Defining and analyzing RRR business cases and models

The objective of this second chapter is to explain how the cases were selected and analyzed and how the authors derived the business models. The starting point was the identification of 'promising' empirical resource recovery and re-use (RRR) enterprises and governmental projects. In other words, the presented models are essentially not theoretical but have been tried – in most cases – in the context of low- or middle-income countries. 'Promising' in this context means that the cases, which informed the models, moved beyond a fully-subsidized pilot stage or were never designed as such, and aim at cost recovery or profit with potential for replication and scaling up. It does not mean that the selected cases are flawless, and there are many lessons to learn from their challenges. With some exceptions, every model presented in the catalogue derived its information from several empirical cases, which allowed extracting and flagging their strengths and opportunities as well as possible weaknesses and threats.

For the purposes of this catalogue, we define RRR **business cases** as:

> Business cases are entities, like enterprises, governmental projects or public-private partnerships (PPPs), that are engaged in the productive and safe recovery of water, nutrients, organic matter and energy from domestic and agro-industrial waste streams (including wastewater) by utilizing the recovery and/or re-use value of waste to generate revenue or recover costs in support of waste management and/or a healthy or more productive environment.

With the objective of showing scalable options, the presented cases are usually operating at community or city scale, i.e. household- or farm-based efforts in RRR have not been included.

Guided by Osterwalder and Pigneur (2010), a **business model** is defined in this catalogue as follows:

> A business model describes how a business creates, delivers and captures value; essentially the entire solution comprising the core aspects of the business – business process (e.g. technology), target customers, produce, infrastructure, organizational structures, trading practices, operational processes and policies, and the strategies it implements to achieve its objectives (be they for cost recovery, profit maximization, social impact, etc.).

Serving different target groups of this book, the presentation of empirical RRR business cases and models was challenging. While business schools might prefer detailed case studies, practitioners or decision makers will prefer a compact overview. The analysis of the cases and development of related business models does not come with the well-established base of literature and guidance that we are accustomed to from more conventional business sectors (George and Bock, 2011). Moreover, the assessment of both formal and informal RRR business cases requires significant groundwork to understand the factors that drive their success and likely sustainability, replicability and scalability barriers, particularities and opportunities. The analysis thus required the development of a suitable methodology, taking into consideration different types of readers, as well as both the micro- and macro-environment that cases operate in, while being flexible to cope with possible data gaps.

Assessment of RRR business cases

The business model concept

It is imperative that the concept of business modelling is clearly defined and more so in the context of resource recovery and re-use of waste. In the past two decades, the business model concept

has become an increasingly pertinent concept in management theory and practice and has received substantial attention from academics and business practitioners (Magretta, 2002; Hedman and Kalling, 2003; Osterwalder et al., 2005; Shafer et al., 2005; Zott et al., 2011). Numerous definitions of the concept have been proposed although no particular terminology has so far been accepted in the domain of RRR (Bocken et al., 2014). In general, a business model describes how a business creates, delivers and captures value. In the RRR or eco-innovation context, the generic value proposition is the recovery of a useful resource from material which would otherwise be wasted. The related direct or indirect benefits can be savings, cost recovery, profits, welfare benefits, or an improved reputation (Beltramello et al., 2013; Hanjra et al., 2015).

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 disaggregated into nine building blocks that, taken together, create and deliver value. These four 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(s)* 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* (costs and revenues) which ultimately determine a firm's ability to capture value from its activities and break even or earn profit.

Based on these core elements, Osterwalder and Pigneur (2010) describe a business model through a canvas of nine components. There are different possibilities to extend or modify the canvas.[1] In this catalogue, we use an extended canvas by the same authors, which considers, with two additional components, possible positive and negative externalities (Figure 3). This extension is particularly important for the waste and sanitation sectors given related risks for human and environmental health, but also significant social benefits.

