

**Resource Recovery and Reuse (RRR)
Project**

Methodological Guidelines for RRR Case Assessment and Model Development

**International Water Management
Institute (IWMI)**

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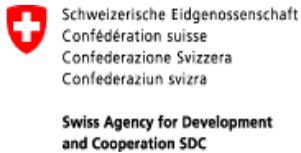


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1. INTRODUCTION

A central objective of the IFAD project is to describe “promising” resource recovery and reuse (RRR) business models based on a) existing or b) emerging empirical cases (projects, enterprises, etc.) or c) of potential nature, i.e. without any existing example. Promising in this context means that waste reuse allows for cost recovery or profit with potential for replication and scaling-up in low-income countries (we might also consider models more suited for emerging economies, but not only). For the purposes of this research, we define RRR business cases as:

“entities that are engaged in the productive reuse of water, nutrients, organic matter and energy from domestic and agro-industrial waste streams to generate revenue or recover costs and consequently contribute to supporting waste management and a healthy environment using its own or any other adopted business model”.

and a business model as:

“describes how a business creates, delivers and captures value (Osterwalder and Pigneur, 2010); essentially the entire solution comprising the core aspects of the business - business process (e.g. technology), target customers, offerings, infrastructure, organizational structures, trading practices, operational processes and policies, and the strategies it implements to achieve its objectives (be it for profit maximization, social impact, etc.).”

The analysis of the empirical RRR business cases and development of RRR business models however does not come with the well-established base of literature that we are accustomed to finding for so many other researchable subjects. The in-depth assessment of both formal and informal RRR business cases to understand the factors that drive their success and likely sustainability, replicability and scalability barriers, particularities and opportunities, require the application of an approach that assesses the RRR entity from a holistic view, taking into consideration both the micro- and macro-environment that it operates in. The analysis required the development of a suitable methodology and framework for reviewing/assessing the business cases combining both a qualitative and quantitative analytical framework. This document thus focuses on what the business model concept is, the approaches used to select RRR business cases for detailed analysis, the approach used for analyzing business cases and ultimately for developing generic RRR business models.

2. ASSESSMENT OF RRR BUSINESS CASES

2.1 The Business Model Concept

In the past decade, starting from the mid 1990s the business model concept has become an increasingly pertinent notion in management theory and practice and has received substantial attention from academics and business practitioners (Magretta, 2002; Osterwalder et al. 2005, Shafer et al 2005; Zott et al., 2011). Numerous definitions of the concept have been proposed in the literature but in general a business model describes how a business creates, delivers and captures value (Osterwalder and Pigneur, 2010). It has been defined as the conceptualization of how a business creates value on the one hand and its market orientation on the other hand (Hedman and Kalling 2003, Osterwalder et al 2005). Moreover, the business model concept builds upon other concepts in business strategy such as Porter's value chain concept and strategic positioning (Porter, 1985).

The business model has become a widely accepted unit of analysis that goes beyond a description of a firm, a product or an industry to include a more holistic, system level approach to explain how firms do business (Zott et al., 2011). In order to understand and operationalize the business model concept, Osterwalder and Pigneur (2010) described a business model as consisting of four core elements which can be decomposed into 9 building blocks that taken together create and deliver value. These core elements describe a firm's: 1) *value proposition* which distinguishes it from other competitors through the products and services it offers to meet its customers' needs, 2) *customer segment* the firm is targeting, the channels a firm uses to deliver its value proposition and the customer relationship strategy, 3) *infrastructure* which contains the key activities, resources and the partnership network that are necessary to create value for the customer and 4) *financial aspects* which ultimately determine a firm's ability to capture value from its activities and earn profit. Based on these core elements, Osterwalder and Pigneur (2010) described a business model through 9 components as illustrated in Figure 1. This approach of decomposing a business model into different components enables firms to explicitly visualize the processes underlying their business model and identify ways to boost its strengths, mitigate its weaknesses and threats; and explore and capture the benefits from any opportunities that exist.

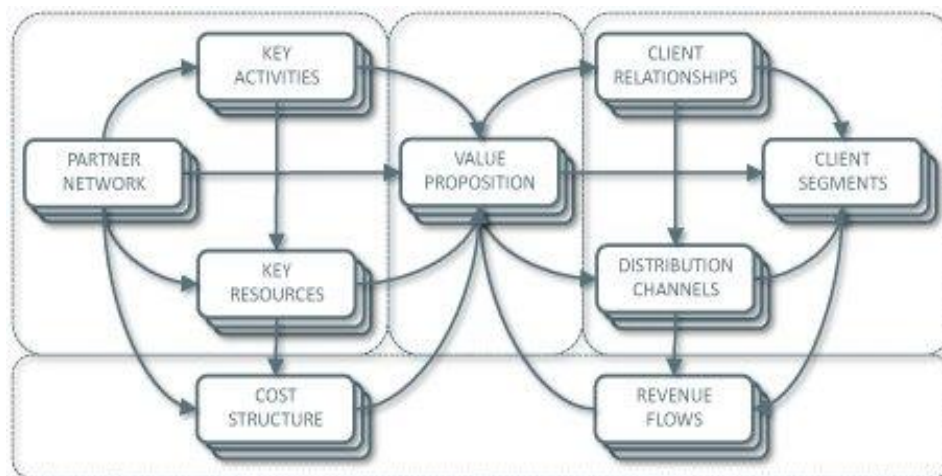


Figure 1. Components of a business model (Osterwalder, 2005)

Generally, all firms have business models, whether they explicitly articulate it or not (Chesbrough, 2007). Businesses inherently see a critical need or a job to be done which the existing market or system is not

addressing. These businesses understand that there is a need and that end users may not be satisfied with the existing offerings. Thus various value propositions are offered through different RRR business models to ensure that customer needs and the business' objectives are met. In this study we employ a combination of the business model concept developed by Osterwalder and Pigneur (2010), a multi-criteria assessment (MCA) framework and a SWOT analysis to assess and describe existing and emerging RRR businesses.

