LAGUNA WATER
A MANILA WATER PHILIPPINE VENTURES COMPANY

LagunaAAA Water Corporation

Portable Toilet Solutions
Phase 2 Pilot Testing Report

APRIL 2018

Executive summary

The Laguna AAAWater Corporation (Laguna Water) provides water services to approximately 80% of households in the municipalities of Biñan, Sta. Rosa, and Cabuyao, in the Province of Laguna. Part of their expansion plan includes the consideration of various options on wastewater management programs.

In line with this, Laguna Water secured a grant from Grand Challenges Canada to conduct a two-phase pilot study that facilitates the scalability and replicability of the portable toilet system model. This report covers an assessment of Phase II of the Portable Toilet Solution Project, which involved continued testing of two prototype systems with 30 target households in Barangays Don Jose, Pooc, and Macabling, Sta. Rosa, Laguna.

This report details the comparison of the two prototype systems, by vendors LIXIL Group Corporation and Loowatt Ltd., through a Multi-Criteria Analysis (MCA). This report also details the baseline water quality analysis and the project risk assessment. The findings detailed in this report are the result of consolidating and cross-validating information and data from interviews, observations and discussions, logging of portable toilet use and cleaning machine use and water consumption, and water sampling.

The MCA scores were based on the identified criterion: financial, environmental, health and safety, customer satisfaction and ability to scale up the business. Each criterion were given specific weights and corresponding scores for each technology. Overall, Loowatt's system is the recommended PTS with a total MCA score of 87.48% as compared to LIXIL's system with a MCA score of 54.18%. Loowatt's system is preferred in terms of financial, environmental and customer satisfaction criterion. LIXIL's system is preferred in terms of health and safety, and ability to scale up criterion.

Water sampling from four sampling stations reveal that there is high level of BOD and total coliform in Barangays Macabling and Pooc sites of the pilot study, which can be attributed to the improper disposal and treatment of human excrements in the area.

Risk assessment identified extreme risks such as insufficient funding, difficulty in land acquisition, possible theft of AS/IBS equipment and potential migration or resettlement of households. Mitigation measures are recommended for each of the identified risks.

Abbreviations

Acronym	
AS	Acceptance station
BOP	Base of the pyramid
BOD	Biological Oxygen Demand
CHO	City Health Offices
COD	Chemical Oxygen Demand
CAPEX	Capital Expenditure
GCC	Grand Challenges Canada
IBS	Industrial bag shredder
IRR	Internal Rate of Return
Laguna Water	LagunaAAA Water Corporation
MCA	Multi-Criteria Analysis
NPV	Net Present Value
OBP	Optimisation Business Plan
OPEX	Operational Expenditure
PTS	Portable Toilet Solution
SSTP	Sewage-Septage Treatment Plant
TCU	Total Colour Unit
TSS	Total Suspended Solids

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1. Introduction

1.1 Project background

LagunaAAA Water Corporation (Laguna Water) is a joint venture between Manila Water Philippine Ventures, a wholly owned subsidiary of Manila Water Company, Inc. and the Provincial Government of Laguna, is developing a portable toilet service (PTS) for households at the base of the pyramid. An Optimisation Business Plan (OBP), inclusive of population and septage volume projections, demographic and socioeconomic characteristics of proposed customers, and cost estimates (capital and operating expense, or otherwise referred to as CAPEX and OPEX), was developed by GHD Pty Ltd (GHD) in February 2016 for this specific service.

In line with this, Laguna Water secured a Transition-to-Scale Grant from Grand Challenges Canada (GCC) for a two-phase pilot study that facilitates the scalability and replicability of the PTS model in 2015, and contracted GHD in 2017 to implement the two-phase pilot study. Recommended options for human waste collection systems and financing scenarios in view of the results of the OBP were implemented during the pilot study. The pilot study comprehensively tested the best model for local conditions from prototypes of two portable toilet vendors. This report details the findings of this two-phase pilot study.

Phase 1 focused on refining the technology of the portable toilets and its supporting infrastructure by obtaining information and feedback regarding toilet use and the prototypes' acceptability in target communities. Consumer insights were obtained from 20 households who used the two prototype portable toilet models from July to September 2017. At the discretion of the two toilet vendors, improvements were made to the prototype toilets based on the outcomes of Phase 1 to be tested during Phase 2.

Phase 2, which was conducted from January to March 2018, continued to test the differences between the two improved portable toilet systems through the participation of 30 households, around half of which were previous participants from Phase 1. At the end of Phase 2, an objective comparison between the portable toilets models and supporting infrastructure was completed, using a Multi-Criteria Analysis (MCA) approach that assigned different weightings to the various aspects of the business, toilet systems and potential impacts and risks. The objective comparison included a re-evaluation of the OBP and customer feedback needed for Laguna Water to launch the portable toilet service by July 2018.

1.2 Purpose of the report

GHD has prepared this report to present the findings of the two-phase pilot study. This report aims to provide Laguna Water with:

- An evaluation on which PTS is recommended in terms of financial comparisons (CAPEX and OPEX), customer feedback, health and safety, and environmental impacts.
- An examination of water quality in relation community health in the areas.
- Recommendations on the possible risks and roll-out strategy of the business.

1.3 Scope and limitations

During the conduct of this study, GHD was responsible for:

- Collection of secondary data relating to health and sanitation.
- Selection of participant households and obtaining initial demographic data.
- Coordination and conduct of all data gathering aspects of the pilot study, including the development of the methodology, survey tools, and instructions for participants, as well as the

completion of all interview, on-site observations, data collection, telephone updates, and SMS reminders for the households.

- Identification of risk mitigation measures.
- Review, analysis, and recommendations on the most commercially viable and socially acceptable option.

Laguna Water was responsible for:

- Liaison with the two toilet vendors, LIXIL and Loowatt, on the supply of prototype toilets and improvements on the design.
- Coordination, delivery, and set up of the supporting infrastructure (i.e. acceptance stations and industrial bag shredder) at an approved site.
- Coordination, delivery, and collection of the portable toilets and cartridges/ barrels to and from the participating households.
- Access by GHD to Laguna Water staff involved in the pilot (i.e. for interviews with technical staff and operators involved at the disposal site and pick-up/collection of human waste).
- Provision of all available and relevant data/information from Laguna Water, LIXIL and Loowatt to GCC.
- Key decisions and assumptions used in the two-phased study, the MCA, and in calculating the CAPEX and OPEX. This includes the projected customer numbers based on existing Laguna Water customers and their water usage, and projections for portable toilet unit purchases.

The limitations and challenges faced during the conduct of the study included:

- Difficulties in recruiting participant households. Despite expression of interest, the portable toilet was not installed in the house of some potential participant households, as the item was not able to fit in the limited space inside some homes.
- Pull-outs. A number of households were not using the portable toilet due to its unfamiliar design and preference for previous practices. Certain households also experienced toilet leakage and had difficulty following instructions.
- Data discrepancies. The methodology included the need for households to complete log sheets, recording toilet usage. The log sheets given to households were not always completed by the participants. This may account for some discrepancies in the data, with adjustments and assumptions made to account for these discrepancies.
- Research implementation interruptions. The availability of participants for interviews was subject to the respective households' timeframes and schedules and in some cases this required repeat or subsequent visits to conduct the interview and obtain the needed data.

This report has been prepared by GHD for LagunaAAA Water Corporation and may only be used and relied on by LagunaAAA Water Corporation for the purpose agreed between GHD and LagunaAAA Water Corporation as set out Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than LagunaAAA Water Corporation arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on feedback and comments received from participants and the assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect or false statements made by participants.

For the purposes of this report, monetary values in US dollar (USD) is equal to 51.00 Philippine Pesos (USD 1.00 = PHP 51.00).

2. Study area

The Laguna Water concession area encompasses the cities of Sta. Rosa, Biñan, and Cabuyao. Three barangays in the municipality of Sta. Rosa were selected to be part of the pilot study (Barangays Macabling, Pooc and Don Jose) due to their proximity to creeks or waterbodies, number of households without proper sanitary toilet facilities, and participation in the previous study (Macabling).

2.1 Demography and socioeconomic profile

According to the 2015 Philippine Statistics Authority's census, the three concessionaire cities had a total population of 993,760 people in 101,385 households. Data from City Health Offices (CHO), as of 2014, reveal that compared to Cabuyao (2.42%) and Sta. Rosa (6.53%), Biñan had the highest percentage of households without proper sanitary toilet facilities (15.04%) (Appendix A).

Sta. Rosa, being the study site in particular, had 353,592 people in 101,385 households as of 2015. In 2014, 6.5% of the total household population in the City of Sta. Rosa did not have a proper sanitary toilet inside the home. For the barangays under study, CHO 2016 data reveal that 1.7% of Don Jose, 9.5% of Macabling, and 3.4% of Pooc household population did not have a proper sanitary toilet.

Barangays with the largest percentage of households without proper sanitary toilet facilities in Sta. Rosa were Aplaya (15.63%), Sinalhan (14.70%), and Caingin (11.42%). Interestingly, these are densely populated barangays that occupy an area less than 0.5 km^2 and are adjacent to Laguna Lake.

2.2 Geophysical characteristics

Sta. Rosa is characterised as a Type I Climate area based on rainfall occurrence (or Corona's Classification) – having a wet season that prevails from May to October with frequent tropical cyclones, and a dry season that prevails from November to April (Figure 1).

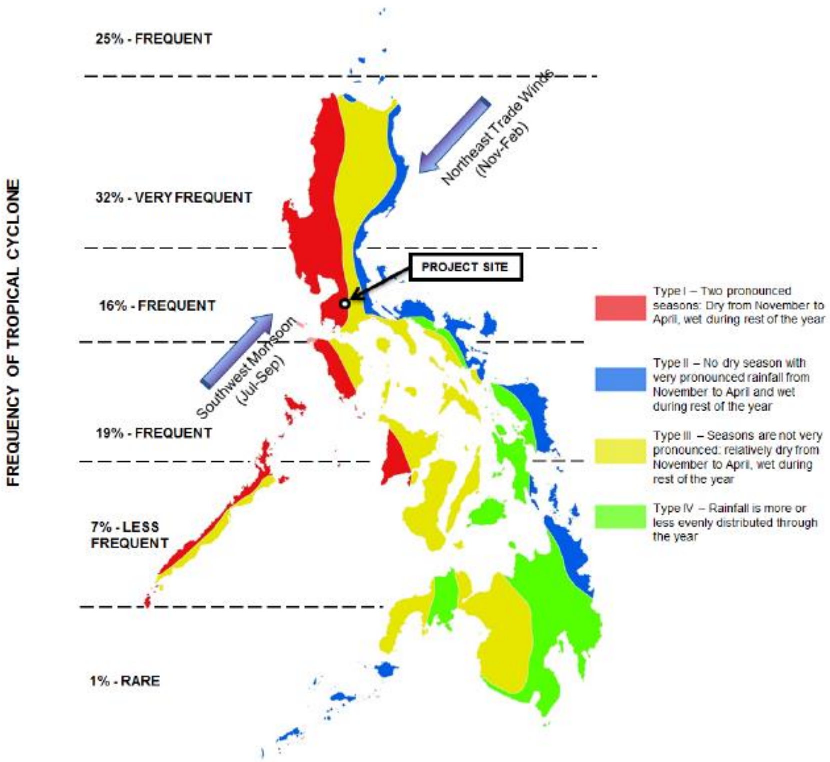


Figure 1 Corona's classification for climate

Characteristic with this Type I Climate, there was heavy rainfall during the conduct of Phase 1 of the two-phase pilot study, and Tropical Depression Maring in the second week of September 2017 caused severe flooding and a state of calamity in the area. Due to accumulated run-off, rising lake levels, low physiographic conditions, poor soil permeability and infiltration, floods in the study area caused by extreme weather conditions typically subside within a period of a few hours to a few days. During Phase 1, this had implications on the usage of the toilets by some participating households, who needed to have the toilet removed from their homes during the state of calamity. The frequency and amount of flooding and other natural disasters is an important consideration in choosing the location of the acceptance stations and service areas, and the need for emergency and disaster planning.

3. Operational and utility business model

The Portable Toilet Solution (PTS) is a business that aims to address the sanitation infrastructure gap in BOP households. Its operational model describes how the business will be run, while the utility business model describes how the business will generate value.

3.1 The operational model

The PTS Operational Model consists of the following elements: (a) the toilet system, (b) the collection process, and (c) the treatment of septage (waste). Figure 2 shows a schematic diagram of the operational model. Wastes from the toilet (contained in cartridges / barrels) are collected from each household and transported to a storage facility through a multicab (small van). Subsequently, the storage facility's containment tank is emptied once a month through a vacuum truck which transports waste from the facility to the sewage treatment plant.

Figure 2 PTS Operational System

3.1.1 Toilet

Target market

Laguna Water aims to address the issue of open defecation at the base of the socio-economic pyramid through marketing the PTS to households who do not have toilets and those without a proper sanitary toilet in the company's service area. A household is defined as "a social unit consisting of a person living alone or a group of persons who sleep in the same housing unit and have a common arrangement in the preparation and consumption of food (NSCB, 2003)." Based on findings from the previous OBP, Laguna Water has narrowed the potential target market through the criteria presented below:

- **No toilet facilities within the housing structure.** Low socio-economic households without toilet facilities either lack the space in the structure or adjacent land for a toilet facility, or prioritize other expenses before sanitation, especially as the expense of building and maintaining a toilet facility can be considerable compared with household income levels. Such households commonly use chamber pots with waste disposed in nearby waterways or a toilet nearby, which is either communal in arrangement or within a neighbour's home. Some of these shared toilets are not proper sanitary toilets. The PTS will offer added convenience for household members, and increased privacy and safety for women and children.

- **Households who use unsanitary toilets.** Unsanitary toilets have an impact on human health, and the PTS can offer households and the community a way to improve human health, quality of water in water bodies and the environment. In this aspect, it is worth noting that the data from the City Health Office (CHO) does not necessarily differentiate households without toilets and households with unsanitary[1] toilets. As such, the numbers given by the CHO may include households with a toilet structure inside the home, albeit not a sanitary type.
- **Base of the pyramid (BOP).** BOP households are among the largest in number, but are the poorest in socioeconomic terms. For the purposes of this project, households that are part of the BOP are identified to be recipients of the *Pantawid Pamilyang Pilipino Program (4Ps),* a national government program that provides conditional cash and social development assistance to residents of the poorest municipalities in the initiative to fulfil commitments to the Millennium Development Goals.
- **Laguna Water customers.** Laguna Water has expressed its commitment to offer the PTS to households that are also the company's water customers. This is because the PTS will be subsidised through the collection of an environmental fee tied to water consumption. There are, however, some areas that water services are not yet offered, limiting households in that area from becoming PTS customers, and there may be land tenure restrictions that create connection application issues.

Figure 3 shows the target barangays in the three concessionaire cities of Laguna Water (Biñan, Sta. Rosa, and Cabuyao). An estimate of the percentage of Laguna Water households without toilets in each barangay (Table 1) was based on the following assumptions/limitations:

- The barangays selected are within Laguna Water's concession area, and
- The City Health Office (CHO) data from all the three cities were used in determining the percentage of the population without toilets
- BOP estimates based on Laguna Water customer households that consume less than 10 m^3 of water per month

[1] Unsanitary toilets refer to sanitation structures without containment tanks or toilets that are not connected to a sewerage system via pipes.

