Decentralized and Integrated Resource Recovery Centers in Developing Countries: Lessons Learnt from Asia-Pacific

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ABSTRACT

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) has been promoting decentralized and Integrated Resource Recovery Centers (IRRCs) in secondary cities and small towns in Asia-Pacific with an objective to recover value from waste and provide livelihood opportunities to the urban poor. The IRRC model uses simple technology, is low cost and aims at financially viability by converting organic waste into compost and valorizing recyclable waste, made possible through the separation of waste at source. This paper discusses the potential for applying the IRRC approach in Asia-Pacific by presenting the key elements of the IRRC in the context of developing countries in the region.

Multiple case study technique has been used to carry out the research, with an objective to discuss experience from practice. The paper draws on the findings of baseline studies conducted in cities of Sri Lanka, Vietnam and Cambodia where IRRCs have been established and lessons learnt during project implementation are presented with an emphasis on partnership arrangements, source separation of waste and financial sustainability.

Evaluating experiences in implementing the IRRC model in several towns and cities across Asia, IRRCs have proven effective in managing waste in a cost effective and environmentally sustainable manner and hold potential for further replication and up scale. Since the projects have to be financially sustainable, there is a need to identify and maximize internal income generation to meet operating expenses. The pivotal role played by sound partnership arrangements by involving and maximizing stakeholder interests is crucial to ensure effective implementation and further contributes to the long term sustainability of the project.

INTRODUCTION

The rapid urbanization and economic development taking place in the Asia-Pacific region is leading to increasing solid waste generation, with an estimated 1.3 billion tons of municipal solid waste generated globally per year and this figure is expected to reach 2.2 billion tons per year in 2025. An increase in disposable income and living standards is marked by a corresponding increase in the consumption of goods and services resulting in higher waste generation rates, with the rate of per capita per day waste generation expected to increase from 1.2 kg to 1.4 kg in 2025 (World Bank 2012). Asia-Pacific is home to almost 2/3 of the world's population and the region is estimated to reach 50 per cent urbanization by 2026. Urbanization in Asia is broad-based rather than concentrated in just a few cities with 60 per cent of its urban population living in small and medium-sized cities (ESCAP and UN Habitat, 2010).

Managing solid waste is one of the costliest urban services in developing countries, where local governments spend 20 to 50 per cent of their budget on solid waste management (UN Habitat, 2010). In low income countries, municipal solid waste management is the single largest budgetary expenditure, with on average 80 per cent being spent on collecting and transporting waste to the dumpsite (World Bank, 2012). Despite the high spending on waste management, cities are finding it increasingly difficult to collect, process and dispose of solid waste in a cost effective and environmentally friendly manner (AIT, 2004). Currently open dumping is the most common method for final disposal of waste as it offers a quick and easy solution in the short run. However this option is not sustainable in the long run as landfills reach capacity resulting from rapid waste generation rates and due to scarcity of land. Finding space for new landfills within municipal boundaries is

becoming increasingly difficult. This problem is further compounded by the opposition of local communities to locate new landfills in their vicintiy (ESCAP, 2007).

Moreover, open dumping causes severe environmental problems. Uncontrolled dumping leads to water and soil contamination, odours, and other health and hygiene problems (IGES, 2006). In addition to these adverse effects, uncontrolled dumping leads to the anaerobic decomposition of organic materials resulting in the release of mathane, a powerful green house gas (GHG), negatively impacting the climate.

Improper waste management practices usually results in higher downstream costs than what it would cost to manage the waste properly in the first place (World Bank 2012). According to the data presented in table 1, only about 5 – 20 per cent of the total waste generated in developing countries of Asia needs to be sent to the landfill, whereas the remaining waste can be recycled back into the economy. The high percentage of organic waste, if recovered by deploying appropriate systems before they enter the mixed waste stream, can be converted into compost which is a source of valuable organic mater and nutrients in agriculture.

Evidently, current approaches in the Asia-Pacific region have limitations in solving the problems arising from growing municipal solid waste generation due to high costs incurred, unavailability of landfill space, lack of attention given to waste to resource opportunities in light of the composition of waste, and lack of importance given to the social dimensions ofwaste generation and minimisation.

