entity for handling the waste act as an incentive to recover a part of their operation and maintenance (O&M) costs for the initial years, before the increase in revenues from compost.

The Gianyar composting plant in Temesi, Indonesia, for instance, demonstrates limited financial feasibility due to the absence of tipping fees. Similarly, subsidies to chemical fertilizers provide an uneven playing ground for the revenue stream of the derived compost. The importance of tipping fees can be explained with the case of Green Crops in Sri Lanka, where the business was revived by tipping fees provided by Matara Municipal Council (USD 5 per ton of waste disposed).

Municipalities should design their KPIs, payment mechanisms and fee structures, keeping in mind that while waste management is a mandate for them in the short run, actual resource recovery and environmental health are the overarching goals.

Less clarity on Government assets and statutory commitments

A lack of clarity on government land and its interdepartmental handover process substantially reduces the project's credibility to attract potential private players. The risk of less transparency on land ownership and its statutory documentation becomes a critical parameter for stimulating the participation of the bidder. The concession authority must ensure that public assets are made available to the bidder for setting up the plant.

Land ownership is a major obstacle for PPPs in Ghana, especially in the Build-Operate-Transfer (BOT) and Design-Build-Operate (DBO) models. A significant share of land in Ghana is owned by traditional authorities, not the government. However, the government has the right to lease it for 99 years. This can lead to a conflict of interest, with projects becoming unduly overburdened financially since they must pay money to both the local assemblies and the traditional authorities simultaneously (Alidu 2018). In the case of the Somanya plant, the site for the plant was changed several times due to land ownership issues leading to delays and additional costs. Tema compost plant in Ghana failed, among others, due to a third party claiming the land of the PPP. The operation of the compost plant in Sri Lanka improved under a 7-year PPP contract where the municipality allowed the private entity to utilize the machinery and equipment payable by the partner. Such arrangements during the contract phase entail necessary stock-taking and proper negotiation between the parties and entities.

For the fecal sludge treatment plant (FSTP) in Devanhalli, the municipality committed to (i) provide the land and approval for the construction, (ii) take responsibility for operating a desludging vehicle on a fee-for-service basis by issuing the license to private desludging operators and (iii) ensure that FS is disposed at the FSTP, and organic waste is delivered to the co-composting plant.

Short-term contractual models

Most resource recovery and reuse (RRR) projects, particularly small, decentralized facilities, face failure due to short-term contractual models (Cookey et al. under review). Bidders are not offered convincing time to reach a breakeven period for their investment if the concession period is not long enough to generate sufficient revenue through the sale of recovered material. A complex set of value domains is critical within PPPs for RRR because it allows the organization to maintain a longer time horizon to realize financial returns. The venture may not generate revenue gains in the short term, as system outcomes centered on social or environmental impact may not always be compatible with economic outcomes (Velis 2015). Thus, a socially-driven enterprise temporarily overlooks the insufficient revenue in the short term. However, they are committed to the long-term endeavor as long as they meet social and environmental objectives and find ways to remain financially viable via other avenues.

Fluctuating carbon price

RRR plants are also eligible for climate financing, i.e., through carbon credits. Many of the analyzed composting plants[8] are highly dependent on the revenues through Certified Emissions Reductions (CERs), a carbon credit scheme obtained through the Clean Development Mechanism (CDM). However, the CERs price has been fluctuating in the recent decade resulting in lower revenues for the RRR projects. Sometimes the CER revenue is too low to even pay for the periodic verification of carbon credits. In this situation, existing projects are no longer viable, which runs contrary to the CDM

[8] Such as Pakistan's Lahore compost plant, Bulta compost plant in Bangladesh, Gianyar composting plant in Temesi, Indonesia.

objective. This is especially applicable to small scale projects heavily dependent on CDM carbon credits.

Waste Concern in Bangladesh, however, managed 34,200 CERs from the Asia Pacific Carbon Fund (APCF) of the Asian Development Bank (ADB). APCF signed an agreement with WWR Bio Fertilizer Bangladesh Ltd. to purchase CERs, stemming from emission reductions generated by the project. This illustrates that alternative source of funds for CERs should be sought by the project.

2.3. Lessons Learned and Possible Mitigation Measures

Many of the above-described challenges lead to increased revenue risks of the RRR PPP project. Other critical factors for poor performance range from insufficient information on the project background, poor quality of scoping due diligences and inefficient bid transaction processes to less clarity on the land availability and associated permits. Some projects face technical problems during operation, causing reduced performance. The market rate of the end-product is also significant in the commercial success or viability of the RRR economy. Low quantity and poor quality of the end-products (e.g., compost manure, soil enricher, bio-fertilizer or power) might reduce revenues and limit the success of the RRR PPP project.

Key barriers recognized in the resource recovery PPP projects can be broadly linked to (i) technical feasibility, (ii) financial viability, (iii) legal and contractual issues, and (iv) communication, education and awareness (see Figure 5). These barriers can be translated into risk factors which need mitigation to achieve a successful resource recovery PPP project (see Table 3). Mitigation measures can be identified by assessing the relevant issues in each key area through the following studies:

1. **Technical analysis**: to find the most appropriate technology
2. **Financial assessment**: to understand involved investment and operation costs, assess economic viability, and develop a financing plan
3. **Legal analysis**: to create the legal basis for implementation and operation, in particular, the roles and responsibilities of public and private partners and
4. **Social and environmental impact assessment**: to understand the likely positive and negative impact on people and the environment and develop mitigation measures, including an education and awareness plan.

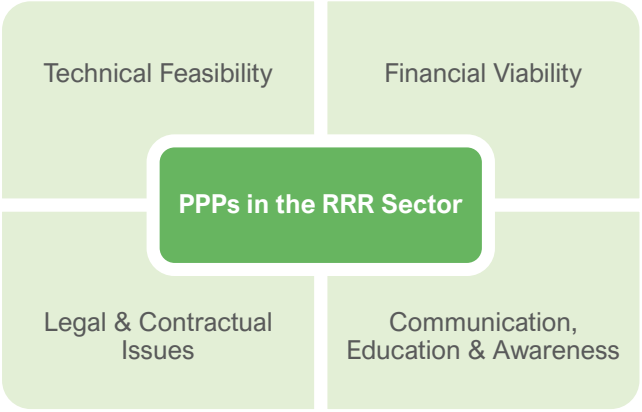

FIGURE 5. FOUR KEY ISSUES FOR ESTABLISHING PPPs IN THE RRR SECTOR.

TABLE 3. BARRIERS AND RISK FACTORS FOR SUCCESSFUL PPP PROJECT IN RRR SECTOR.

Key Issue	Barriers	Risk Factor	Required assessments
Technical feasibility	Poor segregation and substantial variation in the composition of waste	Operational risk, revenue risk	Technical analysis
Financial viability	Not meeting the committed quantity of waste	Revenue risk	Financial analysis
	Short-term contractual models	Contract risk, revenue risk	
	The importance of marketing strategies and market linkages	Revenue risk	
	Fluctuating carbon price	Revenue risk	
Legal and contractual issues	Lack of proper institutional framework	Contract risk, performance, and revenue risk	Legal analysis
	Limited knowledge and planning towards end-product and service delivery	Political risk, performance risk	
	Incentive structures and mechanism	Revenue risk, contract risk	
	Less clarity on Government assets and statutory commitments	Contract risk	
Communication, education and awareness	Limited educational activities and a lack of awareness raising	Health and environmental risk, operational risk	Social and environmental analysis

An important lesson learned from the case studies is that weak linkage between the PPP stakeholders will negatively impact the performance of the RRR project and increase the potential for failure. The needs and requirements of all stakeholders must be balanced to design an effective and successful resource recovery PPP. Figure 6 illustrates the priorities and concerns of the four major stakeholders. For example, the users are looking for an affordable public service while the operator focuses on assessing the market demand. Communication, transparency, efficiency and competition are critical components in designing and implementing a PPP in the RRR sector.

The analyzed case studies illustrate several general challenges along the stages of the PPP project development (Figure 7). In the initial stage, the limited experience of the public authorities, lack of waste data and problems in securing land for the PPP constitute a significant for the project. In the partner identification stage, resource recovery PPPs often face the challenge of potential private partners not being able to meet some critical qualification criteria. Limited financial capacity and contracting problems might also act as substantial bottlenecks. General challenges during the implementation stage range from a lack of service standards and limited monitoring capacity to poor stakeholder or community engagement and weak implementation planning. All challenges require addressal with effective application of strategies and mitigation measures. Table 4 provides a detailed summary of all identified challenges along the project stages with suggestions for possible solutions.

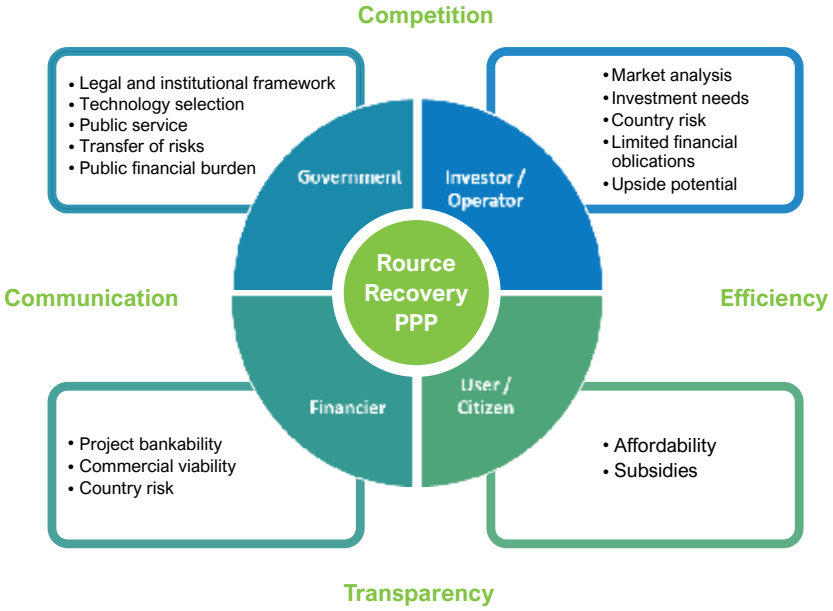

FIGURE 6. KEY STAKEHOLDERS AND THEIR PRIORITIES WITHIN THE CIRCULAR BIO-ECONOMY PPP PROJECT.

Source: Adapted from Fridegotto 2017.

Apart from the general challenges listed above, the analysis of the case studies brought out several specific issues. These issues and possible mitigation measures are discussed below:

Ring-fencing of Municipal Finance — Resource recovery and reuse (RRR) through a PPP model depends on the financial mechanism of the macro project within which the RRR framework is being inbuilt. For example, in a sanitation RRR project where sewerage charges cover the O&M expenses, the public entity bears the revenue risk. They collect the sewerage charges from the end-users but pay the contractually agreed amount to the private sector. In such a PPP system, a payment security mechanism through ring-fencing of the revenue may mitigate the financial risk and burden on the public authority. In a typical bio-circular economy PPP model, where resource recovery is an essential aspect of the value chain, the following components entail ring-fencing to strengthen the financial framework of the model:

TABLE 4. CHALLENGES WITH A PPP FOR CIRCULAR BIO-ECONOMY AND SUGGESTIONS FOR IMPROVEMENT.