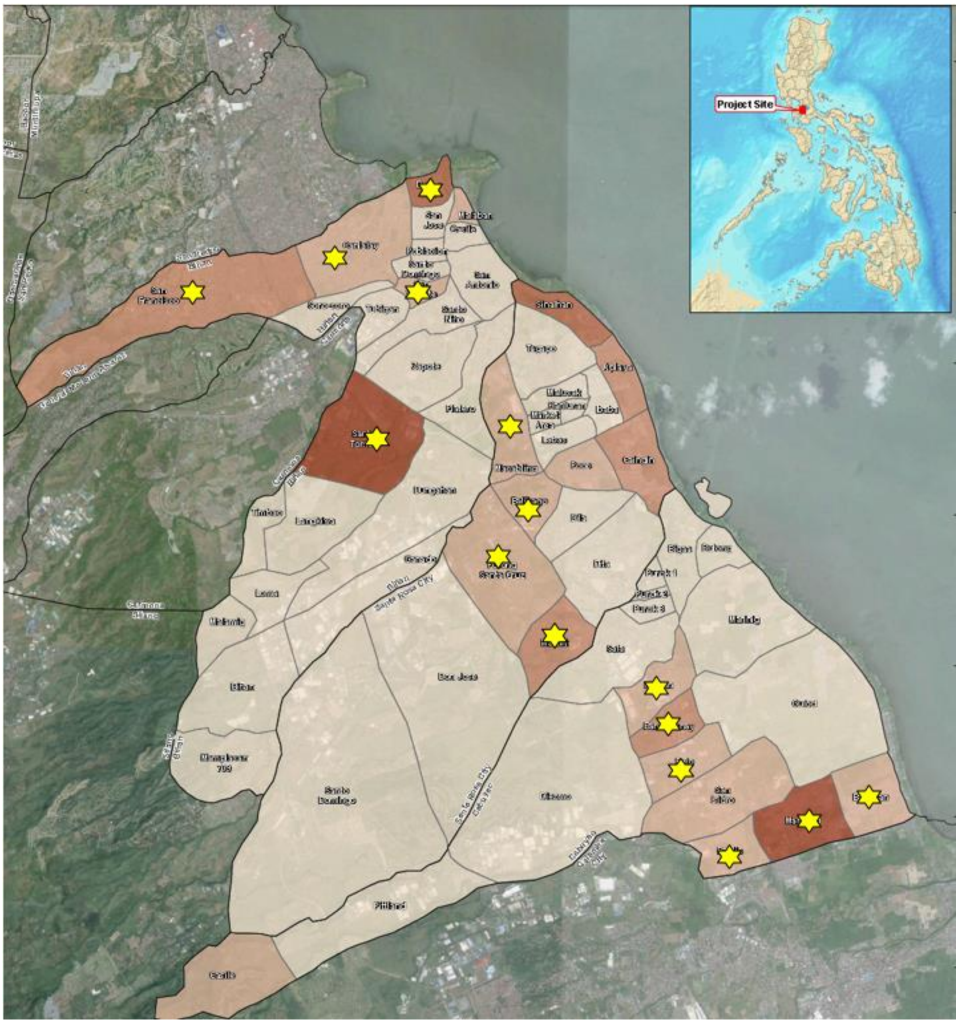


Figure 3 Laguna Water's target barangays

Table 1 Estimates on number of Laguna Water households without toilets

No.	City	Barangay	Total HH Population	LAWC Customers	HH Population w/o Toilet (CHO)[2]	LAWC HH w/o Toilet[3]
1	Biñan	San Francisco	5,734	2,260	803	27
2	Biñan	Canlalay	3,880	2,454	349	30
3	Biñan	Dela Paz	6,275	3,205	1,192	39
4	Biñan	San Vicente	1,706	1,219	154	15
5	Biñan	Santo Tomas	8,616	10,351	1,982	125
6	Sta. Rosa	Sinalhan	6,300	2,100	1,197	25
7	Sta. Rosa	Aplaya	5,400	1,800	756	22
8	Sta. Rosa	Macabling	4,858	4,040	243	49
9	Sta. Rosa	Caingin	28,000	7,000	2,520	85
10	Sta. Rosa	Pooc	19,000	3,800	950	46
11	Sta. Rosa	Balibago	10,578	654	529	8
12	Sta. Rosa	Pulong Sta.Cruz	16,866	2,666	2,361	32

[2] Percentage of households based on most recent City Health Office (CHO) data.
[3] Percentage of households based on LAWC estimates (1.21% of total current customers).

No.	City	Barangay	Total HH Population	LAWC Customers	HH Population w/o Toilet (CHO)[2]	LAWC HH w/o Toilet[3]
13	Sta. Rosa	Malitlit	6,900	2,300	621	28
14	Cabuyao	Mamatid	57,538	10,588	13,234	128
15	Cabuyao	Baclaran	14,050	3,707	703	45
16	Cabuyao	Banlic	17,378	690	869	8
17	Cabuyao	Pulo	27,464	317	1,373	4
18	Cabuyao	Banaybanay	31,136	2,349	2,802	28
19	Cabuyao	Niugan	32,439	5,334	1,622	65
20	Cabuyao	Casile	2,467	-	123	-
		TOTAL	306,585	66,834	34.382	809

At the time of writing this report, there was limited information available on the exact number of existing or potential Laguna Water customers that are considered to be BOP and either have no toilet within the home or use an unsanitary toilet. As a consequence, Laguna Water has calculated the potential customer target market on the assumption that approximately 11% of the total number of current customers are potentially part of the BOP based on the consumption of less than 10 m^3 of water per month. In addition, 11% of these BOP households (1.21% of total current customers) were estimated not to have permanent toilet structures within the home. As this is based on an assumption and limitations of available data, this does not ensure that these households are indeed part of the BOP and that, moreover, they do not have toilet facilities inside the home or access to an unsanitary toilet.

For the purposes of this study, Laguna Water has provided the number of projected PTS customers from 2018 to 2035, as shown in Table 2. It is noted that the projections from the OBP in 2016 and this study are significantly different in terms of quantity due to changes in the criteria for potential target customers, along with further analysis of available data and insights gained during this study that have changed the assumptions used and the calculation of accumulated coverage.

Table 2 PTS purchase (roll out) projections

Year	Accumulated coverage (2016 OBP)	Accumulated coverage (2018 Pilot)
2018	500	100
2019	3,000	300
2020	5,333	550
2021	8,790	850
2022	13,373	1,200
2023	18,886	1,600
2024	19,449	2,050
2025	20,034	2,550
2026	20,631	3,100
2027	21,456	3,700
2028	22,319	4,350
2029	23,205	5,050
2030	24,137	5,800
2031	25,101	6,600
2032	26,101	7,450
2033	27,145	8,350
2034	28,230	9,300

Year	Accumulated coverage (2016 OBP)	Accumulated coverage (2018 Pilot)
2035	29,357	10,300

LIXIL and Loowatt's Portable Toilet Systems

LIXIL and Loowatt's portable toilet systems are similar in terms of the key components. Terms and methodologies, however, are different between the two vendors (Table 3).

Table 3 Key components of LIXIL's and Loowatt's portable toilet systems

Key component	LIXIL	Loowatt
Portable toilet	LIXIL's portable toilet is designed for the user to assume a saddleback-riding position. The toilet is flushed and cleaned through a pre and post spraying process, which helps the waste to slip smoothly into the cartridge (waste container).	Loowatt's portable toilet is designed similar to the common toilet. The bowl of the toilet is lined with a **disposable** plastic-liner, which is flushed together with waste onto the waste container (barrel). The portable toilet may be used with or without water. Dippers have been provided by Loowatt for households that might use water for cleaning themselves during toileting. An **exhaust fan** was also provided to help minimise odour coming from the toilet.
Waste container	Waste is contained inside the portable toilet through a **cartridge** that can collect up to 20 L of waste. The cartridge has a non-mechanical valve, which, together with an additive, addresses odour and separates the toilet user from their waste. The cartridge is collected and returned by collection operators after cleaning.	Waste, together with disposable plastic-liner, is contained inside a barrel located underneath the toilet. Barrels are gathered from households and are replaced with clean ones while the collected used barrels are brought back to the STP for cleaning..
Cleaning machine	Whereas the body of the portable toilet is cleaned by the user, the cartridge is cleaned by Laguna Water through an **acceptance station (AS)**. The acceptance station is an automated machine that clears waste, washes, and adds the odour-minimising additive into the cartridge.	The **industrial bag shredder (IBS)**, similar to the acceptance station, cleans the barrel by separating the accumulated liquid waste from any solids and the disposable plastic-liner. Barrels are then manually cleaned by operators prior to returning to households.

3.1.2 Collection

Waste collection and cartridge/ barrel replacements in households are standardised by Laguna Water to every three to four days (twice a week). One cartridge (LIXIL) or two barrels (Loowatt) are designated in each home in accordance to the capacity of the toilet and the average weight of wastes collected from households based on the outcomes of this pilot study. Collection operators gather used cartridges/ barrels and bring it to a storage facility where it is cleaned by an AS/IBS, depending on the corresponding toilet. Storage facilities, which are distributed throughout the target barangays, have an underground watertight containment tank where wastes are temporarily stored prior to the monthly collection by a vacuum truck. Cleaning is done by a different set of operators, such that cleaning and collection can happen simultaneously and continuously.

3.1.3 Treatment

A vacuum truck transports septage monthly from the storage facility's containment tank to Laguna Water's sewage-septage treatment plant (SSTP).[4] Waste from the PTS is treated together with used water and septage from the rest of Laguna Water's operations.

3.2 The utility business model

Findings from the previous OBP and financial modelling by Laguna Water reveal that BOP households' capability to pay may not be sufficient to cater for the direct costs associated with availing and operating the PTS project. The utility business model addresses this service gap by using revenues from water services to cross-subsidise costs for operating *used* water services, which will eventually include the PTS (Figure 4).

Figure 4 Laguna Water services

Revenues mostly come from water charges and tariffs. In this aspect, it is worth noting that an additional environmental fee, which amounts to 20% of a customer's water bill[5], was already approved by the Provincial Government of Laguna as an amendment to the existing concession agreement. The environmental fee is applied to all Laguna Water customers and, as such, a percentage of the costs of operating the PTS will be shouldered by a cross-subsidy from the overall budget coming from both the water charges and the environmental fee (Figure 5).

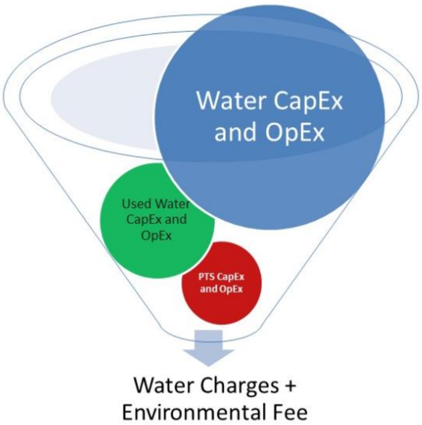


Figure 5 Utility business model

Through this arrangement, customers of high social classes and commercial establishments will be able to support BOP households through their higher tariffs (environmental fees). Moreover, while only a

[4] For the purposes of this pilot study, the AS (LIXIL) was stationed in Laguna Water's Phase 1 lift station facility within Laguna Technopark, Inc. (LTI). Loowatt's IBS, on the other hand, was located in the LTI SSTP septage acceptance area. Transport of wastes from the storage facility's containment tank to the SSTP was not done during the study as the AS and IBS are already connected to the SSTP.

[5] Those identified to be part of the BOP are exempted from the environmental fee for the first two years after signing of the amendment.

certain percentage of the environmental fee is used for the PTS, the remaining budget will then be allocated to other used water services like sewage and desludging services.

The sanitation projects are supported by the local government. Ordinances were already initiated by the local government of Biñan, Sta. Rosa and Cabuyao supporting the roll-out of Sanitation Services in their respective constituencies. Laguna Water launched its Sanitation Services on 05 April 2018 through its Information Education Campaign (IEC) [6] held at Laguna Water's LTI Sewage and Septage Treatment Plant (LTI SSTP).

[6] IEC Campaign entitled "TSEK (Tamang Sanitasyon Equals Kalinisan, Kalusugan at Kaunlaran (*Proper Sanitation Equals Cleanliness, Health, and Progress))* ng Bayan."

4. Methodology

4.1 General approach

The methodology for Phase II of this pilot study is largely based on the findings and recommendations that resulted from Phase I and the OBP.

Whereas Phase I concentrated on refining the portable toilets' technology and its supporting system through feedback from households, Phase II, on the other hand, concentrated on the comparison between the viability, sustainability, and acceptability of the two toilet systems given conditions and projections set by the business model. Objective comparisons between the two portable toilet systems were done through multi-criteria analysis (MCA), where different aspects of the PTS business were is designated different weights according to its influence on the business model. MCA is useful as a decision-making tool as it aids in dividing the decision into concrete parts whose analysis may be meaningful in evaluation and prioritisation. The weights for the different categories used in the MCA were initially recommended by GHD, and adjusted and revised according to Laguna Water's preferences.

For this study, the MCA included the categories presented in Table 4.

Table 4 General multi-criteria analysis (MCA) criterion

Category	Method of analysis	Weight (%)
Financial	Net present value (NPV) and willingness to pay	40
Customer satisfaction	Scoring and exit interviews	40
Environment	Life cycle analysis	10
Health and safety	Risk assessment matrix	7
Capability to scale	Supplier evaluation	3

In line with this approach, GHD did the following tasks for the MCA for Phase II:

- Recruited and interviewed participant households to gather data
- Gathered and analysed other usage data during the pilot study, such as the log sheets of households and Laguna Water operators
- Analysed data gathered from the vendors and Laguna Water
- Developed key assumptions used for projections and modelling in collaboration with Laguna Water
- Identified potential health and safety risks and assessed their likelihood and severity
- Surveyed Laguna Water employees on the toilet vendors' performance during the two-phased pilot study

A general timeline of activities for Phase II is shown in Table 5, and further details of each activity is provided below.

Table 5 Study timeline

Date(s)	Activity
04-08 December 2017	Recruitment/validation of participants
16 December 2017	Phase II Sanitation Summit with participants
08-12 January 2018	Training on the improved prototypes conducted by the toilet vendors/Laguna Water
15-18 January 2018	Portable toilet units delivery (30 toilets) to households and interviews with participants

Date(s)	Activity
22 January 2018	Start of portable toilet usage by the households
26 January 2018	Training on the collection, cleaning, and disposal process of LIXIL
29 January 2018	Training on the collection, cleaning and disposal process of Loowatt
26-29 January 2018	Water quality sampling conducted by Laguna Water
19 February 2018	MCA workshop with Laguna Water
20-23 February 2018	Portable toilet switchover for households
12-15 March 2018	Exit interviews with households
19-23 March 2018	Toilet retrieval from households
04 April 2018	Meeting with Laguna Water on preliminary findings and results
15 April 2018	Submission of Phase II report to Laguna Water and GCC

4.1.1 Job initiation after finalisation of Phase I

The Phase I report for the pilot study was submitted to Laguna Water and GCC on 22 October 2018. For a more detailed analysis of the households' feedback, GHD prepared individual and confidential reports for each vendor, and proprietary information of their respective prototype was not publicly revealed. The Sanitation Summit conducted on 16 December 2017 marked the official commencement of Phase II, with training conducted on the improved prototypes scheduled shortly afterwards on the second week of January 2018.

4.1.2 Recruitment/validation of participants

GHD developed selection criteria for study participants based on findings from the previous OBP and Phase I report. The following criteria served as general guidelines in selecting participating households in three barangays for the Phase II of the pilot study:

- Absence of an existing or functioning toilet (sanitary or unsanitary) in the home of participants
- Willingness to participate by:
  - Agreeing to do the tasks required during the study (e.g. log sheets)
  - Signing the consent form
  - Verbally committing to take care of the prototypes
- Relative location to waterbodies

There were 16 out of the 20 (80%) participant households from Phase I that participated in Phase II of the pilot study (Appendix B). Similar to the selection of participants in Phase I, households representing the general demographics of the study area in terms of average family size (5 members) and gender (mix of both males and females) were prioritised; however, these guidelines were not strictly followed due to the lack of households that fit all criteria. GHD also endeavoured to select a mix of participants that had a range of current toilet practices (e.g. utilizing communal toilets, chamber pots, and direct micturition/defecation in the environment).

A preliminary demographic survey was designed and administered by GHD researchers to validate households that fit the agreed upon criteria (Appendix C). Data obtained from the preliminary demographic survey was u sed to verify and analyse the data gathered during the study – allowing a better understanding of patterns, commonalities and irregularities.

During the process of recruiting participating households, GHD provided potential participants with an information sheet about the pilot study. The information sheet, which became the basis of the households' decision to participate, provided overall details of the study, instructions regarding the portable toilet operations, answers to anticipated questions, roles and tasks of family members, and other valuable information. GHD prepared a consent and participation form signed in agreement by participants to ensure full participation and consent to follow the portable toilet operating instructions, record data and observations, and share insights through interviews (Appendix D).

4.1.3 Training for GHD and Laguna Water operators

Training in the use of the Loowatt and LIXIL portable toilet prototypes were conducted at Laguna Water's office on 10 and 12 January 2018, respectively, for GHD researchers and Laguna Water operators. The training focused on demonstrating the usage of the toilet by showing step-by-step processes and communicating other reminders that needed to be relayed to households. In a similar manner, a training session for the use of the cleaning machines in the acceptance station was also conducted on 26 and 29 January 2018 for LIXIL and Loowatt, respectively. The activity was spearheaded by Laguna Water and conducted by the respective portable toilet vendors.