2.2 Application of the business model concept for assessing RRR business cases

To ensure the adequate assessment of factors comprising the different components of the applied business model concept, we underpin the evaluation of the business case using the business model canvas with a multi-criteria assessment (MCA) framework. The MCA framework used consisted of a 7-component criteria with each criterion having its own set of indicators and related questions. Detailed questions were employed to provide data/information for the evaluation of indicators. The list of criteria selected for the MCA framework is based on previous research and is as follows:

1. Waste supply and availability
2. Market assessment (demand quantification and product market assessment)
3. Technological aspects (waste transport, storage, valorization, process and product safety)
4. Institutional and legal settings and public support
5. Financial feasibility/viability assessment
6. Health and environmental risk assessment
7. Socio-economic impact assessment (valuation of economic benefits and assessment of additional externalities)

The MCA builds on the assessment of a set of criteria and indicators to a) analyze if existing local conditions support the model, and b) to run e.g. sensitivity analyses under various scenarios of demand, supply, technical options etc. Each of the criteria sought to assess the following:

1. Waste supply and availability (access): There is a perception that waste is abundant in urban cities and supply limitations are uncommon. However preliminary observations indicate that different governance systems dictate ownership rights of the city's waste which has implications for accessibility, availability and how efficient the business's processes will be. This criterion is particularly important in explaining a firm's business model as access to inputs (a key resource) represents a major factor of production. Adequate access to waste or a lack thereof may signify an important source of constraint to business viability. Key questions that were sought to be answered include but not limited to: What are the types, quality and quantity of waste available? Who owns the waste currently? What is the periodicity of availability? Who are the actors along the sanitation service chain providing the resource? Which competing alternative destination is available? Is the supply legal? Is the supplied product safe? Are there supply limitations and so on?

2. Market assessment (demand quantification and product market assessment)

This criterion is particularly important in explaining a firm's business model as insufficient market demand may be the key driving force of business failure. The market assessment provides pertinent information on key elements of the business model: value proposition, key resources, cost structure, revenue model, customer relations and customer segments. The estimation of market demand implicitly provides insights on key customer segments that the business needs to target (number of current customers by segment; profitability by segments; growth potential by customer segments). Information on the structure of the output market will guide a business in adopting the most efficient pricing and marketing strategy to ensure it maintains its competitive advantage in the market. These in addition to the assessment of the outlook of the market, efficient marketing strategies will drive how a firm's business model is structured).

3. Technological aspects (waste transport, storage, valorization, process and product safety)

This criterion focuses on the actual technical approach/process applied for the output production. It focuses on the analysis of the technical options for its energy requirement, related costs, repair sensitivity, supply chain, level of expertise available/needed, etc. This criterion is particularly important in explaining a firm's business model as the technical process used represents a key resource for the business. The robustness of the technical process, its safety capabilities and conversion efficiency of waste to the marketable product represents the key strengths of the business model that the business can actually leverage. This criterion focuses on the actual technical approach/process applied for the output production. It focuses on the analysis of the technical options for its energy requirement, related costs, repair sensitivity, supply chain, level of expertise available/needed, etc.

4. Institutional and Legal Settings and Public Support

This criterion targets the legal, institutional and administrative context within which a business case operates, as well as the public perception. As noted in previous research, the success or failure of any business, particularly in developing countries depend largely on institutional factors. A thorough analysis of this criterion is particularly important as the lack of a supportive institutional and legal environment are cited as one of the major constraints to business start-up. Key questions addressed include: ownership of operations, acceptance by local community, the institutional set-up, linkages, dependencies, agreements and decision pathways.

5. Financial feasibility/viability assessment

This criterion assesses the financial viability of the business model. Given a myriad of factors including but not limited to demand, cost structure, macroeconomic factors, etc., is the business model financially viable? This assessment evaluates the investment and production costs, earnings, taxes, depreciation and amortization, funding sources among others and evaluates them to the business model's profitability and operating performance. Key questions addressed include: Is the business financially viable (break-even; profit-generating)? Can the product be produced cost-effectively with positive profits and under what conditions? Is the business financially viable and under what conditions? Is the firm operating at an optimal production capacity based on the choice of technical process, related costs, etc.?

6. Health and Environmental risks and risk mitigation

This criterion focuses on the assessment of the risks associated with production and consumption of the value-added product. Risks (i.e. occupational and consumer) and risk mitigation processes should be assessed across the waste chain (sanitation and solid waste service chain) at all strategic points, starting from the input market to the output market. Key questions addressed include: What are the foreseen health and environmental risks/ challenges associated with informal sector participation in providing services along the waste chain? What are the health risks associated with the handling and processing of the particular waste input used?

7. Socio-economic impact assessment

This criterion provides an assessment of the societal and environmental benefits and costs resulting from the RR&R activity. This criterion assesses the socio-economic impact of the business model based on the valuation of socio-economic, environmental and health benefits and costs associated with the model and any additional externalities.

The list of criteria presented here is based on previous research. While it is impossible to identify a complete list of factors that will influence and determine the sustainability of an RRR business without knowing the specific context, the goal here is to present an extensive range of different criteria that might be of importance in different contexts and that are helpful in accurately assessing the business cases. This

list may be reduced/ expanded for each specific case and context. It is worthy to note that depending on the specific indicators selected to describe the individual criterion, different business models may result.

The MCA is then mapped into the Business Model Canvas where the indicators were used to evaluate the building elements of the business model of a particular business case. As shown in figure 2, the MCA (comprising of several indicators) can be directly linked into the business model canvas. For example in considering the black arrow, we note that indicator, H1: Averted GHG emissions from waste reuse activity; in the “Valuation of Externalities” criterion provides information that allows us to explain/quantify the environmental benefits of a specific RR&R business case. Different indicators were mapped to different elements of the business model canvas (*dashed blue arrows*). These same indicators for the criteria and related questions will form the base for those to be used in the feasibility study of the business models. Using the MCA, a detailed SWOT (strengths, weakness, opportunity and threat) analysis etc. and transferring the data into the Business Model Canvas, will allow us to: (a) describe the business cases in an easily accessible way, (b) derive more generic business models based on findings from the research; and (c) articulate how contextual/environmental variables (e.g., policies, regulations, evolving customer needs, etc.) and internal processes (e.g. strategies) interact overtime to influence the trajectory of the business approach articulated in the model. RRR business models were developed based on the assessment of empirical business cases.

