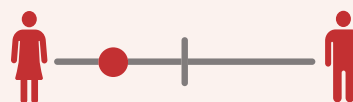


BUSINESS MODEL 3**Biogas from fecal sludge at community level**

Krishna C. Rao and Solomie Gebrezgabher

A. Key characteristics

Model name	Biogas from fecal sludge at community level (while providing sanitation services)
Waste stream	Fecal sludge/night soil and/or kitchen waste from public toilets and residential institutions (like prisons)
Value-added waste product	Biogas for cooking and lighting; bio-fertilizer
Geography	Applicable to residential institutions and public toilets that provide toilet facilities to underserved communities
Scale of production	Small to medium scale; as small as 10 m ³ up to 200 m ³ of biogas per day
Supporting cases in this book	Nepal, the Philippines and Rwanda, India, Kenya
Objective of entity	Cost-recovery [X]; For profit [X]; Social enterprise [X]
Investment cost range	About USD 10,000 to USD 85,000
Organization type	Private and public-private partnership
Socio-economic impact	Environment-friendly cooking fuel, reduced deforestation, air pollution and greenhouse gas emissions, improved fecal sludge management results in improved sanitation and health and reduced pollution of local water bodies, employment generation and better landscaping (by use of bio-fertilizers)
Gender equity	Clean indoor air and working environment; creating new and sustaining existing public toilets reducing personal risks especially for women and girls

**B. Business value chain**

The business model is initiated by either enterprises/NGOs, providing sanitation services such as public toilets or by residential institutions such as hostels, hospitals and prisons that produce large quantity of human waste. The business concept is to construct new toilets with collection and transfer of waste to bio-digester, process and treat human waste and/or kitchen waste in a bio-digester to generate biogas. Biogas can be used for internal use for lighting and cooking or sold to nearby households and businesses. The bio-fertilizers can be used for landscaping or vegetables gardens within the complex or nearby. Value chain of the enterprise varies depending on the entity initiating the business model.