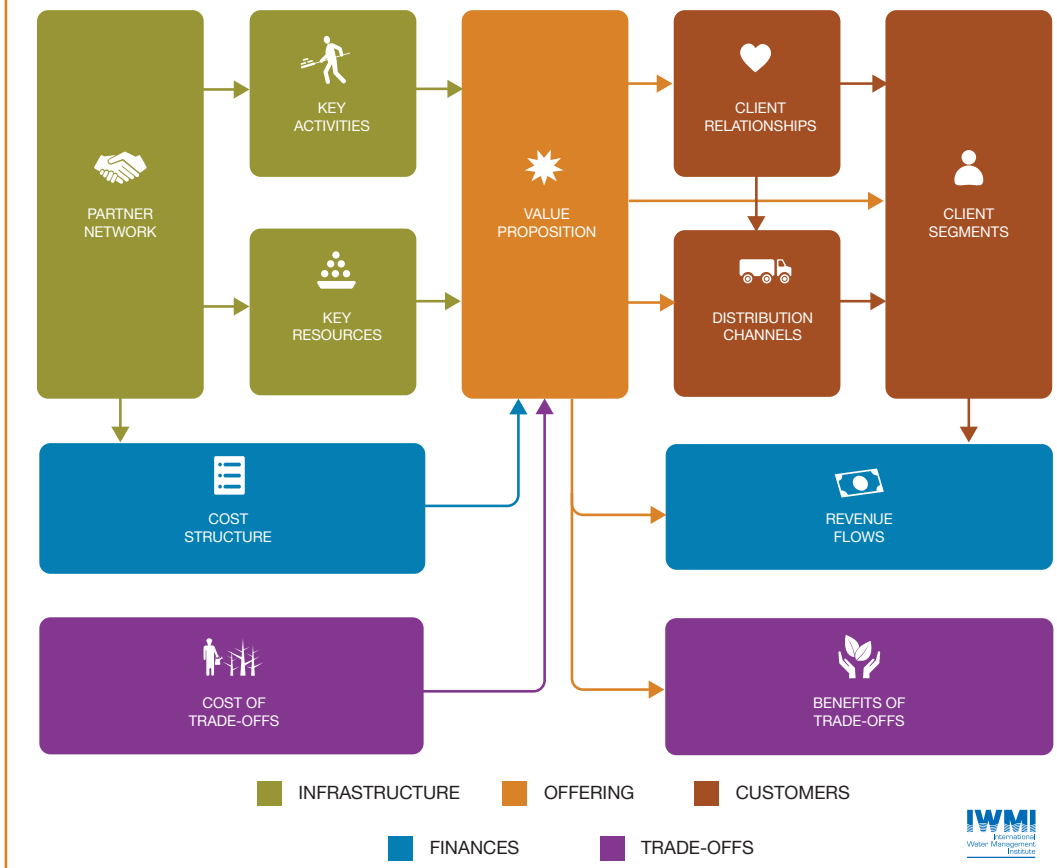
The business model canvas also provides many of the details needed to understand if a particular model could be viable in a different context than where it was used so far. However, the canvas does not provide information of the external business environment, like competition, regulations and the enabling business environment in general (see Chapter 19) which can be captured through RRR feasibility studies (Otoo et al., 2016).

Nomenclature and classification of RRR business models

Bocken et al. (2014) provide a structural approach towards business model categories in the domain of sustainability. The models described in this book fall in general under the archetype 'create value from waste' where we also find the concepts of 'closed loop' and 'circular economy'. However, while we could argue that water, energy and nutrients are indeed materials which are continually recycled through the production system, an alternative term could be 're-materialization', i.e. the innovative sourcing of materials from waste, creating entirely new products such as high-quality fertilizer or energy (Clinton and Whisnant, 2014). Business models within any of these structures could be categorized based on the type of waste, type of recovered resource, type of value proposition, partnership or ownership, or modes or scale of revenue generation (Evans et al., 2013).

These models can be very dynamic as with increasing environmental awareness and technical options, waste management approaches are continuously redesigned to optimize their value proposition. This includes their ability to capture so far missed RRR opportunities and values such as through carbon trading or biodiversity offset programs (Bocken at el al., 2013).

FIGURE 3. COMPONENTS AND INTERLINKAGES OF THE EXTENDED BUSINESS MODEL CANVAS



Source: Based on Osterwalder and Pigneur, 2010.

Given the paucity of a common terminology, the business model names and structure used in the following chapters were in large based on pragmatic reasoning and consent, not any particular academic discourse, and can be further developed and adapted as needed. Wastewater models might for example 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 the type of financing or PPP might allow other categories. The ideal categorization will thus vary between different readers of this catalogue and their objectives.