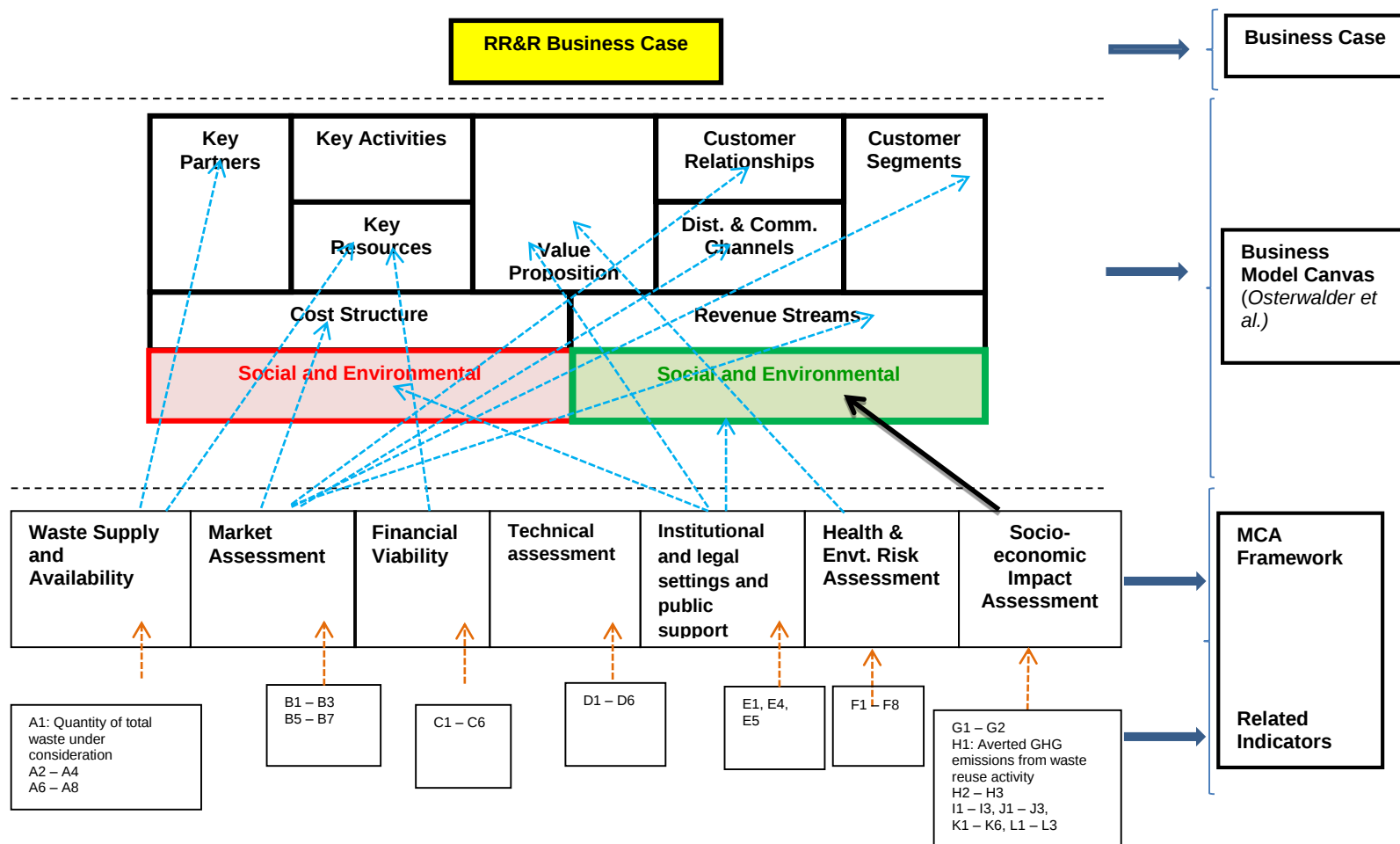


Figure 2: Analytical Framework for Linking the MCA and Business Model Canvas

2.3 Criteria for and the process of selecting RRR business cases

The key objective for the assessment of RRR business cases is to understand their success drivers and sustainability strategies how and based on these business cases construct RRR business models which best describe their businesses and finally develop generic RRR business models with a potential for scaling-up and out in other settings. It was thus crucial to focus on actual activities of existing 'promising' and innovative RRR businesses. 'Promising' in this context means that waste reuse allows for cost recovery or profit with potential for replication and scaling-up in low-income countries (also with consideration of cases with models more suited for emerging economies). A criteria was implemented for the selection of the promising cases evaluated. The selected cases had to evidence the following:

- Operate in Africa, Asia or Latin America; with special consideration for wastewater reuse cases in the MENA region
- Convert waste into one or more of the following outputs: nutrients, energy or water for agriculture (i.e. waste becomes an asset and compensates for resources in short supply)
- Generate cost reductions/recovery or profits or cost savings
- Transactions ideally support sanitation chain financially
- Replicability in low-income countries, potential to work at scale

- vi. Operate beyond reuse at household level unless high potential for large scale replication
- vii. Create possibilities for benefits to accrue in peri-urban or urban areas; improve livelihoods for low income populations, particularly farmers
- viii. Offer positive environmental externalities (e.g. climate change mitigation)

On a portfolio basis:

- i. At least 50% of the cases analyzed were applicable to a model that can work at scale in Sub-Saharan Africa (SSA)
- ii. At least 50% of the cases analyzed had potential to contribute to a model that had an agricultural link; either waste source (e.g., manure, agri. residues, agro-processing waste, etc.) or use of recovered resources (e.g. agro-processing, nutrition, etc.).

The selection and assessment of each business case and development of associated models significantly incorporated information from the analysis of stakeholders along the value chain. Additionally, data used for the analysis of the business cases were collected from different actors in the respective value chains.