A key aspect of waste streams in the Asia-Pacific region is the high percentage of organic content. The organic waste content in developing countries is significantly higher in comparison to developed countries of Asia as per data presented in table 1. In developing countries of Asia-Pacific, the composition of municipal solid waste comprises 40 – 70 per cent organic waste which is unsuitable for incineration due to its high moisture content and low calorific value (Vishwanathan and Glawe 2006). According to ADB (2011), opting for incineration plants for developing countries in Asia is not a viable option unless the present technology is improved to treat the high amount of organic waste present in the municipal solid waste stream.

Table: 1 Composition of solid waste in countries of Asia-Pacific

Country	Waste generation (kg/capita/day)	Composition (in % basis)						
		Bio - degradable	Paper	Plastic	Glass	Metal	Textile/ leather	Inert & other
ASIA								
Hong Kong	2.25	38	26	19	3	2	3	9
Japan	1.1	26	46	9	7	8	-	12
Singapore	1.1	44.4	28.3	11.8	4.1	4.8	-	6.6
Taiwan	0.667	31	26	22	7	4	9	-
S. Korea	1	25	26	7	4	9	29	-
Malaysia	0.5 - 0.8	40	15	15	4	3	3	20
Thailand	1.1	48.6	14.6	13.9	5.1	3.6	-	14.2
China	0.8	35.8	3.7	3.8	2	0.3	-	47.5
Philippines	0.3 - 0.7	41.6	19.5	13.8	2.5	4.8	-	17.9
Indonesia	0.8 – 1	74	10	8	2	2	2	2
Sri Lanka	0.2 - 0.9	76.4	10.6	5.7	1.3	1.3	-	4.7
India	0.3 - 0.6	42	6	4	2	2	4	40
Vietnam	0.55	58	4	5.6	1.6	1.5	1.8	27.5
Phnom Penh, Cambodia	-	63.3	6.4	15.5	0.6	1.2	-	13
Lao PDR	0.7	54.3	3.3	7.8	8.5	3.8	-	22.5
Myanmar	-	73.27	2.24	17.75	0.20	0.45	-	6.09
Nepal	0.2 - 0.5	80	7	2.5	3	0.5	-	7
PACIFIC								
Fiji	0.57	71	11.2	5.8	3.8	1.6	0.3	6.3
Solomon Islands	0.62	64.6	5.9	16.8	4.5	6.1	1.8	0.3
Kiribati	0.33	51.3	7.0	7.2	13.6	9.4	3.0	8.5
Samoa	0.48	64.4	8.0	9.0	1.8	7.8	5.5	3.5
Tonga	0.82	47.2	31.3	5.2	3.3	8.0	3.7	1.3
Tuvalu	0.43	52.4	10.4	9.3	9.5	9.8	2.2	6.4

Source: UNEP 2010, SPREP 2010, Shekdar 2008

The composition of waste in the middle and low income counties in Asia-Pacific holds the potential to change the narrative on municipal solid waste management, whereby waste can be viewed as something that has an economic value and not merely as a cost for local governments. It is in the above context that the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) embarked on a regional project to promote decentralized and Integrated Resource Recovery Centers (IRRCs) in the secondary cities and small towns of Asia-Pacific to manage municipal solid waste in a cost effective and environmentally sustainable manner through community participation, and in a manner which underscores the opportunities provided by waste to resource paradigms, inclusive of the three dimensions of sustainable development and underpinned by effective government partnerships.

THE INTEGRATED RESOURCE RECOVERY CENTER (IRRC) MODEL

Since 2007, ESCAP with technical support from Waste Concern, has been promoting the IRRC approach in line with the principles of 3R (reduce, reuse and recycle). The IRRC model has thus been designed to minimize waste and to recover value from waste by converting waste into resources. Considering the high percentage of organic waste in the Asia-Pacific region, and the opportunities for livelihoods which can be derived from waste, sustainable solid waste management approaches need to be well equipped to deal with the organic fraction as well in order to effectively contribute to the goals of 3R.

For processing the high organic fraction in the municipal solid waste stream in Asia, waste management projects in the past were initiated by means of large scale, centralised and mechanised compost plants based on foreign technologies and designs. These plants were not able to sustain operations due to high maintenance and operational costs and also due to low quality compost resulting from mixed waste. Subsequently, many plants had to shut down due to technical difficulties and problems in marketing and selling the low quality compost derived (ADB 2011). Drawing lessons from these past failures, the IRRC model aims to manage solid waste in a decentralized manner relying on simple technology, reducing operational and maintanance cost and aiming at source separation of waste to produce good quality compost. The decentralized composting system suits the socio economic and physical conditions in low and middle income countries in Asia, and especially in secondary cities and small towns.