One possible classification of the models presented in this catalogue is to start with the main value-added product for reuse, means a) energy recovery, b) nutrient and organic matter recovery and c) water reuse. As any business model is driven by its objective, the next step considered in the decision tree could be the overall *business objective*, followed by the *business model* itself (Table 1).

TABLE 1. A POSSIBLE CATEGORIZATION OF THE PRESENTED RRR BUSINESS MODELS

VALUE-ADDED PRODUCT	SECTOR	OBJECTIVE	BUSINESS MODEL
Water Reuse	Public; Public/private	Cost recovery	Wastewater for greening the desert
			Enabling private sector investments in large-scale wastewater treatment
	Public/private	Welfare/profit maximization	Leapfrogging the value chain through aquaculture
	Public/ Informal Public/ private	Welfare maximization	Cities as their own downstream users
			Inter-sectoral water exchange
			Corporate social responsibility as driver of change
			Wastewater as a commodity driving change
			Farmers' innovation capacity as driver of change
Nutrient and organic matter Recovery	Public / private sector	Cost recovery	Subsidy-free community based composting
			Partially subsidized composting at district level
	Public and/ or Private Sector	Welfare/profit maximization	Large-scale composting for revenue generation
			Compost production for sustainable sanitation service delivery
		Cost savings	Nutrient recovery from own agro-industrial waste
			Phosphorus recovery from wastewater at scale
	Private and/or Informal sector	Cost savings	Outsourcing fecal sludge treatment to the farm
Energy Recovery	Public Sector	Cost recovery	Power from municipal solid waste
	Private Sector	Profit maximization	Briquettes from agro-waste or municipal solid waste
			Bio-ethanol and chemical products from agro- and agro-industrial waste
		Profit maximization/ Cost Savings	Combined heat and power from agro-industrial waste for on- and off-site use
		Profit and Welfare maximization	Power from agro waste
			Combined heat and power from agro-industrial waste for on- and off-site use
		Cost savings/Welfare maximization	Biogas from fecal sludge and kitchen waste
			Power from manure

Criteria and process for the selection of analyzed RRR business cases

The cases presented in this catalogue were selected in different steps each using different criteria. The main objective of the exercise was to understand drivers of success and sustainability strategies; and based on the analysis of different related cases, to extract/construct generic business models, which summarize innovative and promising components of these businesses with potential for scaling up

and out in (other) low- and middle-income settings including emerging economies. Following an initial screening of about 150 cases suggested by the literature, media and experts, over 60 empirical re-use cases were analyzed in detail of which 47 are presented here. As some operate in different locations, the actual number of cases is larger. These selected cases allowed for the development of 24 generic business models, which are also presented.

For the first selection round, the cases had to provide evidence, as much as possible, of the following:

i. Operation in Africa, Asia or Latin America, with special consideration for wastewater re-use cases in the Middle East and Northern Africa (MENA) regions;
ii. Conversion of waste into one or more of the following outputs: nutrients, biomass, energy or water for agriculture (i.e. waste becomes an asset and compensates for resources in short supply);
iii. Generation of revenues from RRR or supporting, at least, cost savings;
iv. Transactions (will) support cost recovery and ideally also parts of the sanitation chain financially;
v. Replicability in low- and/or middle-income countries at scale, i.e. not only at the level of one household or farm;
vi. Distinct creation of social and/or environmental benefits; and
vii. Likelihood of data accessibility.

The empirical investigation of the preselected 60+ RRR businesses was based on a template (Box 4) with questions tailored to the different waste streams and recovered resources. Information was obtained, wherever possible, through local data collection by project staff or consultants, i.e. in direct interaction with the businesses, or remotely via email, explaining the purpose and background of the study and incentives[2] for collaboration. Depending on the sensitivity of the case/business entity, and/or its responsiveness, in-depth literature surveys combined with expert consultations were also employed.

Box 4. Business case assessment template

1) **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 re-use activities within which the business is operating. Most of the information contained in this section is gathered from business entities or secondary literature.
2) **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 market needs. The assessment of the market environment was also supported by a literature review.
3) **Macro-economic environment:** Discusses briefly the global or national market conditions or economic infrastructures that enable or represent a supportive factor or a constraint to the business. Relevant information on the macro-economic environment was gathered from country policy reviews and other relevant literature.
4) **Business model description:** Describes the RRR business case by applying the business model canvas as illustrated in Figure 3. This section discusses the linkages between the elements of the business model and focuses on answering: why the business model works, the core element for its functioning and the essence of the business model. Most of the information was gathered from business entities.