2.4 Data Collection and Case Description of RRR business cases

The empirical investigation of RRR businesses, focused on Africa, Asia and Latin America. In order to get a good understanding of existing and emerging RRR businesses, an exploratory research was conducted followed by fieldwork. Exploratory research prior to the fieldwork suggested that the emerging RRR industry was complex, comprising of many established and start-up companies offering a variety of value propositions to a set of different customer segments through performing various activities. Based on the preliminary information/data, select existing promising cases/clusters contributing to the development of, or representing likely models, underwent an in-depth analysis. This included the collection of further information that was obtained remotely via email contact, reports, etc. on potential cases and also primary data collection from the businesses. Depending on the sensitivity of the case/business entity different approaches for analysis were used and/or combined:

1. Case and context contacts: Contact was established as the case (or cluster) and/or contextual research required. There were different options from roundtable discussions to personal agreements for direct interviews. Contacts were established via consultants or project staff/partners explaining larger picture and incentives¹ for collaboration.
2. Case/cluster Level Assessment: Data collection included qualitative information on the case (either separately or as a cluster), development trajectories, strategies, entrepreneur (if relevant), its context, and quantitative data as far as possible without jeopardizing the relationship. This was easier in some cases and more difficult in others.

The collected data was entered into a standard format template in Excel and analyzed based on the approach outlined above using a combination of the MCA, business model canvas and SWOT analysis. The result is a description of a set of cases following a standard format (Box 1) but with accepted variations in the amount of data/information per section per case.

¹ Exposure of success to donor community, inclusion in best-of catalogue, participation in Entrepreneur Summits; free feasibility studies on their model in different continents.

Box 1: Business case assessment template

Context and background: describes the wider perspective on the history and development of the business. It also describes the geographical location and the government policy on reuse activities within which the business is operating. Most of the information contained in this is gathered from the business entities through the questionnaire.

Market environment: describes the needs in the market that drive the existence and development of the business i.e. it describes what the business does, and how it serves the market needs. The assessment of the market environment is also supported by literature review.

Macroeconomic environment: discusses briefly the global or national market conditions or economic infrastructures that enable or represent a constraint to the business. Relevant information on macro-economic environment was gathered from country policy reviews and other relevant literature.

Business model description: describes the RRR business case by applying the business model concept as illustrated in Figure 1. This section discusses the linkages between the elements of the business model and focuses on answering: why the business model work, the core for its functioning and the essence of the business model. Most of the information is gathered from the respective business entities.

Value chain and position: describes the value chain in which the enterprise positions itself. This section applies Porter's five forces to describe the critical relationships with suppliers, partners, customers and other value chain actors.

Institutional environment: describes any legal or regulatory issues in operating the business in the respective country that support or represent a constraint to the business.

Technology and processes: describes the technology or process used by the business. It also looks at the status of the technology as to whether it is commercially proven, its local appropriateness and risks associated with the technology.

Funding and financial outlook: describes the source of financing for the enterprise. Where data is available, it shows key capital and operational cost, revenue streams and cash flow statement.

Socio-economic, health and environmental impact: discusses the socio-economic impact of the business in terms of for example, number of jobs provided, livelihood created, health and environmental benefits and costs associated with the operation of the business.

Scalability and replicability potential: discusses the potential for scaling up/out or for replicating the business in other geographical location or setting.

SWOT analysis: this section evaluates the strengths, weaknesses, opportunities and threats in the business.

3. DEVELOPMENT OF RRR BUSINESS MODELS

3.1 Development and Description of RRR Business Models

A firm's business model is the collection of the core aspects of the business, i.e. offerings, marketing strategies, infrastructure, organizational structures, trading practices and operational processes and policies (source). A business model allows the firm to distinguish itself from another and is in essence what makes one firm more successful than the other based on their specific objective. That is, for example, what marketing strategy do they adopt, what key strengths do they leverage to generate high profit margins? A firm may choose to do a number of things to achieve a certain objective such as:

- Sell multiple products to maintain high business performance – profitability
- Use a low pricing/ high volume sales mechanism to have a competitive advantage – for example, adopt a specific marketing strategy so as to distinguish themselves from other firms
- Contract-out certain activities to informal sector participants so as to have development impact– a business with a social and economic objective that goes beyond profit and has purpose
- Produce safe products by adhering to quality standards– to create positive environmental and health impacts.

All the decisions a business makes regarding its strategies, processes, markets, etc. define its business model.

The business model development first drew on available experience/data from existing business cases using country case studies, together with a broad range of information sources (literature review, historical analysis, key informant interviews, focus group interviews, secondary quantitative data, and newly collected data). Using a set of indicators, the existing RRR business cases were assessed based on a 7-component multi-criteria assessment (MCA) framework. These indicators shed light on the financial flows, production factors, resources or capacities requirements and economic benefits of the RR&R business and in essence, allows one to address questions of financial sustainability/ viability, scalability, development impact, related health risks and environmental impact of the RRR business case. Results from the MCA of the RRR business cases was then used to evaluate the key elements that constitute the business model of the particular RRR case (i.e. key partnerships, key resources, key activities, cost structure, revenue model, value proposition, customer relations, customer segments, distribution channels, social and environmental costs and benefits (Osterwalder et al., 2010)).