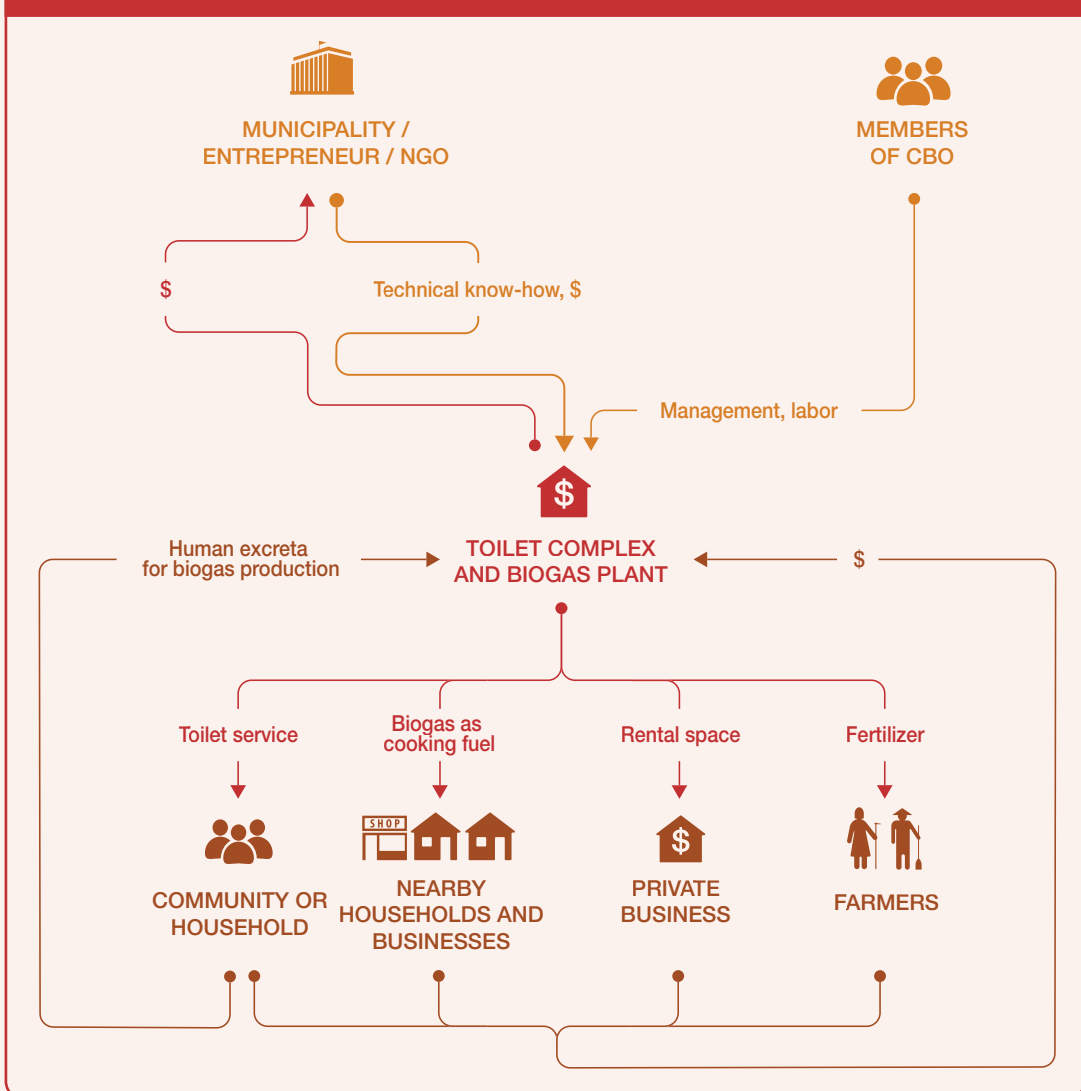
Toilet complex business model

The key stakeholders in this business value chain are the toilet users, technology supplier to install the biogas plant and its maintenance, local bodies and agencies/donors for funding the capital cost, end

users of the additional service (rental space) and value added product (biogas and potentially fertilizer) from the toilet complex (Figure 39).

The ownership and operation of toilet complex can be either by an entrepreneur, a community-based organization (CBO) or municipality. One of the roles of the municipality is to provide land for the toilet complex. Human waste from the toilet complex is fed directly to bio-digester and the biogas generated can be used within the toilet complex for lighting and heating water. The enterprise can also sell biogas to nearby households and businesses as fuel for cooking. Depending on the land space availability, the toilet complex can rent out a space within the complex to a private business such as newspaper/book stand, small neighbourhood retail store and so on. The business could potentially make fertilizer from the bio-slurry output from the bio-digester, which can be used either for landscaping purpose