Where identified value propositions are analysed separately, associated descriptions use the same background colour within the canvas. In the case where characteristics relate to several or all value propositions, a color coding, different from those of the value propositions is used.

5) **Value chain and position in the chain:** Describes the value chain in which the enterprise positions itself. This section applies Porter's five forces methodology (Porter, 1985) to describe the critical relationships with suppliers, partners, customers and other value chain actors.
6) **Institutional environment:** Describes institutional responsibilities and any legal or regulatory factors in the respective country that support or represent a constraint to the business.
7) **Technology and processes:** Describe the technology or process used by the business. The status of the technology as to whether it has been commercially proven, its local appropriateness and risks associated with the technology are also examined.
8) **Funding and financial outlook:** Describes the source of financing for the enterprise. Where data are available, the key capital and operational cost, revenue streams and cash flow statements are presented.
9) **Socio-economic, health and environmental impact:** Discusses not only the socio-economic impact of the business in terms of, for example, number of jobs created, health and environmental benefits, but also experienced or possible negative externalities.
10) **Scalability and replicability potential:** Discusses the potential for scaling up/out the business in other geographical locations or settings.
11) **SWOT analysis:** This section summarizes the model looking at its strengths, weaknesses, opportunities and threats.
12) **Contributors, links and references:** Acknowledge local and international experts and business staff who assisted in data gathering, web links and literature used to compile the case.

The collected data were analyzed using a combination of the multicriteria approach, business model canvas and strengths, weaknesses, opportunities and threats (SWOT) analysis. Depending on data availability and time, the amount of gathered data/information varied. In several cases, financial data were, for example, only available under the condition of non-disclosure, or insufficient for any financial analysis or representative presentation.

Development of RRR business models

The key objective for the assessment of existing RRR business cases was to understand their success, drivers, challenges and sustainability strategies and, based on these cases, construct generic business models with the potential for scaling up and out in other settings. Thus, instead of building theoretical RRR business models, the presented models are based on existing cases, or in other words, each model comes with several application examples. Only a few models were derived from just one case and only one was formulated on promising developments without a particular empirical case. This concerns the potential of corporate social responsibility for addressing unsafe wastewater use in the informal irrigation sector where the priority value proposition would be risk reduction.

The Business Model Canvas (BMC) was the main tool used for the development of RRR business models, based on the 11 fundamental building blocks (see Fig 3). The strength of the BMC lies in its simplicity and ability to provide a holistic overview of the essential components of the business model that the firm leverages. The BMC is best used as a pre-business planning activity to map out the various options a business has for adopting a particular business strategy. In addition, the

BMC allows for stepping away from the details of technological innovations and focusing on the best-fit business organizational form that will support successful implementation and adoption of the technological innovation. The BMC can be used to map existing models (such as the presented cases in this catalogue) and develop new models as adaptations to existing ones or entirely different ones. However, as mentioned above, the canvas only addresses parts of a business case, and requires additional information.

The presented business models draw strongly on the analyzed business cases, supported by additional information from related cases in the literature and interviews. Each model represents an optimized generic business model building on the success factors of its supporting cases, with different degrees of innovation, while incorporating strategies that address identified or likely shortcomings. These relate in particular to the analysis of possible health risks (IFC, 2009) to identify likely hot spots for risk monitoring (WHO, 2015).

The business model description follows, like the case description, a standard template (Box 5) with exception of some wastewater models, which are based on only one case, and follow a hybrid of both templates. Compared with the business cases, some additional components of the model presentation require further explanation. This concerns, in particular, the assessment of potential risks and risk mitigation measures and the summary assessment based on selected criteria.

Box 5. Business model description template

Business value chain: Describes the basic concept behind the business, explaining the different partners and their roles, the organizational structure (public, private etc.), the overall business process flow and value chain, the technology and financial arrangements.

Business model description: Describes the linkages between the elements of the business model canvas (Figure 3) and focuses on answering: why the business model works, the core element for its functioning and the essence of the business model, including information on partners and financial aspects to the extent available. Where identified value propositions are analysed separately, associated descriptions use the same background colour within the canvas. In the case where characteristics relate to several or all value propositions, a color coding, different from those of the value propositions is used.