The **Osterwalder's business model framework** (Figure 1) was then adopted to examine existing RRR business cases to understand their key drivers of success and constraints/limitations and in particular understand the underlying forces (i.e. elements of its business model) that drives RRR businesses to achieve their specific objective and be successful. Several RRR business cases were identified as being successful with replicable/ adaptable business models. For any particular successful business case, the underlying factors that drive its success is largely dependent on several factors (e.g. on its low-cost structure - based on key partnerships, established institutional framework; low-level technical process, efficient distribution channels; great customer relationship; multiple revenue streams, etc.). This implies that for any particular business case, there are a myriad of "factors" (i.e. elements constituting their business model) that drives them to be either succeed or fail. In essence every business case will explicitly or implicitly have a particular business model. Based on this notion, the assessment of business cases allowed the identification and understanding of their individual business model - essentially the factors that drove their success, opportunities and limiting factors to business growth. Having identified the success drivers and gaps in the different business case's models using a SWOT analysis, optimized generic

business models were developed to further highlight the success factors and incorporate strategies that addressed the identified limitations (Figure 3). The resulting RRR business models² developed were thus:

- a. An adaptation of the business models of existing RR&R business cases
- b. A combination of several business models of existing RR&R business cases (it is important to note that particularly for this case, the derived business models were based on a clustering of business cases with similar individual models) or;
- c. A “*totally*” newly developed business model

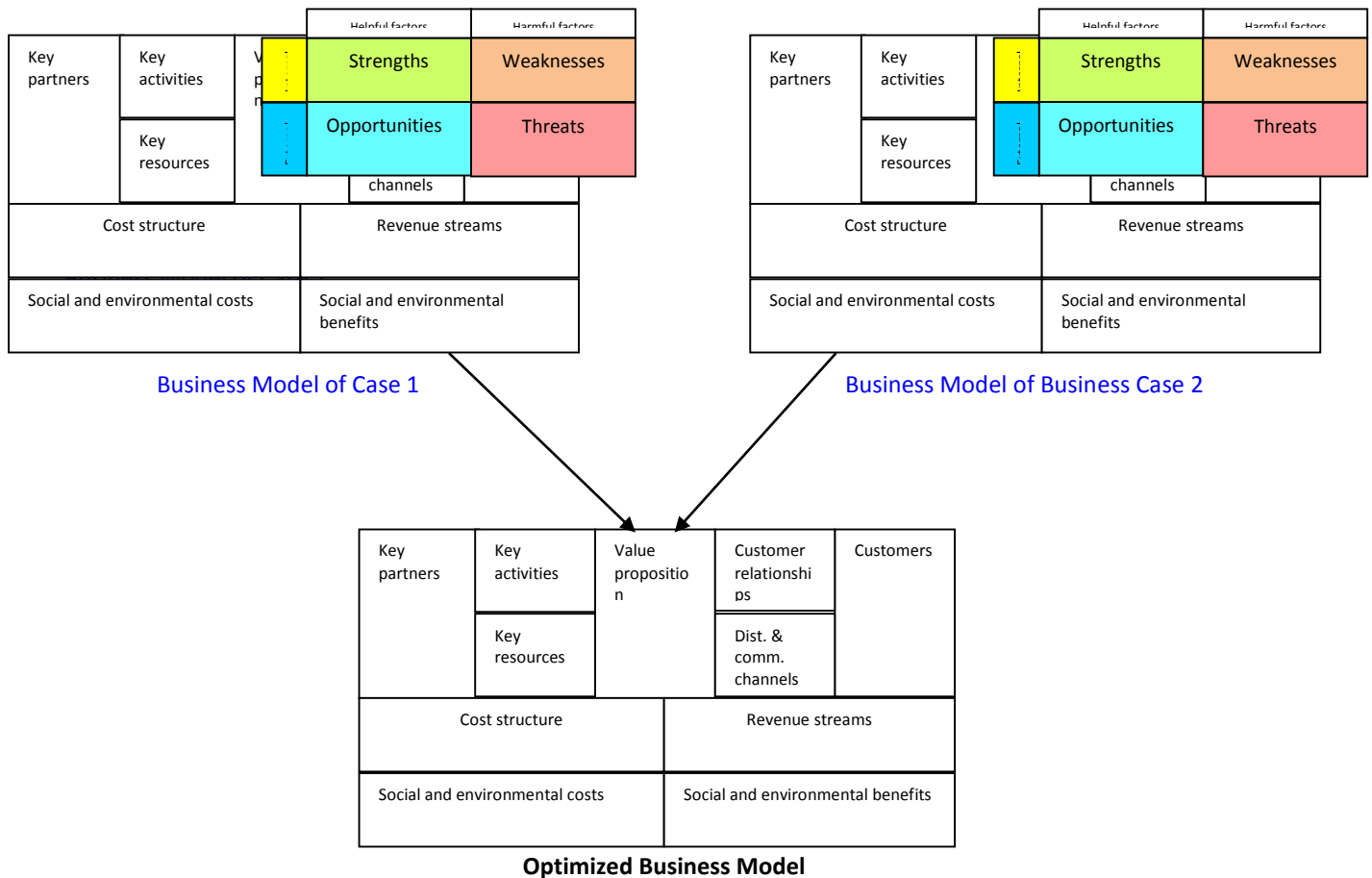


Figure 3: Process of Business Model Development

² It is worthy to note that the different RR&R business models will largely depend on the criteria and indicators selected.

The business model description was done using a standard template highlighting several aspects as outlined in Box 2 below. In addition to detailing the business model concept, the analysis and related model description include an environmental and health risk assessment of all the business models. Although the business ‘models’ imply per definition full compliance with safety measures, it is important to flag potential hazards to provide a first guidance towards required mitigation measures. Given the generic nature of the models, also the risk assessment remained generic and outlined areas that would likely require attention. In the instance, where any model will be implemented, a concrete and site specific risk assessment will be needed which will also consider the actual technology, scale of the enterprise and possible risk factors in the environment, such as groundwater proximity. The risk assessment done here for the select business models, was not applied to the same extent to the reported empirical business cases which generally follow local safety standards and regulations. Reported or observed deviations were analyzed if they represent generic shortcomings to be captured for the related models.

Box 2: Business model description template

Context and background: describes the basic concept inherent in the business that summarizes the business canvas and focused on the background/issues, explaining the generic business model that defines different partners and their roles, the organizational structure (public, private etc.), the overall business process flow, the technology and financial arrangement.

Business model description: describes the generic business model concept as illustrated in Figure X. This section discusses the linkages between the elements of the business model and focuses on answering: why the business model work, the core for its functioning and the essence of the business model, including information of the financials.

Alternative model scenarios: describes the options for alternate models derived from the parent model.