FIGURE 39. VALUE CHAIN OF PUBLIC TOILET COMPLEX ON-SITE ENERGY GENERATION



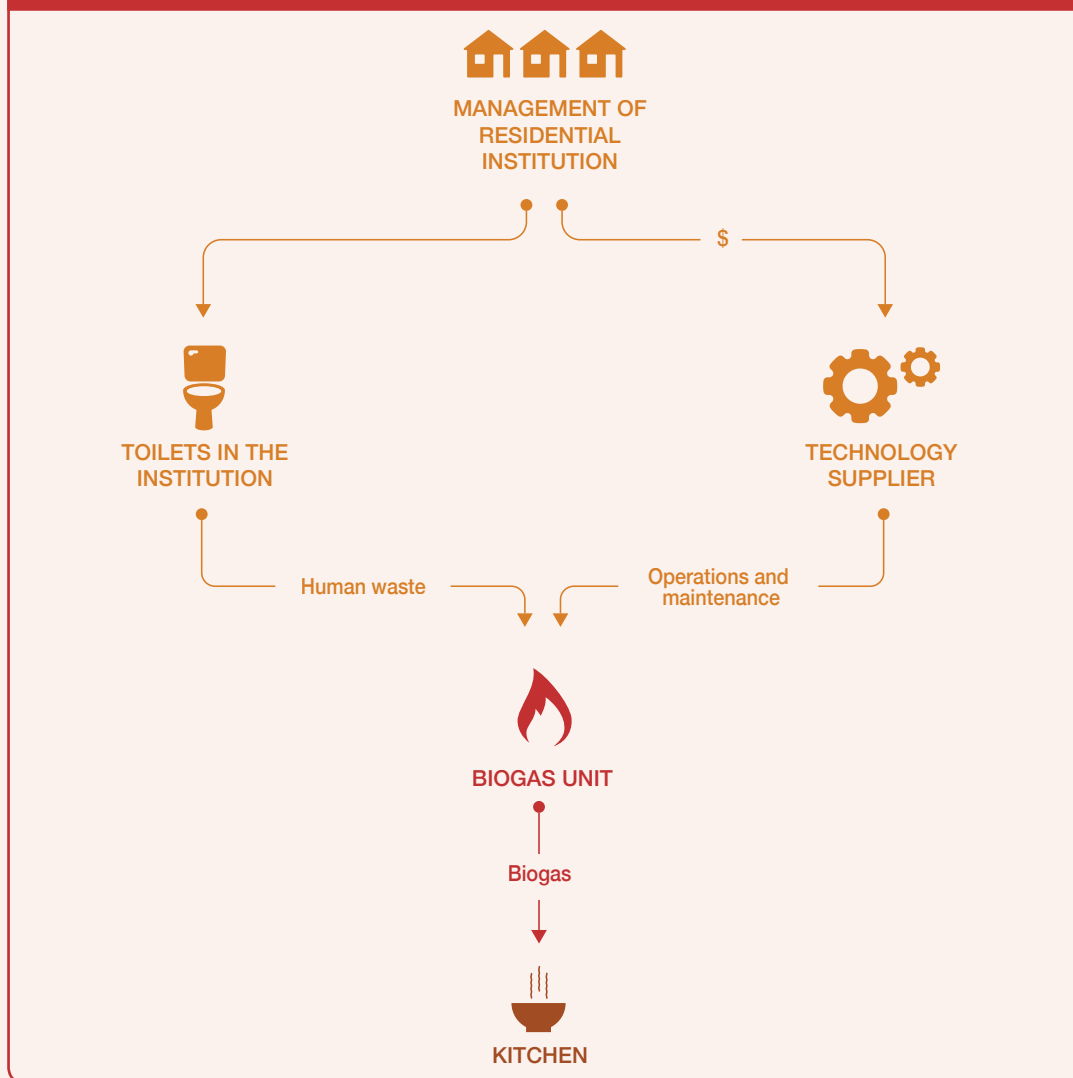
around the toilet complex or sold to farmers. However, since the product is made from human waste, the enterprise needs to take specific care to ensure the product is free from pathogens.

Residential institution business model

The key stakeholders in this business value chain are the management of the residential institution (e.g. prisons), residents (e.g. inmates of the institution), biogas operator and the kitchen management at the residential institution (Figure 40).

The concept in this business is to utilize the concentrated source of human waste generated by residents of the institution to generate biogas, which can be used within the institution premises as fuel for cooking. The process consists of sending human waste from toilets to biogas digester and the biogas produced is used in the kitchen for cooking. As an additional source of income generation,

FIGURE 40. VALUE CHAIN OF RESIDENTIAL INSTITUTION ON-SITE ENERGY GENERATION



potentially the residential institution's inmates can undertake business activity of baking or making processed food that can be sold in nearby town/city. The biogas can also be fed with other organic waste such as kitchen waste and biomass (leaf litter) generated within the institution premises. The bio-slurry from the bio-digester can be used towards landscaping or as fertilizer for growing vegetables within the institution premises under very specific and strict safety protocols.