4.1.4 Baseline water quality assessment

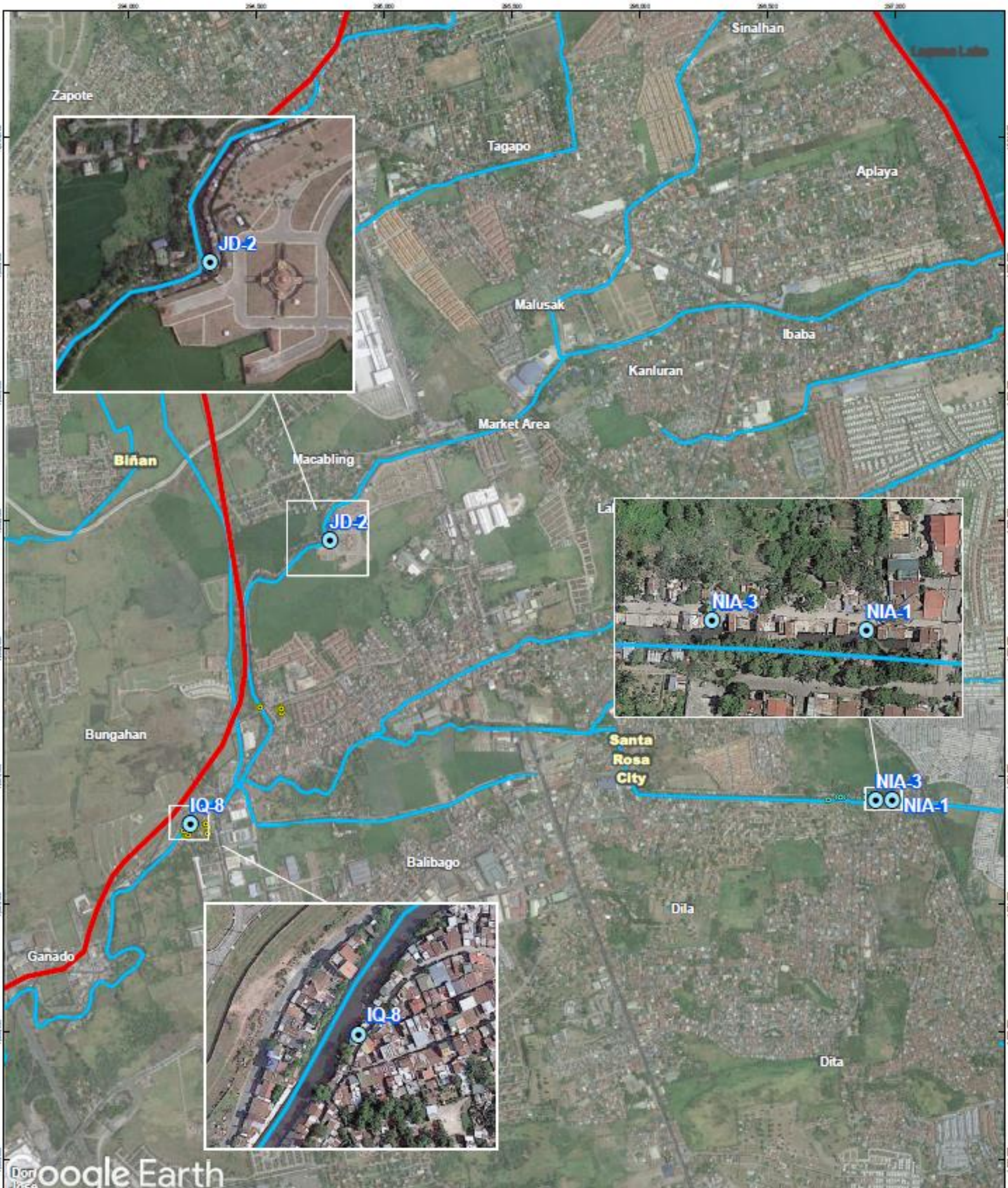
Similar to Phase I, water sampling was conducted by Laguna Water between 26-29 January 2018 at four sampling points in Barangay Pooc and Barangay Macabling (Appendix E) to determine the baseline state of water bodies in areas where it is known that people practice open defecation. Data obtained from this study can serve as a means of comparison for future studies, especially when the proposed PTS is in full implementation. The location and description of the sampling stations are shown in Figure 6 and described in Table 6, respectively. A grab sample was obtained from each of the four sampling sites per day for three days for analysis of the following parameters: biological oxygen demand (BOD), chemical oxygen demand (COD), colour, oil and grease, pH, total suspended solids (TSS) and total coliform. The samples were sent to Mach Union Laboratory, a Department of Environment and Natural Resources (DENR)-recognized laboratory, for analysis. Results were then compared to the DENR Administrative Order (DAO) 2016-08 Water Quality Guidelines (WQG) for Class D type of water body.

Data regarding community health and sanitation were also obtained from the City Health Office to compare the community's water quality and methods of excreta disposal (Appendix F). Preliminary observations regarding possible relationships between health and the environment were noted and are discussed in this report, however, a comprehensive study would still be recommended if a comparative analysis were to be made.

Table 6 Water quality sampling sites

Sampling site	Coordinates	Description
Jordan #20 (JD-20)	14°18'22.00"N 121° 5'50.95"E	• The sampling station is along Silang-Santa Rosa River located in Barangay Macabling, Santa Rosa, Laguna. • The side of the river is vegetated and near a residential area. • Construction was observed nearby. There is an agricultural area upstream of the river. • Solid wastes (i.e., plastic, dried leaves) were observed near the sampling station. • Water is turbid and has a muddy colour. Putrid odour was also observed.

Sampling site	Coordinates	Description
Iraq #8 (IQ-8)	14°17'44.30"N 121° 5'35.30"E	• The sampling station is along Silang-Santa Rosa River located in Barangay Macabling, Sta. Rosa Laguna. • Side of the river is vegetated and near residential area. • Solid wastes (i.e., plastic, dried leaves) were observed near the sampling station. • Water is turbid and has muddy colour. Putrid odour was also observed. • Riprapping activities were observed nearby.
NIA 3	14°17'49.90"N 121° 7'2.50"E	• Sampling station is a roadside creek. • Side of the river is vegetated and near residential area. • Riprapping activities were observed nearby. There is agricultural area upstream of the river. • Solid wastes (i.e., plastic, dried leaves) were observed near the sampling station. • Water is turbid and has muddy colour. Putrid odour was also observed.
NIA 1	14°17'49.80"N 121° 7'4.60"E	• Sampling station is on a roadside creek. • Side of the river is vegetated and near residential area. • Riprapping activities were observed nearby. There is agricultural area upstream of the river. • Solid wastes (i.e,. plastic, dried leaves) were observed near the sampling station. • Water is turbid and has muddy colour. Putrid odour was also observed.



LEGEND

- Water Quality Sampling Site
- Don Jose
- Macabling
- Pooc
- Waterways
- City of Santa Rosa
- Municipal Boundaries
- Waterbodies

Paper Size A3

0 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: WGS 1984
Grid: WGS 1984 UTM Zone 51N

N

GHD

Laguna AAA Water Corporation
LAWC Pilot Study of Portable Toilet Solution

Job Number	71-12564
Revision	A
Date	04 Oct 2017

Water Quality Sampling Stations
Household Survey Map

Figure 6

Data source: GHD - Household - 2017. OSM/Geofabrik - Waterways - 2016. NAMRIA - Barangay Boundaries - 2007. Google Earth - Imagery (Date extracted - 20171002). Created by kjvelasco

4.1.5 Workshop with Laguna Water

A workshop with Laguna Water was conducted on 19 Feb 2018 to align assumptions and expectations in the study (Appendix G). The major outcomes of the workshop were as follows:

- **Assignment of MCA weightings.** Categories of the MCA were designated different weights in accordance to the priorities of Laguna Water. It was determined that the financial and customer satisfaction aspects will account for the majority of the MCA, each comprising 40% of the total weight. Environment, health and safety, and capacity to scale, on the other hand, will only take up 10%, 7%, and 3% of the total weight, respectively. Questionnaires and other survey materials were designed in accordance to the categories and parameters included in the MCA.
- **Business model and target market.** Aspects of the business model and the definition of target customers were discussed during the workshop. It was established that the projections and model would operate under defined assumptions, depending on the business design and information gathered during the pilot study.
- **Deliverables.** It was discussed that the output for Phase II would be a single collective report for GCC, the vendors, and Laguna Water. Specifics of the prototype portable toilet model and system of each vendor is not disclosed in this report at the request of the vendors.

4.1.6 Testing of toilets

Arrival interviews

Laguna Water made arrangements and appointments to deliver the portable toilets to each of the 30 households on 15 to 19 January 2018. Fifteen households initially received LIXIL's model, while the remaining 15 received Loowatt's model. A single type of toilet was deployed per barangay at a time to avoid comparison between models among neighbours. GHD researchers accompanied Laguna Water on these deliveries to provide detailed instructions to the households on how to use the portable toilet prototypes. Standard arrival interviews were also conducted with a member of each household on their initial perceptions and willingness to pay for the toilet unit, sanitation services, and connection to a water meter (Appendix H). Detailed information on the socioeconomic background and previous toilet practices of the households were also gathered in a comprehensive demographic questionnaire administered after the arrival interview (Appendix I). Together with the briefing on instructions, households were also asked to record toilet usage on log sheets made and distributed by GHD and Laguna Water, respectively. Phone numbers of GHD's and Laguna Water's team members were provided in the log sheets if there were problems.

Additional information was recorded by GHD researchers such as verbal and non-verbal expressions and observations during the arrival of the toilet in the homes. During this process, GHD researchers sought to build rapport with the main contact in the household, in the hope of strengthening their commitment to record usage data, as well as open up about their perceptions and feelings regarding the portable toilet models. This process also enabled GHD researchers to assess the acceptability, enthusiasm and willingness to participate in the study.

Monitoring and log sheets

Monitoring, through the usage of log sheets, was done by the households and operators on a daily basis. For households, log sheets included information on the number of times the toilet was used per day for each member of the family (Appendix J). Log sheets for operators, on the other hand, were differentiated according to the nature of work, with cleaning operators recording automated station (AS) or industrial bag shredder (IBS) status and cleaning paraphernalia, and collection operators keeping track of weight volumes and the condition of each of the prototype toilet (Appendix J) . Logging of such information generated the values used for the MCA and assisted in determining assumptions used in the expenditure projections and economic and financial models.

Follow-up phone calls and SMS

GHD encouraged open communication with the household participants, continually following-up on toilet usage throughout the duration of the study via cell phones. Phone calls and SMS were also used for requests (e.g., collection and disposables), dissemination of announcements, and reporting of issues. Phone calls, together with observations from the Laguna Water collection operators, were used to determine if the households were fully cooperating in the study. SMS reminders were also sent to households to complete their diaries and usage logs. In addition, collection operators visited households almost every day to check on and address commonly encountered problems and encourage full participation in the study.

Switchover of toilet models

GHD researchers and Laguna Water operators returned to households after the first month to swap over the portable toilet with the alternate model. GHD researchers conducted interviews with heads of the household to discuss any issues with the research methodology and obtain information regarding the households' preference for water use (Appendix K.). They also provided instruction for the operation of the alternate model.

New participants to the study were recruited when some households needed to be replaced due to non-use of the toilet in the home and/or major issues with toilet usage. As such, arrival interviews and demographic surveys were conducted in these households in the same way as the first batch of participants. Follow-up phone calls and SMS updates were also made after the installation of the second toilet model.

Exit interviews and toilet retrieval

GHD conducted exit interviews focusing on comparisons between the two portable toilet systems in terms of the households' willingness to pay and overall satisfaction with the product and service (Appendix L). To aid comparison, a scale of zero to four (zero being the lowest, and four the highest) was used to rank different portable toilet attributes based on the criteria developed for the MCA. Descriptions for each rank were provided to facilitate a relatively subjective measure of the different parameters, such as odour, ease of use, comfort, perception of durability, size, aesthetic, and health and safety. Comparisons were done by asking the household to rank each toilet system simultaneously, such that they would be able to provide a preferred toilet for the various aspects of its usage. Toilet retrieval was completed a week after the exit interviews.

Key informant interviews

Key informant interviews were conducted with Laguna Water operators to determine challenges encountered during the collection and cleaning process (Appendix M). Questions on the operators' perceptions regarding the toilet features and its usage by the households were also included. This enabled GHD to validate observations and feedback from households, and better understand the encounters stated by participants during the exit interview.

4.1.7 Supplier evaluation

In addition to the experience of households and Laguna Water operators with the portable toilets and its respective cleaning systems, the vendors were also assessed based on their capability to scale up, as well as overall relationship with Laguna Water through an online questionnaire (Appendix N). The questionnaire was designed by GHD to gauge the perceived capability and overall relationship of the toilet vendor with Laguna Water. It was administered to three Laguna Water employees that engaged directly with the vendors during the study.

4.1.8 Data analysis and report writing

Data obtained from interviews and questionnaires regarding customer satisfaction and vendor evaluation were encoded, processed and analysed after the households had stopped using the prototypes. In a similar manner, information pertaining to waste volume, toilet physical status, collection and cleaning were gathered after the system had been pilot tested for 52 days (22 Jan 2018-15 Mar 2018). Results were summarised and assessed using the MCA, and conveyed to Laguna Water through a meeting held on 04 April 2018. The meeting also served as a means to revalidate key assumptions used for the projection, economic and financial models.

4.2 Multi-criteria analysis

4.2.1 General approach

The MCA has been used as a tool to aid in the analysis of the two portable toilet products and supporting infrastructure. It is based on direct numerical rating values that are aggregated to come up with a total score. For the purposes of this study, the main criterion for the assessment of the toilets are shown in Figure 7.

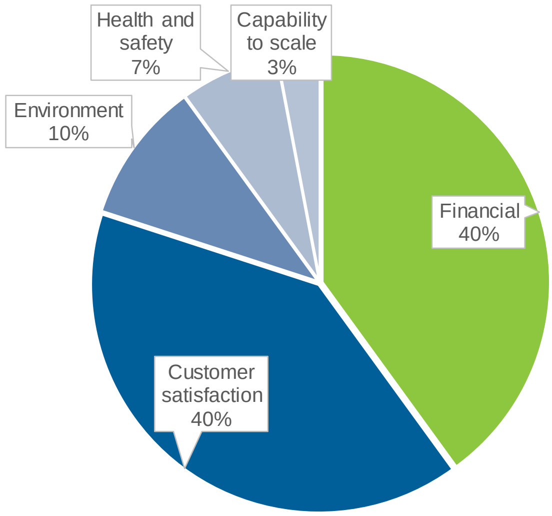


Figure 7 General MCA weightings

The different criterion for the assessment of the two portable toilets are summarised as follows:

- **Financial (40%).** The financial criterion pertains to the portable toilet system's net present value (NPV) and the households' willingness to pay. The NPV is already inclusive of the CAPEX and OPEX of both portable toilet systems.
- **Customer satisfaction (40%).** The customer satisfaction criterion relates to the customers' satisfaction with the prototype model in Phase II and their preference for a specific unit based on different qualities and attributes.
- **Environment (10%).** The environment criterion pertains to the likely environmental impacts of the two options. It was done by taking into account the materials used to manufacture the products (toilet and cleaning machines) and the amount of resources the system needs to operate.
- **Health and safety (7%).** The health and safety criterion pertains to the risks and consequences presented by the portable toilet system, both to the household (using the portable toilet in the home) and the operators (collecting the wastes from the households and cleaning the cartridges/barrels).

- **Capability to scale (3%).** The capability to scale criterion refers to the perceived capability and overall relationship of Laguna Water with the vendors throughout the course of the pilot study.

The different criterion are further subdivided into different categories and, consequently, into measurable and quantifiable parameters. Table 7 shows a summary of the different criterion and categories used for the MCA. From here thereafter, category weights refer to percentages within the criterion, while composite weight refers to percentages within the entire MCA.

Table 7 Multi-criteria analysis (MCA) categories

Criterion	Category	Category weight (%)	Composite weight (%)
Financial (40%)	Net present value	90	36
	Willingness to pay	10	4
Customer satisfaction (40%)	Odour	20	8
	Comfort	20	8
	Ease of use	20	8
	Aesthetic	15	6
	Size	13	5.2
	Perception of durability	12	4.8
Environment (10%)	Water	20	2
	Petrol	20	2
	Energy	20	2
	Materials	20	2
	Chemicals	10	1
	By-products	10	1
Health and safety (7%)	Household	50	3.5
	Operator	50	3.5
Capability to scale (3%)	Strategic direction	20	0.6
	Operational capability	20	0.6
	Customer approach	20	0.6
	Economic performance	20	0.6
	Research and development	20	0.6
		TOTAL	100

Leaders for each criterion were identified by adding the composite weight of the different categories. In the same manner, an overall leader between the two toilet systems was also determined by adding the calculated weights of the different categories.

An automated spreadsheet was provided to Laguna Water, so that the weights of the various criteria and categories of the MCA may be adjusted in accordance to the objectives and priorities of the business. In addition, this tool can also help identify which specific parameters have positive and negative influences on a specific portable toilet system.

4.2.2 Financial

Overview

The financial criterion accounts for a large percentage of the MCA as, ultimately, the objective of the PTS is to scale up the PTS into a business solution for sanitation. It measures the viability of the business in terms of expenses and profits. As such, financial criterion is essential in the comparison assessment between the two portable toilet vendors' products.

The financial criterion was assessed using the portable toilet systems' NPV and the households' willingness to pay for the product. The values shown in Table 8 show the different parameters' weights in the evaluation. From hereunto, section weight refers to the percentage within the criterion, whereas, the composite weight refers to the percentage within the total MCA.