Stages	Challenges	Impact	Recommendations
Initiation	Limited experience of the public service authority to function effectively as client, regulator and enabler within the PPP framework.	Limits PPP expectations and reduces clarity in responsibilities.	Establish PPP units within the central governments to strengthen the authority's understanding, and to build to build capacities and systems, for example in contract management, monitoring and enforcement.
	Municipal authorities often lack systems to measure the waste generation quantity and monitor the waste composition. Available waste data are primarily estimates.	Limited understanding of the nature and magnitude of the waste problem to design appropriate management options.	Establish a monitoring system for waste generation, including quantity and quality, resulting in better long-term planning of waste management and RRR.
	Difficulty in securing land availability and clearance. Changing implementation sites due to land tenure issues will require repeating feasibility studies (waste supply, market demand).	Lack of adequate land for waste processing and landfills constraints project implementation.	The government should identify and allocate land to handle, manage, process and dispose of waste, taking the expected waste generation amount over the next 40–50 years as a priority. The PPP contract should not exceed the maximum time of available land for processing and disposal of waste amount.
Identification of private sector	Challenges in contracting processes, e.g., cumbersome due diligence, contract drafting and negotiations.	Leads to prolonged and sometimes delayed contract implementation.	Preliminary investigation on possible contractual arrangements to identify problems that could constrain contracting for infrastructure management and services. Select PPP options that are legally possible and most suitable under the givenv context, policy, and revenue streams.
	Lack of essential qualification criteria in mitigating performance risk.	Defining loose qualification criteria could lead to unfair competition and increases the risk of non-serious operators getting in.	Define relevant qualification criteria to enhance a transparent bidding process and effective shortlisting of reputed bidders with a demonstrated track record. While developing qualification criteria, the public partner should balance quality/ experience considerations with contestability. While setting very stringent standards could reduce competition intensity.
	Limited financial capacity.	Late withdrawal can negatively impact resources and timelines.	Consider the private partner's financial capacity and genuine interest at the proposal preparation stage.
Identification of public sector	Delays in receiving feedback on documents and lengthy procedures for legal review.	The public sector usually works within power and authorities, which might involve lengthy bureaucratic	To address this challenge, organize short briefing sessions and constant follow-up with key decision-makers to obtain feedback on important decisions. procedures.

(Continued)

TABLE 4. CHALLENGES WITH A PPP FOR CIRCULAR BIO-ECONOMY AND SUGGESTIONS FOR IMPROVEMENT. (CONTINUED)

Stages	Challenges	Impact	Recommendations
Negotiation	Partners who are new to technology and required to commit their resources can be affected by skepticism.	Partners might not see the prospects of the business. Low confidence in RRR business and technology among partners.	Decision-making officers should help clarify the business potential of RRR project and build technology confidence among partners. Conduct a regular and open discussion on the business ideas and requirements involved.
Implementation	Loose standards for service provision. Limited capacity for monitoring and enforcement of standards.	It reduces the viability of private sector-led services.	Develop and apply innovative and cost-effective smart monitoring and regulatory measures (such as GPS tracking of vacuum trucks in Kampala). Additional modes of monitoring and enforcement can complement the public sector efforts.
	Difficulty in getting private sectors to invest in RRR business because of low demand and limited proven market for sanitation products.	Some private entities scout for donor agencies to invest in RRR. Minimal capital investments.	Public funds can de-risk capital investments in innovative business models by supporting capacity building or incentivizing the private sector.
	Poor stakeholder engagement, lack of transparency and openness in the PPP processes.	Lingering conflict among stakeholders. Risks pushed to the public partners due to sole sourcing.	PPP can adopt a merit-based approach to attract partners with the required resources in terms of expertise, technology and finance. Avoid partisan considerations. Adopt an open and transparent process as much as possible involving all potential private actors to bid for the process.
	Lack of a flexible legislative framework and weak local implementation plan.	Weakens local government institutions.	Strengthen the capacity of local government to formulate laws and principles for PPP regulation. Provide robust regulatory frameworks with monitoring systems to prevent, for example, excessive tariffs from the private institutions.
	Lack of cooperation or involvement of community members.	Without the active participation of people and communities, even well-funded RRR projects may fail.	Ensure good communication and engagement with the community. Build strong partnerships with local communities and users to gain trust and support.
	Poor client relationship.	Reduced confidence level in good service provision and customer dissatisfaction.	Establish customer complaint and redressal system and use feedback to improve constantly quality of service.
	Insufficient waste supply during the concession period.	Lower end-product quantity and quality, e.g., lower power generation. Reduced revenue lead to lower profitability.	The government should guarantee to supply the required waste amount to the concessionaire in accordance with the agreement signed by both sides.

(Continued)

TABLE 4. CHALLENGES WITH A PPP FOR CIRCULAR BIO-ECONOMY AND SUGGESTIONS FOR IMPROVEMENT. (CONTINUED)

Stages	Challenges	Impact	Recommendations
Implementation (continuation)	Financial limitations and uncertainty.	Unexpected delays and additional costs during the implementation stage.	The government should explore as early as possible funding sources, such as appropriate allocation of taxes, capturing commercial potential through recycling and levying user charges. Encourage community participation and management of a door-to-door collection of user charges.
	Limited technical and financial capacity of local municipality regarding waste management.	Slow responses and delays in decision-making processes and action implementation.	National policies and regulations with an implementation and financing scheme that empower local governments and equips them with the required capacities for implementation.
	Technical challenges due to the and construction of the recycling to plants.	The recycling plant is not able to produce at full capacity.	Find a strong implementation partner and foster technological innovations retrofit existing plants.

FIGURE 7. OVERVIEW OF GENERAL CHALLENGES ALONG THE PPP PROJECT STAGE.

- Desludging charges paid by users to the service provider
- Property tax designated for FSM-related activities
- Tipping fees from private operators may be charged at designated disposal sites
- Registration and licensing charges or deposits to be paid by the desludging operators
- Fines for faulty containment system construction and illegal disposal of fecal sludge
- Sale of by-products — compost, soil enricher, bio-fertilizer, biogas, etc.
- Other sources, e.g., advertisements

The system needs to be a self-sustainable model bringing the different components under a single umbrella.

Proper scoping to engage the private sector — The private sector engagement should be guided through a scoping mechanism with key considerations (Figure 8). First, a common understanding of the operational role and responsibility of the private sector and linkages with the public sector (mostly municipalities) is vital. The operating limit can either be spatially demarcated or based on activities. The contract to engage the private sector can subsequently be designed basis these operating limits. Second, the private sector should formulate financial plans to determine their operations' feasibility. The financial feasibility comprises defining viable revenue stream(s) capital investments, and operational and maintenance costs. For developing a robust plan, private entities require information from the public sector in the form of assets (to be generated and shared), the payment mechanisms and the project's tenure. The public sector usually derives this information while conducting the project's feasibility assessment. The public entity must take stock of their capital investments in the form of land, machinery and equipment; the assets shared for implementation of the project must be delineated. Additionally, the public sector should undertake planning for a payment structure based on benchmarking (quality and standard of output and services) and project tenure. Altogether, these processes indicate the risks for the private sector; thus, the private sector should accordingly plan for risk mitigation measures.

Implementation through Hybrid Annuity Model (HAS) — The Hybrid Annuity based PPP model for RRR projects, a well-balanced framework with clear commitments and risk-sharing from both parties, has been successful in developing countries. Thereby, the most critical feature is the Annuity and O&M payments being linked to the performance. A well-performing plant will eventually lead to effective resource recovery and reuse of the end products (soil enricher or bio-fertilizer). It will also ensure the sustained usage of the assets due to better accountability, ownership and optimal performance. The role of transaction advisory is essential to not only develop a balanced 'Request for Proposal' but also for market development by promoting the project with the right target group. Continued engagement with the private sector through the project's life is indispensable for building trust. Revenue risk is one of the biggest challenges in RRR projects arranged through a PPP model — both demand and payment are critical factors for performance. However, such risks have been somewhat counter-measured in the hybrid PPP models.

Close Monitoring — Depending upon the end use, the implementing agency should closely monitor the soil, crop products and health of the associated farmers to ensure the quality of recovered material such as soil enricher, bio-fertilizer, etc. Active participation of the fertilizer organization, agricultural research institute and other concerned stakeholders is needed from the onset of the project formulation.

Preparedness for the PPP procurement process — PPPs should provide a transparent risk-sharing arrangement between the parties involved. The general principle is

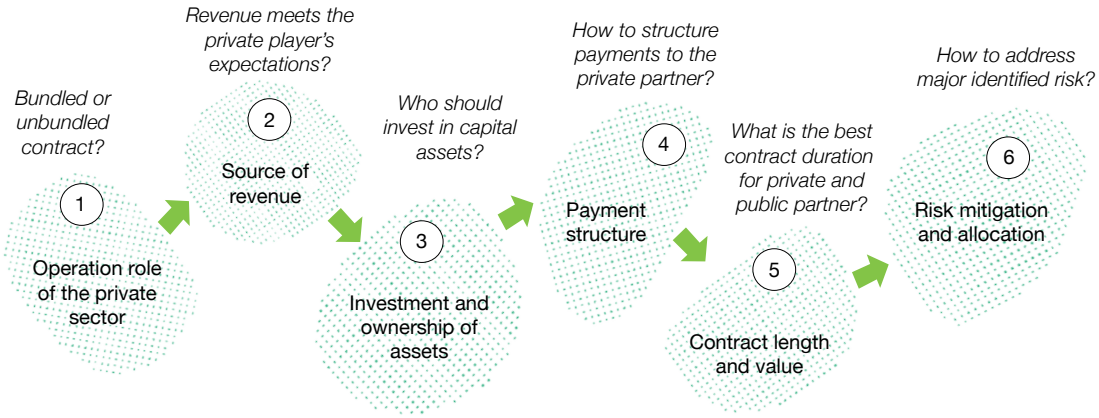

FIGURE 8. KEY CONSIDERATION FOR PROPER SCOPING OF PRIVATE SECTOR ENGAGEMENT IN A CIRCULAR BIO-ECONOMY PPP.

Source: CEPT University 2015.

that project risks are allocated to the most cost-effective party. For example, political and regulatory risks are more appropriate to the public sector, while the private sector handles construction and operation risks. The allocation of commercial risks depends on the expected demand for services produced by the project and the predictability of costs and revenues.

Pre-bid due diligence — The government, as a party to the PPP agreement, should ensure preparedness during the pre-bidding phase, with due attention to the following:

- Standardized documents (request for qualification, request for proposal),
- Selection of appropriate project site,
- Land procurement arrangements,
- Project appraisals,
- Detailed technical studies,
- Financial and risk analysis and
- Required statutory and regulatory approvals, permits, and clearances.

A readiness mechanism aids in streamlining and facilitating the bidding process. The plant's technical parameters are the governing criteria for a PPP project to become successful or fail. Two critical technical parameters are (ii) the demand for the recovered product in the market and (ii) the quantity of feedstock (septic sludge or organic agro-waste). These should satisfy the design capacity of the plant.

Scalability — Project scalability is essential for enhancing the PPP revenue from resource recovery. In the decentralized system, the option of a modular capacity increase of the FSTP or organic waste composter might raise the revenues. The modality of scalability could be achieved in three ways:

- Scale up at the current production facility by optimizing the use of existing production facilities whereby the production process should be reexamined to identify and reengineer the critical bottlenecks to improve efficiency,
- Scale-out through replication at other sites, increasing the total output of the RRR outcome, thereby reaching economies of scale and a subsequent decrease in the unit price or
- Scale up through partnerships with other socially conscious organizations, for example, a private company with other private or public entities interested in establishing similar RRR businesses.

Connecting the last mile — In most cases, a resource recovery project is an integral part of a larger project, such as a wastewater treatment plant, a fecal sludge treatment plant (FSTP) or an integrated waste management system. In such cases, the success largely depends upon the service chain, in which the overall performance does not necessarily lie upon a single accountability point. Therefore, stringent monitoring of regulatory compliance is essential at each service chain of the PPP project. An integrated and inclusive approach which can ensure regular and sufficient supply of feedstock (from multiple sources) can lead to business sustainability (Cookey et al. under review).

Other Measures — To regulate and make the PPP contract more effective, the contract should provision for penalties for the illegal dumping of fecal sludge and waste. During the design of the plant capacity, the provision to accommodate future requirements should also be considered. Giving incentives to the private partner is another effective tool for performance consistency. For example, the contract with the private partner may be extended by another 5 years after satisfactory performance. Such incentives could be linked with targets of achieving a certain collection ratio. Performance-linked incentives will push the private partner to accomplish the project's KPI) (SNV Bangladesh 2020).

3. THE ROADMAP FOR AN EFFECTIVE PPP IN THE RRR MARKET

Lessons learned from PPP projects in the RRR market have shown promising potential for attracting private investment. However, it is important to consider the key associated barriers and address them through suggested mitigation measures. The roadmap presented outlines critical issues to be evaluated while developing and implementing a PPP in the RRR sector. It aims to guide public authorities, PPP advisors and private stakeholders to establish a successful resource recovery PPP.