Potential risks and mitigation measures: describes the potential risks associated with the business model and related mitigation measures. The risks considered include market, competition, technology performance, political and regulatory, and environmental and health risks.

Scalability and replicability potential: discusses the potential for scaling up/out or for replicating the business in other geographical location or setting.

Conclusion: describes in general how the business model is rated based 5 criteria (profitability, scalability, replicability, social impact and environmental impact). It provides an overview of the conditions under which the business model should be undertaken and which factor constraints such as those related to land, investment and finance should be given crucial consideration.

3.2 Nomenclature and classification of RRR business models

It is important to note that the RRR business models can be described according to various parameters which might vary from one to another in their significance, and there is no fixed framework as to how business models can be classified. Wastewater models might for example best be distinguished by the agricultural end-product, energy projects by the business approach they use, nutrient cases by the way of waste valorization, while factors like PPP might allow other categories. The ideal ones might vary between different catalogue users.

For the purposes of this catalogue, the nomenclature tree started with a) the value-added product (i.e. end-use). Thus at the start we had 3 main categories of value offer driven by the end-product: a) energy recovery; b) nutrient and organic matter recovery and c) water reuse. As any businesses' model is driven by its objective, the next step considered in the tree was the *business objective*, followed by the *business model* itself and finally the *alternative scenarios* of the model. Table 1 below provides a classification of the business models presented in this catalogue.

Table 1: Categorization of RRR business models

VALUE-ADDED PRODUCT	SECTOR	OBJECTIVE	BUSINESS MODEL
Water Reuse	Public Sector	Cost recovery	On-Cost Savings and Recovery
	Private Sector	Welfare/profit maximization	Beyond Cost Recovery: the Aquaculture case
			Hedging and Matchmaking of Futures Contracts
			Inter-sectoral Water Exchange
	Informal sector	Welfare maximization	Informal to formal trajectory in wastewater irrigation Groundwater Recharge
Nutrient and organic matter Recovery	Public Sector	Cost recovery	Subsidy-free community based community Partially subsidized composting at district level
	Private Sector	Welfare/profit maximization	Large-scale composting for revenue generation
			High value fertilizer production for profit
			Compost production for sanitation service delivery
	Informal sector	Welfare maximization	Nutrient recovery from own agro-industrial waste
			Urine and struvite use at scale
			Out-sourcing faecal sludge treatment to the farm
Energy Recovery	Public Sector	Cost recovery	
	Private Sector	Profit maximization	Dry fuel manufacturing
			Energy service companies at scale
		Cost savings	Energy generation from own agro-industrial waste
			Manure to Power
			Emerging technology model
		Welfare maximization/ Corporate social responsibility	Onsite energy generation by sanitation service providers Biogas from food waste

3.3 Potential Risks and Mitigation Measures

a) Business Risk

An optimal business model will seek to minimize all related business risks. These will include but are not limited to: a) market risks, b) competition risk in both input and output markets, c) technology performance risk, d) political and regulatory risks. Thus the business models presented here were designed and optimized based on the analysis of different cases in the development of the RRR business models, while noting the potential associated risks and mitigation measures. It is important to note that the business related risks are context-specific and for the models presented, based on the underlying empirical business cases which focused towards a developing country set-up. For market risks, the key factor considered was market demand for the output product (if any) and the potential risks associated with a decrease in demand. This is closely related to *competition risks* - which assesses the likely sources of competition and ease of entry into the market given the structure of the market. Technological performance risks are related to whether the technology is commercially proven and if there are foreseen

challenges with repair & maintenance from a developing country perspective. As business sustainability is largely influenced by the macro-economic environment, political and regulatory risks considering policies to rectify market failures (e.g. price subsidies) should be considered.

b) Environmental and Health Risk assessment of RRR business models

An environmental and health risk assessment was applied to all business models. Although the business 'models' imply per definition full compliance with safety measures, it is important to flag potential hazards or 'rest risks' to provide a first guidance towards required mitigation measures. Given the generic nature of the models, also the risk assessment has to remain generic and outlines areas which will likely require attention. In the instance, where any model will be implemented, a concrete and site specific risk assessment will be needed which will also consider the actual technology, scale of the enterprise and possible risk factors in the environment, such as groundwater proximity. The risk assessment done here for the select business models, was not applied in the same extent to the reported empirical business cases which generally follow local safety standards and regulations. Reported or observed deviations were analyzed if they represent generic shortcomings to be captured for the related models.

Some of the business models presented in the '*Catalogue*' have sub-models where e.g. an alternative institutional set-up was suggested. In such cases the assessment was conducted for the generic model. However, if sub-models implied for example a change in technology or in- and outputs possible implications were noted. Following the structure of the catalogue each of the main categories (1) nutrient, (2) wastewater and (3) energy were analyzed for key exposure groups and risk pathways. Models on water and nutrient recovery, for example, usually have farmers as users of the generated product, while the possible risks groups continue along the value chain. The situation is obviously different for energy models with biogas, electricity or briquettes as final product. Based on this analysis a generic risk assessment template was developed following the source-pathway-receptor model. The four key exposure groups are shown in Table 2.

Table 2: The four exposure groups

Risk type	Exposure groups
1.Occupational risk on site	Workers, employees
2. Occupational risk off site	Farmers/users of RRR product
3. Consumption risk	End users
4. Social environment	Community near treatment facility

Table 3 shows typical pathways linking exposure groups with potential risks. In some countries natural resources themselves are considered as receptors (e.g., water resources in the United Kingdom). In this analysis, air, water and soil were mainly considered as pathways than receptors. Table 2 also presents common mitigation measures that can be put in place to prevent likely risks.

Table 3: Exposure pathways and mitigation measures

Exposure pathway	Description	Typical mitigation measures
Direct contact	Handling, sorting, mixing, collecting, transportation	Protective wear – boots, gloves, coats and overalls, and hygiene
Insects	Carriers and vectors	Insect spraying, cleaning, netting
Air	Aerosols, particles and gases	Protective wear – goggles and masks, wind barriers, covering of waste piles
Water and Soil	Effluent, leachate and leakages	Avoid untreated discharge, phyto-remediation
Food	Insufficiently treated waste products used in farming	On-farm risk (contact) reduction, produce washing and/or boiling, crop restrictions

The level of risk was categorized as low, medium or high considering (a) level of exposure, (b) hazardous level of the respective material, and (c) cost of mitigation measures. Emphasis is placed on likely hazards, not all theoretically possible hazards.

