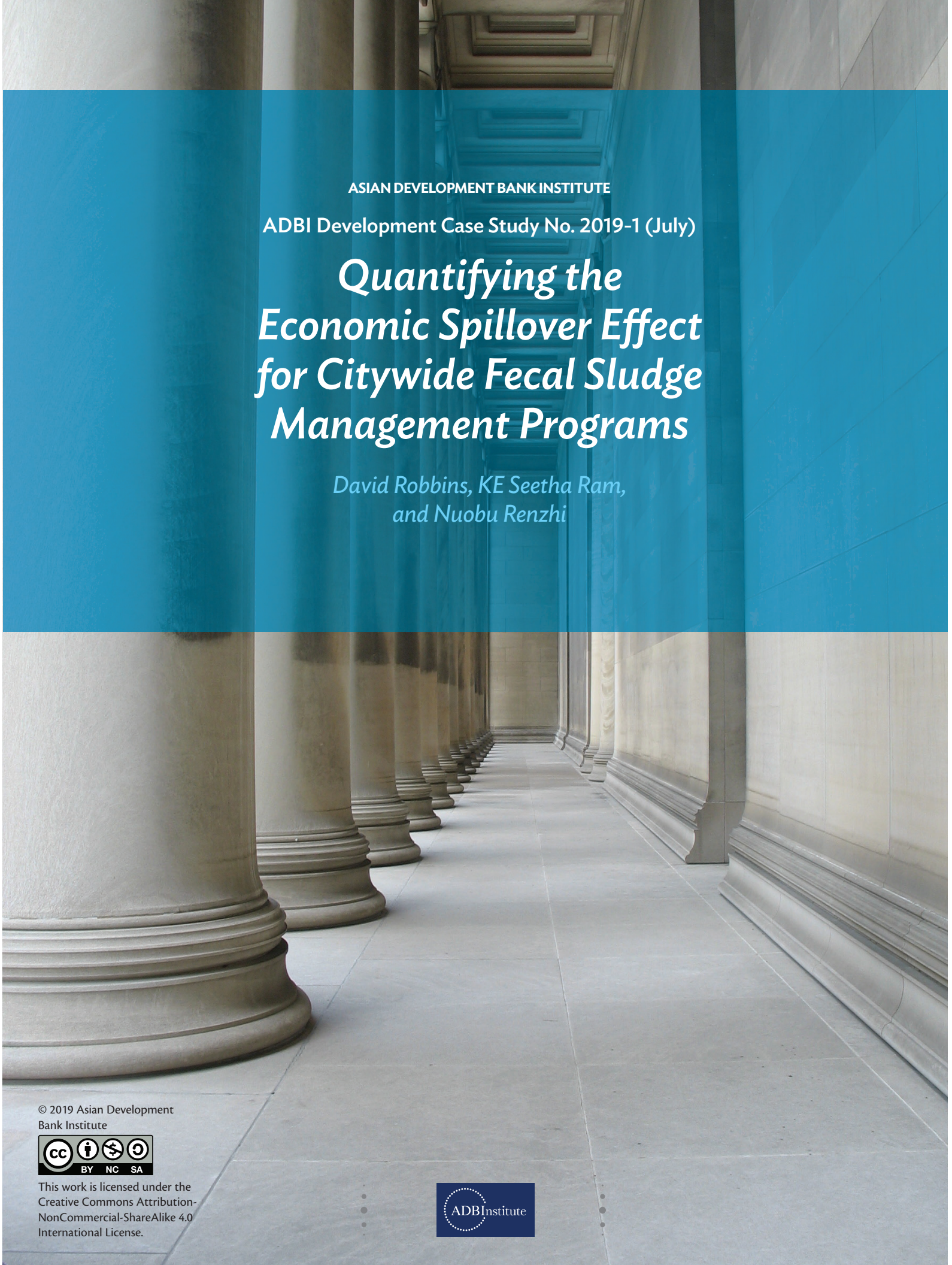

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Quantifying the Economic Spillover Effect for Citywide Fecal Sludge Management Programs

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ADBInstitute

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1. Introduction

The economic spillover effect relates to ancillary benefits from development projects beyond their intrinsic values. For citywide fecal sludge management (FSM) projects, such benefits could be increased property values and tax revenues as the environmental health of the city improves over time. Other potential ancillary benefits include (i) increased tourism as the water quality of bays, beaches, and rivers improves; (ii) livelihood opportunities as pollution is reduced in fisheries; (iii) health improvements and increased worker productivity; and (iv) overall economic development.

To illustrate these spillover effects, this study looks at two projects in the Philippines: the Dumaguete City FSM program, on the island of Negros in central Philippines, and the Veterans Water Reclamation Facility (known as Project 7), a co-treatment program in Manila in the National Capital Region.

Both Dumaguete City and Project 7 are existing citywide FSM programs that have generated enough data to support a model for spillover effect valuation, which can be illustrated as follows:

Value of an FSM project = intrinsic value of the project
+ additional internal effect values
+ external spillover effect values.

Additionally, we present a methodology to quantify the spillover effect values, represented mathematically as:

$$Spillover\ Value = (G_a - G_0) \times I \times C \times L,$$

where the spillover value[1] of a benefit or parameter is equal to the product of

- the difference between the growth trend projected after the commissioning of the project (G_a) and the growth trend before the project (G_0);
- the impact factor (I), which is defined by the level of impact on the parameter by poor sanitation;
- the correlation factor (C), which is based on the likelihood that the intervention (the FSM project) will sufficiently address the impacts over time; and
- the linkage factor (L), which describes how FSM is related to other issues that are impacting upon the benefit or parameter.