Both the business models are eligible for sale of carbon as the biogas is generated from human waste. In both these business models, there is scope for private technology enterprise that could get into Build, Own and Operate (BOO) or Build, Own, Operate, Transfer (BOOT) arrangements. The private entity could bring all investment to set up the biogas technology while the institution provides land and sends human waste to the biogas plant. The private entity designs, constructs and maintains the biogas unit until BOOT period is expired after which it assists the institute to operate the unit.

C. Business model

The primary value proposition of the business model for both public toilet complex and a residential institution is to provide improved safe sanitation service in an environmentally responsible manner and secondary value proposition is to generate biogas from human waste. The value proposition remains same irrespective of the entity driving the business initiative which is either the public toilet complex, residential institution or private biogas technology supplier that uses BOO or BOOT approach to provide improved human waste management service to the institution along with provision of environment friendly fuel for cooking. The business model also offers value proposition of providing organic compost from bio-slurry, the output from the biogas plant.

The business model canvas is significantly different for public toilet complex and residential institution (Figure 41). In addition to the value propositions mentioned above, the public toilet complex with biogas plant can offer rental space for a business with access to a uniform group of customer segment.

Public toilet complex enterprise has multiple revenue sources. The primary revenue is from the fees collected for usage of toilet. Other revenue sources are from sale of biogas, compost and rental income. The model requires partnership with municipality or local community for access to land to build the toilet complex.

In the residential institution business model (Figure 42), the biogas is used primarily for internal consumption thereby the institution incurs substantial savings from avoided fuel purchase for cooking. The business model offers scope to sell either entire or excess biogas to nearby households and businesses. In the case of compost, the residential institution can use it internally for landscaping or growing vegetables for internal consumption. The inmates of residential institutions could be organized to undertake business activity of making processed food such as snacks and bakery product and in the process have additional revenue source from sale of these products.

Residential institution model requires developing partnership with biogas technology supplier whose assistance is critical in the initial stages towards operation and maintenance until a local labor is trained. The key activities include the production of biogas and the key resources are land, equipment, biogas technology and access to human waste.

Both these business models are eligible for carbon offset, however the biogas plant size is small to be viable to apply for Clean Development Mechanism (CDM) projects due to associated transaction costs and preferred route would be to apply for carbon offset on Voluntary Emission Reductions (VERs) market.