(a) Direct Contact

Low risk	Contact with hand and foot during operations possible (or use of less hazardous waste). Contact can be easily avoided by employing low-cost risk mitigation measures.
Medium risk	Contact with skin during operations likely. This can be easily avoided by employing low to medium cost risk mitigation measures.
High risk	Contact with skin during operations is difficult to avoid, unless by employing high cost risk mitigation measures.

(b) Insects (flies, mosquitoes, etc.)

Low	Process creates unfavorable conditions for breeding and waste materials have low pathogen levels. Risks can be avoided by employing low cost risk mitigation measures.
Medium	Process creates favorable conditions for breeding or involves materials (feces) with high pathogens load; but risks can be avoided by employing low to medium cost risk mitigation measures.
High	Process creates favorable conditions for breeding and/or deals with high pathogens load which are difficult to avoid unless by employing high cost risk mitigation measures.

(c) Air (Aerosols, dust particles, gases, etc.)

Low	Low emission and can be avoided by employing low cost mitigation measures.
Medium	Significant emission which can be avoided by employing low to medium cost mitigation measures.
High	Significant emissions which are difficult to avoid unless by employing high cost risk mitigation measures.

(d) Water and Soil (leachate, leakages, etc.)

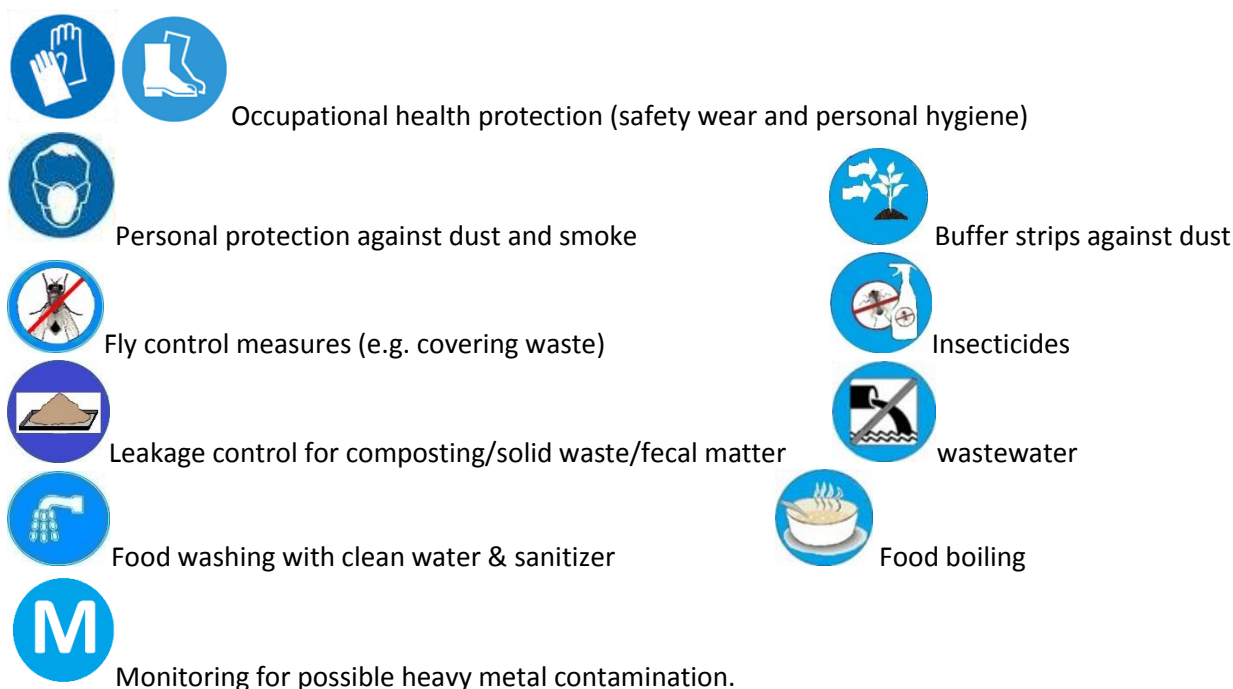
Low	Low leachate production or only partially treated effluent potentially released to the environment which can be avoided by employing low cost mitigation measures.
Medium	High leachate production or partially treated effluent potentially released to the environment. This can only be avoided by employing medium to high cost mitigation measures.
High	High leachate production or untreated effluent potentially released to the environment and it can only be avoided by employing high cost mitigation measures.

(e) Food

Low	Low risk of microbiological contamination which can be avoided by employing simple mitigation measure such as produce washing, smoking, or boiling.
Medium	Microbiological contamination which can be avoided by employing mitigation measures which require more efforts such as investments in drip kits for irrigation and compliance monitoring.
High	Chemical contamination, (e.g., heavy metals) which is possible but difficult to mitigate, unless via more complex or higher cost risk mitigation measures, such as more waste sorting or additional treatment steps.

For more details on exposure pathways, risk evidence and mitigation, please see Stenström et al. (2011).

Mitigation measures glossary:



Risk assessments were conducted for all business models and based on a 4-level ranking system:

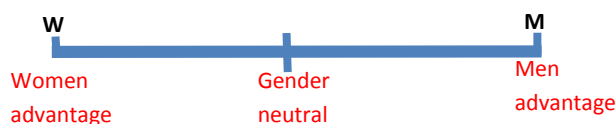


3.4. Gender perspectives of RRR business models

RRR businesses represent a subsector of a “larger” sanitation value chain with notable inter-linkages with the agricultural and energy sectors amongst others. The sanitation value chain, for instance, consists traditionally of 3 components (subsectors) characterized by their activities: 1) waste generation and capture; 2) collection and separation; and 3) treatment and reuse. Inter-linkages and interdependencies exist among these activities and its relevant economic actors. Given that the RRR subsector does not exist in isolation, related business development activities have the potential to impact other subsectors and players either adversely or create opportunities for increased benefits. In that regard, it is imperative that all RRR business models that are promoted do not disadvantage one gender group over another.