3.1 PPP Project Preparation

3.1.1 PPP Project Selection and Development Process

The first and most important step before developing a PPP project for RRR is to identify the needs and analyze the project's viability. For this purpose, a project's cost-benefit analysis shall be conducted as a part of the feasibility study. The cost-benefit analysis must consider the government's strategic objectives and available budget, along with ensuring legal and regulatory compliance. The probability of success, possible externalities, social costs and stakeholders' accountability shall also be considered as a part of the viability analysis.

A Strength, Weakness, Opportunity, and Threats (SWOT) analysis on private operators, availability of public funds and project risks are required to identify project risks and provide mitigation strategies. The optimal utilization of public funds and the efficient reuse of the recovered material should be key driving parameters while formulating the PPP RRR project.

In the implementation of a resource recovery project in the solid waste or sanitation sector,[9] two major parameters at the forefront are (i) the effectiveness of waste management system and (ii) efficiency of the resource recovery in terms of technical and financial viability. Through a PPP framework, these can primarily be addressed during the project development process itself. A PPP project will be more effective and efficient if the following requirements are fulfilled:

- Scope for an open technological intervention and innovation for private contractors,
- Optimization of the operational expenses,
- Minimizing the technical risk by introducing KPIs,
- Greater speed of delivery,
- Cost certainty at early project stage and
- Less administrative complexity.

For a successful implementation of the RRR project, the structure of the PPP is fundamental. Critical components to be considered at the project development and implementation stage are enumerated in Table 5.

3.1.2 Prefeasibility Assessment and Risk Allocation

Public consultations and detailed technical surveys and audits are the most significant parameters in determining the baseline condition during the project development. Thorough and extensive collection of baseline data can mitigate the risk of failure to a substantial extent during the implementation phase.

A project information memorandum (PIM) document must be prepared and validated through competent technical agencies for robust and realistic project scoping. The viability of achieving sufficient segregation is one of the governing parameters while implementing the RRR project. Therefore, a feasibility assessment on waste composition and the public authority's commitment to promoting waste separation are two game changers for the PPP private contractor.

Through literature review and primary survey, the quantity of fecal sludge and solid waste generation in the target area must be verified first. Before project implementation, the current use of waste and unprocessed waste details shall be identified, along with the sessional fluctuation of quantity and quality. Besides physical feasibility, other important information, such as local labor charge, transportation costs, etc., shall also be gathered during the project preparation and development period. A clear and transparent vision on land availability for setting up the recycling and recovery facility (FSTP, co-compost plant or waste-to-energy plant) should be in place.

Information, education and communication (IEC) must be initiated from both partners for a robust outcome. The municipal authorities shall inform and consult all key stakeholders — users, community groups and associated NGOs, potential private operators, financial institutions, political representatives and other government organizations — during the project development phase. Furthermore, the local demand for recovered material and energy, the market link, the user's readiness, and the acceptability must be analyzed before the implementation. A business development plan and promotion strategy for the recycled end-product is recommended as part of the feasibility assessment.

The municipality should also assess its financial status to determine the revenue surplus or deficit. This analysis will also determine the possible financial contribution of local authorities. An initial assessment of possible technical options might be required at this step.

[9] For a conceptual exploration of PPPs related to CBE sanitation please refer to Cookey et al. (under review).

TABLE 5. KEY ELEMENTS OF THE PPP DURING THE PROJECT DEVELOPMENT AND IMPLEMENTATION STAGE.

During Project Development Stage	During Implementation Stage
✓ Volume and quantity of the agro-waste, sludge	✓ Construction plan
✓ KPIs and standards	✓ Project implementation, operational and maintenance plan
✓ Environmental parameters	✓ Monitoring and environmental management plan
✓ Land details	✓ Revenue collection mechanism
✓ Asset ownership details	✓ Pay out mechanism
✓ Engineering aspect, design and estimation responsibility	✓ Disaster mitigation plan
✓ Penalty and risk parameters	✓ Risk allocation and sharing plan
✓ Procurement plan and bid process management	✓ Reporting framework
✓ Source of finance	
✓ Investment model and period	
✓ Financial model, tariff and revenue structure	

3.1.3 Commercial Viability Assessment and Financial Strategy

Commercial viability is the major parameter that decides the fate of a PPP project. A commercial viability assessment involves public and private partners as well as the users.

Commercial viability from citizens' perspective — Assessing the Willingness-to-Pay (WTP) is an integral part of many PPP projects. In a centralized system, the financial mechanism or viability of the project largely depends upon the user charges. When the integrated system comprises collection, transportation, processing, treatment and disposal, the user charges are vital for the success of the overall project development. WTP studies are often more optimistic than actual revenues show; nonetheless, they can serve as a planning indicator to stratify the population into groups more or less willing to pay.

User changes are the source of the public fund disbursed to the private contractor in terms of installments through the Hybrid Annuity Model. Therefore, in a centralized or integrated system, the community's willingness to pay user charges plays an important role and is indirectly linked with the financial success of the RRR component in that service chain. On the other hand, in a decentralized RRR mechanism such as small fecal sludge treatment plant or decentralized biomethanation plant, the operational cost is also linked with the fees paid by the public towards the collection and conveyance of waste to the decentralized plant. In both cases, the willingness to pay user charges or service fees is a critical financial parameter linked with the recovery success of a PPP RRR project, although the WTP might not reflect the users' ability to pay given other financial household constraints.

Preliminary information on users' willingness to pay is however a useful indicator to assess the possible revenue stream from users for the project's commercial viability. Either the municipality collects this information beforehand, or the private party undertakes data collection as part of due diligence before bidding.

Commercial viability from a public perspective — The financial strength of the ULB or municipality in terms of recovery or collection of municipal tax, indirectly governs the success of the PPP project. The structure of municipal finance, tax collection and other departmental revenues eventually impact the annuity or installments to be disbursed to the private players. Therefore, the economic strength and weakness are important parameters on which feasibility assessment is also required.

Commercial viability from private players' perspective —The commercial quote of the private contractor indicates an initial viability of the project during implementation. In the instances where the final selection criteria are hinged on the least cost method, the bidder's quote should not be too low so as to become non-viable for operation. Before quoting, bidder must undertake sufficient due diligence, background exercise and project appreciation. The bidder's financial strategy should evaluate the project baseline, inflation, return on investment and payback period through the revenue model.

External Fund Sourcing — If external funding is needed to support the PPP, the carbon market or other green finance options should be explored as well as agencies which contribute funding for sanitation, agriculture or soil regeneration projects. Loans from international development banks could also be considered by the public partners for the partnership because of the social and environmental impacts created by the cases described above. If banks were to provide favorable loans for emerging social impact projects, more entrepreneurs might be observed to be engaging in the RRR sector. For example, if companies with a mandated corporate social responsibility (CSR) offer favorable loans to RRR projects such as the above-described cases, it can help incentivize other companies or entrepreneurs to enter

into the RRR market. Ghanaian banks provide extremely high-interest loans for risky ventures. These loans entail interest rates ranging between 30–70%. Therefore, the government can legislate regulatory reforms to help projects with social impact. If the PPP is facilitated by a third party the financial obligations of all parties have to be clearly defined.

3.1.4 The Hybrid Annuity PPP Model

There exists several PPP models — Build-Operate-Transfer (BOT), Design-Build-Operate (DBO), Design-Build-Operate-Transfer (DBOT), etc. (PPIAF 2009). However, from the resource recovery and reuse point of view, the most popular and widely accepted model has been the DBOT Hybrid Annuity Model (HAM). Here, the concessionaire is responsible for setting up the facility (FSTP, compost plant, biomethanation plant or any other waste-to-energy plant) on Design, Build, Operate and Transfer (DBOT-Hybrid Annuity) basis. The concessionaire is responsible for effectively treating and recovering fecal sludge and sewage.

In HAM, the engaging authority will finance the capital expenditure and the periodical O&M Costs. An agreed percentage amount of the quoted project cost (e.g., 50%) would be paid during the construction period. The remaining project cost, along with interest and the periodical O&M cost is disbursed in certain installments during the entire operational period, where the engaging authority makes these payments through an escrow account. The concession period would be a minimum of 10 years. The resources recovered in the process (in form of compost, bio-fertilizer, soil enricher, biogas, electricity, etc.) are managed by the concessionaire, which shall market, distribute and sell them. The revenue generated through resource-recovered material or energy will be kept with the concessionaire.

3.2. Structuring of the Project for Effective RRR

The effectiveness of the circular bio-economy, framed in a PPP model, is dictated by the structuring of the PPP framework. Essentially, the structuring indicates various stages of the PPP procurement process (Figure 9).

Key considerations and details of project requirements such as the prequalification and evaluation criteria, key elements of the PPP contract as well as details on the procurement management are deliberated in the following sections. The process can be facilitated by the public sector or a third party.

3.2.1 Prequalifying Criteria

To maximize the participation and engagement of a competent set of private parties, the bid qualification conditions shall encourage private sector players, with a provision of consortium or join venture with locals small and medium scale enterprises. Although the number of small enterprises or SMEs in the market in the resource recovery sector is limited, these small players could be very effective in the last mile connections. While SMEs cannot play a large role in setting up the plant or facilities, they can however be instrumental in different segments of the value chain such as:

(i) Waste segregation,
(ii) Collections,
(iii) Marketing of compost,
(iv) Sale of compost,
(v) Awareness raising, education, communication and community mobilization and in
(vi) Controlling the quality of the recovered material.

Municipalities can be critical in attracting the small parties,[10] where the involvement of small enterprises or SMEs enlarges the participant pool in the tender leading to cost optimization, improved output effectiveness and easing of the local operation. Technology choice driven by an outcome orientation instead of prescribing selected technologies will encourage broader participation.

The scope of agglomeration or consortium of cross-functional private entities should be encouraged in the pre-qualification criteria. The stringency on past experience should be kept as optimal as possible, to better induce the engagement of small and medium scale enterprises and players. However, past experience on resource recovery and PPP projects of the partners will be a significant criteria. The financial turnover may be considered predominantly for the consortium with a reasonable weightage to the individual turnover.

3.2.2 Evaluation Criteria

The lack of technological competencies leads to the failure of many PPP projects which have resource recovery as an integral part (refer to Section 2 - Lessons learned from the Asian and African RRR market). Bid evaluation criteria, structured upon the lowest cost solution (LCS) method may not always guarantee the best technological solution. Therefore, it is necessary to frame the bid structure through Quality Cost-Based Selection

FIGURE 9. PROJECT STRUCTURING FOR EFFECTIVE PPP PROCUREMENT.

[10] Refer to case study of Kolkata solid waste management improvement project.

(QCBS) with a minimum qualifying technical score of 70% for further evaluation. Appointment of independent agencies to monitor the performance of the indicators, quality assurance and control would be an important condition to be stipulated in the bid structuring.

To implement an effective recovery through PPP, a range of qualitative parameters for the bidder need inclusion. Such parameters should encompass technology know-how, operating experience, approach towards managing existing workforce and bridging strategy for gaps in the existing waste systems. Evaluating bidders' capability and commitment is critical against outcome and service delivery performance parameters. Table 6 summarizes the most essential prequalification and evaluation criteria.

The composition and prequalification criteria of the team of experts should be very clear and rigid. A typical PPP project with resource recovery from the bio-waste must include the following key experts in the proposed team:

- Sectorial expert (wastewater, solid waste)
- Process expert
- Quality assurance and quality check expert
- PPP expert 1 with an in-depth knowledge of public health sanitation aspects
- PPP expert 2 with an in-depth understanding of the private sector
- Financial expert
- Procurement expert
- IEC or communication expert

3.2.3 Key Components of the PPP Contract Agreement

The content of a PPP contract necessarily varies across different countries depending on the type, terms and conditions of the agreed PPP arrangements. Below, the key components of an RRR PPP contract along with an explanation of each section and its purpose have been discussed to help project developers and stakeholders to adapt the PPP contract agreement to the local situation. A summary checklist for PPP contract preparation is provided in Box 2.

Definitions — This is usually a brief section providing descriptions of the key terms included in the contract. It must include an explanation of the relevant parties to the PPP arrangement. It should also list each party's 'successors and assigns' in situations where one of the parties is merged or acquired. Naming successors will avoid disputes about whether the contract still binds the successor entity.

General provisions — The general provisions section covers the legal basis upon which the PPP will be established, and other critical issues related to the structure of the deal such as:

(i) The rights and obligations of the private firm and government,
(ii) The start date of the contract and
(iii) Any specific agreements made by the private firm to enable it to enter into the contract.