Table 8 Financial categories for the multi-criteria analysis (MCA)

Criterion	Category	Parameter	Category weight (%)	Composite weight (%)
Financial	Net present value	Inclusive of CAPEX and OPEX	90	36.00
	Willingness to pay	Percentage of households willing to pay for all services (monthly)	10	1.33
		Highest price willing to pay (monthly toilet and sanitation only)		1.33
		Value perception		1.33

NPV accounts for roughly 36% of the MCA and is, therefore, the parameter with the biggest weight in the whole MCA. It was derived from rollout and waste projections and, subsequently, from CAPEX and OPEX calculations. Willingness to pay, on the other hand, was segregated into smaller categories, which, in total, accounts for 4% of the total MCA.

Rollout projections

Laguna Water supplied the rollout projections to GHD for the calculation of the NPV (Table 2). The rollout projections are the number of portable toilet units that Laguna Water intend to purchase per year in order to calculate the NPV. The projections were based on the number of target customers (Section 3.1)[7]. Projected portable toilet units from 2018-2035 were used to project septage volumes, volume and quantity of the waste containment tanks, and determining the CAPEX and OPEX of the two portable toilet products and systems.

The replacement cycle of each portable toilet was considered in the rollout projections by adding a computed number of purchases per year, depending on the life span of the model. As the prototype toilets were tested for a period of two months, the projected lifespan of the portable toilet was provided by the vendor, and was not verified by Laguna Water nor GHD. The same procedure was done for each respective toilet's cleaning machines (AS and IBS).

As detailed above in Section 3.1, aside from rollout projections, no data was available at the time of the study on the existing and potential BOP Laguna Water customers without proper sanitary toilets inside the home. As such, the size of the target market was estimated by Laguna Water based on data from the following sources and definitions:

- Laguna Water's customer base per barangay
- City Health Office (CHO) data on households without sanitary toilets
- BOP estimates based on Laguna Water customer households that consume less than 10 m^3 of water per month
- It is worth noting that the data from the CHO does not necessarily differentiate households without toilets and households with unsanitary[8] toilets. As such, the numbers given by the CHO may

[7] It should be noted that the rollout projection estimates were made for the purposes of this study, and Laguna Water may choose change the number of units it purchases in the future.
[8] Unsanitary toilets refer to sanitation structures without containment tanks or toilets that are not connected to a sewerage system via pipes.

include households with a toilet structure inside the home, albeit not a sanitary type. In addition, BOP households were defined in the operational model as those in the lowest socio-economic classes, majority of whom are recipients of the national government's 4Ps program. For the computations, however, it was assumed that households in this specific group could be estimated by a water consumption of less than 10 m^3 per month.

Septage volume projections

Septage volume projections were based on the following sources:

- **Literature-based values.** Literature-based values were obtained from the works of Rose, et al. (2015) and Ferreira (2005). The wet volumes of faecal matter, urine and water for flushing were added to get the volume in litres per capita per day and multiplied to the average number of days for collection (3-4 days).
- **Data from the actual run.** Data from the actual run was obtained by averaging waste volumes from barrels (Loowatt) and cartridges (LIXIL) on a per collection basis.

Computing for waste volume on a per collection basis takes into account possible differences between the two toilet systems in terms of water consumption and, possibly, behavioural change in the household. Whereas per capita calculations are dependent on the characteristics of the household and usage of the individual, waste volumes per collection already takes this into account, assuming that averages are obtained from a relatively diverse pool of households with differing characteristics (e.g. size and sex composition) and behaviours. Nonetheless, the study sample size of 30 households is very small and cannot be used to represent the broader population. Laguna Water is advised to account for expected differences in waste volume that are expected during rollout and operation of the PTS in the future.

CAPEX and OPEX

PTS rollout and septage projections were used to calculate the expenditures of the project. The CAPEX and OPEX of the items shown in Table 9 were made on an annual basis from 2018 to 2035.

Table 9 CAPEX and OPEX items

	LIXIL	Loowatt
CAPEX	Portable toilet unit	Portable toilet unit
	Cartridge	Barrel
	Acceptance station (AS)	Industrial bag shredder (IBS)
	Storage facility (inclusive of containment tank and appurtenances)	Storage facility (inclusive of containment tank and appurtenances)
	Land procurement	Land procurement
	Multicab	Multicab
	Vacuum truck	Vacuum truck
OPEX	Water (cleaning and additive dilution)	Water (cleaning and bleach dilution)
	AS (manpower and electricity)	IBS (manpower and electricity)
	Multicab (manpower and fuel)	Multicab (manpower and fuel)
	Vacuum truck (manpower, fuel and waste treatment)	Vacuum truck (manpower, fuel and waste treatment)
	Maintenance expenses (PTS, AS, multicabs and vacuum trucks)	Maintenance expenses (PTS, IBS, multicabs and vacuum trucks)
	Additives	Additives Disposables

A summary on the sources for the values used in the CAPEX and OPEX are shown in Table 10.

Table 10 Sources for CAPEX and OPEX assumptions

Item	Parameter	Source
Portable toilet unit	Cost of portable toilet unit	Vendor financial proposal
	Service life of portable toilet unit	Vendor toilet specifications
	Number of barrels/cartridges per PTS customer	Vendor toilet specifications
AS/IBS	Cost of AS/IBS	Vendor financial proposal
	Service life of AS/IBS	Vendor toilet specifications
	Dimensions of AS/IBS for land requirements	Vendor toilet specifications
	Processing time	Operator log sheets
	Volume of water	Operator log sheets
	Price of water	Operator log sheets
	Amount of electricity required	Vendor toilet specifications
Storage facility	Cost of containment tank	PTS-OBP (2016)
	Cost of electricity	MERALCO electricity rate
Land procurement	Cost of land	BIR database, brokers, recent project pricing
Multicab	Cost of multicab	PTS-OBP
	Stacking capacity of barrels/cartridges	Laguna Water
Vacuum truck	Cost of vacuum truck	PTS-OBP
	Capacity of vacuum truck	Laguna Water
	Cost for waste treatment	Laguna Water
Fuel	Cost of fuel	PTS-OBP
Manpower	Number of personnel	Laguna Water
	Working hours	Laguna Water
	Working days	Laguna Water
	Monthly salary	Laguna Water
Maintenance	Price of maintenance	Laguna Water
Additives/ disposables	Price of additives/ disposables	Vendor financial proposal/ Operators

Key assumptions

Assumptions and values used for the septage projection, CAPEX, and OPEX are shown in Table 11, Table 12, and Table 13, respectively. These were obtained from the various sources discussed in Section 4.2.2.

Table 11 Data and assumptions for septage projections

Item	Parameter	LIXIL	Loowatt
Waste characteristics (literature)	Faecal Wet Weight (Median Value)	128 g/capita/day	128 g/capita/day
	Average density of human faeces	1 g/cm^3	1 g/cm^3
	Faecal Wet Volume (Median Vaue)	0.128 L/capita/day	0.128 L/capita/day
	Urine Wet Weight	1.4 L/capita/day	1.4 L/capita/day
	Water for additive dilution	2.00 L/cartridge	2.00 L/ barrel
	Water for washing	1.00 L/cartridge	1.00 L/ barrel
Toilet users	Number of active toilet users inside the home	3 people	3 people
Waste characteristics (actual)	Waste volume per cartridge or barrel	0.6990 L/cartridge	0.9987 L/barrel
Water needed for cleaning	Water for additive dilution	0.50 L/cartridge	-
	Water for flushing	1.21 L/cartridge	0.30 L/barrel
	Total Water	1.71 L/cartridge	0.30 L/barrel
Additives/ chemicals	Amount of needed additive per cartridge or barrel per desludging	2.42 mL/cartridge	-
	Amount of bleach needed per cartridge or barrel per desludging	-	2.96 mL/barrel
	Amount of oil per run hour	-	3.16 mL/barrel

Table 12 Data and assumptions for computation of CAPEX

Item	Parameter	LIXIL	Loowatt
Portable toilet and cartridge/barrel	Portable toilet	PHP 6,120 (USD 120) per unit	PHP 18,360 (USD 360) USD per unit
	Service life of portable toilet	7 years	8 years
	Cartridge/barrel	PHP 9,180 (USD 180) per unit	PHP 1,530 (USD 30) per unit
	Service Life of cartridge/barrel	3 years	3 years
	Number of cartridge/barrel per portable toilet	1	2
Acceptance station (AS) and industrial bag shredder (IBS)	Cost	PHP 1,530,000 (USD 30,000) per unit of AS	PHP 4,335,000 (USD 85,000) per unit of IBS
	Service life	5 years	10 years
	Processing time	7.49 minutes	3.06 minutes
	Capacity	175 cartridges	502 barrels
Containment tank or storage facility and its appurtenances	Distribution of waste per barangay	Same distribution of PTS among barangays	Same distribution of PTS among barangays
	Procurement date	First year (2018)	First year (2018)
	Allowance	20%	20%

Item	Parameter	LIXIL	Loowatt
	Cost per cubic meter	Based on GHD related projects	Based on GHD related projects
Land cost	Land acquisition	PHP 8,000 (USD 157) /m^2	PHP 8,000 (USD 157)/ m^2
	Distribution of waste per barangay	Same distribution of PTS among barangays	Same distribution of PTS among barangays
	Procurement date	First year (2018)	First year (2018)
	Depth/height of containment tank/storage facility	2 m	2 m
Multicab	Cost of multicab	PHP 850,000 (USD 16,667) per unit	PHP 850,000 (USD 16,667) per unit
	Number of cartridge/barrel than can be carried per trip	22[9]	30
	Number of trips per hour	0.6	0.5
	Working hours per day	8	8
	Number of cartridges/barrel that can be collected per day	106	120
	Number of working days per month	24	24
	Number of cartridges/barrel that can be collected per month	2,534	2,880
	Number of trips needed per household for collection per month	16[10]	8
	Number of households serviced per month per multicab	317	360
Vacuum truck	Cost of one unit of vacuum truck	PHP 4,500,000 (USD 88,235)	PHP 4,500,000 (USD 88,235)
	Volume of waste that can be collected per trip	5 m^3/trip	5 m^3/trip
	Number of trips per hour	0.25	0.25
	Working hours per day	12	12
	Volume of waste that can be collected per day	15 m^3/day	15 m^3/day
	Number of working days per month	24	24

[9] This will require the multicab to be fitted with a shelf as the cartridges cannot be stacked.
[10] Note that LIXIL requires twice the number of multicabs (and corresponding personnel) as the cartridge will have to be returned immediately to the household after cleaning within the day.a

Item	Parameter	LIXIL	Loowatt
	Volume of waste that can be collected per month	360 m^3/month	360 m^3/month

Table 13 Data and assumption for computation of OPEX

Item	Parameter	LIXIL	Loowatt
Water needed for desludging/cleaning PTS cartridges/barrels	Water for additive dilution	0.50 L/cartridge	-
	Water for flushing	1.21 L/cartridge	0.30 L/barrel
	Total water	1.71 L/cartridge	0.30 L/barrel
	Water cost	PHP 24.00 (USD 0.47) per cubic meter	PHP 24.00 (US 0.47) per m^3
Additives	Amount of needed additive per cartridge per desludging	2.42 mL/cartridge	-
	Amount of Bleach needed additive per barrel per desludging	-	2.96 mL/barrel
	Amount of oil per run hour	-	3.16 mL/cartridge or mL/barrel
	Waste volume per cartridge or barrel	0.6990 L/cartridge or L/barrel	0.9987 L/cartridge or L/barrel
Manpower and electricity	Number of personnel per machine	2 personnel	2 personnel
	Working hours	8 hours a day and 6 days a week	8 hours a day and 6 days a week
	Salary	Minimum wage of PHP 363 (USD 7) per day	Minimum wage of PHP 363 (USD 7) per day
	Cost of electricity	PHP 8 (USD 0.17)/kwh	PHP 8 (USD 0.17)/kwh
	Electricity consumption	198 kwh/day	120 kwh/day
Multicab	Number of personnel per multicab	2 personnel	2 personnel
	Working hours	8 hours a day and 6 days a week	8 hours a day and 6 days a week
	Salary	Minimum wage of PHP 363 (USD 7) per day	Minimum wage of PHP 363 (USD 7) per day
	Gas expense	PHP 1,000 (USD 20)/day	PHP 1,000 (USD 20)/day
Vacuum truck	Number of personnel per vacuum truck	2 personnel	2 personnel

Item	Parameter	LIXIL	Loowatt
	Working hours	8 hours a day and 6 days a week	8 hours a day and 6 days a week
	Number of trips per hour	Depends on the volume of projected waste to be obtained from acceptance stations	Depends on the volume of projected waste to be obtained from acceptance stations
	Gas expense	PHP 2,000 (USD 39)/day	PHP 2,000 (USD 39)/day
	Treatment cost	PHP 11 (USD 0.22)/m^3	PHP 11 (USD 0.22)/m^3
Maintenance expenses	Maintenance for PTS	10% of CAPEX	10% of CAPEX
	Maintenance of multicab and truck	5% of CAPEX	5% of CAPEX
Additives and disposables	Cost of additive needed per cartridge per desludging	PHP 20 (USD 0.39)/L	-
	Cost of bleach needed per barrel per desludging	-	PHP 20 (USD 0.39)/L
	Cost of oil per barrel	-	PHP 100 (USD 2)/L
	Disposables	PHP 212.50 (USD 4) /Unit/Month	PHP 380.64 (USD 3)/Unit/Month

Net present value

The financial viability of the two portable toilet systems were compared by computing for the NPV, which takes into account the CAPEX, OPEX and revenue streams evaluated over a period of 15 years (2018-2032). The basic assumptions for NPV computation include the following:

- Project CAPEX will be financed through 70% debt and 30% equity
- Three loans will be taken to cover the capital expenditures in years 2018, 2023 and 2028
- Loan term is for 5 years, with a one-year grace period and amortisation of four years
- Interest rate of 7% per annum
- The cost of equity (COE) is assumed at 15%
- The computed weighted average cost of capital (WACC) is 9.40%
- Corporate tax of 30%
- Depreciation is based on a project life of 5 years
- Average water tariff is PHP 24.43 per m^3, with a tariff escalation at 1% per annum, and a 10% tariff adjustment on 2018 and 2021
- Environmental fee is 20% of the water bill for all Laguna Water customers[11]

[11] Except for BOP customers which are exempted from 2018-2019

- Under Scenario 1 (base case), 15.11% of the environmental fee will be used for the PTS project for Years 1 to 8 (2018-2025), while 55% of the environmental fee will be used for years 9 to 15 (2026-2032) to cover for the higher capital, operations and maintenance costs during this period
- Inflation rate is assumed at the rates shown in Table 14[12]

Table 14 Inflation rates

Year	Inflation rate (%)
2018	4.00
2019	3.80
2020	3.60
2021-2022	3.50
2023-2035	3.30

Willingness to pay

Due to the operational model of the proposed business, it was agreed that the total monthly payment for the household would consist of fees for leasing of the toilet unit, the collection service, monthly water consumption costs and, for households that are not yet connected to Laguna Water, the monthly instalment for the water meter.

Willingness to pay was evaluated through the following parameters:

- **Percentage of households willing to pay for all services.** The design of the operational model aggregates the sanitation service offer to include the portable toilet, its respective collection system, and connection to water. Willingness to pay for the whole service offer, therefore, is important to note, as this is, ultimately, what the household will be paying for, rather than just the toilet itself (unless the household is an existing Laguna Water customer).
- **Price willing to pay for toilet and collection service.** The portable toilet's appeal to the household in the decision to avail of the sanitation service may also be indicated by the price they are willing to pay just for the portable toilet system itself.
- **Price perception.** Equity for the portable toilet and the price households are willing to pay may be influenced by their perception of the value of the toilet.

Data for willingness to pay was gathered during the exit interviews with households and processed only for households that were able to use both portable toilet models during the study. MCA inputs for both the NPV and willingness to pay were computed based on the relative percentage of raw values of one portable toilet compared to the other.

4.2.3 Customer satisfaction

Similar to willingness to pay, customer satisfaction was based on feedback gathered from the households during the exit interviews. Responses that were used for the evaluation of the portable toilet prototypes were filtered to include only households who could give comments on both portable toilet models in the study. The weightings for the different parameters under the customer satisfaction criterion are shown in Table 15.