Alternative model scenarios: Describe the option for alternate models derived from the parent model.

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

Business performance: Summarizes the potential for scaling up/out or for replicating the business in other geographical locations or settings. It also describes in general how the business model has been appraised based on five performance criteria (cost recovery/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 factors, such as those related to land, investment and finance, should be given particular consideration.

Business risks and risk mitigation

An optimized business model will seek to minimize business risks. These can 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 and e) the risk of undermining social equity. Thus, the business models presented here tried to capture possible risks based on the analysis of their supporting cases. As business-related risks are context-specific, the risk section can only touch on the possible complexity. For market risks, the key factors considered were, e.g. changes in supply and demand, as well as likely sources of competition and ease of entry into the market, which depends again on location-specific market structures. Technological performance risks are related to whether the technology is commercially proven and if there are anticipated challenges with repair and maintenance from a developing country perspective. As fledgling businesses and their sustainability are largely influenced by their enabling environment, political, regulatory and financial instruments to rectify, for example, market failures (e.g. price subsidies), are briefly addressed. However, given its crucial role, Chapter 19 provides more details and examples on how regulatory mechanisms and finance instruments can shape an enabling environment for RRR. Finally, social equity related risks were assessed in view of poverty alleviation (employment) and gender inclusiveness.

To illustrate the qualitative assessment steps and criteria used, further details for the (i) health and environmental risks and (ii) social equity risks are provided in the following:

(i) Health and environmental risk assessment

Given that RRR businesses deal with potentially harmful source materials, special attention was given to environmental and health risks. Although the 'models' imply, per definition, full compliance with safety measures, it is important to flag critical control points and common mitigation measures. Given the generic nature of the models for possible application in different countries, the risk assessment had to remain generic. In the instance of a model being implemented, a concrete and site-specific risk assessment will be needed, taking into consideration the actual technology, scale of the enterprise and possible risk factors in the environment, such as groundwater proximity (Otoo et al., 2016; Winkler et al., 2017).

The risk assessment drew from the studied cases although it was not applied to the same extent to the cases themselves, which generally followed local safety standards and regulations. Reported or observed deviations were analyzed if they represented generic shortcomings to be captured for the related models. Some of the presented business models have submodels in which, for example, an alternative institutional set up was suggested. In such cases the assessment was conducted for the generic model. However, if submodels implied, for instance, a change in technology or inputs and outputs possible implications were marked. Following the structure of the catalogue each of the main categories – (1) energy, (2) nutrient/organic matter and (3) wastewater – 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 risk groups continue along the food chain. The situation is obviously different for energy models with biogas, electricity or briquettes as the 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 products
3. Consumption risk	End users
4. Social environment	Communities near treatment facilities

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 rather 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 good hygiene
Insects	Breeding sites for carriers and vectors	Insect spraying, cleaning, netting
Air	Aerosols, particulates and gases	Protective wear – goggles and masks, ear plugs, wind barriers (e.g. tree belts), coverage of waste piles
Water and soil	Effluent, leachate and leakages	Avoid untreated discharge, support e.g. phytoremediation
Food	Insufficiently treated waste products used in farming	On-farm risk (contact) reduction, crop restrictions, produce washing and/or boiling

The level of risk was categorized as low, medium or high considering: nature of exposure (direct, indirect, external, internal, etc.), intensity of exposure (severity and probability), and required effort of mitigation (**simple** like via safety gear; **advanced**, e.g. via emission reduction; **substantial,** e.g. via addition treatment). 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 simple risk mitigation measures.
Medium risk	Contact with skin during operations likely. This can be easily avoided by employing more advanced mitigation measures.
High risk	Contact with skin during operations is difficult to avoid, unless by applying substantial mitigation measures.

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

Low	Process creates unfavourable conditions for breeding and waste materials have low pathogen levels. Risks can be avoided by employing simple mitigation measures.
Medium	Process creates favourable conditions for breeding or involves materials (feces) with high pathogen loads, but risks can be avoided by employing advanced mitigation measures.
High	Process creates favourable conditions for breeding and/or deals with high pathogen loads which are difficult to avoid unless by employing substantial mitigation measures.

(c) Air (aerosols, dust, particulates, gases, machinery sound, etc.)