Conditions precedent — This section presents a summary of the issues that must be concluded before the PPP start date for the contract to come into force. In some cases, if the actions are left pending before contract signature, then only the contract bit might be signed. The most typical conditions precedent are:

(i) Provision of land, which is usually the responsibility of the government,
(ii) Securing any necessary permits,
(iii) Developing and agreeing on an asset register and
(iv) Securing the finance required to fund the project.

Grant of PPP — This specifies that the private firm has been granted the rights to construct and operate the resource recovery facility under the PPP arrangement for the specified location.

Duration of PPP — Here, the length of time for which the PPP arrangement will be in place is specified, including a clear indication of:

(i) When the contract commences and expires,
(ii) When the obligations that have been set out in the agreement become effective and
(iii) Whether the contract can be renewed, and if so, the length of time it can be renewed.

Early Termination Payments — In case of early termination of the contract and project assets reverting to the public sector, the contract should set out the compensation payment depending on the cause of the early termination. There are three broad reasons for early termination:

(i) Default by the private party,
(ii) Termination by the public party, whether due to defaulting for reasons of public interest, and
(iii) Early termination due to some external reason (force majeure).

Handover arrangements — Specifics include the contract close date, and processes in place to manage the on-time termination and handover of any assets at the end of the PPP contract or in the event of an early termination.

Representations and warranties — This defines any warranties in place related to, for example, the quality of the assets included as part of the PPP arrangement, or the minimum levels of water to be provided to the scheme.

Other obligations — This part of the contract should not only detail any other obligations of the private firm, but also define the obligations of the relevant government authority. This will include obligations such as the obligation:

(i) To provide land and specified assets;

TABLE 6. MATRIX INDICATING PREQUALIFICATION AND EVALUATION CRITERIA.

Criteria	Prequalification conditions	Evaluation process
Legal status	• Registered business entity • Fulfillment of legal compliances	Document verification
Social vision	• Community level involvement to improve sanitation • Role in market exploration and past growth	• Social mission statement and achievements
Domain expertise	• Have existing or past experience in waste management/reuse related businesses; or • Credibility of partnering with established domain players	• Check of their past/current activities • Presentation of technical expertise
Collaboration with the public sector	• Have positive experience working with the municipalities and local government • Have experience in PPP management	• Preference given to partner with strong management and operational team of working experience with the municipality
Marketing and distribution expertise	• Have experience selling a product to a diverse customer base, e.g., farmers or landscapers; agreement, MoA with agencies, industries, or • Have partnership with entities that meets this requirement	• Compost sale agreement, power purchase agricultural department, etc. • Proof of target milestone achievement
Solvency	• Financial contribution (in the form of labor, operations and management) at least towards the total cost of the business operations and capital cost to bridge any gap in revenues till break-even is achieved	• Audit report

(ii) To obtain permits for the private firms;
(iii) To provide agreed payments to the private firms where relevant; and
(iv) To carry out required capital investment, repair and renewals where relevant.

Periodic and extraordinary tariff adjustments — This section should describe the processes or mechanisms for managing changes to the tariff agreements. It will include making changes to the tariff in response to inflation through agreed indexation mechanisms and the development of tariff 're-openers' that allow for changes to the tariff in the event of significant and unexpected changes to the conditions faced by the private firm that might arise over a longer-term contract.

Reporting and data requirements — This section will detail any reporting and data requirements for the private firm and other parties to the PPP arrangement as and when relevant. When developing these requirements, the following issues should be considered:

(i) The information or data needed to be included in each of the reports and the likely availability of this information or data,
(ii) The frequency with which the reports need to be produced,
(iii) The government agency responsible for reviewing and acting upon the information or data being produced, and the capacity of the agency to review the information adequately, and
(iv) The need for third-party verification or auditing of the information that is being produced.

Monitoring — The contract usually identifies the party responsible for monitoring the performance of the private firm. Monitoring can be undertaken by the communities, ministries or other authorities, or a combination of these stakeholders. The private firm must provide financial and operational performance data for verification of the contract compliance. Monitoring and evaluation results are reported to the granting authority, which oversees the project development and enforces private-sector compliance.

Dispute Resolution Mechanisms — The contract should identify the mechanisms designed to enable the resolution of disputes between the parties to the agreement before reaching the stage of litigation. While traditional instruments involve the courts, these may be differently effective or efficient depending on the country's context. Alternative mechanisms may involve moving the disputes to a third-party forum better suited to handling contractual disputes.

3.2.4 Procurement Management

Navigating the various stages outlined above can prove to be challenging for public authorities. They must manage the different technical and financial elements of the bids. A checklist can help to make sure that all issues are considered (Figure 10). The public entity must also effectively coordinate with private sector firms and other project stakeholders. The common functionaries involved in the procurement management include the contract authority, contracting authority, local governments, operators, private service providers, regulators, government services, monitoring and support services and non-profit organizations.

Developing a management team with the capacity to manage the bid process is very important. This team should include a steering group of representatives from key government agencies and individuals with the technical expertise to review and evaluate the bids. The individuals in the technical team will need to include at the very least some experts with experience managing a PPP deal, process engineers (waste management and sanitation), financial experts, economists and lawyers. It is typical for the government to use external advisers with the necessary skills to support the process completion. The procurement team should be careful with handling the provision of information to prospective private sector bidders and other relevant stakeholders.

The effective monitoring and evaluation of the contract is a pivotal task for ensuring that the PPP arrangement delivers value for money. Throughout the contract's life, the PPP contract manager must ensure that the service standards specified in the contract are effectively monitored and that any performance-based bonuses or penalties are applied transparently and consistently.

3.2.5 Service Level Benchmark and Key Performance Indicators

Overview of the Indicators and their Importance

The objective of benchmarking of KPIs is to ensure the quality of outcome of the PPP projects. The performance indicators considered in a typical PPP RRR project are as follows:

- Quantity of the assured feedstock (organic waste, fecal sludge, agro-waste),
- Composition and characteristics of the waste,
- The quality of the end-product,
- The percentage or fraction of the recovered product (e.g., generated compost) against waste input,
- The generation of power (MW), in case of waste to energy project,
- Offtake agreement and feed-in-tariff,
- Emission control and liquid waste management (from process),
- Actual cost recovery through selling of recovered product,
- Reliance on local government for waste supply and payment of tipping fee, and
- Percentage of compost sold versus organic waste collected.

A review of selected CBE-related PPP tender documents offered some insights into its content and structure (Srinivasan 2018; Rao et al. 2020). Vital information generally omitted from most of the tender documents are:

(i) Details on the land, its area and site characteristics (topography, hydrogeology, soil, drainage, etc.),
(ii) The actual fecal sludge and waste characteristics, and details on the type of containment systems (septic tanks vs. pits, pour pour-flush vs. cistern flush),
(iii) Appropriate standards for bio-solids (most tenders were either silent on this or referred to multiple standards, thus confusing the bidders),
(iv) Compliance with environmental and food safety regulation, and
(v) Process or service standards and/or RRR products' standards expected from the FSTP operations (Rao et al. 2020; Mansour et al. 2021).

The above-mentioned parameters should be considered as KPIs in a structured PPP document. KPIs should be rationally framed and gradually tightened with the progression of the project instead of excessively high threshold values at the commencement during the signing of the contract. There should be a provision for revising the KPIs every 5 years to establish a realistic contextual mode of operation.

Selection of Key Parameters and Values

Selection or finalization of values of different KPI parameters depends upon the national and local context of the developing countries. For a successful implementation through an outcome-based approach, the selection of critical parameters and values must always be rationalized. However, specific widely accepted parameters ranges as per international standards could always be referred to as guidelines in defining the national or regional standards (Box 3).

BOX 2: CHECKLISTS FOR CONTRACT PREPARATION.

Criteria	Components	Description of the components
Feedstock 	Sourcing	✓ Collection and transportation of the waste (municipality, third party or community) ✓ Assign responsibility for weighing the waste ✓ Changes required for waste collection and delivery from the existing condition ✓ Responsibility for maintaining quality of the incoming waste
	Materials	✓ Guidelines on quality requirements of the feedstock input - specification of waste and characteristics ✓ Treatment of waste if any at transfer station (or during transportation)
	Fees	✓ Gate fees for accepting waste ✓ Specification of quantity in a day
Production 	Quantity	✓ Quantity (or units in case of energy) of compost/co-compost/energy produced
	Incoming materials	✓ Frequency of monitoring ✓ Guidelines for receiving incoming organic materials, unloading, sorting, debagging and grinding, screening, and removal of excess waste materials ✓ Distribution of roles between owner and operator
	Process and hygiene	✓ Maximum holding period of feedstock ✓ Specification of technology to be used and technical standards
	Equipment	✓ Specifications for the process to maintain hygiene within the plant ✓ Responsibility for providing equipment along the production chain ✓ Assets and equipment to be used within the plant
	Final processing steps	✓ Storage area specification ✓ Responsibility for disposal of rejected materials ✓ Quality specification of rejects
Sales and Use 	Quality assurance and final product testing	✓ Specifications about the product and product testing
	Ownership	✓ Ownership about the end product and share of output and revenue
	Marketing	✓ Guidelines on marketing, if required, specifying co-sale (with chemical fertilizers through fertilizer vendors), packaging requirements, quality assurance labels (certifications) and price of the product ✓ Guidelines on use cases (for compost, co-compost, soil enricher) where the application is feasible
	Sales	✓ Specification of channels to be used (direct at site or through municipal/ private owned shops; or indirect through retailers and wholesalers) ✓ Ownership of revenue and payment mechanism for the private party
Legal, Administrative, and other Considerations 	Basic Provisions	✓ Awareness and clarity about the definitions of the contract among all parties and entities ✓ Specification of clauses such as contract period, terms of renegotiation and renewal, contract amount and payment mechanism (amount and frequency), summary of the scope of services
	Performance and deliverables	✓ Guidelines on time period for stocking the feedstock before processing, with specification about maximum end-to-end processing time (especially for compost and co-compost) ✓ Details around the payment structure, including terms, amount, frequency, invoicing and renewal process ✓ Process to be followed if output fails to meet quality and quantity standards
	Labor	✓ Legal requirements around labor that need to be adhered ✓ Responsibility for processing payroll ✓ Rules around hiring and layoff, employee payment, minimal wage

(Continued)

BOX 2: CHECKLISTS FOR CONTRACT PREPARATION. (CONTINUED)

Criteria	Components	Description of the components
	Record keeping	✓ Detailed description on record keeping with responsibilities (including materials amount, production quantity, revenue and operational record like utility bills, wages and salary) ✓ Instructions on data sharing between different parties and entities
	Permit, insurance and safety	✓ Environmental permits along with compliance to regulations (during construction, operation) ✓ Ensuring safety protocols through signage, procedures, awareness drill, equipment standards and inspections ✓ Anticipated insurance purchases and responsibility of procurement ✓ Anticipated utilities required and responsibility for procurement

Source: Adapted from Kaza et al. 2016.