The key aspects of the IRRC model are presented below.

Source separation: In order to divert waste from going to the landfill (downstream), the IRRC model relies on source separation of waste and improved waste collection services (upstream) with an aim to recover resources before they lose their utility and value. Source separation of waste is thus an essential element of the IRRC with two main benefits:

- Source separation prevents the organic waste from getting mixed with inorganic waste and helps provide clean organic feedstock which is a pre-requisite for producing good quality compost;
- Source separation also increases the possibility for recovering recyclable waste, such as paper and cardboard, as it does not get soiled by wet organic waste.

In addition to the aforementioned benefits, source separation also saves costs as workers spend less time sorting and cleaning the waste once it is transferred to the IRRC. Decentralized composting also fosters source separation of waste as communities cooperate in separating waste as a result of awareness campaigns carried out by non-governmental organizations (NGOs), community-based organizations (CBOs), local government bodies and other local community networks. Moreover, by involving citizens in solid waste management, this contributes to changing perceptions and attitudes towards waste.

Livelihoods: In the process of converting waste into resource, the IRRC provides green jobs to the urban poor and waste pickers, including better incomes and working conditions. In order to provide jobs to the urban poor, the IRRC uses simple/replicable and cost effective technology that requires manual labour, practices door to door waste collection and uses the raw materials and resources available locally to construct the IRRC. The IRRC approach also pays close attention to improving the working conditions of labourers by protecting them from occupational hazards while working with waste through regular use of gloves, boots,

uniforms and masks. Workers have also access to training opportunities to upgrade their skills. IRRC have also a gender dimension, as workers tend to be either all male or all female according to the country.

Financial sustainability: The IRRC model has been designed to operate in a financially sustainable manner by covering all operational expenditures and holds the potential to generate limited profits. The three main sources of revenue for the IRRC are derived from:

- ✓ Sale of compost/ biogas/ refuse derived fuel (RDF) or a combination of these.
- ✓ Sale of recyclables.
- ✓ Collection fee for waste collection services or a tiping fee.

Since the IRRC aims at financially sustainability and profitability, it is important to market the resources effectively in order to derive revenues to cover the operating expense incurred. With regard to composting, Ali (2004) and Rouse et al. (2008) ascribe the failure of compost plants processing municipal solid waste to lack of attention given to marketing the end product. Though many projects are successful in producing compost, they may not be sustainable as compost needs to be marketed and sold on a continuous basis. Therefore the IRRC model pays close attention to marketing and selling the product in order to derive steady revenues to sustain the operations.

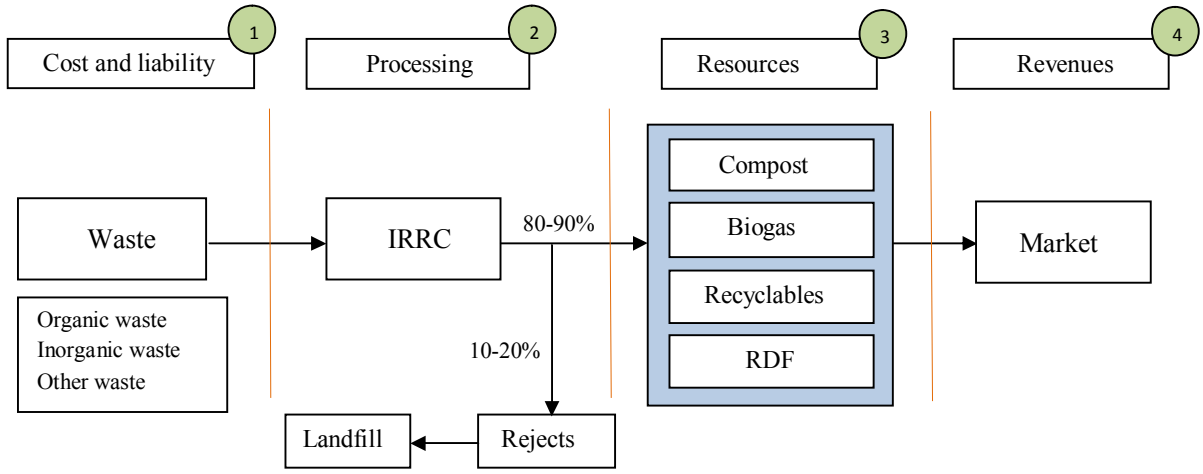

Figure 1: The IRRC model

One of the key points of the IRRC approach is its triple win outcomes that strengthen all three dimensions of sustainable development. By processing one ton of waste, an IRRC provides the following benefits:

Social benefits

- Creates 2-4 green jobs for urban poor/waste pickers;
- Provides steady source of income and better working conditions to urban poor/waste pickers;
- Reduces the spread of vectors, diseases and odours;
- Directly benefits 1,500 - 2,000 people through better hygeine and improved urban environment;
- Increases the awareness of the community on sustainable solid waste management and 3R.