Low	Low emission and noise which can be avoided by employing simple mitigation measures.
Medium	Significant emission and/or noise which can be avoided by employing advanced mitigation measures.
High	Significant emissions and/or noise which are difficult to avoid unless by employing substantial 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 simple mitigation measures.
Medium	High leachate production or partially treated effluent potentially released to the environment. This can only be avoided by employing advanced mitigation measures.
High	High leachate production or untreated effluent potentially released to the environment and it can only be avoided by employing substantial mitigation measures.

(e) Food chain

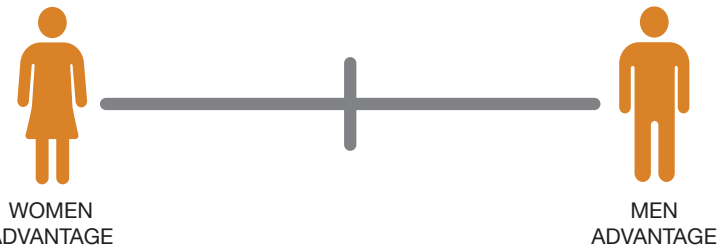
Low	Low risk of microbiological contamination which can be avoided by employing simple mitigation measures such as produce washing, smoking or boiling.
Medium	Microbiological contamination which can be avoided by employing mitigation measures that require more efforts such as investments in drip kits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

For more details on exposure pathways, risk evidence and mitigation, please see Stenström et al. (2011) and WHO (2015), and the application example to RRR business models by Winkler et al. (2017).

The overall risk assessment for each model used the following scale and risk mitigation symbols:

(ii) Social equity related risks

Equal employment opportunities and other gender-specific benefits or burdens were analyzed as far as possible for each business model. The assessment of equality considered in particular how far either men or women might be (dis)advantaged in engaging in the waste valorization process, as an entrepreneur or worker, or as a 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 improved services or clean energy (clean air, studying after sunset/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 0–3 factors which were given equal weightage. The most common factors providing advantages for women relate to energy production for the benefit of households, allowing women to save time for collecting external fuel, as well as a healthier (fire- and smoke-free) working environment. The most common factor to advantage men was related to gender-specific labor roles, like construction work or truck driving. Particular advantages for one group do, however, not imply a direct risk or disadvantage for the other. The judgement, which remains without local context tentative and preliminary, has been summarized in a pictorial balance beam reflecting possible gender specific dis/advantages.



Performance potential

For the last part of the business model template, the suggested models were evaluated for their performance potential, expecting a triple bottom line based on the following indicators/criteria: a) profitability/cost recovery, b) social impact, c) environmental impact, d) scalability and replicability and e) innovation. Each criterion was evaluated on a three-level scale based on the average score of a three-level ranking of the constituent parameters (Table 4). The ranking of the parameters and the resulting ranking of the indicators was based on a combination of quantitative and qualitative data sourced from empirical cases and application of the Delphi method[3], respectively.

TABLE 4. GUIDELINES FOR RANKING OF BUSINESS MODELS

INDICATORS	GUIDING QUESTIONS	PARAMETERS	SCORE
Profitability/ cost recovery	What is the level of operational profits/ cost recovery achieved by the business model on an annual basis?	Loss making	1
		Break-even	2
		Profit	3
	How many revenue streams does the business model depend on and how strong are these revenue line items?	One strong revenue source	1
		Two or more revenue sources with one strong revenue line	2
		Two or more revenue sources with two strong revenue lines	3