Determining the expected spillover effect values for projects that have not been built yet is a subjective process. The methodology presented herein is designed to provide a platform where practitioners can evaluate the variables based on likely scenarios as their cities develop over time. A toolkit (under construction) is introduced that simplifies the math through a questionnaire interview format.

2. Spillover Effect of Sanitation Improvement

Developing countries throughout Asia have made impressive gains in sanitation improvement through efforts to reduce open defecation and improve toilet coverage as measured by the Millennium Development Goals.[2] Toilets function by collecting fecal waste and separating it from residential environments. To function effectively, toilets must either be connected to sewers that convey wastewater to off-site treatment works, or to on-site wastewater management systems consisting of septic tanks and pits that are designed to contain the fecal sludge, while dispersing the effluent through soil-based systems. Establishing sewer systems is expensive and generally beyond the capability of all but the largest cities. Therefore, on-site wastewater management is the only other alternative. To function effectively, on-site systems must be properly sized and maintained, which requires periodic desludging.

As more people begin to rely upon on-site wastewater treatment systems (as open defecation decreases), hygienic citywide fecal sludge management programs become critical. Most cities in Asia have some form of septic tank or pit latrine desludging service. This may range from unhygienic services performed by informal desludging crews that operate on a demand basis, to government-organized programs that provide citywide desludging services on a rotating schedule. While the latter are rare, where they do exist, these organized programs accomplish the collection, transport, and treatment of the fecal sludge and septage, as well as the reuse or dispersal of the treatment by-products. The intrinsic value of these programs is in reducing the amount of fecal

[1] The spillover value is expressed as a percentage of the growth of the parameter tested.

[2] United Nations. Millennium Development Goals. http://www.un.org/millenniumgoals/environ.shtml (accessed 20 March 2018).

waste and pathogens discharged into the environment, while reducing the threat of infection from the pathogens found in wastewater.

There are often ancillary impacts associated with FSM programs beyond the intrinsic values that are realized as sanitation improves in a given community. These must be considered when looking at overall program costs and benefits. These economic impacts may include (i) increases in property values and the associated tax revenues, (ii) increases in tourism and its associated revenues, (iii) overall economic development that can be enabled as citywide sanitation improves, and (iv) environmental health improvements and other related benefits. These parameters may be considered "spillover" effects realized from the FSM program. In some instances, organized FSM programs can be integrated into existing or planned sewerage programs and realize "internal" program benefits. The most common example of this is the internal program benefits realized through co-treatment, or the co-management of fecal waste with the city's sewage. In these programs, costs are reduced through efficiency of operations, while value is added through increased utilization of the treatment plant or avoiding the cost of stand-alone fecal sludge treatment systems. The spillover effects of FSM programs may be substantial. In the two city examples provided, the spillover effects are greater in terms of economic value than the original capital costs of the programs. Quantifying the spillover effect can provide a significant motivator that can be used to persuade local decision makers to accelerate citywide FSM programs.

2.1 Sanitation Success Stories from the Philippines

The Philippines has witnessed impressive economic growth in recent years. From 2010 to 2017, the country achieved an average gross domestic product (GDP) growth rate of 6.4%, which was a great achievement compared to the average GDP growth rate of 4.5% in 2000–2009 and 2.4% in 1980–1999. This rapid growth also has drawn the attention of many researchers and policy makers. Felipe and Estrada (2018) show that the recent economic growth in the Philippines is mostly driven by the increase in labor productivity growth in the manufacturing and service sectors. Yoshino and Nakahigashi (2018), by using Thailand data, give further evidence that the increase in labor productivity growth in the manufacturing and service sectors is largely caused by the positive effect of infrastructure investment. The *Asian Development Outlook 2018* also points out that infrastructure development in the Philippines fuels the country's strong economic performance.

Conversely, the Philippines also has large disparities in terms of regional economic growth. The Central Visayas Region had an average GDP growth rate of 8.2% in 2010–2017 and contributed 7% of GDP growth in the whole country, making it the fifth-largest contributor to the country's economy. However, the province of Negros Oriental in the Central Visayas Region has been one of the poorest provinces in the country. Inadequate infrastructure has been a critical constraint to local economic growth (ADB 2007), as it increases the cost of business activities and has an adverse impact on local property values. Combating the poverty in the province requires more infrastructure investment to decrease business costs and create more economic opportunities. In 2010, the local government in Dumaguete City embarked on a program to do just that—by starting the full operation of its citywide FSM program.

3. Dumaguete City Fecal Sludge Management Program

3.1 Background

Dumaguete City is located in the province of Negros Oriental in central Philippines. Its population is approximately 130,000 people. Planning for their FSM program began in 2006 and was fully operational in 2010. The program provides citywide FSM services for desludging most septic tanks on a 5-year rotating schedule. It includes a fecal sludge treatment plant as well as a fleet of seven desludging trucks. The program was implemented in parallel with other sanitation improvements, including a properly functioning on-site wastewater system for the public market.