Economical benefits

- Produces 0.2 ton of good quality compost;
- Produces 40-80 m^3 of biogas (480-240 kwh);
- Requires only 150-200 m^2 of land, saving 2.2 m^3 of landfill volume;
- Promotes sustainable consumption and production through closed loop material cycles;
- Saves fuel costs as waste need not be transported to the landfill which are usually far from the city.

Environmental benefits

- Avoids 0.2-0.3 m^3 of leachate water;
- Avoids the emission of 0.5 ton of CO_2eq;
- Compost offers multiple benefits to the environment as it:
  - re-establishes soil fertility by returning organic matter to soil;

- is a source of valuable nutrients and minerals to the plants;
- improves soil structure by creating a better plant root environment;
- improves the water holding capacity of soil in drought prone areas;
- reduces the levels of chemical fertilizers that goes into the soil;
- increases particle adhesion to the soil, thereby reducing erosion on slopes caused by rainwater flow (Dulac 2001).

IRRC IMPLEMENTATION IN CITIES OF SRI LANKA, VIETNAM AND CAMBODIA

ESCAP has been piloting the IRRC model in a number of cities across Asia-Pacific. Three case studies from three different countries are presented in this paper, namely: Matale (Sri Lanka), Quy Nhon (Vietnam) and Kampot (Cambodia). Table 2 provides an overview of key data related to the three case studies, and in particular waste generation rates and composition, drawing from data collected through baseline surveys conducted at the outset of the project.

Table: 2 Waste generation rates and waste composition in cities where IRRCs are operational

City, Country	City classification	Population	Total waste generated /day	Waste generated /capita/day	Organic waste	Recyclables	Others/ Inert
Matale, Sri Lanka	Small town	40,674	21 ton	0.51 kg	75%	18%	7%
Quy Nhon, Vietnam	Secondary city	271,248	195 ton	0.71 kg	72%	13%	15%
Kampot, Cambodia	Small town	34,000	18 ton	0.53 kg	65%	23%	12%

Source: ESCAP, Baseline surveys conducted in Matale, Quy Nhon and Kampot.

Matale, Sri Lanka

Matale generates 21 tons of waste per day from its domestic and commercial units. Prior to the implementation of the IRRC, the municipality collected 17 tons of waste and transported it to the dumpsite. In light of the favourable waste composition patterns and as a result of the strong commitment of the local government to the 3R principles, ESCAP provided seed fund to set up, in partnership with Sevanatha (a local NGO) a pilot 2 ton IRRC in 2007. Based on the success of this plant in diverting 2 tons of waste from the dumpsite on a daily basis and after evaluating the positive effects of the IRRC model in producing resources from waste, the Central Environment Authority of the Ministry of Environment in Sri Lanka provided additional funding through the Pilisaru[1] Project to build another IRRC facility to process 2 tons of waste in 2011. In 2013, one more IRRC was built with the support of ESCAP with a capacity to process 5 tons of organic waste. The IRRCs put together have a combined capacity to treat all of the organic waste that Matale generates. In addition to the capacity to process 9 tons of organic waste, the IRRC has facilities to sort and store 3 tons of recyclables on a daily basis.

All the IRRCs in Matale are located within the neighbourhood they serve, which keeps transportation costs down and even allows fruit and vegetable vendors to take their waste directly to the plant. The central location of the IRRC adjacent to the mayor's residence has helped publicize the merits of the IRRC, thereby rendering encouragement to the community to separate their waste and to purchase compost directly from the IRRC.