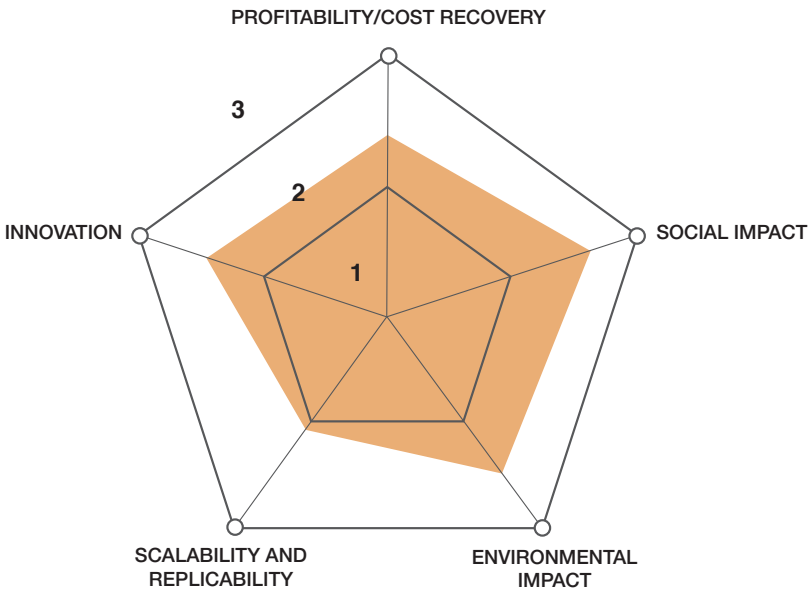
TABLE 4. *CONTINUED*

	How many of these factors represent a risk of increased costs to the business model? Factors are: 1) high worker and managerial skill requirements, 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 jobs are created/provided by the business model compared with the range of all the business cases within the same section (energy or nutrients or water)?	Low	1
		Medium	2
		High	3
	Number of people with increased positive health impact from the business model compared with the range of all the business cases within the same section (energy or nutrients or water).	Low	1
		Medium	2
		High	3
	How many of these factors does the business model have an improved/ increased positive impact on? Factors are: 1) water security, 2) food security, 3) energy security, 4) improved living standards, 5) reduced governmental costs for waste management services (sanitation), health services and 6) gender	Meets 0–2 factors	1
		Meets 2–4 factors	2
		Meets more than 4 factors	3
Environmental impact	What quantity of waste is being processed/ re-used compared with the range of all the business cases within the same section (energy or nutrients or water)?	Low	1
		Medium	2
		High	3
	How many of these factors does the business model have an improved/ increased positive impact on? Factors are: 1) health of waterbodies, 2) reduced GHG emissions, 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 factors limit the replication potential of the business model elsewhere? Factors are: 1) new technology, 2) policies and regulations, 3) strong institutional capacity, 4) specific waste availability 5) 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 ease of scaling 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 easy is it to finance 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 technology or process?	Known technology or process	1
		Relatively new to developing countries (technology transfer)	2
		New to the world	3
	How innovative are the partnership arrangements?	No partnerships required	1
		Partnerships within the same sector	2
		Partnerships cross-cutting different sectors (PPP, R&D, finance)	3
	How innovative is the product or value proposition?	Standard product and value proposition	1
		Relatively new product or value proposition	2
		New to the world	3

The overall appraisal of the indicators for each business model is represented in a radar diagram (Figure 4). It is important to note that this is an overview assessment and any actual implementation of any RRR business model will require a context-specific and more detailed ex ante feasibility assessment (Otoo et al., 2016).

FIGURE 4. PERFORMANCE APPRAISAL DIAGRAM EXAMPLE



Limitations

The information provided in the case studies refers to the **time of their individual assessment** between 2012 and 2017. The authors regret any possible error or missed update. Case descriptions are detailed to serve students as case studies, probably too detailed for practitioners and investors, while there are still many other criteria to assess business cases and describe business models, which we were not able to capture. This concerns for example the history and timeline of the cases, the personal engagement, contacts and investments of the entrepreneurs, their experiences with seeking an appropriate business partner and lessons learned *vis-à-vis* their local regulatory, financial and administrative challenges, or the difference between the official and *de facto* enabling environment. Other limitations faced, concern the availability or accessibility of (in particular financial) data and common lack of quantitative impact assessments. Data access from private enterprises was challenging. In several cases, they were unwilling to provide financials or information on the technology. In such cases, the authors had to rely on secondary sources with their limitations. While the private sector had its reasons to withhold data, accessing data from the public sector came with its own challenges related to their availability, like in many parts of Africa. Often only older data were available, if any. As business operations are dynamic, data of the presented cases will change over time. Finally, the investment ranges stated for the business models are largely based on the analysed case studies, and could be larger.

References and further readings

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Notes

1 See for example: www.ppplab.org/wordpress/wp-content/uploads/2016/04/PPPCanvas_Example.pdf (accessed November 5, 2017).
2 Exposure of success to the donor community, inclusion in this catalogue, participation in follow-up conferences, feasibility studies for their models in different continents.
3 https://en.wikipedia.org/wiki/Delphi_method (accessed November 5, 2017).