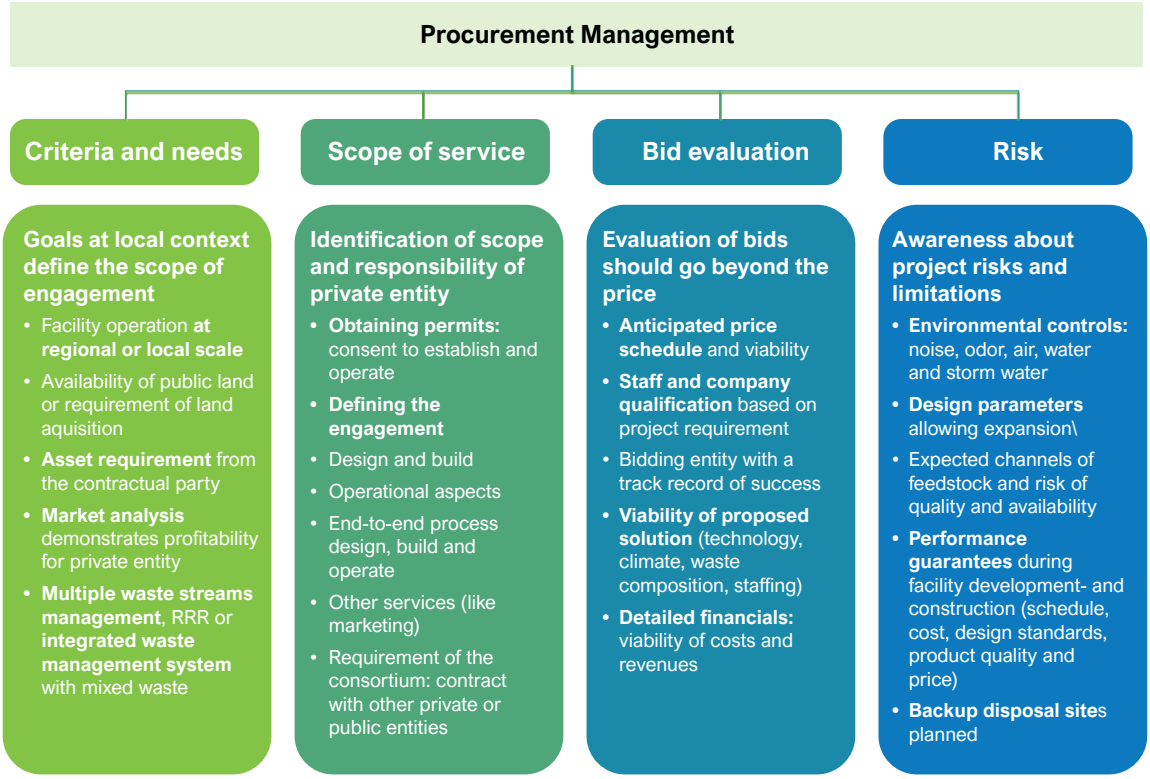

FIGURE 10. CHECKLISTS FOR PROCUREMENT MANAGEMENT TO FACILITATE TENDERING PROCESS.

BOX 3: AN EXAMPLE OF BENCHMARKING FOR FSTP BIOSOLIDS.

Bio-fertilizer as a material resource recovered from fecal sludge treatment plant (FSTP) shall satisfy the basic standard of certain parameters before application to the field. As per USEPA (United States Environment Protection Agency) guidelines, it should meet the following
criteria of Class A Bio-solids:

- Fecal coliform density < 1000 MPN/g total dry solids
- Salmonella sp. Density < 3 MPN/4 g of total dry solids
- Helminth egg concentration of < 1/g total solids
- E coli of 1000/g total solids
- pH (at 5%) suspension: 5–7
- Moisture (%): 10–30%
- Organic carbon (%): 10–25%
- Organic Nitrogen: 2–5%
- Phosphorus: 0.2–1%
- Bulk Density (Specific gravity): 0.65–0.9

4. ROLES OF STAKEHOLDERS IN PPP FRAMEWORK

Both public and private sector perform an important role in a successful resource recovery PPP. During the initiation phase, the public sector is responsible for defining objectives, prioritizing project criteria, framing the applicable policies and finalizing the type of PPP to be implemented. During the negotiation stage, both parties are involved in the partnering process and finishing the project scope and preparatory work. During the implementation stage, the private sector has a leading stake in implementing and performing, while the public sector primarily acts as a monitoring agency. PPPs can be planned as centralized and decentralized, clustered based on the waste management approach. Centralized PPP models prove to be effective in the urban areas where there is a commitment of large volume of segregated organic waste. In contrast, decentralized PPP models are more appropriate where waste can be tackled in smaller volumes across different waste collection points. This model requires stronger community involvement along with public and private parties. Clustered waste management comprises of institutional arrangements between different municipalities. Therefore, based on the waste management and planning for CBE, the involvement of the stakeholders varies, which entails careful consideration in the implementation of a PPP for CBE.

4.1. Public Sector Participation

While the government could fund a PPP project entirely with public resources, doing so reduces the incentive for the private party (or parties) to improve the scheme's efficiency. It could also make it easier for the company to leave the project if the project fails. Therefore, the government must strike a delicate balance in providing sufficient support to enable the private firm to finance the project but not to such an extent to deter the private-sector incentives. The following describe the optimal conditions for public sector involvement:

- The contract is long-term
- The scheme delivers value for money for service users and the government
- Risks are allocated to the party best able to manage them
- The public sector can hold the private party accountable for meeting its obligations
- The private sector provides an innovative and effective service delivery
- The private sector brings technical expertise

The tier-wise mandates of the government sector in the implementation of a PPP project are discussed below.

4.1.1 At National Level

At the national or central level, the public sector's role is primarily focused on developing the necessary policies for establishing the PPP. In particular, it is responsible for formulating service level benchmarks for the outcome of the PPP model and providing financial mechanisms to target the PPPs. Standardization of different parameters in terms of KPIs is one of the critical roles that the public sector plays at the national level. National government's

policy for the utilization and application of the recovered product from agro-waste, bio-waste and septic sludge largely governs the outcome of the PPP model and its viability. The national waste management guidelines set up by the central government of developing countries need to accommodate a detailed provision of circular bio-economy, where the policies for PPP intervention on resource recovery and reuse need to be understood. The procurement policies, institutional framework, public participatory approach, financial mechanism, and provision for incentive, rewards and penalties should be clearly outlined. Such policy-level PPP intervention on the circular bio-economy would be instrumental in undertaking an effective resource recovery project implementation.

4.1.2 At Regional Level

In a PPP framework, the regional or state government has a pertinent role in capacity building and awareness generation for the appropriate recovery and reuse of the bio-waste, fecal sludge and agro-residues. The state project management unit develops technical sessions and programs to enable the stakeholders, including the community, to engage in understanding the benefit of the use of recycled/recovered bio- or agro-waste residues. State-level project or program management units will work in close coordination with the private entity to ensure the robust implementation of the PPP project.

Regional governments or administration shall also be instrumental in establishing the cost benchmark for the recoverable items such as bio-fertilizer, soil enrichers or compost. In the case of digested sludge, the state government shall identify the project's location and map the area that could benefit the generated power. The state government will also initiate and monitor the power purchase agreement between the PPP contractor and the concerned board.

4.1.3 At Local or ULB Level

Any successful resource recovery and re-use (RRR) project depends upon the roles and responsibilities of the stakeholders at the local level, where the local authority should maintain a high quality of the input waste. The segregation of inorganic and organic waste must be strictly monitored, and the organic wet waste delivered to the composting or the waste-to-energy facility.

Poor waste segregation decreases the plant's performance and reduces the degree of recovery of material (as bio-fertilizer or organic compost) and energy. Municipalities must ensure that there is no mixing of industrial sludge in the FSTP or hazardous waste in the municipal waste stream.

In a PPP model, the contractors' revenue is primarily governed by the quality and quantity of the recovered material. The local authority shall be responsible for the delivery of assured quantity and quality of waste to the bidders, as committed in the PPP concession agreement.

Besides technical mandates, the local authority is further responsible for the enforcement of local rules, RRR regulation and bylaws, as a mechanism of successful PPP project implementation. Local authorities have always been instrumental to encourage, motivate and mobilize the community towards the usage of recovered materials from bio- or agro-waste. Stakeholder consultation and public participation are the two main foundations on which the implementation of a successful PPP RRR project is carried out.

4.2. Private Sector Participation

A well-designed and managed PPP has an advantage of attracting private sector participation. Following are the key aspects for which private sector participation is involved:

- The allocation of risk and the associated performance rewards and penalties create incentives in the PPP contract to encourage the private partner to achieve efficiency at each stage, and also to introduce efficiency improvements where possible. At the same time, by displacing the risk onto private partners, the public sector is able to check its own exposure to cost escalation. For private sector, a counterproductive strategy is an effective mechanism which can make the system a win-win proposition. Instead of direct escalation of user charges by public entity, private contractor can be given the decision-making opportunity on the user charge as per their commercial mechanism. Public sector can freeze the regulation and KPIs for the private sector and the private party should ensure the service. Thus, through a counterproductive mechanism, the service level benchmark can be achieved, deterring conflict between the public sector and citizens.

- PPPs can be structured to create a whole-of-life focus in which the private partner designs the project to take account of the link between construction and operation to minimize the cost over the project's lifetime. A private partner, which in addition to designing and building the project, also provides the ongoing operations and maintenance management, has the incentive to ensure that the design and construction facilitate efficient O&M.

- Competition is introduced during the bidding stage, bringing market procurement benefits. As long as the project is well specified in terms of the output requirements (rather than specifying the inputs), each private sector bidder is incentivized to propose innovative solutions and minimize cost.

During the project development process, both parties of the PPP framework should develop a shared vision of the requirements, risks and mitigation measures. An inevitable

risk in the short-term is financial in nature, incurring a loss instead of a profit — experience indicates that RRR businesses are not always profitable in the short term. Therefore, it is particularly appealing to social enterprises. An enterprise is socially-driven when its objective is to meet social needs through business innovations (Surie 2017; Ramani et al. 2017; Bornstein 2004). Ramani et al. (2017) defines three conditions for socially-driven enterprises: (i) they offer a market or non-market avenue to address a social need, (ii) they are financially viable, in whatever way they can finance their operation and (iii) they apply business management principles in their mode of operation and service delivery.

A PPP in RRR business which does not make a profit or break even is a big risk when compared to a traditional business. Private sector partners that are socially motivated are fairly different since they prioritize meeting social or environmental needs alongside the business and technical goals (Milward-Hopkins et al. 2018). At the core, they are risk-taking — perhaps even risk-seeking — to allow for the growth of their business and accept uncertainty with risks (Hovy 2015). Such partners have a respect for new technology and in exploring innovative solutions (Bornstein 2004). They are collaborative and maintain a level of openness to capture learnings and develop innovative solutions alongside the many stakeholders involved (Székely and Knirsch 2006).

4.3. Matching Expectations between Private and Public Partners

In a successful PPP for resource recovery, public and private entities must work in tandem, based on a relationship of mutual trust to pursue a common goal. In this context, developing a shared understanding can be achieved by matching the needs of each part for a successful business proposition. Tables 7 and 8 summarize the typical expectations and suggests recommendation for action to address them.

4.4. The Role of Small & Medium Enterprises (SMEs)

Resource recovery from bio- or agro-waste though PPP attracts local small and medium players to become a part of the service chain. For example, in a decentralized resource recovery facility, a small decentralized biomethanation plant (3 to 5 tons per day) or an organic waste compost plant can be operated by a local enterprise or the local community. Local SMEs are critical for understanding the demand for recovered material in the local market. They also possess an effective economical network, as well as knowledge of reliable and guaranteed end-uses in the local market. Alternatives to soil degenerating fertilizers and more sustainable sources for animal feed are also driving demand in local markets. Many distributors operate at the wholesale and retail levels and advertise their products accordingly. By partnering with such SMEs, private RRR companies chance upon the opportunity to access established distribution networks with the benefit of an increased geographical reach as well as benefit from their experience in marketing and sales. The challenge will be to create a suitable financial arrangement that meets the needs of the concerned parties and the various distributors. This could be a necessary investment to address any weaknesses in marketing, sales and distribution in the short term.

4.5. Role of Community Members

PPPs targeting resource recovery precipitate positive impacts such as enhanced public health and environment in the long run, along with improvement in the livelihood conditions. In RRR cases related to service delivery, community members themselves are users of the service — the PPP should therefore focus on meeting their needs. However, in achieving an optimal service through efficient resource recovery, a strong role of the community in waste management is vital. As mentioned earlier, source segregation of waste is an important means for RRR, and households should accommodate the practice. This would help to achieve higher efficiency of resource recovery by reducing costs of segregation and enhance the cost recovery through recycling of other materials (example metals, glass, cardboards, etc.), adding savings to the household budget. The community members need to abide by laws, follow the guidelines stemming from the awareness drive and should participate in the local meetings conducted to provide a comprehensive understanding of waste management at the household and community level. Waste related PPPs need to incorporate payment mechanisms which the community members should be willing to pay, making the system financially viable.

TABLE 7. EXPECTATIONS FROM PUBLIC BODIES AND RECOMMENDED ACTIONS FOR PRIVATE ENTITIES.