Dumaguete City represents a model for how local governments can actualize cost-recoverable and sustainable citywide FSM programs. The basic concept behind the program is that if everyone pays a small amount, it could fund the capital as well as operational expenses of the service. In this instance, the small amount is a tariff of around $1 per family per month that is attached to the water bill and collected by the water district. This was enough to achieve full cost recovery for the capital and operational expenses in 6 years. The service is septic tank desludging for residential, commercial, and institutional on-site wastewater systems on a 5-year cycle. The monthly tariff is easier for families to afford than having to pay a lump sum.[3]

Box: The Spillover Effects from Fecal Sludge Management: Dumaguete City

In Dumaguete City, Philippines, managing fecal waste is spurring economic growth. Besides cost savings from placing desludging fleets at convenient locations, the city has seen higher property values, improved tourism, more jobs, and better health and productivity. **Watch. ▶**

"The city council then found it urgent, practical, and necessary to preserve lives and to maintain cleanliness in our drinking water."

— Felipe Antonio B. Remollo, Mayor, Dumaguete City

"The procedure of collecting from us a septage fee is fair and better for us, because we will not be buying the equipment they have. The result is uniform function for all of us."

— Roy Cang, Pioneering Hotelier

"You can benefit from it through the fees that people would pay. At the same time, you're doing good to your people by maintaining sanitation, preserving the environment."

— Felipe Antonio B. Remollo, Mayor, Dumaguete City

"It's not intended for us to make money out of it. It's simply to recover what we have invested... You cannot measure in terms of money the safeguards you have made to avert any possible contamination of your groundwater."

— Esperato Dicen, General Manager, Dumaguete City Water District

[3] Interview with local government water district. For details, see video at https://www.adb.org/news/videos/spillover-effects-fecal-sludge-management-dumaguete-city.

In Dumaguete City, septic tank desludging services are provided through a program that is jointly managed by the city government (or local government unit) and the Dumaguete City Water District. The water district maintains and operates the fleet of seven desludging vehicles, while the local government unit maintains and operates the septage treatment plant. The treatment plant uses waste stabilization pond technology and was designed with an operational capacity of 85 cubic meters of septage per day. Tariffs are collected to cover the cost of the services including full cost recovery for the capital expenditures (CAPEX) and operational costs (OPEX).

The local government collects about $1 each month from every household to empty out their septic tanks every 5 years.

Prior to the investments, the bay fronting the downtown area was experiencing degraded environmental health due to unregulated discharge of sewerage and septage. Eight years after the sanitation improvements were commissioned, the nuisance is now reduced, and thousands of people use the waterfront park every day. Business revenue from restaurants and hotels fronting the bay have increased as have the property values and tax revenues. Rizal Boulevard fronting the bay is now an important tourism draw, resulting in more meals served at local restaurants and rooms rented at local hotels. There have been other economic spillover impacts as well that have been realized in Dumaguete City as a result of their FSM program. When the treatment plant was installed, as incentives to the host community, the local government improved the roads, built a health center, created a scholarship fund, and provided local employment opportunities at the fecal sludge treatment plant. Property values in the areas surrounding the treatment plant have since increased, and what was once a barren outskirt of the city is turning into an upscale residential neighborhood. These spillover effects, driven in part by the implementation of the FSM program, have resulted in real economic development that has had a significant and substantial impact on the city.

3.2 Estimating the Value of Spillover Effects

To fully explore the spillover effect of the Dumaguete City FSM program, data were obtained from the city tax office, city health office, water district, and host community, with data points beginning in 2005, well before the implementation of the program. The trends were evaluated both prior to and after the commissioning of the FSM program.

3.2.1 Economic Data from the City Government

Key metrics in this category include (i) business taxes collected; (ii) number and type of business entities; (iii) business and residential rental costs; and (iv) activities related to tourism including number of tourists and of hotel rooms rented. The data show that, prior to the FSM program, the trends were low growth increasing at around the national rate of inflation. However, following the advent of the program, the growth trend in the metrics increased, with tax revenues and rental values somewhat above the national rate and with tourism-related activities well above the rates prior to the program.

3.2.2 Health Data from the City Health Office

The health data obtained from the municipal health office provide information on two metrics: (i) number of gastrointestinal disease incidents and (ii) number of waterborne disease outbreaks.

It is assumed that improving citywide sanitation through septage management will have a positive impact upon health as the pathogen loading into the environment is reduced. Evaluating these impacts, however, is difficult. Disease reporting is not an exact science as many people, especially poor people, may not seek or may delay formal medical treatment for diarrheal diseases. Further, waterborne disease outbreaks are relatively rare in Dumaguete, so establishing trends is difficult. There may also be confounding factors, as all waterborne disease outbreaks or gastrointestinal disease events may not be due to contaminated septage or wastewater.

3.2.3 Data from the Water District

The data from the water district are used to find the intrinsic value of the FSM service by comparing the number of service connections and volumes of water delivered with the number of desludging events. They are also used to gauge the efficiency of the program by looking at the percentages of customers that have their on-site systems desludged each year, and the overall percentage of residential and commercial buildings desludged within the 5-year cycle.

3.2.4 Data from the Host Community

The data from the host community look at the number of new homes and businesses, and associated property values, to gauge the economic benefits from the project. Other impacts are also captured, including (i) the number of scholarships awarded that are funded through the FSM tariff, (ii) the value of the health-care facility and of the services provided, (iii) the value of the road improvements, and (iv) the value of the local employment realized through the project.