The role played by the Public Health Department towards effective source separation of waste in Matale is noteworthy. In the Public Health department of the Matale Municipality, Community Development Officers (CDOs) carry out door to door awareness on issues relating to public health and hygiene to control outbreak of diseases, especially dengue. The service of these officers were solicited in carrying out the awareness

[1] Pilisaru in Sinhala language mean 'waste to resource' and through this project grants are provided to local authorities in Sri Lanka to build facilities to convert the organic waste into compost and bio gas.

campaigns on source separation of waste and its links to sustainable solid waste management and improved urban environment and hygiene. The CDOs visit every household in the thirteen wards of Matale at least once a month and communicate about the benefits and progress of the source separation program and the IRRC project. Since the communication program is backed by the Municipal department this has also lent credibility to the source separation program and contributed to achieving source separation rates of 60 per cent in the community. The leadership and strong commitment displayed by the mayor and the municipality has played an important role in promoting the IRRC as an effective model that fits into the 'green city' vision of Matale.

The IRRC in Matale is operated through a partnership between Matale Municipal Council and MEC Pvt. Ltd. MEC Pvt. Ltd was formed by the NGO Sevanatha as a social business with a view to operate the IRRC by converting waste into resources and in the process improve the urban environment and provide jobs to the urban poor. Though the agreement to operate the IRRC is between the Muncicipality and MEC Pvt. Ltd, capacities and skills of all other stakeholders have been leveraged to set up the IRRC and to support various project activities. The interaction between all project partners/stakeholders and the key roles they have played during the implementation of the IRRC are illustrated in figure 2. After scaling up to process 12 tons of waste, the IRRC is financially sustainable and provides 20 jobs for urban poor employees in carrying out daily operations of the IRRC.

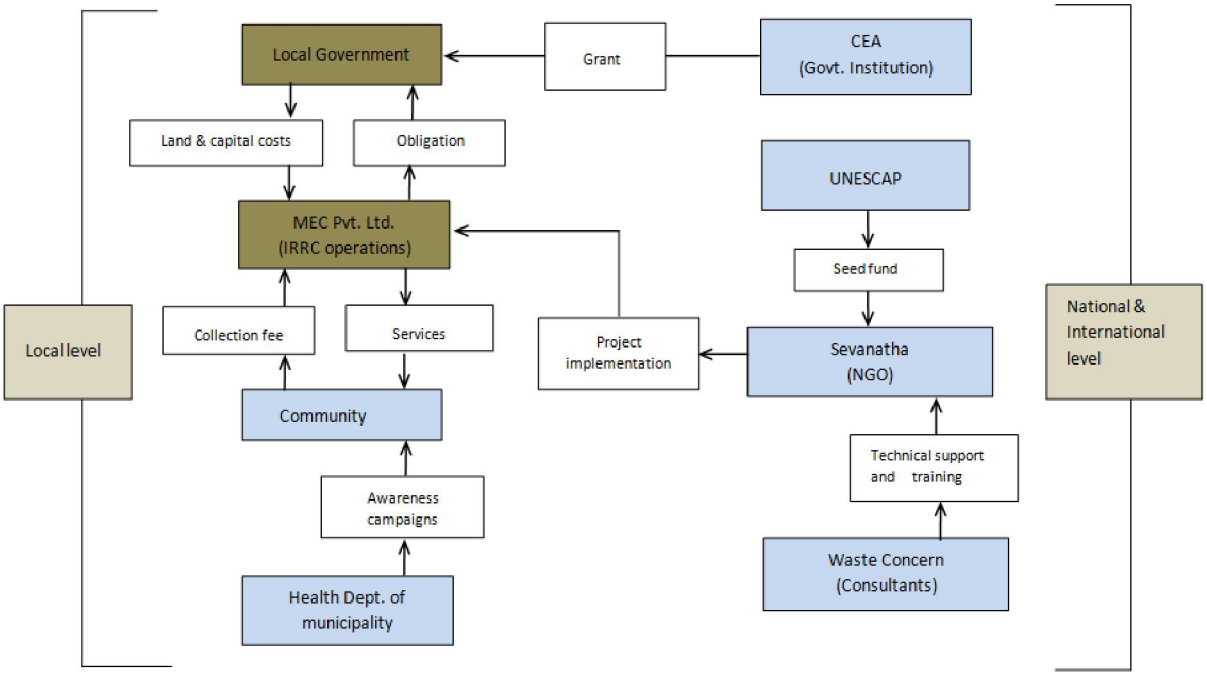

Figure 2: Partnership arrangements for the IRRC in Matale, Sri Lanka

Quy Nhon, Vietnam

ESCAP through its partner - Environment and Development Action in the Third World (ENDA), an NGO - built in 2007 a pilot IRRC of a capacity of 1 ton/day to manage the waste generated in the ward of Nhon Phu in the city of Quy Nhon in a decentralized manner with a focus on source separation of waste through community participation. This IRRC, which is managed and operated by a workers cooperative, has been able to cover all operational costs and generates surplus revenues which are shared by the workers. The source of revenues for the IRRC is derived from the sale of compost, recyclables and a collection fee for door-to-door waste collection from 700 households and 2 small markets. The compost produced is mostly absorbed locally through sales within the neighbourhood. In addition to providing 6 jobs through the cooperative, the IRRC project has also created a strong sense of ownership as the workers are trained to manage and operate the IRRC and their performance is inextricably linked to the long term sustainability and profitability of the IRRC.