FIGURE 41. BUSINESS MODEL CANVAS FOR PUBLIC TOILET COMPLEX

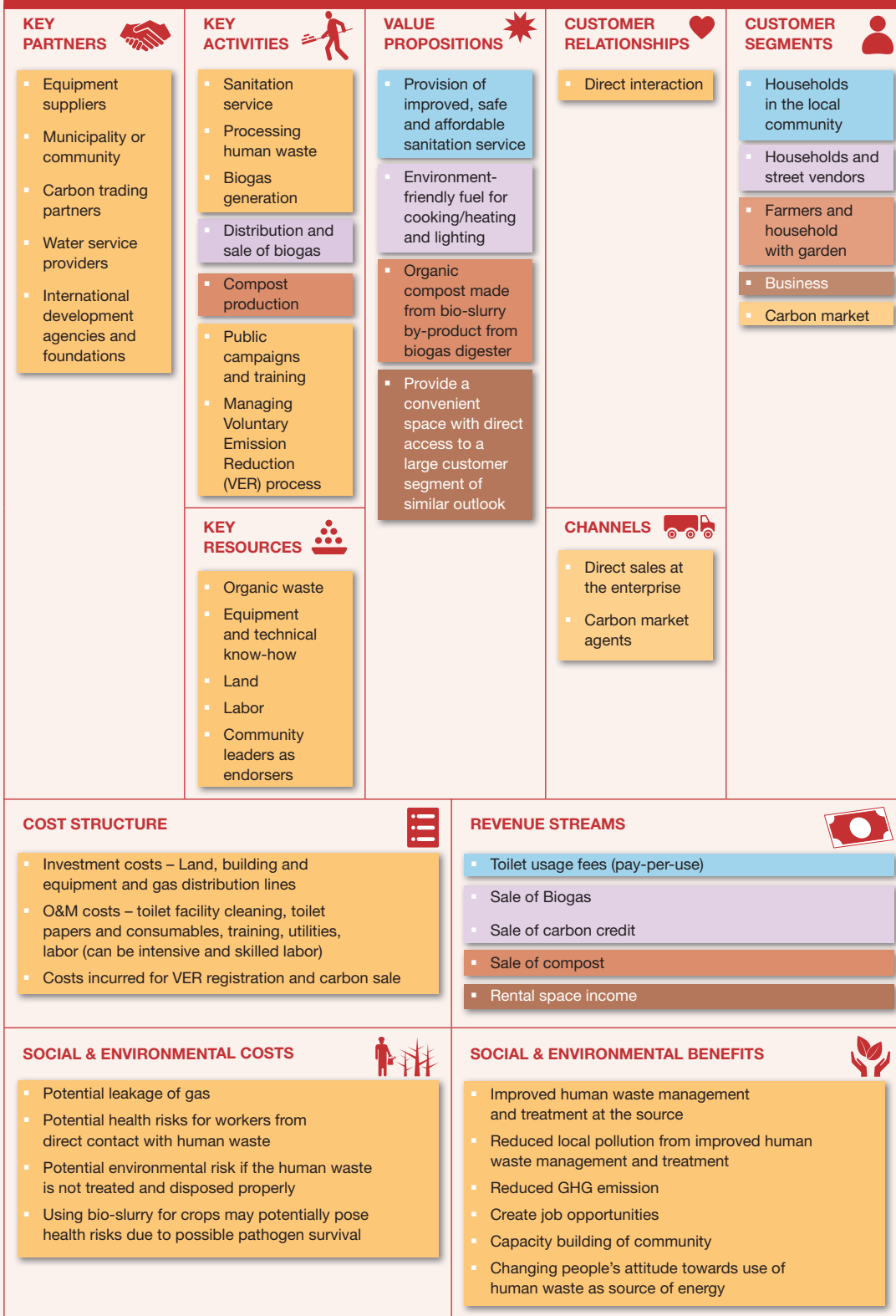
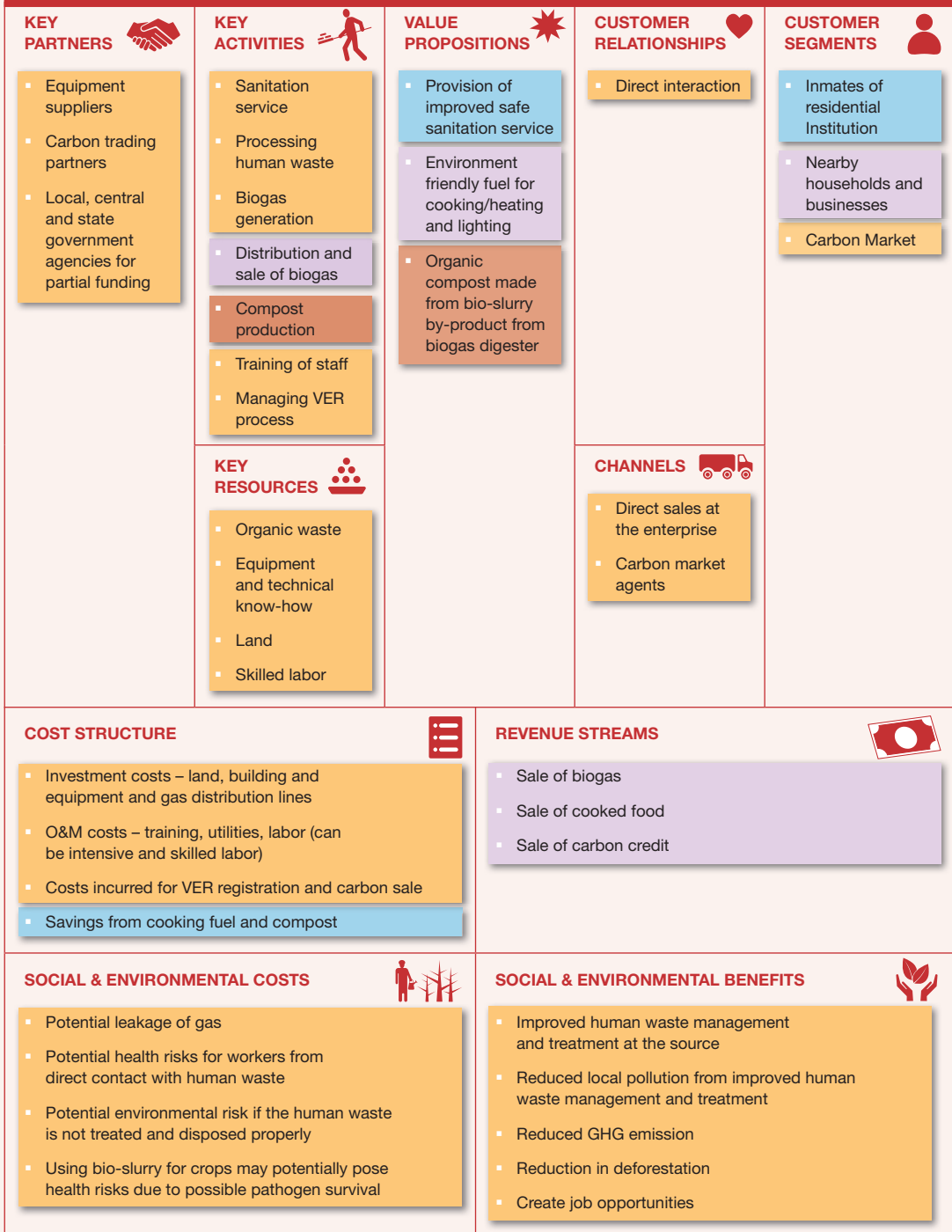