4. The Fecal Sludge Management Valuation Model

The economic model of an FSM program valuation shows that the total project value is equal to the sum of (i) the intrinsic value of the project, (ii) any internal benefits, and (iii) any spillover effect benefits.

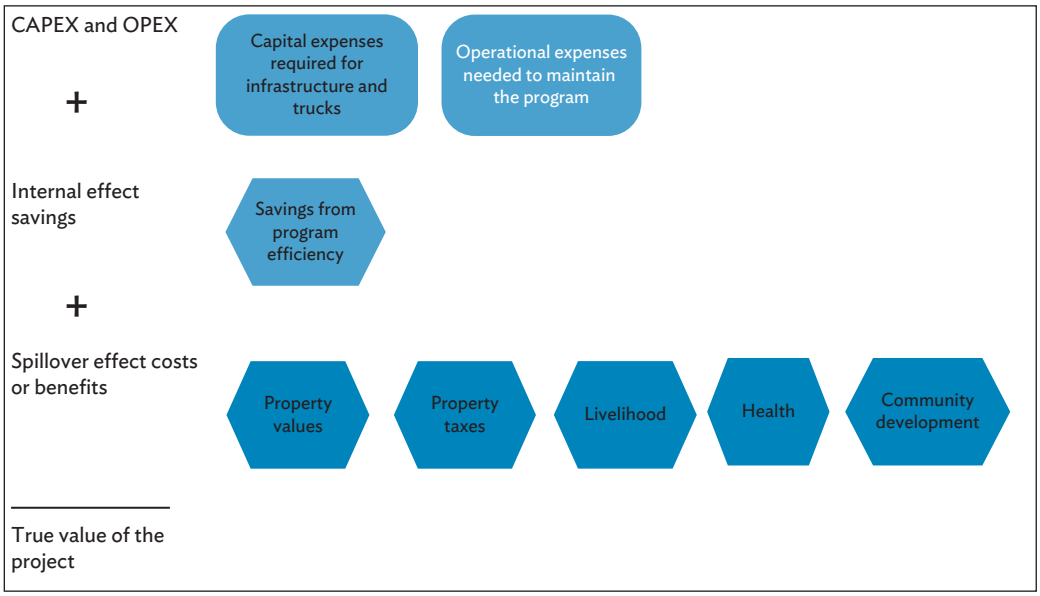
4.1 Methodology of Calculating Spillover Effect Values

From the model (Figure 1), we see that the true value of a project is equal to the sum of

- the intrinsic value of the project, represented by the initial capital expenses and the ongoing operational expenses;
- the internal savings through program efficiency; and
- the value of the spillover effect benefits, including property values and taxes, livelihood opportunities, health improvements, and overall economic development activities.

The intrinsic value, represented by the CAPEX and OPEX, is a direct value that is easily obtained. The internal savings through co-treatment efficiency or other economies of scale can be modeled to obtain a fairly accurate valuation. This is presented for Project 7 in the next section.

Figure 1. True Value of a Sanitation Project



CAPEX = capital expenditures, OPEX = operational costs.
Source: Authors.

It is the spillover values that are normally not easy to measure. There are many potential external benefits (parameters) associated with citywide sanitation improvement that a community may realize.

For Dumaguete City, they can generally be broken down into four categories. They are presented below along with their indicators:

1. Property values and real property taxes
   - Number of lessors
   - Number of building permits
   - Tax assessment totals
2. Tourism and associated revenues
   - Number of food service establishments
   - Number of hotels
   - Tourism tax revenues
3. Economic development
   - Number of banks and financial institutes
   - GDP for the city
4. Health
   - Number of reportable diseases
   - Worker productivity

Variables to consider when estimating the spillover effect are the following:

- impact (I): the degree that the parameter is impacted by poor sanitation;
- correlation (C): the likelihood that the intervention will improve the condition;
- growth trend (percentage) prior to the implementation of the FSM project (G_0);
- growth trend (percentage) anticipated after the project (G_a); and
- linkage (L): the link between the intervention and the growth of the parameter.

This can be shown mathematically through the following formula:

$$Spillover\ Value = (G_a - G_0) \times I \times C \times L.$$

4.2 The Impact (I) Variable

Determining the impact of a proposed intervention (implementing an FSM program) is subjective, often relying upon opinions where solid data are not available. Using this methodology along with sound planning and visioning exercises can improve the accuracy of the valuations sought.

Property values and property taxes provide a good example for the discussion of the impact (I) variable. For Dumaguete City, there was a moderate association between the degraded environmental health of the bay and property values of the commercial and residential parcels fronting it. Consider Table 1, which presents a ranking of the possible impacts of poor sanitation on the property values parameter on a scale from 0 to 1, where 0 is no impact and 1 is a strong impact.

Table 1. Impact Variable and Ranking Criteria

Rank	Value
0 – There is generally no impact on properties from poor sanitation.	.1
1 – There is a minor impact on properties due to poor sanitation.	.2
2 – There is a distinct impact on properties due to poor sanitation.	.4
3 – There is a definite impact on properties due to poor sanitation.	.6
4 – There is a major impact on properties due to poor sanitation.	.8
5 – There is an extreme impact on properties due to poor sanitation.	1

Source: Authors.