[12] Provided by Laguna Water

Table 15 Customer satisfaction categories for the multi-criteria analysis (MCA)

Criterion	Category	Parameter	Category weight (%)	Composite weight (%)
Customer satisfaction	Odour	Frequency of bad smells when using the toilet	20	2.00
		Intensity of bad smells when using the toilet		2.00
		Frequency of bad smells after using the toilet		2.00
		Intensity of bad smells after using the toilet		2.00
	Comfort	Sitting position comfort (adult/child, male/female)	20	4.00
		Opening comfort (adult/child, male/female)		4.00
	Ease of use	Ease of understanding instructions	20	2.00
		Ease of directing faeces/urine into the opening without splashback (male/female)		2.00
		Ease of clearing the opening from faeces/urine, i.e., the 'flush' mechanism		2.00
		Ease of barrel/cartridge use		2.00
	Aesthetic	General toilet appearance	15	2.00
		Material appearance judgement		2.00
		Colour appearance judgement		2.00
	Size	Judgement of the toilet size	13	5.20
	Perception of durability	Material degradation estimation	12	2.40
		Technology degradation estimation		2.40

The different category weights were based on findings from Phase 1. It was observed that individuals consider odour, comfort, and ease of use as the main influencing parameters when choosing a toilet of their preference and, although other categories do have an impact, its influence on the individual's choice is relatively less compared to the aforementioned. Laguna Water collaborated in determining the percentage weightings and approved the final weightings per category.

Questionnaires administered during the exit interviews were designed so that personal preferences, judgements and of the households were given numerical equivalents that can be processed and considered in the MCA. A scale of zero to four was provided, with zero being the lowest score reflecting negative feedback and four being the highest score reflecting positive feedback.[13] An example of a question and its corresponding scale is shown in Figure 8.

[13] This component of the MCA is based on subjective data gathered from participants of the pilot study and, due to the small sample size, may not be representative of the wider target market.

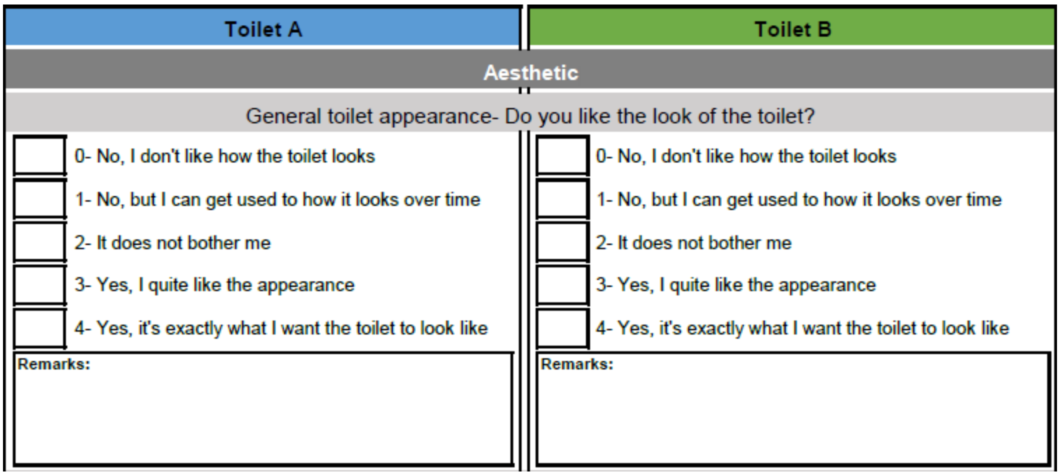

Toilet A	Toilet B
Aesthetic	
General toilet appearance- Do you like the look of the toilet?	
0- No, I don't like how the toilet looks	0- No, I don't like how the toilet looks
1- No, but I can get used to how it looks over time	1- No, but I can get used to how it looks over time
2- It does not bother me	2- It does not bother me
3- Yes, I quite like the appearance	3- Yes, I quite like the appearance
4- Yes, it's exactly what I want the toilet to look like	4- Yes, it's exactly what I want the toilet to look like
Remarks:	Remarks:

Figure 8 Customer satisfaction answer scale

Raw scores were totalled and divided by the full possible score on a per parameter basis to obtain a multiplier that could be used to get the corresponding composite weight.

4.2.4 Environment

Environmental evaluation pertains to the likely environmental impacts of the project. Although the project is expected to have a very positive impact on the environment, certain options have higher environmental risks. A partial life cycle analysis was made to evaluate the two different portable toilet systems, in terms of operations and production to end-of-life. A summary of the parameters considered are listed in Table 16.

Based on the gathered information, each environmental parameter was given weights (Table 16) corresponding to its importance and potential impact to the environment.

In the MCA, environment criterion comprises 10 percent of the total score. This 10 percent was then distributed among the different sections allotting two percent each for water consumption, petrol requirement, energy usage and materials composition. The remaining percentage was broken down to chemical usage and by-products released, each comprising one percent of the score.

Each section was then assigned different parameters with different weights as shown in Table 16. These assigned composite weights serve as perfect score for each of the parameters.

Table 16 Environment categories for the multi-criteria analysis (MCA)

Criterion	Category	Parameter	Unit	Category weight (%)	Composite weight (%)
Environment	Water	Average contents weight of barrel/cartridge	kg	2.0	1.0
		Volume of water required to clean each portable toilet unit	L		1.
	Chemicals	Volume of chemicals used in operations (additives/cleaning agents)	mL	1.0	1.0
	Petrol	Number of barrels/cartridges that can fit in one multicab	Barrels/ cartridges	2.0	1.2
		Average weight of full barrel/cartridge	kg		0.8
	Energy	Energy consumed during the cleaning process	kwh/ day	2.0	1.0
		Cleaning machine run time	min		1.0

Criterion	Category	Parameter	Unit	Category weight (%)	Composite weight (%)
	By-products	Generation of solid by-products (excluding human waste)	---	1.0	1.0
	Materials	Total weight of materials used	kg	2.0	0.5
		Average lifetime of materials	years		0.5
		Percentage of environmentally friendly materials	%		1.0

Based on gathered information, environmental parameters were given weights and were agreed upon with Laguna Water in terms of its perceived importance and potential impact to the environment. It is worth noting that the environmental criterion was especially challenging to assess as the severity of impact of different parameters depends on the local conditions and manner of application, and the complexity of modern manufacturing process, operational requirements and disposal processes available locally. The categories, parameters and weightings were carefully considered by GHD as a way of comparing the two prototype models and approved by Laguna Water for consideration in the MCA.

4.2.5 Health and safety

An evaluation of the health and safety implications of the portable toilet models was done through a risk assessment matrix in accordance with the Australian Standard and New Zealand Standard ISO 31000 developed in 2009 (AS/NZS ISO 31000-2009). Risks and possible consequences were identified and registered through an automated spreadsheet that determined the base risk levels considering a five-level qualitative description of the likelihood and consequence for each risk identified (Table 17). Likelihood, by definition, is a way of expressing knowledge or belief that an event or incident will occur or has occurred (Table 18), whereas, consequence is something that logically or naturally follows from an action or condition (Table 19).

The risk identification exercise was performed to identify potential sources of health risks, areas of impacts, events and their likely causes and potential consequences. Inputs from a workshop conducted on 19 February 2018 with GHD and Laguna Water[14] formed the basis for the identification of risks.

Table 17 Risk assessment matrix

Likelihood	Consequence				
	A- Insignificant	B- Minor	C- Moderate	D- Major	E- Catastrophic
5- Almost certain	Moderate	High	Extreme	Extreme	Extreme
4- Likely	Moderate	Moderate	High	Extreme	Extreme
3- Possible	Low	Moderate	High	High	Extreme
2- Unlikely	Low	Low	Moderate	High	High
1- Very unlikely	Low	Low	Moderate	High	High

Table 18 Likelihood descriptors

Level	Descriptor	Description	Frequency	Probability
5	Almost certain	The event is expected to occur in most circumstances.	Once per week	> 90%
4	Likely	The event would occur on recurrent intervals.	Once per month	51 - 90%
3	Occasional	The event occurs on an irregular basis.	Once per year	21 - 50%

[14] Operators and households did not participate in the risk assessment during the workshop, but their feedback was incorporated.

2	Unlikely	The event would be an uncommon occurrence and would occur in remote circumstances.	Once per 5-10 years	10 - 20%
1	Rare	The event may occur only in exceptional circumstances. The event is not likely to occur in this location.	Once within 10 years	< 10%

Table 19 Consequence descriptors

A Insignificant	B Minor	C Moderate	D Major	E Catastrophic
Low-level short-term inconvenience or symptoms. No measurable physical effects. No medical treatment required.	Reversible disability/impairment and/or medical treatment injuries requiring hospitalisation.	Moderate irreversible disability or impairment (<30%) to one or more persons.	Single fatality and/or severe irreversible disability or impairment (>30%) to one or more persons.	Short or long-term health effects leading to multiple fatalities, or significant irreversible human health effects to >50 persons.

Results from the assessment were validated with actual information on the instances of risk events during the course of the study. Base levels were adjusted accordingly for parameters with actual reported risks. The various parameters identified for the toilet systems are shown in Table 20 and are differentiated between the main groups of people involved in the operational model, namely the customers (households), collection operators, and operators.

Table 20 Health and safety categories for the multi-criteria analysis (MCA)

Criterion	Category	Parameter	Category weight (%)	Composite weight (%)
Health and safety	Customer	Instances and intensity of leaks, overflow and seepage	50	1.17
		Instances and intensity of muscle strains during use, or physical collisions		1.17
		Electric failure of power cord for vent (Loowatt), causing fire		1.17
	Operator	Instances and intensity of leaks and overflow	50	0.44
		Instances and intensity of muscle strains during collection		0.44
		Possibility of collection vehicle being involved in a road accident whilst on-duty		0.44
		Physical contact with waste, or interactions near waste without physical barrier		0.44
		Instances and intensity of muscle strains during cleaning		0.44
		Instances and intensity of skin and nose (scent) irritation, nausea due to scents		0.44
		Machine failure during the cleaning process		0.44
		Electric failure of cleaning machine electronics, causing fire		0.44

The different base risk values determined for each parameter were converted into percentage equivalents, which, in turn, served as multipliers used in obtaining a corresponding composite index (Table 21).

Table 21 Base risk levels equivalent

Base risk level	Percentage equivalent (%)	Multiplier
Low	100	1.00
Moderate	75	0.75
High	50	0.50
Extreme	25	0.25

4.2.6 Capability to scale

The vendors' capability to scale was measured through the parameters presented in Table 22. A Google Forms questionnaire was designed by GHD and sent to members of the Laguna Water team who had direct transactions and interactions with the vendors.

Table 22 Capability to scale categories for the MCA

Criterion	Category	Parameter	Category weight (%)	Composite weight (%)
Capability to scale	Strategic direction	Management approach, business structure, corporate strategy, and corporate governance	20	0.60
	Operational capability	Product quality, human resources, admin systems, logistical capability, information technology	20	0.60
	Customer approach	Key customers, market position, customer relations, commercial approach, external relations	20	0.60
	Economic performance	Profit level, profit centres, financial structure, risk exposure, cash flow	20	0.60
	Research and development	Core competency, research capability, process scale-up, project management, intellectual property	20	0.60

The categories for the capability to scale criterion were assigned equal weights. Specific questions for each parameter were answered through a scale of one to five, one being the lowest and five being the highest. A sample question and its corresponding scale of answers is shown in Figure 9. In a manner similar to that of customer satisfaction, raw scores were summed up and divided by the full possible score based on a per parameter basis to get a multiplier used in calculating the composite weight.

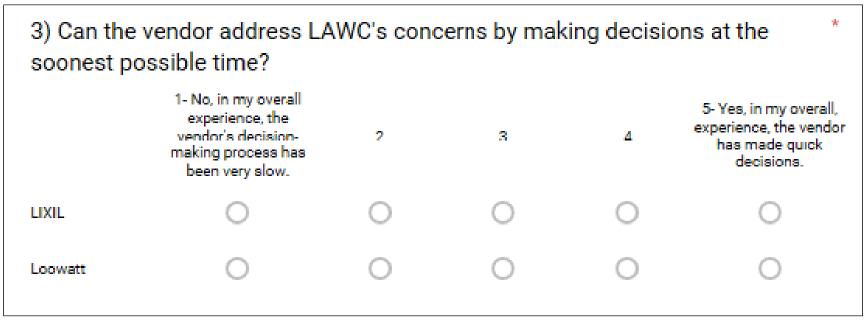


Figure 9 Vendor evaluation answer scale

4.2.7 Formulas

Calculations for each criterion of the MCA are presented in Table 23. Variables obtained from continuous numerical values (financial and environment) were calculated by the relative percentage of values of one toilet model compared to the other. On the other hand, variables obtained from discrete numerical values (customer satisfaction and capability to scale) were computed by the summation of raw scores and its division to the highest possible score to obtain a multiplier. In addition, ordinal data, such as that for health and safety, were converted into numerical values, which, in turn, serves as multipliers as well.

Table 23 Formulas used for MCA calculations

Criterion	Assumption	Sample calculations	Variables
Financial (40%)	Higher NPV and willingness to pay gets full composite weight. Lower NPV and WTP score based on relative percentage of values to higher NPV and WTP.	For toilet with lower actual values: $CCW = 1 - \frac{AV_H - AV_L}{AV_H}$	CCW= Calculated composite weight AV_H= Actual value of higher toilet AV_l= Actual value of lower toilet
Customer satisfaction (40%)	Higher score does not necessarily correspond to full composite weight. Comparison against highest possible score on a per parameter basis.	$CCW = \frac{TRS}{FPS} \cdot FCW$	CW= Calculated composite weight TRS= Total raw score FPS= Full possible score FCW= Full composite weight
Environment (10%)	Toilet that consumes fewer/better resources gets full composite weight. Score of toilet that consumes more resources/ based on relative percentage of values to higher NPV and WTP.	For toilet that consumes more resources: $CCW = 1 - \frac{AV_M - AV_F}{AV_M}$	CCW= Calculated composite weight AV_M= Actual value of toilet that consumes more resources AV_F= Actual value of toilet that consumes fewer resources
Health and Safety (7%)	Percentage equivalent of base risk levels used as multiplier to full composite weight.	$CCW = PE \cdot FCW$	CCW= Calculated Composite Weight PE= Percentage equivalent of base risk level FCW= Full composite weight

Criterion	Assumption	Sample calculations	Variables
Capability to scale (3%)	Higher score does not necessarily correspond to full composite weight. Comparison against highest possible score on a per parameter basis.	$CCW = \frac{TRS}{FPS} \cdot FCW$	CW= Calculated Composite Weight TRS= Total Raw Score FPS= Full Possible Score FCW= Full Composite Weight

5. Findings

5.1 Participant households

Thirty-three (33) households were able to use the toilet throughout the duration of Phase II of the pilot study, 26 of which were able to use the prototypes from both toilet vendors. The remaining seven participants either pulled out from the study or were able to use only one toilet model. Households, accounting for 156 people in total, were distributed in Barangays Macabling (16), Pooc (11), and Don Jose (6).

Demographic surveys show that that these households have an average family size of five members and a total monthly income of PHP 13,580.30 (USD 453). This corresponds to a monthly budget of PHP 2,809.43 (USD 55) per person, which is above the 2015 poverty threshold of PHP 1,812.80 (USD 36) per person per month. Despite this, it is worth noting that among the 33 participant households, seven were still below the poverty line, six of which live in Pooc and Macabling, and one living in Don Jose (Figure 10).

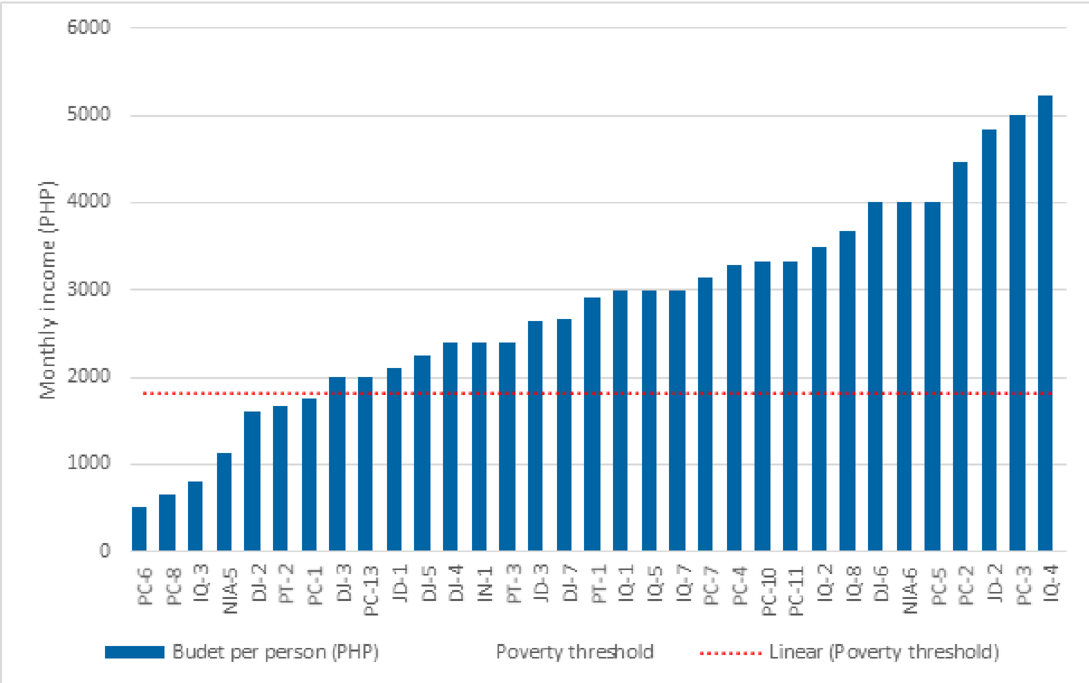


Figure 10 Household monthly income

Majority of households had one to two income earners, most of whom finished either elementary or high school education. Income earners were involved in construction, domestic work, manufacturing, transport, security, and a variety of other livelihoods, including managing micro enterprises (Figure 11). In addition, a relatively large percentage of the total population of participant households were students (24%) and housewives (22%).