FIGURE 42. BUSINESS MODEL CANVAS FOR RESIDENTIAL INSTITUTION



D. Potential risks and mitigation

Market risks: The market risk is different for both toilet complex and residential institution business model. Market risks hardly exist if the business is initiated by the residential institution; however, in the case of toilet complex, it has risks of community or household willing to use the toilet facility. In both the cases, there is a potential social implication of willing to use biogas and bio-fertilizers generated from human waste for cooking and landscaping purpose.

Competition risks: Biogas competes with LPG, kerosene or other traditional cooking fuels such as fuel wood and charcoal. In most developing countries, kerosene and LPG are subsidized for domestic consumption and thus biogas should be produced at a lower cost than these competing products to get buy-in from end users. For end users who use charcoal and fuelwood, there is a need for additional investment in cooking stoves for them to shift to biogas use. However, for the residential institutions with biogas plant, expense incurred for purchasing cooking fuel is reduced significantly. On a long-term basis and before the life cycle of the biogas plant, investment cost of the plant and its operation cost is completely recovered by the residential institution.







Technology performance risks: The technology used is anaerobic digestion, which is well established and mature. However, the type of digester required could potentially be sophisticated and might not be available in developing countries, and in addition the technology requires skilled labor. It is ideal for the business to transfer the technology from a market where it is widely implemented and have their staff trained in repair and maintenance of the technology. The extra care will have to be taken by operators to make sure that digested slurry is free from pathogens before using it as fertilizer.

Political and regulatory risks: In most developing countries, price of cooking fuels such as kerosene and Liquefied Petroleum Gas (LPG) are subsidized for domestic consumption. Such government policies can diminish the economic advantage offered by the biogas supplied to households and in unlikely case, if the policy is extended to commercial entities, the business model is unviable. Lately, governments are encouraging green initiatives by providing incentives such as financial assistance, concessional loans and depreciation benefits. Policies supporting green initiatives make this business model highly attractive.

Social-equity-related risks: The public toilet complex model offers greater benefits to women from increased privacy rather than defecating in the open. The biogas generated from the toilets, if used in household for cooking, would again benefit women due to use of cleaner fuel. The biogas used internally for energy savings and for residential institutions is gender neutral. Both the models mostly offer energy savings and the benefit is accrued by the institution or toilet complex. Employment opportunities, while limited, benefit the marginalized. Improved sanitation in the case of public toilet complex model benefits the underserved.