Using this ranking method, an investigator can break down the parameter (in this case, property values) into subparameters (Table 2). We can consider the subparameters that are directly related to the property impact from fecal sludge and the associated ranking for Dumaguete prior to the FSM program.

To calculate the impact value for property and tax values, we must first determine which subparameters are most relevant and then assess an impact ranking for each. We can then

Table 2. Subparameters for the Property Valuation Impact

Parameter	Impact Ranking
Properties are impacted by overflowing septic tanks or raw sewage	.8
Properties are impacted by odors from sewage	.8
Properties are impacted by vectors (flies, mosquitoes, helminths)	.6
Overall impact (average of the three)	.73

Note: Each issue is assumed to be of similar importance.
Source: Authors.

calculate the average impact ranking in order to obtain an estimate for the impact value for the overall parameter using the following formula:

$$\textit{Impact value} = (.8 + .8 + .6) / 3 = .73$$

In Dumaguete, there were significant indications that improving sanitation would improve the parameter of property values. This is shown by a relatively high impact value of .73.

4.3 The Correlation (C) Variable

The correlation (C) variable describes the likelihood that the project will succeed and that the anticipated impacts will be realized for the development parameter being valued. In Asia, development projects sometimes do not fully succeed, and anticipated expectations may not be realized. This can be the result of (i) the poor design or construction of physical facilities, (ii) lack of funding for long-term operation and maintenance, (iii) the skill level of the operators, (iv) immature value chains limiting the flow of spare parts, (v) political or climate risks, and/or (vi) the level of regulatory enforcement. FSM programs may not succeed in delivering anticipated environmental health improvements due to external factors as well. For example, property values may not improve after FSM programs are implemented if other factors such as solid waste or drainage are also impacting the property values.

For the correlation (C) variable, the same ranking system is used (Table 3).

Table 3. Correlation Variable Ranking and Valuation

Rank	Value
0 – The project will likely not deliver the anticipated results for the parameter.	.1
1 – The project will have minor success at delivering results for the parameter.	.2
2 – The project will have limited success at delivering results for the parameter.	.4
3 – The project will be moderately successful at delivering results for the parameter.	.6
4 – The project will be significantly successful at delivering results for the parameter.	.8
5 – The project is anticipated to fully succeed at delivering results for the parameter.	1

Source: Authors.

In Dumaguete, the indiscriminate dumping of septage prior to the intervention was believed to be impacting property values and therefore tax revenues. However, the city was new at septage management, and the ability of the city to enforce the local ordinance on septage management was unknown. At the time of the intervention, a correlation rank of between 2 and 3 (correlation values of between .4 and .6) would have been a reasonable assumption, meaning a limited to moderate chance of achieving success at positively impacting property values through FSM. As it turned out, the correlation was more positive than initially thought. Looking back, it is easy to quantify the results of the septage management program and see the benefits. One can safely say that the project was moderately to significantly successful at delivering results for this parameter (improved property values), earning it an actual rank of 3 or 4. For this example, a rank of 3 is chosen, which equates to a correlation value of .6.

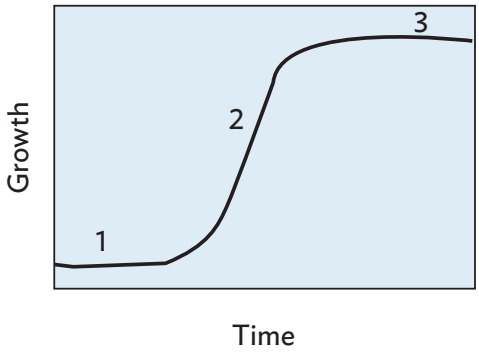
4.4 Growth Trend Prior to Implementation (G_0)

Understanding the growth trends for certain parameters requires data. Dumaguete City has documented numerous data points that are useful for evaluating growth trends. For example, the number of banks and financial institutions is tracked each year. It is believed that the rate of growth in the number of banks and financial institutions is a good indicator of economic development.

To determine a growth trend prior to the project, one method could be to look at the first 2 years after the intervention when impacts are just starting to be seen. Interventions such as citywide FSM programs take time to scale up. It is reasonable to assume that spillover effect values would be minimal during the first 2 years of operation. Evidence from the Dumaguete City experience indicates that the spillover effect exhibits a logistic growth curve (Figure 2).

Figure 2. Phases of Logistic Growth Curve

1. Lag Phase – little initial growth
2. Rapid Growth Phase – exponential growth
3. Stable Phase – stabilizing factors limit growth



Note: Data from Dumaguete City indicate that spillover effect values exhibit similar phases with the lag phase sometimes extending 2 or more years until the project scales up.
Source: Authors.

Between 2010 and 2012, the number of banks and financial institutions increased at a rate of 1.04% per year, closely paralleling the population growth rate. This appears to be a reasonable correlation as the number of banks would be generally proportional to the population served. Any reported increase in the ratio of the number of banks to population would be due to some other factor, such as increased economic activity driven by tourism, for example.

For the purposes of quantification, the G_0 variable (the trend prior to the intervention) for banks and financial institutions in Dumaguete is 1.04.

4.5 Growth Trend after Implementation (G_a)

Fortunately, Dumaguete City has data on the number of businesses after the project intervention. These make it easy to calculate the growth trend after implementation. In this case, between 2010 and 2017, the average annual growth in the number of banks and financial institutions is 8%. Therefore, the G_a variable (the trend after the intervention) equals 8% growth per year (Table 4).