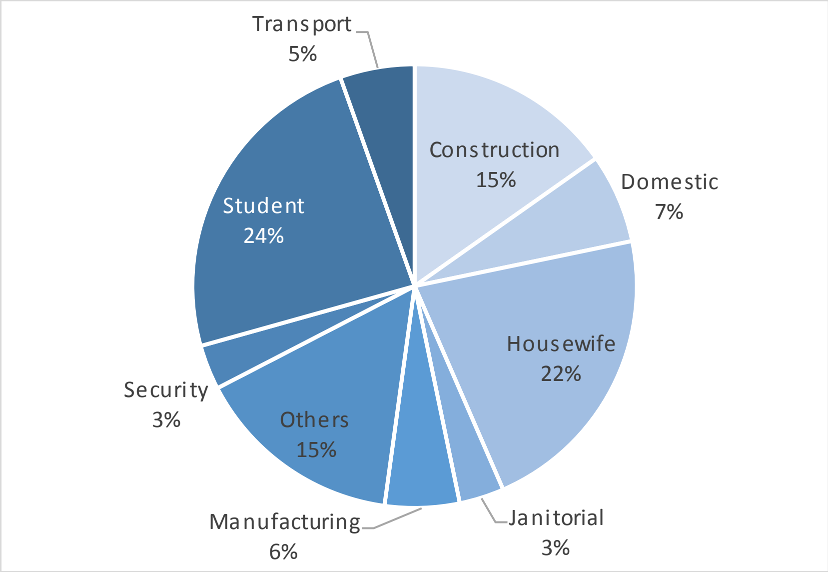


Figure 11 Occupation

There was a relatively high dependence ratio, as 45% of the total people from participant households were aged 14 and below. In terms of sex, it was observed that there were more males in the younger age groups (14 and below) and more females in the older age groups (15 and above). Most households had adults in their twenties to thirties, and children aged 10 and below. There were also some cases where the household had three generations living inside the home with grandparents in their fifties to sixties, parents in their twenties to thirties, and children aged ten and below (Figure 12). In addition, a number of households (6 out of 33) also have a family member with a permanent disability or lifetime illness such as Down syndrome, polio, thyroid inflation, cleft palate, leukaemia and neurodevelopmental disorders.

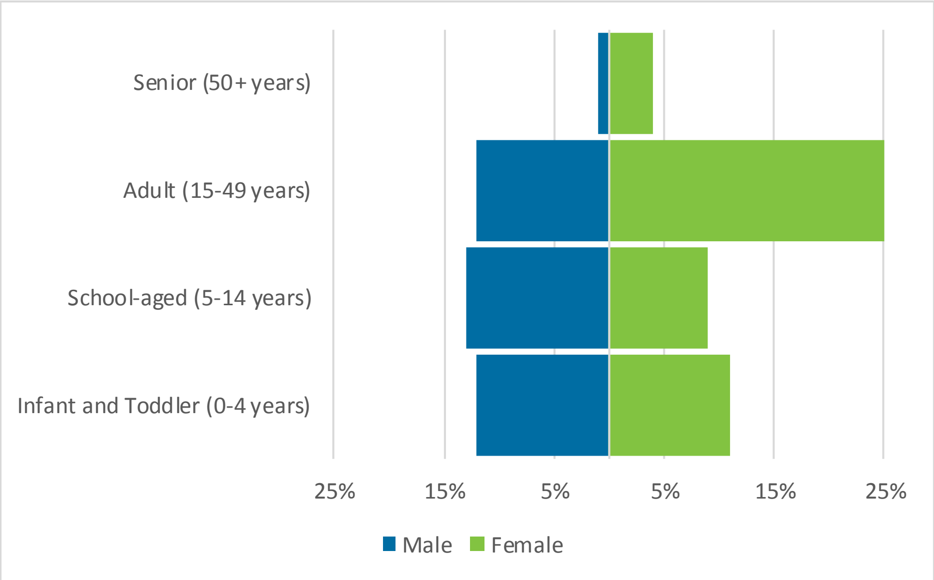


Figure 12 Sex and age demographic

Houses were typically made out of galvanised iron sheets for roofing, walls were made from wood or salvaged materials, and concrete or linoleum used for flooring (Figure 13). Due to the materials used to build the structure, houses in the area are generally alterable by nature. Detachable walls and appurtenances make it relatively easy to reformat and rearrange the structure, furniture and dimensions of the house, especially if there is available space adjacent to the structure. Structures were usually owned and built by the family on land owned by either the government (18%) or an unknown private entity (48%). More than half (54%) of participant families have stayed in the same barangay and/or house structure for more than 10 years. The area occupied by each house was typically very small, with an average floor area of 20-25 sq. m, encompassing one to two rooms with improvised walls (e.g. cloth, pieces of wood) that serve as temporary dividers between the activities being conducted in the room.

Figure 13 Typical house structure

As for electrification, all households that participated in the study had access to power. Almost all households (32 out of 33) also had at least one mobile phone inside the home, albeit there were a number of cases where the gadget was lost or non-functional during the study.

As for previous toileting practices prior to the introduction of the PTS, majority of the people belonging to the interviewed households used the chamber pot (36%) and the neighbour's toilet (23%) for micturating, and the neighbour's toilet (47%) and the chamber pot (19%) for defecating (Figure 14).

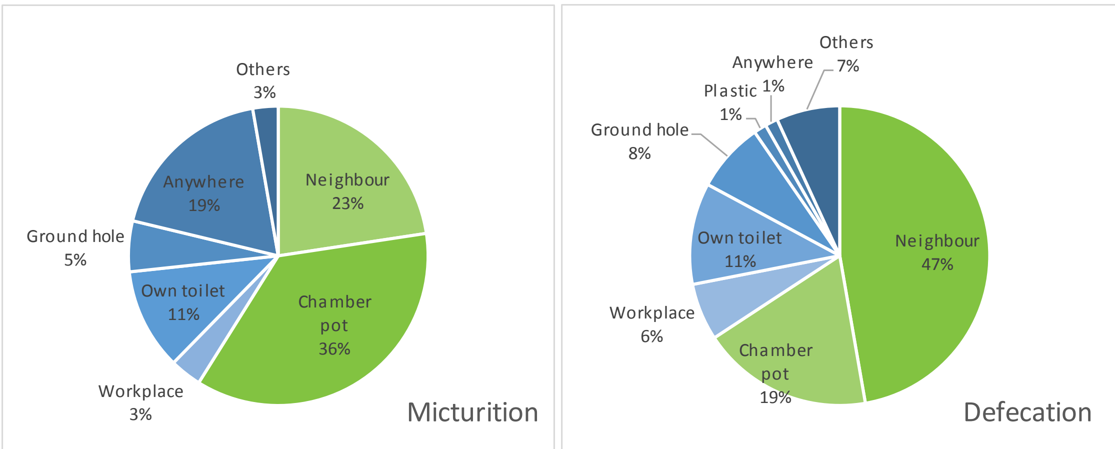


Figure 14 Toileting practice prior to PTS

5.2 Baseline water quality assessment

The quality of nearby surface waters were assessed against the DAO 2016-08 Water Quality Guideline and Effluent Standards for Class D based on the following parameters analysed: biological oxygen demand (BOD), chemical oxygen demand (COD), colour, oil and grease, pH, total suspended solids (TSS) and total coliform.

5.2.1 Biological oxygen demand

All BOD values were above the maximum limit (15 mg/L) of DAO 2016-08 WQG (Figure 15) with the highest BOD level (230 mg/L) recorded at NIA 1 and NIA 3 during Phase I. The lowest BOD level (16 mg/L) meanwhile was obtained at Iraq 8 and Jordan 20 during Phase I and Phase II, respectively.

High levels of BOD may be attributed to high amount of oxygen depleting organic wastes in the body of water. This could include domestic waste and direct discharge of organic matter such as food and excrement into nearby waters. High levels of BOD can deplete oxygen in receiving waters, causing death to aquatic organisms and consequently, adverse ecosystem changes.

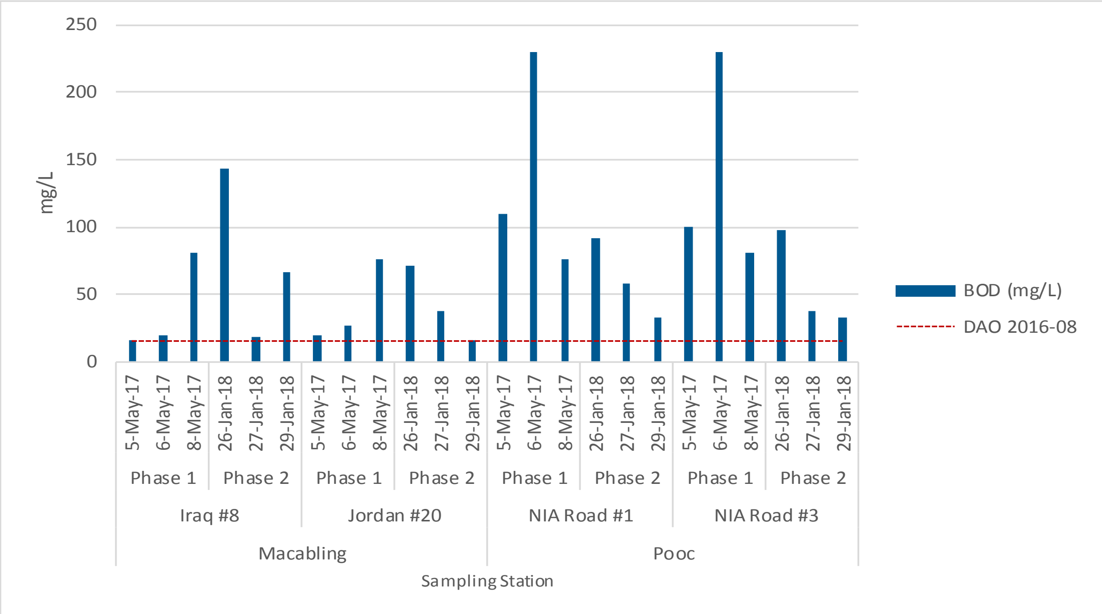


Figure 15 Biological oxygen demand results

5.2.2 Chemical oxygen demand

COD is both an inorganic and organic water pollutant. Inorganic sources include domestic chemicals such as used oil, paint, soap and other petroleum-based cosmetic products. Organic sources also include excrement from both human and animals. High levels of COD can also deplete oxygen in the receiving waters.

In the absence of COD limits in the DAO 2016-08 WQG, results were compared against the DAO 2016-08 the General Effluent Standards (GES) for Class D waters. All COD levels were within the DAO 2016-08 GES (200 mg/L) apart from three sampling events exceeding the limit during Phase I only (Figure 16). The highest exceedance was detected at NIA 3 (480 mg/L), followed by NIA 1 (350 mg/L) and then NIA 3 (230 mg/L). The rest of the samples within criteria ranged between 20 and 177 mg/L with the lowest COD level (20 mg/L) was recorded at IQ 8 twice during Phase I and once during Phase II.

COD levels in Barangay Pooc sites are relatively higher than in Barangay Macabling. This may be related to the significantly higher population density in Barangay Pooc, which means a greater potential for more oxygen-depleting chemicals to be present brought about by anthropogenic sources. Moreover, Pooc is also situated downstream relative to Macabling.

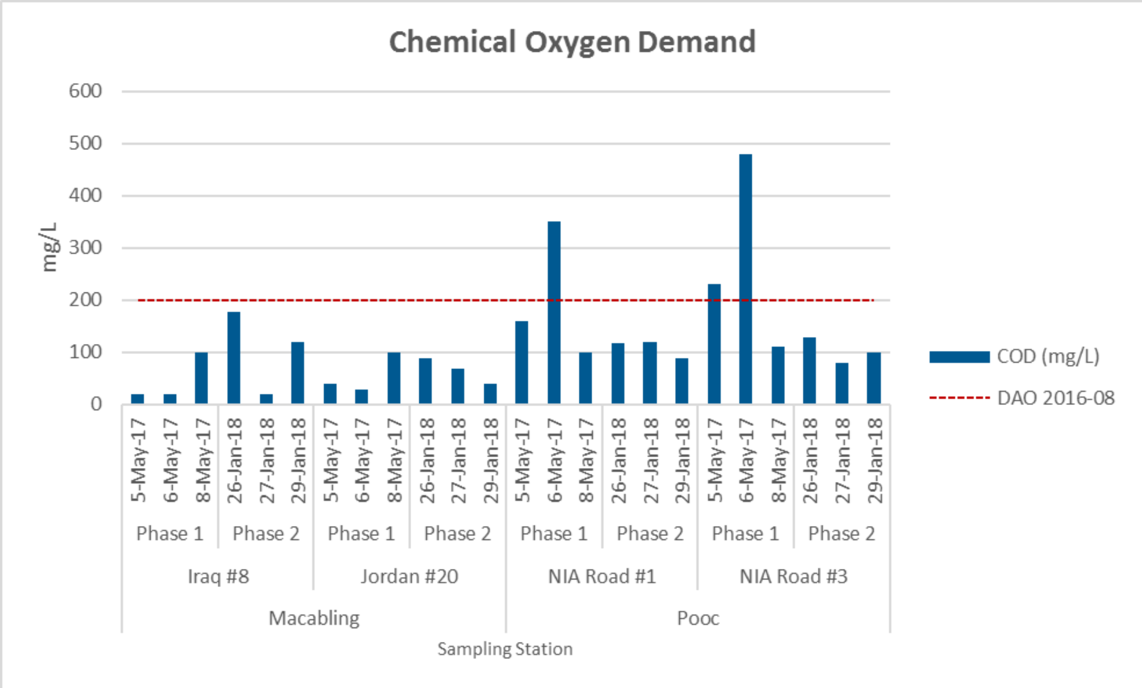


Figure 16 Chemical oxygen demand results

5.2.3 Color

Color is mainly due to the presence of dissolved organic matter in water bodies. Color in surface waters may be affected via waste discharges, such as dyeing operations in the textile industry, paper manufacturing, etc. The measure of true color is the colour after particulate matter has been filtered in the sample.

Total color unit (TCU) of water samples in the area were all within the DAO 2016-08 limit (150 TCU). The highest color was observed at NIA 3 (100 TCU), closely followed by NIA 1 (91 TCU) in January 2018 during Phase II (Figure 17). The high color may be attributed to the presence of dissolved organic matter in the sample, which is also consistent with the high BOD levels recorded. The lowest (5.0 TCU) was observed twice during Phase I at Iraq 8 and once during Phase II sampling at Jordan 20.

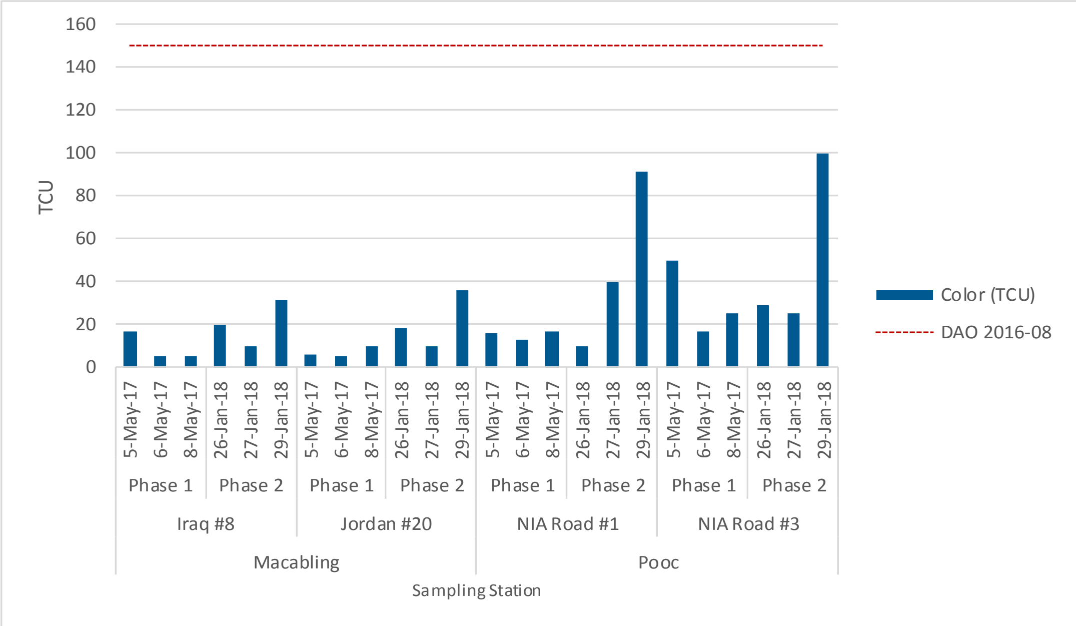


Figure 17 Total colour results

5.2.4 Oil and grease

Oil and grease levels were within the DAO 2016-08 limit (5 mg/L) apart from Iraq 8 and NIA 3, which exceeded the criteria with 16 mg/L (26 January 2018) and 8.2 mg/L (29 January 2018), respectively (Figure 18). The rest of the sites across sampling periods ranged from <0.5 to 5 mg/L.