Expectations from the public bodies	Recommendations for the private entities
• Private entities should initiate partnerships with research-based organizations, entrepreneurs and trade organizations for technology innovation, product development and marketing and sales.	• Identification of such bodies in the project area at the early stage • Exchange of dialogues with such organizations • MoU or formalization of association as technology partner
• A proactive and strategic planning to maximize revenue generation from waste (fecal sludge, organic municipal waste, agricultural waste, etc.), with the aim to become commercially self-sustainable and reduce the dependency on public funds.	• Piloting the project to assess the technical viability of the process before commercialization • Maximization of resources, time, and operational aspects
• The private sector should provide a long-term service rather than just being an upfront project contractor and take the responsibilities of designing, building, operating and financing projects.	• Express an interest towards a long-term contract and indicate the same in the project tendering (or Request for Proposal)
• The private sector should be technically capable and experienced to understand waste flows and assess the need for change in operational procedure, if required. Private partners should also engage with small enterprises and entrepreneurs to establish a good market linkage.	• Reconnaissance survey • Stakeholder consultation • Desktop research • Regular review of process and operation • Identifying of SMEs • Workshops and brainstorming sessions with entrepreneurs
• Private parties should develop an integrated plan and communicate and consult it with stakeholders from community. • Develop well-structured information, education and communication (IEC) activities for citizen, SMEs, conservancy workers, and employees to be discussed with the public entity at early project stage.	• Development of IEC material through professional organizations • Holding roadshows, flyers, posters, etc. for sensitizing the citizens, households, commercial users • Promotional sessions with nursery owners, farmers, horticulture agencies for the use of recovered materials
• A thorough and adequate information on the project background, understanding bidders' scope is expected the public authority. • Public authority also expects bidder to conduct a proper due diligence of the project, site visit, understanding of the project area and market, including the citizens' willingness to pay for the service.	• Site visit • Assessing market demand for compost, bio-soils or other endby products of the RRR plant • Interaction with the market linkages or facilitators (retail enterprises) who could facilitate compost selling
• The public authority expects the bidder to meet all service level benchmarks as per the KPI prescribed in the agreement.	• Internal monitoring of the performance • Review of process and modification if required • In case of non-meeting of KPI, technical QA/C and laboratory testing to achieve the required quality, revisiting of process and design parameters
• The public authority expects bidders to quote a price that ensures viable for operation. • The private sector should take all the risks linked to construction, cost escalation, and tax and be solely accountable for any operation-related functionality.	• Detailed analysis of the project costing, with escalation, contingencies, and other unforeseen costs • Judicious estimation of operational cost and profit margin • Proposing a realistic quote
• The private party should have prior operational experience of working with the municipality. • Having skills and experience in selling their product to a diverse customer base, e.g., farmers or landscapers.	• Understanding the proposed project and linking with projects executed in past • Adopt the best available practices and showcase in the bid the credential obtained from past clients
• Should have a strong team of experts with experience in the sector, the process, PPPs (with both public and private sector knowledge), quality assurance and control, procurement and IEC.	• Create a resource pool of in-house and external experts • Induce all experts during the technical bid submission stage for writing approach and methodology • Review of process and operational performance by the experts • Onboarding ofexperts for all essential meetings with municipalities and higher authorities

TABLE 8. EXPECTATIONS FROM PRIVATE ENTITIES AND RECOMMENDED ACTIONS FOR THE PUBLIC SECTOR.

Expectations from the private entities	Recommendations for the public entity
• Administrative facilitation in the marketing of soil enricher and compost, etc., produced from solid waste, co-compost plant or fecal sludge treatment plant.	• Assisting private party to brand the recovered product • Helping private partner to get introduced to the potential market
• Support to cope with unforeseen political and administrative risk, change in the project timeline, reallocation of responsibilities, etc., if required.	• Initiate an open discussion to find solutions for risk mitigation
• Public bodies should develop and enforce a regulatory framework (including policies and by-laws) that promote the use of recovered resources (soil enricher, bio-soils, compost etc.).	• Holding meetings for industries and SMEs • Advocating for the benefit of using recovered material and incentivize the use of soil-enricher, bio-soils, and compost
• A strong institutional framework ensures consistent waste flow and sensitizes contractors and citizens for proper waste handling. • Assure the delivery of waste quantity in a segregated waste, having organic components only.	• Develop guidelines for waste segregation (at household and commercial level), collection and transportation • Defining parameters in the contract for waste management, feedstock characteristics and volume
• The public sector should ensure a strong coordination along the entire service chain including segregation, collection, transportation and hand-over of the waste to private sector which is responsible for resource recovery. The effectiveness of resource recovery depends upon performance at each of the stages.	• Organize coordination meetings with all parties of the service chain • Brainstorming on evolving issues to optimize operational aspects • Encouraging a good network among different parties of the service chain
• A long-term PPP contract (10–15 years minimum) is preferred instead of short phases (annual or 2-3 years).	• Plan for a long-term contract during the screening phase and prepare a feasibility study • Set clauses in the tender advertisement and the contract
• The private bidder expects clarity on available government land for the recovery plant. The public administration should also arrange permits to use the land.	• Document of land status • Hand over documents • Map, site plan, and layout • Satellite imagery of the site • Site surrounding features (physically on map) • Legal deeds, conversion and registration documents
• Administrative support for sensitizing the community (the primary waste generators).	• Support the private party to hold meetings, and workshops with stakeholders • Facilitate private parties with letters, authorization statements
• Financial solvency of the public authority or municipality to release payments according to performance as agreed in the contract.	• Ring-fencing of the municipal finance for the project
• Technological flexibility will bring innovative solutions (instead of prescribing a specific treatment process in the Request for Proposal).	• Mention a wide range of possible technologies and options • Stipulating the outcome-based parameters, e.g., capacity or tons of recovered material • Special recognition for innovative technology options
• Incentive mechanisms like tipping fees would boost the revenue for the initial years to recover a part of their operation and maintenance costs. Similarly, subsidies to chemical fertilizers provide an uneven playing ground for the compost.	• Private partner expects a balance between incentives to private players and subsidies to industries • Discuss agreement between private party, the industry body and public authority on the controlled use of chemical fertilizer
• Flexible prequalification criteria: - Scope for joint ventures or consortiums - Nominal annual turnover criteria - Moderate qualifying technical cut-off score	• Suitable clauses in the tender document (or Request for Proposal) to accommodate the expectations
• The private contractor expects the public sector to gradually tighten the KPIs in the future instead of imposing excessively high threshold values when signing the contract. There should be a provision for the revision of KPIs every 5 years.	• Provide a time-based mandate (in the Request for Proposal scope) to achieve the 100% of the stipulated KPIs • Possible revision of scope and KPIs within a predefined timeframe

5. CONCLUSION

The public-private partnership (PPP) framework is an effective instrument for scaling resource recovery projects from bio-waste, agricultural residues and fecal sludge. Promoting circular bio-economy through a PPP framework is often technology (efficiency) driven. It serves to reduce the waste volume, but is missing the potential for a market-driven enterprise. A related enabling environment will help to (i) reduce barriers along the municipal solid waste (MSW) and sanitation management chains, (ii) promote actual resource reuse like market-driven waste-to-energy (WTE) pathways and (iii) balance the risks shared by the private sector and the government.

The main factors for the success of resource recovery PPP projects consist of the following elements (Figure 11):

1. An adequate municipal waste supply chain,
2. Strong government policies and regulations with enforcement,
3. Access to diverse financing and government subsidies,
4. Access to advanced engineering and reliable equipment,
5. Cost-effective operation and maintenance by the private sector,
6. Stringent environmental and social compliance and
7. Good public relations which foster community support

PPP projects for resource recovery might fail due to financial constraints, institutional weakness, lack of technical expertise, or limited capabilities of municipal authorities. To mitigate these barriers and risks, the planning and execution of the PPP should include (i) technical feasibility, (ii) financial viability, (iii) appropriate legal and contractual issues and (iv) communication, education and awareness. The process of establishing the PPP can be initiated by any party, including a third party, and should be driven by local demand (and commitments) by the public and private sectors and not predominatly be an externally driven 'project' as some of the less successful case studies showed.

This study has prepared a roadmap for a successful PPP in the RRR market, outlining the critical issues which need consideration. It is important to start the PPP process via a thorough project preparation to ensure the technical and commercial viability of the project. Early engagement with the private sector and the local community is required to attract private sector investment and ensure the citizen's acceptance.

A practical regulatory framework and effective project structuring will make it easy for the public sector to implement the PPP. The legal framework involves environmental laws, regulations on the proper management of municipal bio-waste, fecal sludge and agro-waste, procurement management guidelines for engaging private parties and operational procedures for PPPs, including contractual design. For finding a strong private partner, it is crucial to set the right prequalification and evaluation criteria in the procurement process. Key Performance Indicators (KPIs) will aid in ensuring the quality of the end product or service of the PPP, and should go beyond resource transition or recovery, but include sales.

In a successful PPP, public and private entities must work hand in hand based on a trustful relationship with the common goal in mind, bridging across the waste/sanitation management and the agricultural or domestic reuse sectors. This mutual understanding can only be developed through continuous engagement and exchange starting with project preparation.

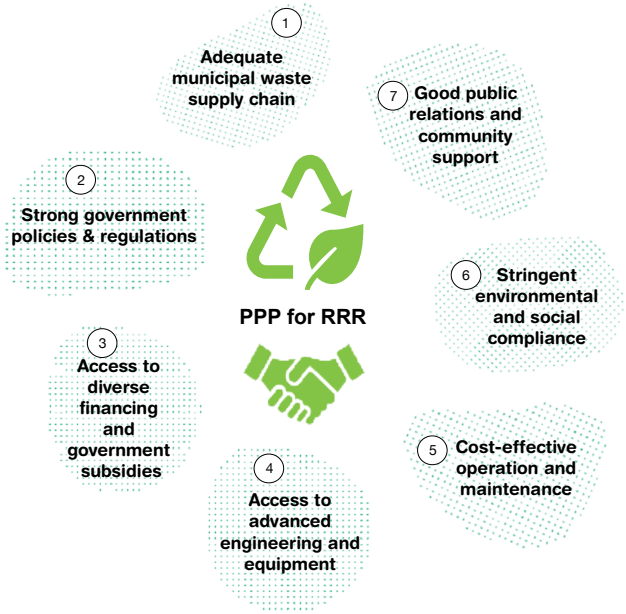

FIGURE 11. MAIN SUCCESS FACTORS OF RESOURCE RECOVERY PPPs IN DEVELOPING COUNTRIES.

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ANNEX. BRIEF DESCRIPTION OF CASE STUDIES

Somanya compost and briquette plant, Ghana — The co-composting and briquette production plant at Somanya, Ghana is a concessionary PPP arrangement between Jekora Ventures Limited (JVL, a private entity) and the public entity Yilo Krobo Municipality Assembly (YKMA). It was initiated and set up by a third party with external funding with the aim to commercialize compost from the combined treatment of dry fecal sludge and organic waste from municipal solid waste as well as briquettes from waste biomass. The composting plant has the capacity to transform up to 5,000 cubic meters (m^3) of fecal sludge and 300 tons of organic waste per year. The fecal sludge is sourced from private and public onsite sanitation systems in nearby communities; organic waste is obtained from local markets. The briquette plant has a capacity of 1,000 tons per year. Briquettes are produced using sawdust and wood shavings sourced from nearby communities. Although the public entity provides land for the operation, there is no contract ensuring adequate waste for the private party. This is a challenge as JVL competes for waste with other big players.

There is a huge seasonal local market for the compost, among mango farmers, where the demand is much higher than the plant's capacity (even beyond maximum production capacity). However, as this demand is seasonal, there is a time-based output constraint for the plant. To reach a solution, alternative markets have been explored to make the plant operation commercially viable.

Similarly, a local textile company offers to absorb the produced dry fuel for its biomass boiler which could establish the plant's overall commercial profitability for briquettes. To meet the market demand and make the plant more commercially viable, there is a need to run the plant on multiple shifts (as the demand of the textile company is estimated to 600 TPD and plant's capacity is 8 TPD). This case study shows that from a demand perspective a successful operation of a plant is feasible, provided steps are taken to address the feedstock shortage which undermines the plant from reaching the required operational capacity to break even. Contractual agreements between public and private parties on waste supply have to consider competing services.