The number of businesses has increased annually by 8% after Dumaguete City's Fecal Sludge Management Program took effect.

Table 4. Data on the Types and Number of Businesses in Dumaguete City, 2010–2017

Type of Business	2010	2011	2012	2013	2014	2015	2016	2017	% Annual Increase
Population	120,883					131,377			
Banks and other financial institutions	239	248	244	322	339	361	372	396	8
Caterers and food establishments	570	632	605	685	640	667	684	740	4
Manufacturing	150	150	138	152	153	165	157	166	1
Printing and publications	13	17	16	15	14	14	14	18	5
Real estate lessors	390	427	450	531	555	603	649	697	10
Retailers	1,676	2,632	2,500	2,748	2,730	2,858	2,887	3,102	10
Services	1,113	1,128	1,154	1,282	1,290	1,383	1,426	1,519	5
Wholesale/ distribution	164	179	170	197	207	201	201	190	2
Exempted business entities	49	195	87	196	171	79	114	134	22
Other impositions/ fixed taxes	No data	No data	2,344	2,516	2,430	2,490	2,470	2,578	
Total	4,364	5,608	7,708	8,645	8,530	8,821	8,974	9,450	15

Source: Dumaguete City.

The difference between G_a and G_0 therefore is the growth in economic development in the years following the intervention as expressed in the formula:

$$G_a - G_0 = \textit{additional growth for that parameter above the existing trend.}$$

In this case, $G_a - G_0 = 8\% - 1\% = 7\%$ growth per year.

4.6 The Linkage (L) Variable

The economic dynamics in a city are complex, and growth in economic development, for example, may have a number of causes. The linkage (L) variable is used to reflect the degree that the project intervention is the causative factor in the rate of growth. In Dumaguete City, diverting the sewage from the public market to the treatment system instead of the bay, as well as collecting the septage and banning the indiscriminate discharge of septage, had a direct impact on improving the environmental health conditions in the central business district and around the bay frontage. Was that the only reason that tourism numbers began to increase around that time? Table 5 provides the rationale for this variable.

Table 5. Linkage Variable Ranking and Valuation

Rank	Value
0 – The intervention is not generally linked to growth of the parameter.	.1
1 – The intervention is a minor factor in growth.	.2
2 – The intervention is a significant factor responsible for growth.	.4
3 – The intervention is a major factor responsible for growth.	.6
4 – The intervention is the only factor responsible for growth.	.8
There is no 5 ranking here as it is assumed there are always some external factors influencing growth.	

Source: Authors.

From the example, the impact on property values is significantly linked to poor sanitation. Therefore, a linkage value of .6 is selected.

Considering the above variables, it is shown that some of the realized increases in property values after the implementation of the project can be attributed to FSM. This is shown through the spillover valuation calculation using the formula:

$$\textit{Spillover Value} = (G_a - G_0) \times I \times C \times L,$$

i.e., Spillover Value = (8% – 1%) × .73 × .6 × .6 = 1.85% per year.

This means that of the growth in property values and property tax collections, 1.85% of the 7% growth for this parameter can be attributed to the FSM program intervention. The same strategy can be used for the other parameters to obtain the full economic picture of the spillover effect.

5. How to Use This Information

Up until now, the discussion has been about citywide improvements. The spillover effect can also be measured locally. Consider the real estate along the first two streets fronting the bay at Dumaguete City. For every $25 million of real estate valuation, 1.85% per year of property value growth can be attributed to the fact that there is a functioning FSM program in the city. By the 10th year of the project, this value amounts to almost $0.75 million—and that is just one parameter evaluated.

For every $25 million of real estate valuation, 1.85% per year of property value growth can be attributed to the fact that there is a functioning FSM program in the city.

This information can be transferred to other cities interested in implementing FSM projects, which can utilize trends for the various parameters from Dumaguete City. As more cities develop their FSM programs and more data are accumulated over time, more accurate trend lines can be established.

5.1 Health

For communities influenced by waterborne disease outbreaks, the external spillover effects from environmental health improvements realized through citywide sanitation projects can be significant. Schistosomiasis, for example, is an infection by a parasitic worm and one type of waterborne illness tracked by most local health departments in Asia. Research indicates that there is a correlation between water supply and sanitation and the prevalence of this disease. Programs that improve sanitation and at the same time reduce the disease incidence would see (i) reductions in the amount families spend for medical care, and (ii) reductions in lost time due to illness and therefore greater productivity. Gastrointestinal cases in addition to schistosomiasis are tracked in Dumaguete (Table 6).

Table 6. Number of Gastrointestinal Cases by Year in Dumaguete City, 2005–2017

Year	No. of Gastrointestinal Cases
2005	483
2006	No data
2007	1,288
2008	373
2009	1,853
2010	724
2011	695
2012	647
2013	304
2014	360
2015	322
2016	637
2017	553

Source: City of Dumaguete Planning Office, 2017.