The assessment of the gender neutrality of the business models considered how far either men or women might be (dis)advantaged in engaging in the waste valorization process, as an entrepreneur or worker, or as direct beneficiary of the resulting products. The assessment was qualitative and considered positive implications for (a) common gender roles, like time spent for water or fuel collection; and (b) comfort at home/workspace through the provision of toilet facilities or clean energy (clean air, girl literacy). The assessment also considered gender-specific disadvantages related to (i) the recommended technology, (ii) business related job opportunities, as well as (iii) gender-specific occupational health risks. Each analyzed model displayed between 0 and 3 factors which were given equal weightage. The most common factors providing advantages for women related to energy production for the benefit of households, allowing women to save time for collecting other sources of fuel, as well as a healthier (fire and smoke free) working environment. The most common factor giving advantage to men was related to common

labor roles, like truck driving. Given the location-independent character of the business models, any country specific cultural implications for gender were not considered. The results are presented with a pictorial balance beam.



Based on the business models presented in the catalogue, the majority of the recommended models is either gender neutral or brings advantages to women. Of the 24 presented models 10 are gender neutral, 1 has advantages for men, and 13 have advantages for women. The analysis was significantly influenced by those models producing alternative energy sources which are positively addressing challenges many women face in terms of time to collect firewood and/or smoke in the working environment.



3.5 Ranking of RRR business models

The idea behind the ranking of the RRR business models is to provide different stakeholders, in particular, investors with an overview of the potential for implementation of the business model they which constraints, if any, possibly related to factors such as land, investment, finance, etc., they should consider prior to their investments. It is important to note that this is an overview assessment and any actual implementation will require an ex-ante detailed feasibility assessment. The key focus for the business models considered was that they have at least triple bottom line targets: high impact from a scalability and replicability perspective and catalyze innovation adoption. The different criteria/indicators selected to assess these targets are: a) profitability/cost recovery, b) social impact, c) environmental impact, d) scalability and replicability, and e) innovation. Each criterion was evaluated on a 3-level scale based on the average of 3-level ranking of the constituent parameters. The specific parameters and related questions was for their evaluation are provided in table 4 below.

Table 4: Guidelines for Ranking of Business Models

Indicators	Guiding Questions	Parameters	Score Guide
Profitability/Cost Recovery	What is the level of <u>operational profits/cost recovery</u> achieved by the business model on an annual basis?	Loss Making	1
		Breakeven	2
		Profit	3
	How many <u>revenue source</u> does the business model depend on and how <u>strong</u> are those revenue line items?	One strong revenue source	1
		Two or more revenue source with one strong revenue line	2
		Two or more revenue source with two strong revenue line	3
	How many of these <u>factors increase the risks of costs associated with the business model</u> ? Factors are: 1) High Worker and Managerial Skill, 2) Diverse Customer Base, 3) Diverse Products, 4) Need for R&D and 5) Self distribution of product to end customer	More than 3 factors applicable	1
		2 - 3 factors applicable	2
		0 -1 factor applicable	3
Social Impact	How many <u>jobs are provided</u> by the business model? <u>Note:</u> Please define the parameters based on the range you have for all the business cases within your respective classified (energy or nutrient or water) business model.	Low	1
		Medium	2
		High	3
	Number of <u>people having positive health impact</u> by the business model <u>Note:</u> Please define the parameters based on the range you have for all the business cases within your respective classified (energy or nutrient or water) business model.	Low	1
		Medium	2
		High	3
	How many of these <u>factors have improved/increased positive impact</u> ? Factors are: 1) Water Security, 2) Food Security, 3) Energy Security, 4) Improved living standards, 5) Reduced Govt. costs and 6) Gender	Meets 0 - 2 factors	1
		Meets 2 - 4 factors	2
		Meets more than 4 factors	3
Environmental Impact	How much <u>quantity of waste is being processed/reused</u> ? <u>Note:</u> Please define the parameters based on the range you have for all the business cases within your respective classified (energy or nutrient or water) business model.	Low	1
		Medium	2
		High	3
	How many of these <u>factors have improved/increased positive impact</u> ? Factors are: 1) Health of water bodies, 2) Reduced GHG, 3) Soil Fertility, 4) Renewable source/raw material and 5) Reduced Deforestation	Meets 0 - 1 factor	1
		Meets 2 - 3 factors	2
		Meets more than 3 factors	3
Scalability and Replicability	How many of these <u>factors limit business model replication elsewhere</u> ? Factors are: 1) New Technology, 2) Special Policies and Regulations, 3) Strong Institutional Capacity, 4) Specific Waste Availability 5) Special Market Demand, and 6) Ambiguity of Product Acceptance	Meets more than 4 factors	1
		Meets 3 - 4 factors	2
		Meets 0 - 2 factors	3
	What is the <u>ease of scaling</u> the business model vertically and horizontally?	Low potential for vertical AND horizontal scaling	1
		High potential for either vertical OR horizontal scaling	2
		High potential for BOTH vertical and horizontal scaling	3
	How <u>easy is it to finance</u> the business model elsewhere?	Investment is HIGH and financing is UNIQUE	1
		Investment is HIGH and financing is COMMON	2

		Investment is LOW and financing is UNIQUE	2
		Investment is LOW and financing is COMMON	3

Innovation	How innovative is the <u>technology or process</u> ?	Known technology or process	1
		Relatively new to developing countries (technology transfer)	2
		New to the world	3
	How innovative is the <u>partnership arrangements</u> ?	No partnerships required	1
		Partnerships within the same sector	2
		Partnership cross-cutting different sectors (PPP, R&D, Finance)	3
	How innovative is the <u>product or value proposition</u> ?	Standard product & value proposition	1
		Relatively new product or value proposition	2
		New to the world	3

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