Detected levels of oil and grease observed across most stations may be attributable to anthropogenic sources, such as improper disposal of cooking oil, animal-derived fats, motor oil, lubricating oil and the like. Oil and grease is insoluble in water and may impede reproduction and survival of aquatic organisms.

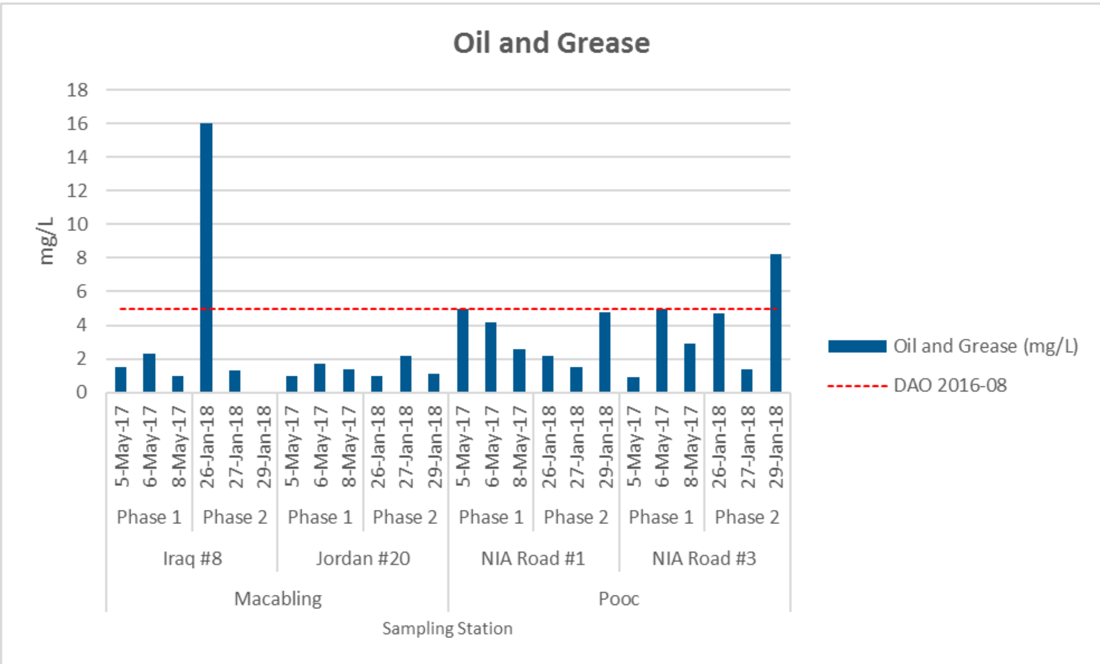


Figure 18 Oil and grease results

5.2.5 pH

Water samples across all sites were within the prescribed pH range (6.0 to 9.0) of DAO 2016-08 WQG (Figure 19) during Phase I and II. The lowest (6.73) and the highest (8.9) pH values were recorded at Iraq

8 during the Phase I and Phase II sampling, respectively. An abrupt variation in pH levels was observed at Iraq 8 over the 3-day sampling period increasing from 7.4 to 8.9 then decreasing to 7.1 between the 5th and 8th of May. The fluctuation in pH levels in waters may be due to several factors, which may include changes temperature, presence of carbon dioxide, dissolved minerals and/or chemicals. Despite the change in pH conditions, levels were within criteria.

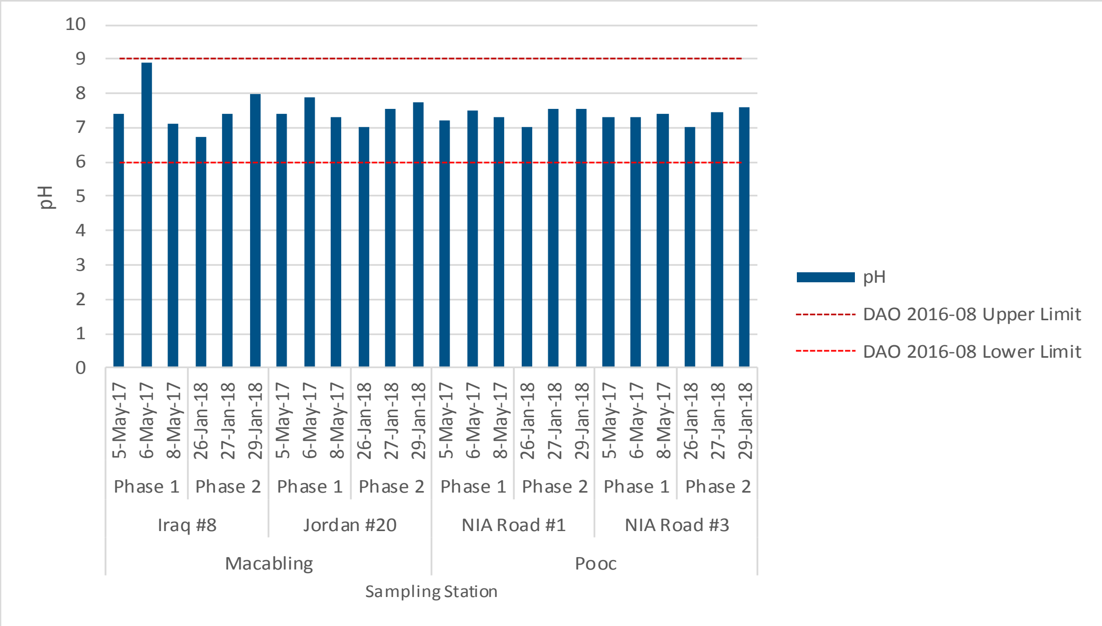


Figure 19 pH level results

5.2.6 Total suspended solids

Levels of TSS were within the DAO 2016-08 quality guideline (110 mg/L) apart from three sampling events exceeding the limit during Phase I only (Figure 20). The highest exceedance was detected at NIA 3 (140 mg/L), followed by NIA 1 (120 mg/L) and then Jordan 20 (115 mg/L). The rest of the sites had TSS levels ranging from 7 to 87 mg/L.

Suspended solids in a body of water are often due to natural causes. These natural solids include organic materials such as algae, and inorganic materials such as silt and sediment. However, excess TSS are often attributed to human influence such as construction debris, wastewater effluent, sewage and airborne particulates. Excessive TSS can impair water quality for aquatic and human life and increase flooding risks.

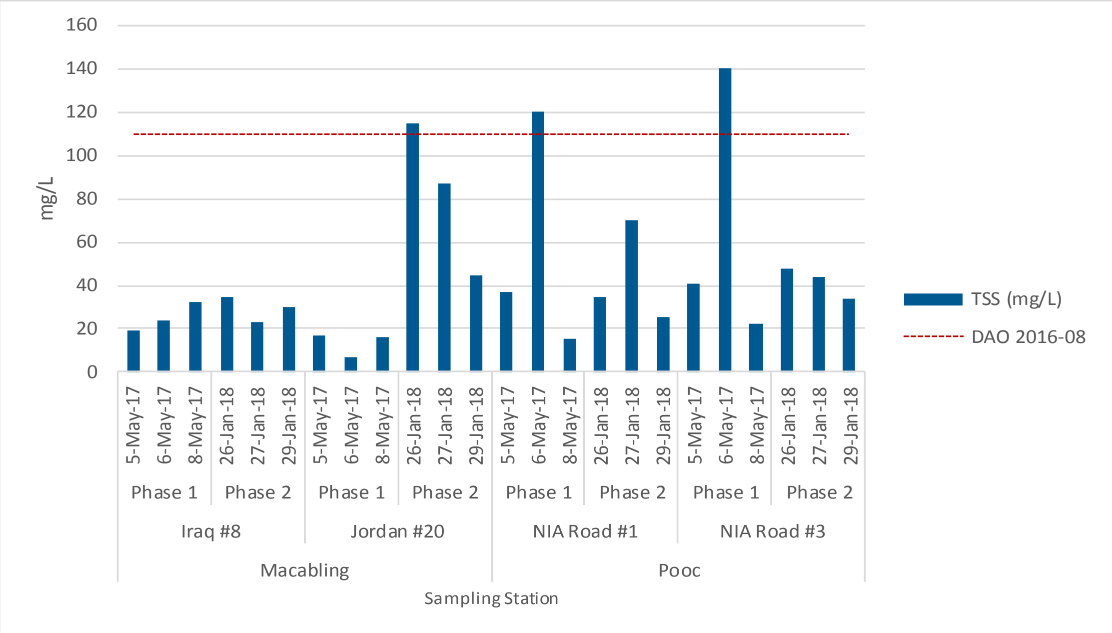


Figure 20 Total suspended solids results

5.2.7 Total coliform

All total coliform values from all four sampling sites were above the maximum limit (15,000 MPN/100mL) set by DAO 2016-08 guideline (Figure 21). The highest value (130 Million MPN/100mL) and the lowest value (1.3 Million MPN/100mL) was recorded at Jordan 20 during Phase I sampling. The lowest value was nevertheless 86 times that of the maximum daily limit.

High level of total coliform can be attributed to natural or anthropogenic sources. Natural sources include decomposing plants and contaminated soil that could have been washed by the rain into the receiving water. Anthropogenic sources include animal and human wastes. Existence of unsanitary toilet and improper disposal of human excrements in the area could have contributed to the significantly high level of total coliform.

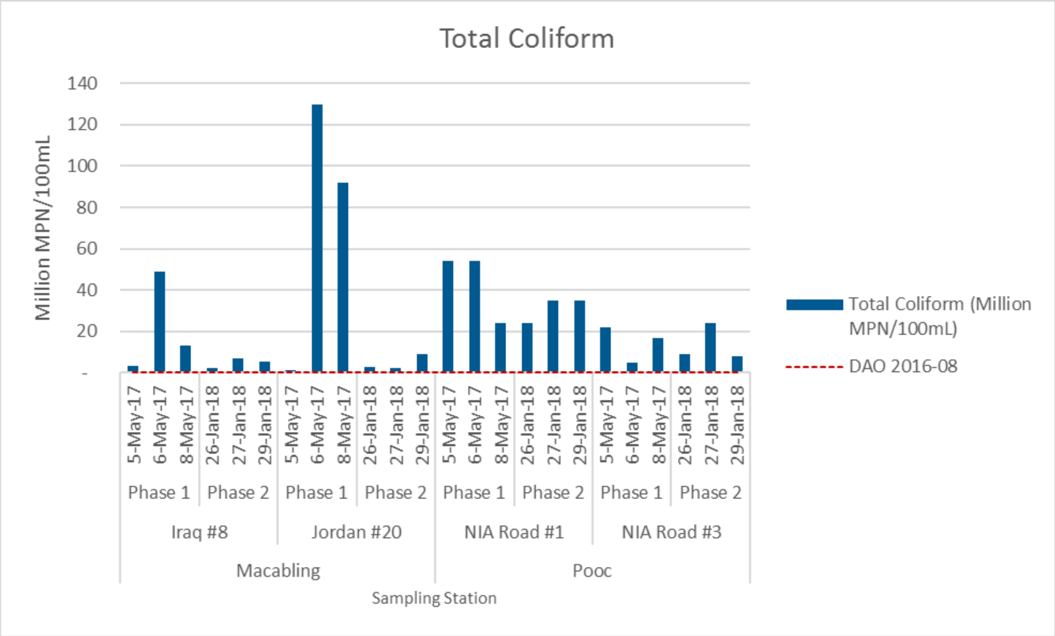


Figure 21 Total coliform results

5.2.8 Water quality averages

Results over the 3-day sampling were averaged for both phases and are presented in Table 23. Chemical oxygen demand (COD), colour, oil and grease, pH, and total suspended solids (TSS) parameters across all stations were within the maximum limits of DAO 2016-08 for Class D type of water body. However, values for biological oxygen demand (BOD) and total coliform were above the prescribed limits in all sites. High levels of BOD may be attributed to the high amounts of oxygen depleting organic wastes in the water body. High counts of total coliform may be attributed to natural sources (e.g. soil bacteria) and/or animal and human wastes.

NIA 1 had the highest BOD average (99.83 mg/L) while NIA 3 had the highest values for COD (187.67 mg/L), colour (51.33 TCU), and TSS (54.83 mg/L). Meanwhile, water samples taken from Iraq 8 had the highest pH (7.59), and oil and grease (4.42 mg/L) while Jordan 20 had the highest total coliform (39.6 Million MPN/100mL). Values were higher on several parameters in Barangay Pooc (NIA 1 and NIA 3) than in Barangay Macabling (Iraq 8 and Jordan 20). This may be, in part, due to the higher population density in Barangay Pooc, resulting in more potential wastewater discharges from households into nearby water bodies. Moreover, Pooc is also situated downstream relative to Macabling.

Phase I values were considerably lower than that of Phase II values at Barangay Macabling for BOD, COD, color, oil and grease and TSS. It is worth noting that there was a higher amount of rainfall during Phase I sampling days. Rainfall can be a factor of variation in surface-water quality and may influence color and TSS levels.

Table 24 Baseline water quality averages at the four sampling stations (Phase I and II)

Barangay	Sampling station	BOD (mg/L)	COD (mg/L)	Color (TCU)	Oil and grease (mg/L)	pH	TSS (mg/L)	Total coliform (MPN/100mL)
Macabling	**Iraq #8 (IQ-8)**	**57.17**	**75.83**	**14.67**	**4.42**	**7.59**	**27.17**	**13,350,000**
	Phase 1	38.67	46.33	9.00	1.60	7.80	25.00	21,766,667
	Phase 2	75.67	105.33	20.33	8.65	7.37	29.33	4,933,333
	Jordan #20 (JD-20)	**41.17**	**60.83**	**14.17**	**1.40**	**7.48**	**47.83**	**39,616,667**
	Phase 1	40.67	55.67	7.00	1.37	7.53	13.33	74,433,333
	Phase 2	41.67	66.00	21.33	1.43	7.43	82.33	4,800,000
Pooc	**NIA 1**	**99.83**	**155.83**	**31.17**	**3.38**	**7.34**	**50.33**	**37,666,667**
	Phase 1	138.67	203.00	15.33	3.93	7.33	57.33	44,000,000
	Phase 2	61.00	108.67	47.00	2.83	7.35	43.33	31,333,333
	NIA 3	**96.67**	**187.67**	**41.00**	**3.85**	**7.35**	**54.83**	**14,166,667**
	Phase 1	137.00	273.33	30.67	2.93	7.33	67.67	14,633,333
	Phase 2	56.33	102.00	51.33	4.77	7.36	42.00	13,700,000
DAO 2016-08 (Class D)		**15**	**200***	**150**	**5**	**6.0 - 9.0**	**110**	**15,000**

* DAO 2016-08 Effluent Standard

Barangay	BOD (mg/L)	COD (mg/L)	Color (TCU)	Oil and grease (mg/L)	pH	TSS (mg/L)	Total coliform (MPN/100mL)
Macabling	49.17	68.33	14.42	2.77	7.53	37.50	26,483,333
Pooc	98.25	171.75	36.08	3.62	7.34	52.58	25,916,667

5.3 Financial

5.3.1 Roll out projections

Laguna Water provided rollout projections that show an increase in portable toilet unit purchases from an initial 100 units in 2018 to a total of 10,300 units by 2035 (Table 25).

Table 25 PTS purchase projection by Laguna Water

Year	Accumulated coverage	Yearly addition
2018	100	100
2019	300	200
2020	550	250
2021	850	300
2022	1,200	350
2023	1,600	400
2024	2,050	450
2025	2,550	500
2026	3,100	550
2027	3,700	600
2028	4,350	650
2029	5,050	700
2030	5,800	750
2031	6,600	800
2032	7,450	850
2033	8,350	900
2034	9,300	950
2035	10,300	1000

5.3.2 Septage volume projections and containment tanks

Septage volume projections based on secondary literature and actual study data are shown in Appendix O and Table 25. Water used for cleaning and desludging was considered as part of the septage volume as it will still be disposed in the containment tanks and, ultimately, in the treatment plant. The values obtained were added and then multiplied to the PTS rollout projection. Differences between the actual septage data of the two portable toilet models can be attributed to the difference in waste volume and the applicability of certain parameters to only one specific vendors' model.