In Dumaguete City, the public market is a major generator of wastewater in the downtown business district that drains to the bay. The bay is used for recreational swimming by locals and some seafood production. In 2006, through the assistance of the Bremen Overseas Research and Development Association (BORDA), a wastewater system for the public market was constructed and put into operation. There was an immediate reduction in wastewater entering the bay. The operations of the wastewater treatment plant were intermittent during the first few years, until in 2010 when the fecal sludge treatment plant came online, and the market wastewater system was fully functional. Pollution entering the bay was drastically reduced. This corresponds to low levels of waterborne illness. The improved environmental health can be seen in the health data. In 2007 and 2009, incidence of gastrointestinal diseases was high, which may be due to the fluctuating operation and maintenance of the wastewater system at the public market during that time period.[4]

Note the rise in cases starting in 2016 showing that there is a general increase in gastrointestinal diseases reported. This may be related to the deterioration of the public market wastewater system that occurred at around this time. While funding has been appropriated for repairs, no action has been taken due to political opposition to the project regarding the continued operation of the wastewater system in the park across from the market.

5.2 Net Present Value of Spillover Benefits in Dumaguete

To estimate this FSM project's economic spillover effects on local economic performance, city-level data are used, where the parameter of "annual regular income" is the indicator of local GDP and real property tax is an indicator of property value, which is provided by the Bureau of Local Government Finance. In this way, the net present value (NPV) of the spillover effects on local economic development and property values can be examined. Similar to the discussion on property values above, the estimation uses the same formula as:

$$\textit{Spillover Value} = \textit{Initial Value} \times (G_a - G_0) \times I \times C \times L,$$

where

- *Initial Value* refers to the value of the parameter in the base year 2009,
- G_a is the annual growth rate of the FSM project from 2010 to 2016,
- G_0 is the average pre-project growth rate from 2010 to 2012,
- I represents the degree that the parameter is affected by poor sanitation,
- C refers to the likelihood that the intervention will improve the condition, and
- L is the linkage of the intervention and the growth of the parameter.

Also, to make the estimation of the economic effect of the FSM more concrete, a benefit–cost analysis is employed by calculating the NPV of the spillover effects and comparing it to the project initial cost.

[4] Basic Needs Services Philippines Incorporated. DEWATS for Dumaguete Public Market. https://bnsphils.wordpress.com/projects-implemented/dewats-for-dumaguete-public-market/ (accessed 20 March 2018).

Table 7. The Spillover Values and Net Present Value of Fecal Sludge Management Project in Dumaguete City

	Year						
The Spillover Values	2010	2011	2012	2013	2014	2015	2016
GDP growth	$87,517	$287,617	$224,404	$389,627	$618,314	$859,519	$1,080,719
Property tax	$10,867	$11,743	$21,793	$36,269	$23,277	$25,985	$33,275
	NPV Value				Ratio to Initial Cost		
NPV (GDP growth, 7-year)	$2,277,229				4.55		
NPV (Property tax, 7-year)	$111,203				0.22		
NPV (GDP growth, 4-year)	$771,673				1.54		
NPV (Property tax growth, 7-year)	$662,148				1.32		

GDP = gross domestic product, NPV = net present value.

Note: The unit of spillover value and NPV is $1; the discount rate used in calculating NPV is the social discount rate of 9% from the Asian Development Bank; and the initial value used in the estimation of the spillover effect value and NPV is $7,308,866 for annual regular income and $311,022 for the real property tax. All these values have been transformed into United States dollar from Philippine peso using an exchange rate of $0.02 = ₱1.00. The initial cost of the fecal sludge management project is $500,000.

Data source: Bureau of Local Government Finance.

The estimation results of the spillover values and NPV are shown in Table 7. We can see that there is a large increase in GDP growth and property tax value from 2013 compared to the mild growth in 2010–2012, which shows there is a 3-year lag period of the FSM project to have tremendous economic spillover effects. On the other hand, by estimating the NPV and comparing it to the project's initial cost (approximately $500,000), the whole-period NPV of GDP growth spillover value is 4.55 times higher than the initial cost, and the estimation results show that it takes only 4 years to pay back the initial cost considering the NPV of GDP growth spillover value. On the other hand, the whole-period NPV of property tax spillover value is about 22% of the initial cost, which is not as high as the GDP growth spillover value. However, if we only consider the pure increase of the property tax, the estimation shows that the whole-period NPV of property tax growth is 1.32 times higher than the initial cost, which is still a plausible result. Therefore, the empirical results suggest that the FSM project in Dumaguete City has been positively affecting local economic development and capital values, which gives additional evidence of the benefit of infrastructure investment in Dumaguete City.

6. Estimating the Internal Effect Values through Co-Treatment in Project 7

To continue the discussion of the full valuation of FSM projects, we have already discussed the capital and operational expenses, as well as potential spillover effects. There are also internal savings that can be realized through smart management that we call the internal effect. One method of smart management is co-treatment, or the management of fecal sludge and septage along with municipal sewerage.

Maynilad Water Services Incorporated (MWSI) maintains a fleet of 10-cubic-meter desludging trucks, each costing the equivalent of about $120,000.[5] In Manila, septic tank volumes vary widely depending on the size of the property and wealth of the family served by the tank. In the Project 7 area, the estimated volume of residential septic tanks is just under 2 cubic meters. For commercial and institutional septic tanks, the estimated volume is approximately 6.5 cubic meters. The procedure is for the truck operators to bring full loads to the septage treatment facilities, which means that typically more than one septic tank is desludged to fill the truck prior to bringing the load back to the treatment plant. MWSI utilizes private sector contractors to operate their trucks. The 2018 rate of the private sector operator is approximately $8 per cubic meter for the septage collected and transported, which includes the costs for drivers, helpers, fuel, and operation and maintenance of the truck.