Large-scale composting Bulta, Bangladesh — In Bangladesh, a private entity Waste Concern has set an example for a successful case study though a large-scale community-based waste management solution at Bulta, Roopganj in Dhaka. The plant was commissioned by WWR Bio Fertilizer Bangladesh Ltd. — a joint venture company of Waste Concern in association with its Dutch partners, World Wide Recycling B.V., FMO Bank and High Tide Worldwide B.V. Under this project, vegetable waste from markets is being collected using the project's own transport networks, and taken to the compost plant built on land owned by the project without any investments from the government. An agreement has been signed between WWR Bio Fertilizer Bangladesh Ltd. and Dhaka City Corporation (DCC) to collect waste from the DCC area.

The compost plant daily processed between 75–100 tons of organic waste between 2009 and 2010. By 2012, the project had processed 76,697 tons of organic waste and generated 34,200 CERs. This project has improved livelihoods in the community, creating 150 direct jobs for the poor, with these jobs cutting across the entire MSW value chain from compost plant operation, transportation of waste and in the distribution of compost. Around 6% of the operational expenditure is disbursed for the welfare of the plant workers. The model caters to the contexts in both urban and rural areas, displaying great potential for implementation in slum areas at a small-medium- or large-scale. The sustainability of this model is grounded in strong partnerships and the assured benefits accruing to each partner. This partnership provides access to an assured, large, growing market base for Waste Concern, having sold about 10,000 tons of organic fertilizer per year (2010).

While this initiative addresses the imminent environmental and social challenges, the production of compost represented a valuable agricultural input alternative for farmers. Waste Concern has forged strategic partnerships with the local government, private enterprises and community-based organizations (CBOs) to optimize the allocation of resources and activities, reduce risk associated with high capital investments and establish an assured market for their product. Research institutes (universities) undertook and continue to provide periodic quality testing of the finished compost for which Waste Concern pays for the services. The local government delivered land for the composting plants and offered Waste Concern legal access to the city waste. In alleviating Waste Concern's initial investment costs, the municipality gains from reduced waste collection and landfill costs. The customer segment targeted for marketing recovery product and revenue generation includes rural and urban farmers, direct and bulk selling to fertilizer trading companies, municipalities and international carbon credit market. Waste Concern faces a strong buyer power as they mainly sell their compost to price-setting private chemical fertilizer companies which rebrand and sell the compost product. This model is a good example of a win-win partnership between key players. It has been instrumental in attracting large amounts of foreign direct investment (FDI) in organic composting and carbon trading. Compost produced by Waste Concern has increased per hectare yield by 30–50%

by adopters (potato farmers). This model has already been replicated in 27 cities of Bangladesh and 10 cities of other developing countries with support from external support agencies and local entrepreneurs.

Matara compost plant, Sri Lanka — In 2005, the Matara municipal council, in Sri Lanka, established a solid waste composting plant with a private company Greenfield Crops (GC), targeting 300–400 tons of organic waste every month. Initially the company was not making profits and was dependent upon government funding. It was not performing well due to management and marketing issues of the entity. Generally, compost sales have been noted to be very low in Sri Lanka. This has been attributed to inadequate marketing strategies. Standard compost products penetrate less than 3% of the fertilizer market. The extensive use and over-application of chemical fertilizers have been in practice in the Eastern Province of Sri Lanka. This represents an opportunity for initiatives such as GC to access the market by producing high quality compost products.

In 2010, GC revived the business through a PPP agreement for 7 years, with the first two being probationary years. Under this agreement, the private entity (GC) pays a service fee of USD 1,500 per month to the public entity (municipal council) for using the infrastructure (land, composting facility and machines). The municipality in turn pays USD 5 per ton of waste disposed as a tipping fee to GC. Forty tons of waste is collected daily by the municipal council in Matara city and delivered to several different processing sites. GC started satellite compost stations closer to local markets to minimize transportation costs both for waste collection for the municipality and distribution of compost product for the business. The organic compost produced is sold in local markets through selected retailers. Plantation farmers such as tea, cinnamon and coconut farmers constitute the main users of the organic compost produced. The municipality set up the composting facility and provided the land and other required infrastructure. GC only manages the business and bears the cost of operations and maintenance. It pays the municipal council for the use of the resources provided, i.e., the composting facility and equipment. The municipal council on the other hand pays GC tipping fees for the disposal and processing of solid waste. GC also partners with research institutes (Tea Research Institute and Coconut Research Institutes) for product quality analysis and USAID, which provided funds for the establishment of a laboratory. The satellite compost stations operated by GC are essential to this model. These stations are close to local markets and farmers, resulting in minimizing transportation costs for waste collection for the municipality and distribution of compost product for the business, thus increasing farmer accessibility to the organic fertilizers. GC sells its compost at a flat price exclusive of transportation fee. The PPP has saved the municipal council a significant amount of money which hitherto was used in operating the composting business as it was incurring losses. Additionally, through charges for the use of the composting facility and equipment, it can implement a mutual financial sustainability strategy. In this model, GC has adopted a system of compost production where the compost is produced at vantage points close to local markets. This model is highly replicable in medium to sizable towns.

Lahore compost plant in Pakistan — The compost plant project at Lahore (LCL) has been set-up on a Build–Operate–Transfer basis for a period of 25 years. The project's pilot phase started operation in March 2006 to initially process up to 300 tons/day of MSW. The project was registered as a Clean Development Mechanism (CDM) project by the Board of the United Nations Framework Convention on Climate Change (UNFCCC) in April 2010. Unable to generate profits, the project was hampered by delays in registering and a slow pace of developing the local market for compost (Masood et al. 2014). Poor marketing strategy and unsatisfactory quality of the compost also contributed towards not achieving the success.

Since this was the first commercial attempt for using composting technology and equipment in Pakistan, LCL faced several technological barriers — the lack of technical expertise and lack of available after-sales support on the equipment. Subsequently, extensive technical research was conducted on compost manufacturing and its utilization. Several composting companies around the world were reached out to for sharing their experience. A few composting plants in Europe, India and the United States were also visited to discuss issues involved in the manufacturing, marketing and utilization of compost. In addition, LCL staff were trained to handle the composting machinery by the supplier, allowing them to manage the existing facility successfully. After that, the entity started working to enhance awareness among the farming community about the benefits of organic manure and demonstrate the benefits of compost use to help boost crop yields and in turn farmers' productivity and income. The project also improved local employment and expertise through regular training programs, often employing previously underemployed workers and scavengers (ESMAP 2010). The composting plant ran at its full capacity and received approximately 1,000 tons per day of mixed waste collected from the city (UNFCCC 2013). Later the plant closed down and was reopened in 2016 running a lower capacity of 50 tons per day. It was envisaged to run the plant in limited scale for three months and then scale up the operations to 500 tons per day in March 2017.[11] However, the plant could not achieve the operational scale and was closed for three years. In 2021, the rehabilitation of the compost plant was

[11] https://dailytimes.com.pk/43893/lwmcs-compost-plant-resumes-operation/ (accessed on January 26, 2023)

initiated and production was initiated.[12] The compost production ratio for this facility is 17%, as the plant receives waste on 275 days of the year. The mixed waste is manually and mechanically sorted. About 65% of the total waste received is organic waste that goes to the composting plant, and the remaining 35% is a combination of recyclable waste and rejects. Although the project offers a model with many benefits, the business is yet to reach breakeven due to poor initial marketing strategies and the low value of CER earnings. Such benefits include reducing waste going to landfills, decreasing environmental and health hazards and increasing the recycling of valuable materials. The compost can be used for agriculture, and the plant provides employment opportunities. The PPP has attracted private sector investment for such municipal services.

Integrated solid waste management with compost and waste-to-energy recovery in Pune, India — Pune Municipal Corporation (PMC) had conceptualized PPP arrangement between PMC, SWaCH (an NGO) Mailhem Engineers Pvt. Ltd. for the management of waste to produce biogas, electricity and bio-sludge. The operations of biogas plant at Katraj Gaon electoral ward in Pune started in 2009. The land and building costs were covered by the municipality at an existing facility. Investment towards plant and machinery cost was USD 180,000, with PMC funding the entire investment on financials. The annual operation and maintenance cost incurred is about 18,000 USD/year. PMC has a contract with SWaCH to deliver organic waste from MSW, and as a part of providing waste management service to households, it pays an agreed amount. There is no additional amount given to SWaCH for supplying organic waste to the plant. Cummins India gave USD 45,000 to Janwani and offered 3,000 employees as volunteers, helping Janwani to create awareness. PMC biogas has indirect revenue sources in the form of savings from electricity and fertilizer. Based on these savings, PMC biogas plant has a payback period of 19 years on its investment with an internal rate of return of 2%. PMC can generate revenue from annual carbon sales. It offsets 76.1 tCO_2eq per year. The plant effectively manages municipal solid waste generated within the Katraj Gaon ward, one of the biggest divisions in Pune, therefore providing environmental benefits as well as health benefits from proper waste management. PMC biogas plant in Katraj Gaon also has several interlinked value propositions production of biogas to generate electricity to provide street lighting services to Katraj–Kondhwa Road in Pune and organic compost produced from slurry and waste output from the biogas plant for landscaping of electoral wards within the Pune municipality. The project also displaces electricity for street lighting in Katraj–Kondhwa Road and displaces 144 MWh/year of electricity purchases by PMC otherwise. Furthermore, it mitigates GHGs totaling 76.1 tCO_2eq/year as a result of the avoided electricity consumption. The key drivers for the success of this business are (i) partnerships with SWaCH/NGOs to deliver segregated organic waste to the plant, (ii) technology partnership with the stakeholders for operation and maintenance of the plant, (iii) capturing demand for end products – electricity and compost, (iv) government policy toward renewable energy and (v) rising electricity tariffs. The contract can be renewed after 5 years. Segregation promoted by PMC has helped in the scaling up of the biogas project (only 20% of waste coming to biogas plant is rejected). This offers an example of how a proper waste segregation and robust institutional mechanism of an Urban Local Body could make a waste to energy technically viable and financially sustainable.

Briquettes from solid waste in Kigali, Rwanda — Rwanda has established a commercially sustainable small circular bio-economy model, which could be replicated in many small ULBs, peri-urban towns. They have been successful in tapping a dedicated market for selling of the recovery product from their briquette manufacturing plant. The project is a collaboration between a private entity named COOCEN and Kigali City Council which has provided land (7 hectare) as investments for production of briquette. COOCEN being the only player in briquette production, is the sole supplier of fuel briquettes to 16 prisons in Rwanda. The payback period for this project has been only 3 years and gross margin is 42%. However, COOCEN anticipated an increase in briquette demand, because of the rising price of charcoal coupled with the government policy to protect the environment and promote alternative sources of energy. Thus, there is a bright opportunity to scale up the plant in future and make it more commercially viable. This evidence represents how correct identification of market demand, tapping the same, and then fulfilling that demand by an effective supply of recovered resource could make a project viable and successful.

Devanahalli fecal sludge treatment plant and the co-compost unit, Karnataka, India — Devanahalli Town Municipal Council (DTMC), India, in collaboration with Bremen Overseas Research & Development Association (BORDA, a NGO specializing in full-cycle decentralized sanitation), and Consortium for Decentralized Wastewater Treatment System (DEWATS) Society (CDD) has developed and implemented a fecal sludge treatment plant (FSTP) in 2015. It is financially supported by the Bill & Melinda Gates Foundation (BMGF) (Mallory et al. 2020; Rao et al. 2020). However, a year after the start of FSTP operations, it became necessary to deactivate the helminth eggs that were retained in the solid component of the fecal sludge (FS) at the end of the treatment. Therefore, a co-composting unit was set up using the windrow process. The unit processes 150 to 200 kg of organic waste daily (CDD Society 2019). This has also helped to handle the disposal of huge quantities of organic solid waste generated in the town from hotels, municipal markets and event

[12] https://www.thenews.com.pk/print/885702-lwmc-starts-rebuilding-compost-plant (accessed on January 26, 2023)

halls (Rao et al. 2020). In this PPP concession, the municipality provided (i) the land and approval for the construction, (ii) responsibility for the operations of the desludging vehicle on a fee-for-service basis and (iii) issuance of licenses to private desludging operators, ensuring that FS was disposed at the FSTP and organic waste is delivered to the co-composting plant. After biogas production, stabilization and drying, the FS is mixed with municipal solid waste for co-composting to produce and sell (CDD Society 2020). The CDD has been responsible for the operations and maintenance of the FSTP and the co-composting Plant for about 2 years. The CDD sells the co-compost to the farmers on behalf of the municipality. Since its commissioning, the plant has been operating under capacity due to low demand for desludging and FS delivery from the municipal trucks. This necessitated adjustments to the technical design to ensure optimization of the treatment process. The option of technological flexibility and scope of process modification in the operational phase, renders the plant operationally successful. Thus, the plant is now operating in technically and commercially viable conditions. A transparent well defined institutional framework among the stakeholders, with clear commitments on the operational aspects and revenues, has been a vital parameter for the success of this plant. The co-compost produced is sold to farmers. The contractor collects payment for the co-compost and transfers it to the authority at the end of the month (after covering incidental costs for maintenance). During the project development process, an Induction and close consultation with the NGO, government authority and contractor were organized. The project also involves highly motivated conservancy staff in its framework. Therefore, the project runs on a self-sustainable commercial mode. During the project development process itself, the gaps in Devanahalli residents' behaviors were identified, and an (IEC) campaign was implemented. In this case, community engagement initiative has been initiated to be implemented in parallel to FSTP construction and operations. Furthermore, farmers were motivated to use FSTP by-products. The community engagement strategy was fine-tuned based on local requirement.