Safety, environmental and health risks: Safety and health risks to human arise when processing any type of waste but the risks are further increased when dealing with human waste. Labor in such enterprises should be provided with appropriate gloves, masks and other appropriate tools to handle the waste to ensure their safety. Ideally, the enterprise should have strict safety policies as the potential for direct human contact with human waste is very high. The risk of environment pollution is high if human waste is not treated properly and is disposed of openly leading to groundwater or surface-water pollution. The environmental risks associated with the anaerobic digestion units include possible leakage of gas and these emissions should be controlled. Compost from bio-slurry has high risks of pathogens, if not treated properly. However, if proper operation procedures are followed, the risks are reduced significantly (Table 14).

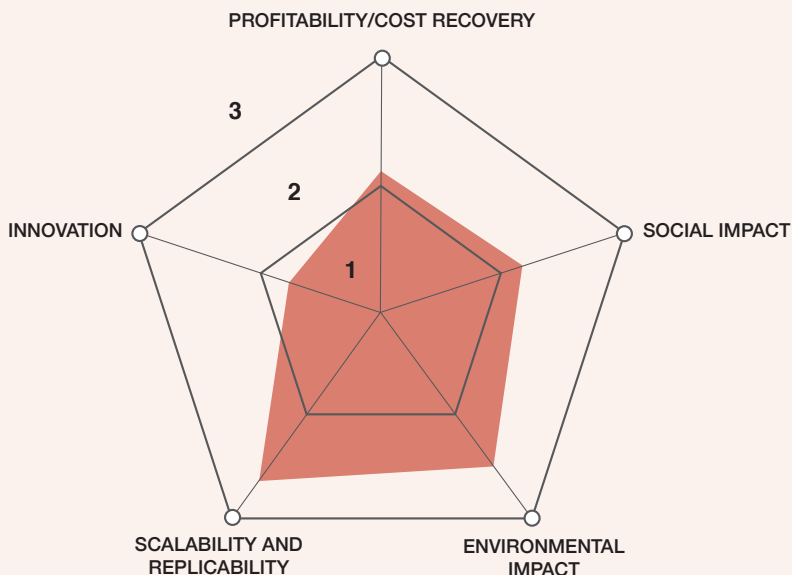
TABLE 14. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 3

RISK GROUP	EXPOSURE ROUTES					REMARKS
	Direct contact	Air	Insects	Water/ Soil	Food	
Worker						Direct contact risks exist for workers if fecal sludge is wrongly handled, and if also compost is produced. Food produced with bio-slurry compost could have pathogen exposure and should be cooked for safe consumption.
Farmer/User						
Community						
Consumer						
Mitigation Measures				 		
Key	 NOT APPLICABLE	 LOW RISK	 MEDIUM RISK	 HIGH RISK		

E. Business performance

This business model scores high on scalability and replicability followed by environmental impact (Figure 43). The business model has high potential for replication in developing countries and, except for the social acceptance of the product from human waste, there are no factors that limit its potential for replication. The business model offers horizontal and vertical scaling by expanding business to other sectors, such as compost and selling cooked food; however, expansion to these other businesses is a theoretical possibility. The environmental impact scores high because of high replication potential that

FIGURE 43. RANKING RESULTS FOR BIOGAS FROM FECAL SLUDGE BUSINESS MODEL



the business model offers that could result in safe management of human waste and in the process reduced pollution of groundwater and surface water resulting in lesser damage of ecosystem and its services.

The business model scores reasonably well on social impact largely from the treatment and safe management of human waste. Depending on the type of entity initiating the business, the revenue source can vary. However, even in the toilet complex business model, which offers multiple revenue source, these will remain modest, while building on cost savings based on reduced fuel expenses. The business model scores low on innovation as the technology and financing required is fairly straightforward.