Prior to the commissioning of the Project 7 co-treatment plant, all septage collected from MWSI customers was transported to the Dagat-Dagatan septage treatment plant. Trucks on average would be able to make one complete trip per day. This includes (i) driving from the truck yard to the first septic tank to be desludged, (ii) desludging that tank, (iii) driving to the next building to be desludged, (iv) desludging that septic tank, (v) continuing to desludge additional tanks until the truck is full, (vi) driving to the treatment plant, and (vii) driving back to the truck yard. With the advent of Project 7, drive times were greatly reduced allowing for each truck to make two complete trips per day on average. This greater efficiency resulted in significant savings from the collection activities as the number of trucks (and their drivers and helpers), fuel, and other operational expenses were reduced.

The design capacity for septage acceptance at Project 7 is 240 cubic meters per day (Table 8). However, the current average daily flow is 110 cubic meters per day. This is in part due to low acceptance by the customers, which in turn is due to a lack of knowledge about the septage programs on the part of the building owners, as well as inability to desludge the tank in some cases due to access or inability to locate it. As more of the cities within the coverage area adopt local ordinances on septage management, and as promotional campaigns promoting the service are stepped up, the actual daily septage volumes delivered to the plant is anticipated to approach the design flow.

[5] Philstar. 2013. Maynilad Inaugurates P266 Million Sewage and Septage Treatment Plant. 19 October. https://www.philstar.com/business/2013/10/19/1246787/maynilad-inaugurates-p266-m-sewage-and-septage-treatment-plant (accessed 20 March 2018).

Table 8. Data Input Values of Maynilad Water Project 7

Residential septic tank volume	1.7 m^3
Commercial septic tank volume (average)	6.5 m^3
Desludging frequency (building not connected to combined sewer)	5 years
Desludging frequency (building connected to combined sewer)	7 years
Working days per month	25
Crew hours per day	10
Assumed cost for trucking operation and maintenance	$8 per cubic meter desludged (does not include cost of trucks)
Truck cost	$120,000
Truck volumetric capacity	10 m^3
Number of full loads per day prior to project	1
Number of full loads per day after project	2
Treatment plant design capacity for septage	240 m^3

m^3 = cubic meter.

Source: Interviews with Maynilad Water Services Company staff, 2017.

6.1 Internal Effect Values of Project 7

Table 9. Persons Served

Currently served: residential tanks	65,000
Maximum residential tanks at full capacity	195,500
Currently served: commercial/institutional tanks	9,750
Maximum commercial tanks at full capacity	29,775

Source: Interviews with Maynilad Water Services Company staff, 2017.

MWSI projections achieve full sewerage connectivity for the coverage area by 2037.

6.2 Estimates of Savings

The impact of Project 7 in terms of desludging costs is significant. Due to the added septage delivery location, the trucking operation has become more efficient. Each septage truck is now expected to make two full trips per day delivering 20 cubic meters per truck per day. That is twice the delivered volume of septage that went to Dagat-Dagatan prior to the commissioning of Project 7. Twice the efficiency of the trucking operation means that only half of the prior number of trucks are required to do the job, resulting in half the cost of the trucks and related fleet expenses, which breaks down as shown in Table 10.

Table 10. Savings of Maynilad Water Project 7

	1 Year	10 Years	20 Years
Fuel savings (assuming truck uses 8 liters per hour)	$130,680	$1,306,800	$2,613,600
Truck savings (assuming 10-year depreciation)	$33,825	$338,250	$676,500
Operation and maintenance of fleet	$129,406	$1,294,061	$2,588,122
Total	**$293,911**	**$2,939,111**	**$5,878,222**

Source: Interviews with Maynilad Water Services Company staff, 2017.

The septage treatment components of Project 7 are estimated at about 25% of the total cost of the facility, or approximately $1.4 million. Therefore, the spillover effect savings over 20 years are more than three times the CAPEX for the septage equipment, solely through fleet management savings.

As shown, the internal benefits of co-treatment for Project 7 are significant. In the coming months, the project team will collate data on increases in tax revenues and health impact to estimate the spillover effect in Quezon City, similar to what was performed for Dumaguete City.

7. Conclusion and Policy Implications

The spillover effect is real and significant, as demonstrated by the citywide FSM project in Dumaguete City. The effect comprises increases in property value and tax revenue, livelihood, health, and economic development. Policy makers are reluctant to support FSM projects that typically report lower benefits in ex ante and ex post project evaluations. Quantifying the spillover effect of FSM projects makes it easier to persuade policy makers to accelerate such projects. More importantly, with a better understanding of the spillover effects, policy makers can also persuade prominent beneficiaries, such as resort owners and businesses to pay high user charges to cover the recurrent costs to sustainably operate FSM projects.

A toolkit (under development) will simplify the process for city officials and policy makers through an interview-style platform that they can use to adjust the variables based on likely but conservative values for their cities. As more cities enact FSM projects and collect data, trend lines both before and after project implementation can be established, which can be used by other cities to estimate their own potential spillover effect valuations as they develop their own FSM projects.

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Study Questions

1. What is unique about this solution?
2. What are the lessons for cities in your country and/or other countries?
3. What are the policy messages?
4. What are the conditions to replicate the solution?
5. What are the conditions to scale up the solution?

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