Co-composting plant in a small municipality of Sakhipur, Bangladesh — In a small municipality of Sakhipur, Bangladesh, a co-composting plant was established in 2019 with an annual handling capacity of 1,500 tons of fecal sludge and 150 tons of solid waste. The plant is based on aerobic decomposition of dried fecal sludge and organic solid waste. The organic solid waste, dried fecal sludge and sawdust are mixed at a bulk volume ratio of 3:1:1. Plant construction was financed by WaterAid Bangladesh, without any public funds. An account is operated by the municipality and for the sale of compost. Farmers have accepted co-compost (for which there is a higher demand than supply) and the plant is running successfully. The Department of Agricultural has been providing technical guidance for recovery and reuse of compost. They are also assisting to enhance the capacity of the ULB in awareness creation and proper distribution of the compost among local farmers. Farmers are using the compost as a soil conditioner and their feedback is encouraging.

The municipality, WaterAid Bangladesh and its partner BASA are the three major stakeholders involved in the operation. WaterAid provided technical and financial support (particularly linked to plant construction and part of the operation and maintenance) and BASA worked as the implementation partner. A proper institutionalization of responsibilities has made the project effective and successful. Representatives of all key stakeholders formed a committee with the mayor as its advisors to carry out the process of implementation and service delivery. Planning and implementation were done in phases, with the technology chosen to construct in a modular fashion, such as opening more drying beds as coverage increased. The 6-month trial period helped establish confidence in the technology and its end products. Continuous performance monitoring is carried out periodically from government laboratories. Sufficient baseline study, due diligence and stakeholder consultation before the project have been instrumental to safeguard any unforeseen risk during implementation. Participatory methods like face-to-face interactions, focus group discussions and media (print and audio) were used to communicate the benefit and importance of utilization of recovered product such as compost. There are nine Community Based Organizations (CBOs) in Sakhipur which could be potential entrepreneurs in sanitation and solid waste management. This plant is a replicable example of successful circular bio economy, which has been driven by organized capacity building, well defined operational framework, scaling up arrangement and awareness campaigning. It offers evidence and learning on FSM in the context of Bangladesh, especially for small municipalities with limited resources and with key driving factors as – (i) technology, (ii) process, (iii) estimate of resource needs, (iv) reuse potential, (v) socio-economic aspects of co-composting, (vi) identification of the impacts of using the compost on crops and soil and (vii) raising awareness and knowledge about co-composting as a waste recycling option.

Kolkata Solid Waste Management Improvement Project, India — Japan International Cooperation Agency (JICA) implemented the Kolkata Solid Waste Management Improvement Project (KSWMIP), in 2007 in six municipalities, namely Champdani, Baidyabati, Serampore, Rishra, Konnagar and Uttarpara-Kotrung within the Kolkata Metropolitan Area in the state of West Bengal. The project was conceptualized on PPP basis. Procurement was done on equipment, and waste treatment facilities were constructed as assets. Initially, however, the equipment and facilities were not fully utilized due to insufficient management capacity of municipality, improper waste separation, low awareness of the residents and inefficient market linkages. Furthermore, an organization for facility management was not decided among the related local

governments, and a necessary budget for operation and maintenance was not secured. There are six compost plants under this project, which were not properly utilized due to an absence of a strategic plan for waste collection system. Besides that, forward linkage of the recovered resource (as compost) was not also established. All the facilities had little incoming waste. The facilities could not operate appropriately for the small amount of incoming waste. The plant in Konnagar did not provide a segregation service to collect valuable materials.

Moreover, it was observed that there are organizational deficits in the operation. Handling of waste, temperature and moisture control, and turning were not appropriately maintained. The compost plant also did not have any schedule of activities and was not monitored. Despite these setbacks, specific initiatives by the JICA project team were able to turn around the project into an efficient resource recovery project. As a first measure, an institutional strengthening and sufficient awareness sensitization drive were undertaken. All chairpersons of those municipalities were encouraged to deliver the desired quantity of waste in a segregated manner. They were also handheld on the operational aspects of the compost plant. The importance of source segregation was highlighted. The JICA Project Team held a workshop for the promotion of compost sales in January 2017. Many stakeholders, such as chairmen, councilors of all ULBs, farmers, youth club, nursery owners, business associations and chemical fertilizer companies, were involved in the workshop. The possibility of testing the quality of the product, attracting compost packaging, implementing traveling sales, and collaborating with business associations to sell compost at the local market was considered. Around 300 retailers were contacted for the forward linkage of recovered products. Advertisements on the sale are spread through the newspapers and leaflets, and local canvassing was conducted. To compensate a part of the O&M cost for the compost plant, JICA Project Team has supported Uttarpara-Kotrung to sell compost by contacting retailers, and municipalities have taken good initiative for selling of compost with micro retailer. The JICA project team along with the municipalities, had strategized the following innovative steps — (i) Implementation of pilot project of mobile retailing fertilizer shop to household residents for their kitchen garden, (ii) promoting and advertising the sales through newspaper, leaflets and miking, (iii) coordination with public institutions in the municipality to use the compost for the fertilizer of the garden, (iv) organizing compost selling participatory promotional workshop and (iv) making municipality instrumental in negotiating with the retailers as they are potential heavy buyer. The project made efforts to invite as many visitors as possible to the compost plants site to motivate the site staff to be proud of their roles and to enhance the operation. As a result, sanitary inspectors of the Uttarpara-Kotrung and Baidyabati municipalities started taking responsibility on the activities of negotiation for compost sale, along with the buying stakeholders. Capacity development of staff and workers and cooperation from the residents are required to adequately utilize the facilities constructed by KSWMIP. The Project held site visits and workshops for the decision makers many times to enhance their involvement and understanding to KSWMIP. This project is a successful case study of establishing that an effective social mobilization activity, active participation of ULBs and stakeholders, and a strategic marketing linkage could be a triggering factor to reviving resource recovery project. It can also support to be a self-sustainable model (JICA Report 2017).

Gianyar composting plant, Temesi, Indonesia — Gianyar composting plant in Indonesia was based on the commercial model of compost revenue and CDM. Nonetheless, reaching the project's financial viability has been a challenge and there was a deficit of 68% to cover all costs. The main challenges cited by the organization are – (i) Absence of tipping fees, (ii) source segregation is lacking and they need to outsource segregation activity which is 42% of their total annual cost, (iii) decentralized composting is favorable for the organization than this centralized facility, (iv) subsidies for chemical fertilizers lead to an uneven playing ground and (v) the compost production is unable to tap the rice farmers which is the largest market. Therefore, the plant has not been a great success. The parameters mentioned above could be taken as lessons learned while developing a project from a commercial viability point of view.

Tema co-composting plant, Ghana — The co-composting plant for organic waste from MSW and fecal sludge was set up between the Tema municipality and a local waste management company for a period of 25 years at Ghana. The operators encountered competition for feedstock which limited supply to the plant, and kept operations below 40% capacity. Insufficient marketing strategies affected revenues. These challenges were compounded by land tenure problems, resulting in a further decrease of operations. As a result, the generated resources from the plant could not reach commercial production level, thereby making the plant commercially non-viable and due to the land tenure problem, embroiled in a legal limbo. The PPP was facilitated by a third party with most initial funding covered by an external donor.

Waste to energy plant at Timarpur, New Delhi, India — The first WTE plant came up in Timarpur in Delhi in 1987. It was designed to incinerate 300 TPD of mixed waste and produce 3.75 MW of electricity. It failed and was soon shut down. The reason most often cited for its failure was a mismatch between the plant's waste input requirements and the quality of waste it received in terms of calorific value, moisture content and physical composition. Subsequently, in 1995, a Planning Commission High Powered Committee Report stated that, as Indian waste has low calorific value, it is usually unsuitable for self-sustained combustion. Hence, incineration-based technologies might be uneconomical in most cases. However,

in 2007, the apex court asked the ministry of New and Renewable Energy (MNRE) to set up five plants on a pilot basis. MNRE took up five pilot projects with an aggregate capacity of 57 MW under its 'Programme on Energy Recovery from Urban, Industrial and Agricultural Wastes/Residues'. Under these five pilot projects, one plant each in Timarpur-Okhla and Ghazipur is operational; the remaining three, however, could not be operationalized because of the paucity of funds and other technical reasons. The capacity planned was conversion of 1,300 TPD MSW to Refuse Derived Fuel (RDF) at Okhla and 650 TPD at Timarpur (for a total capacity 1,950 TPD), along with a 23 MW power plant at Okhla. The project was conceptualized on PPP Build-Own-Operate-Transfer with 25 years concession period. A Special Project Vehicle (SPV) was signed between the private contractor and New Delhi Municipal Council while IL&FS conceptualized the project. A Power Purchase agreement for 25 years was signed with BSES Rajdhani Power Limited for 50% of the electricity generated, while the remaining 50% was sold through open access.

The waste-to-energy plants have regularly faced disputes from residents and societies in the neighborhood. Residents of the Sukhdev Vihar colony near the Okhla plant in New Delhi, have protested the plant since 2003, for alleged toxic emissions. The Okhla WTE plant has been allowed to run despite its proximity to residential areas, three major hospitals and a significant green cover. The emission from waste to energy power plant has long been a great social and environmental concern. The overriding concern is whether the WTE plants are intended to treat mixed waste of one city alone rather than of a cluster of cities. The combustible, non-recyclable fraction of waste in one city is too little to feed a single plant. Also, the 'not in my backyard' effect is prevalent for WTE plants. Notably, almost all WTE projects in India have faced public protests and some have even been subjected to public litigations. Incineration-based WTE plants have not been successful in India mainly because of poor systems for source segregation, seasonal variations in waste composition and characteristics, inappropriate technology selection as well as operational and maintenance issues. The presence of inert MSW delivered for processing makes the operation difficult and expensive. In most cases, the issue of non-supply of committed quantity/ quality of waste to the plant by the municipal authority is a critical factor. WTE plants continue to face public outcry and protests. The sufficiently high-calorific value of the waste in Western countries makes incineration an effective means of waste disposal. In India, on the other hand, domestic waste has high moisture (47% on average) and inert content (as high as 25%). As per the World Energy Council Report, capital and O&M costs are significantly higher in the case of WTE. India's experience with WTE has been less than satisfactory in this context. WTE is a sophisticated technology with high associated costs. Since the feed for the plant can vary, a study of the composition, waste generation and collection patterns, and plant location should be undertaken before considering a WTE plant. Similarly, socio-economic conditions concerning waste must be evaluated before planning for incineration plants.

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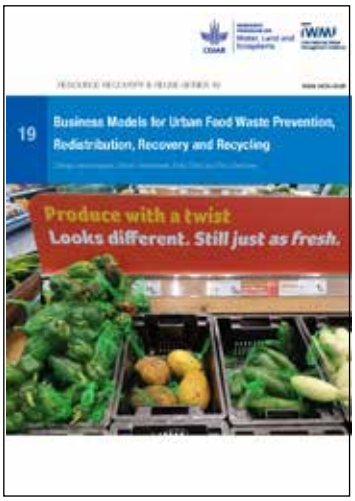

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