Community mobilization for source separation of waste was carried out by leveraging the already established local community network of the Community Development Fund (CDF). In Quy Nhon, the CDF had organized households into various groups for income generation activities. ENDA worked with these groups and through their network, the message was passed to the local community for source separating waste. In addition to this, the local authority passed a legal directive for source separation among commercial entities which resulted in 80 per cent source separation rates among non-households.

The partnership arrangements and the interactions between all partners and the key roles played in the IRRC project are illustrated in figure 3:

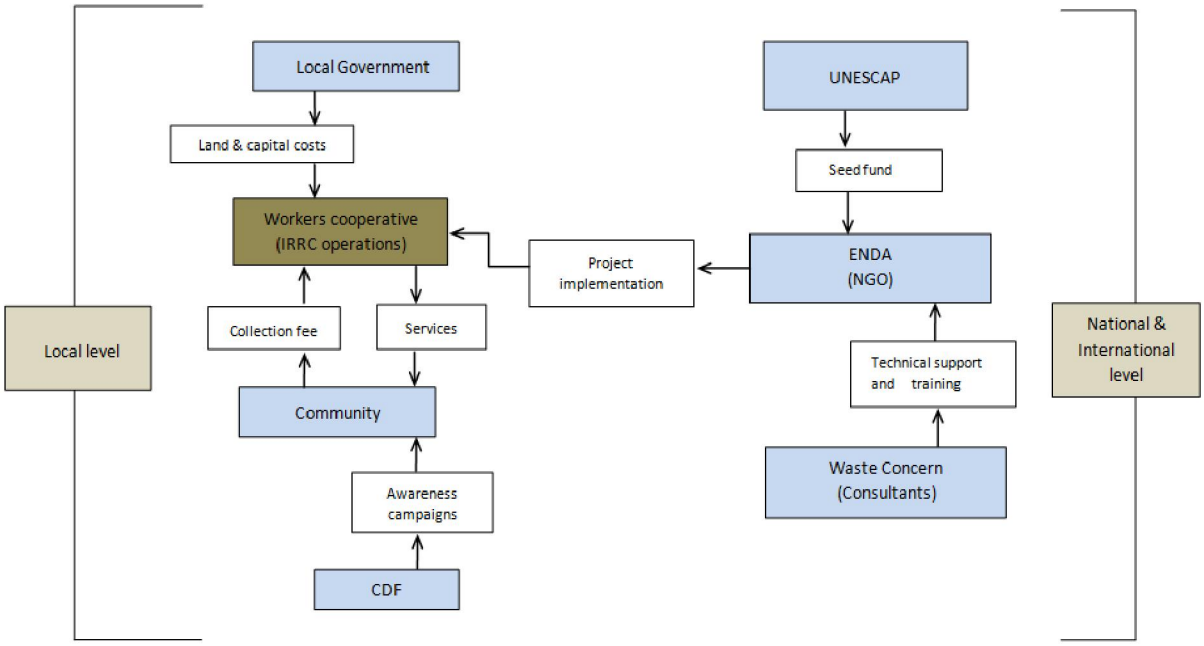

Figure 3: Partnership arrangements for the IRRC in Quy Nhon, Vietnam

Drawing from the success of the IRRC model and the lessons in source separating waste, CITENCO (the state owned company in charge of waste management) and the People's Committee of Quy Nhon have been promoting source separation of waste among non-households including markets, schools and enterprises throughout the city with the aim to increase the volume of clean organic feedstock for the large scale compost plant in Long My. Since 2008, a large scale composting plant has been operational at the Long My landfill complex with a capacity to process 250 tons of waste per day. However the plant never operated at full capacity due to operational problems and in the initial years processed about 80 tons of waste at 32 per cent of the total capacity. In 2010 due to problems arising from processing mixed waste, the compost plant