Table 26 Septage projection based on literature and actual data in m^3/month

Year	Literature			LIXIL			Loowatt		
	Faeces + urine (L)	Water (L)	Total (L)	Waste (L)	Desludging water (L)	Total (L)	Waste (L)	Water + additives (L)	Total (L)
2018	9	2	11.6	6	1	7.7	9	0	9.2
2019	28	7	34.8	19	4	23.0	27	1	27.7
2020	51	13	63.9	35	8	42.1	49	1	50.8
2021	78	20	98.7	53	12	65.1	76	2	78.5
2022	111	29	139.4	75	16	91.9	108	3	110.8
2023	147	38	185.8	101	22	122.6	144	4	147.7
2024	189	49	238.1	129	28	157.0	184	5	189.2
2025	235	61	296.2	160	35	195.3	229	6	235.4
2026	286	74	360.0	195	42	237.4	279	8	286.2
2027	341	89	429.7	233	51	283.4	333	9	341.5
2028	401	104	505.2	274	60	333.2	391	11	401.6
2029	465	121	586.5	318	69	386.8	454	12	466.2
2030	534	139	673.6	365	79	444.2	521	14	535.4
2031	608	158	766.5	415	90	505.5	593	16	609.2
2032	686	179	865.2	469	102	570.6	670	18	687.7
2033	769	200	969.8	525	114	639.6	751	20	770.8
2034	857	223	1,080.1	585	127	712.3	836	23	858.5
2035	949	247	1,196.2	648	141	788.9	926	25	950.8

5.3.3 CAPEX

The yearly CAPEX was computed based on the data and assumptions provided in Table 27 and Table 29. It is the sum of annual expenses based on the cost for the portable toilet, cartridge, AS/IBS, storage facility, land acquisition, multicab and vacuum truck (Appendix P).

The CAPEX for the portable toilet was rolled out in replacement cycles dependent on the service life of the item. For example, the 100 portable toilets from LIXIL purchased in year 2018 should be replaced in years 2025 and 2032, given its seven-year service life. Although there are more toilets to be purchased for LIXIL due to its shorter lifespan, the yearly expense for Loowatt is greater because its toilet cost per unit is more expensive. The yearly CAPEX of the cartridge for LIXIL and the barrel for Loowatt were also calculated in the same manner. One cartridge and two barrels are to be purchased for LIXIL and Loowatt, respectively, depending on the proposed system by the vendors. By the end of year 2035, it was calculated that a total of 28,050 cartridges would need to be purchased from LIXIL and 56,100 barrels would need to be purchased from Loowatt.

Annual contribution to the CAPEX from AS and IBS machines are computed by obtaining the number of AS and IBS to be purchased per year and multiplying it to the unit cost of PHP 1.53 million (USD 30,000) for the AS and PHP 4.34 million (USD 85,000) for the IBS. The number of AS and IBS machines to be purchased is dependent on the number of portable toilet units purchased yearly and the number of cartridge and barrels that each AS and IBS can accommodate, respectively. The data obtained from pilot testing showed that the IBS takes an average of 3.06 minutes to process and clean a barrel, and the AS takes an average of 7.49 minutes to process and clean a cartridge. The replacement of the AS and IBS is continuous given its service life of 5 years and 10 years, respectively.

Aside from the AS and IBS machines, capital budget is allotted for containment tanks to temporarily hold septage and a storage facility to temporarily store barrels or cartridges. The volume capacity of the containment tank and storage facility needed for each barangay was obtained by adding a 20 percent allowance on the total volume of projected wastes from 2018 to 2035. This volume capacity was multiplied with the cost per cubic meter of the containment tank that was obtained from the OBP. The cost estimates include preliminaries, containment tank, station house and fencing costs. Preliminaries include site set-up, mobilization, and health and safety equipment. Fifteen percent (15%) of the containment tank cost is assumed to represent the cost of preliminary works.

In addition, land acquisition costs budgeted in the CAPEX of both portable toilet systems was computed based on the volume of the containment tank and size of the storage facility. The volume is divided by the assumed depth of 2 meters to get the land area. The values are then rounded up to 100 square meters, given that the minimum land area to be acquired by Laguna Water is 100 square meters. The total land area is multiplied with the average land cost in the Laguna area (PHP 8,000 (USD 157) per square meter) to get the land cost CAPEX for both LIXIL and Loowatt. All land procurement is set on the first year of roll out (2018).

CAPEX on the purchase of multicabs are computed by multiplying the required number of additional multicabs to the unit cost of multicab (PHP 850,000= USD 16,667). The number of multicabs needed depends on the number of households that can be serviced considering the collection and returning of cartridges/barrels to respective households. Households use one cartridge for LIXIL and two barrels for Loowatt. While one of the two barrels for Loowatt can be used by the household while the other is being collected for hauling and cleaning, the single cartridge for LIXIL will have to be returned to the household within the same day.[15] The cycle continues during the duration of the project.

[15] As the LIXIL toilet needs to be returned within the same day, one multicab is assigned for collecting the cartridge, while another is assigned to return the cartridge to minimise waiting time while the cartridge is being cleaned. This entails a higher CAPEX for the number of multicabs needed to bring the cartridge back and forth to the household.

Given these conditions, one multicab is enough to carry the operations for the 100 cartridges and barrels to be collected for 2018. Additional multicabs are to be purchased once the capacity is maximized based on the assumptions given in Table 12. The number of multicabs for 2035 will reach 66 multicabs for LIXIL and 29 multicabs for Loowatt.

Aside from the multicabs, the number of vacuum trucks purchased to transfer septage from containment tanks to the sewage treatment plant was computed. The proposed vacuum truck can hold up to five cubic meters of septage and is calculated to undertake 72 trips per month, which is equivalent to 360 m^3 of septage per month. Given this capacity and the projected waste for LIXIL (7.7 m^3 per month) and Loowatt (9.2 m^3 per month), only one vacuum truck is required for 2018. Additional vacuum trucks are needed as the number of portable toilet units increases. In total, there are three vacuum trucks needed for LIXIL that will be purchased on 2018, 2029 and 2035. Although Loowatt requires the same number of vacuum trucks, the items will have to be purchased on different years (2018, 2028 and 2033). The CAPEX on the vacuum truck is accounted for in the year that it is purchased and multiplied by the unit cost of PHP 4.5 million (USD 88,235) per vacuum truck.

Table 27 to Table 30 summarizes the yearly CAPEX for LIXIL and Loowatt. The bulk of the first year's CAPEX is spent on the construction of containment tanks, storage facilities, and the acquisition of land. This is on top of the other initial investments needed to run the operation. It is worth noting that the first year CAPEX for Loowatt was higher than LIXIL's due to the higher cost of the IBS (PHP 4.34 million= USD 85,098) compared to the AS (PHP 1.53 million= USD 30,000). In the long run, however, the CAPEX for Loowatt is smaller than LIXIL's because the processing capacity of the IBS (number of cartridges/barrels it can clean) is higher than the AS. Subsequently, the bulk of the CAPEX in the succeeding years for Loowatt is influenced by the purchase of the portable toilet units (PHP 18, 360= USD 360 per toilet), whereas the bulk of LIXIL's CAPEX is determined by the number of cartridges (PHP 9,180= USD 180 per cartrdige).

The total CAPEX required for LIXIL (PHP 619,682,849= USD 12,150,644) is higher than the total required CAPEX for Loowatt (PHP 532,157,449= USD 10,434,460).

Table 27 CAPEX for LIXIL (PHP)

Year	Portable toilet (PHP)	Cartridge (PHP)	AS (PHP)	Containment tank and storage facility(PHP)	Land (PHP)	Multicab (PHP)	Vacuum truck (PHP)	Total (PHP)
2018	612,000.00	918,000.00	1,530,000.00	11,163,849.02	15,200,000.00	850,000.00	4,500,000.00	34,773,849.02
2019	1,224,000.00	1,836,000.00	1,530,000.00	-	-	850,000.00	-	5,440,000.00
2020	1,530,000.00	2,295,000.00	3,060,000.00	-	-	1,700,000.00	-	8,585,000.00
2021	1,836,000.00	3,672,000.00	1,530,000.00	-	-	1,700,000.00	-	8,738,000.00
2022	2,142,000.00	5,049,000.00	3,060,000.00	-	-	1,700,000.00	-	11,951,000.00
2023	2,448,000.00	5,967,000.00	6,120,000.00	-	-	2,550,000.00	-	17,085,000.00
2024	2,754,000.00	7,803,000.00	4,590,000.00	-	-	1,700,000.00	-	16,847,000.00
2025	3,672,000.00	9,639,000.00	7,650,000.00	-	-	3,400,000.00	-	24,361,000.00
2026	4,590,000.00	11,016,000.00	6,120,000.00	-	-	2,550,000.00	-	24,276,000.00
2027	5,202,000.00	13,311,000.00	9,180,000.00	-	-	3,400,000.00	-	31,093,000.00
2028	5,814,000.00	15,606,000.00	10,710,000.00	-	-	3,400,000.00	-	35,530,000.00
2029	6,426,000.00	17,442,000.00	10,710,000.00	-	-	3,400,000.00	4,500,000.00	42,478,000.00
2030	7,038,000.00	20,196,000.00	15,300,000.00	-	-	4,250,000.00	-	46,784,000.00
2031	7,650,000.00	22,950,000.00	12,240,000.00	-	-	4,250,000.00	-	47,090,000.00
2032	8,874,000.00	25,245,000.00	16,830,000.00	-	-	5,100,000.00	-	56,049,000.00
2033	10,098,000.00	28,458,000.00	18,360,000.00	-	-	4,250,000.00	-	61,166,000.00
2034	11,016,000.00	31,671,000.00	19,890,000.00	-	-	5,100,000.00	-	67,677,000.00
2035	11,934,000.00	34,425,000.00	22,950,000.00	-	-	5,950,000.00	4,500,000.00	79,759,000.00
Total	94,860,000.00	257,499,000.00	171,360,000.00	11,163,849.02	15,200,000.00	56,100,000.00	13,500,000.00	619,682,849.02

Table 28 CAPEX for LIXIL (USD)

Year	Portable toilet (USD)	Cartridge (USD)	AS (USD)	Containment tank and storage facility (USD)	Land (USD)	Multicab (USD)	Vacuum truck (USD)	Total (USD)
2018	12,000.00	18,000.00	30,000.00	218,899.00	298,039.22	16,666.67	88,235.29	681,840.18
2019	24,000.00	36,000.00	-	-	-	-	-	106,666.67
2020	30,000.00	45,000.00	60,000.00	-	-	33,333.33	-	168,333.33
2021	36,000.00	72,000.00	-	-	-	33,333.33	-	171,333.33
2022	42,000.00	99,000.00	60,000.00	-	-	33,333.33	-	234,333.33
2023	48,000.00	117,000.00	120,000.00	-	-	50,000.00	-	335,000.00
2024	54,000.00	153,000.00	90,000.00	-	-	33,333.33	-	330,333.33
2025	72,000.00	189,000.00	150,000.00	-	-	66,666.67	-	477,666.67
2026	90,000.00	216,000.00	120,000.00	-	-	50,000.00	-	476,000.00
2027	102,000.00	261,000.00	180,000.00	-	-	66,666.67	-	609,666.67
2028	114,000.00	306,000.00	210,000.00	-	-	66,666.67	-	696,666.67
2029	126,000.00	342,000.00	210,000.00	-	-	66,666.67	88,235.29	832,901.96
2030	138,000.00	396,000.00	300,000.00	-	-	83,333.33	-	917,333.33
2031	150,000.00	450,000.00	240,000.00	-	-	83,333.33	-	923,333.33
2032	174,000.00	495,000.00	330,000.00	-	-	100,000.00	-	1,099,000.00
2033	198,000.00	558,000.00	360,000.00	-	-	83,333.33	-	1,199,333.33
2034	216,000.00	621,000.00	390,000.00	-	-	100,000.00	-	1,327,000.00
2035	234,000.00	675,000.00	450,000.00	-	-	116,666.67	88,235.29	1,563,901.96
Total	1,860,000.00	5,049,000.00	3,360,000.00	218,899.00	298,039.22	1,100,000.00	264,705.88	12,150,644.10

Table 29 CAPEX for Loowatt (PHP)

Year	Portable toilet (PHP)	Barrel (PHP)	IBS (PHP)	Containment tank and storage facility(PHP)	Land (PHP)	Multicab (PHP)	Vacuum truck (PHP)	Total (PHP)
2018	1,836,000.00	306,000.00	4,335,000.00	13,381,449.02	15,200,000.00	850,000.00	4,500,000.00	40,408,449.02
2019	3,672,000.00	612,000.00	-	-	-	-	-	4,284,000.00
2020	4,590,000.00	765,000.00	4,335,000.00	-	-	850,000.00	-	10,540,000.00
2021	5,508,000.00	1,224,000.00	-	-	-	850,000.00	-	7,582,000.00
2022	6,426,000.00	1,683,000.00	4,335,000.00	-	-	850,000.00	-	13,294,000.00
2023	7,344,000.00	1,989,000.00	4,335,000.00	-	-	850,000.00	-	14,518,000.00
2024	8,262,000.00	2,601,000.00	4,335,000.00	-	-	850,000.00	-	16,048,000.00
2025	9,180,000.00	3,213,000.00	4,335,000.00	-	-	1,700,000.00	-	18,428,000.00
2026	11,934,000.00	3,672,000.00	4,335,000.00	-	-	850,000.00	-	20,791,000.00
2027	14,688,000.00	4,437,000.00	4,335,000.00	-	-	1,700,000.00	-	25,160,000.00
2028	16,524,000.00	5,202,000.00	8,670,000.00	-	-	1,700,000.00	4,500,000.00	36,596,000.00
2029	18,360,000.00	5,814,000.00	8,670,000.00	-	-	1,700,000.00	-	34,544,000.00
2030	20,196,000.00	6,732,000.00	8,670,000.00	-	-	1,700,000.00	-	37,298,000.00
2031	22,032,000.00	7,650,000.00	8,670,000.00	-	-	1,700,000.00	-	40,052,000.00
2032	23,868,000.00	8,415,000.00	8,670,000.00	-	-	1,700,000.00	-	42,653,000.00
2033	25,704,000.00	9,486,000.00	13,005,000.00	-	-	2,550,000.00	4,500,000.00	55,245,000.00
2034	29,376,000.00	10,557,000.00	13,005,000.00	-	-	1,700,000.00	-	54,638,000.00
2035	33,048,000.00	11,475,000.00	13,005,000.00	-	-	2,550,000.00	-	60,078,000.00
Total	262,548,000.00	85,833,000.00	117,045,000.00	13,381,449.02	15,200,000.00	24,650,000.00	13,500,000.00	532,157,449.02

Table 30 CAPEX for Loowatt (USD)

Year	Portable toilet (USD)	Barrel (USD)	IBS (USD)	Containment tank and storage facility (USD)	Land (USD)	Multicab (USD)	Vacuum truck (USD)	Total (USD)
2018	36,000.00	6,000.00	85,000.00	262,381.35	298,039.22	16,666.67	88,235.29	792,322.53
2019	72,000.00	12,000.00	-	-	-	-	-	84,000.00
2020	90,000.00	15,000.00	85,000.00	-	-	16,666.67	-	206,666.67
2021	108,000.00	24,000.00	-	-	-	16,666.67	-	148,666.67
2022	126,000.00	33,000.00	85,000.00	-	-	16,666.67	-	260,666.67
2023	144,000.00	39,000.00	85,000.00	-	-	16,666.67	-	284,666.67
2024	162,000.00	51,000.00	85,000.00	-	-	16,666.67	-	314,666.67
2025	180,000.00	63,000.00	85,000.00	-	-	33,333.33	-	361,333.33
2026	234,000.00	72,000.00	85,000.00	-	-	16,666.67	-	407,666.67
2027	288,000.00	87,000.00	85,000.00	-	-	33,333.33	-	493,333.33
2028	324,000.00	102,000.00	170,000.00	-	-	33,333.33	88,235.29	717,568.63
2029	360,000.00	114,000.00	170,000.00	-	-	33,333.33	-	677,333.33
2030	396,000.00	132,000.00	170,000.00	-	-	33,333.33	-	731,333.33
2031	432,000.00	150,000.00	170,000.00	-	-	33,333.33	-	785,333.33
2032	468,000.00	165,000.00	170,000.00	-	-	33,333.33	-	836,333.33
2033	504,000.00	186,000.00	255,000.00	-	-	50,000.00	88,235.29	1,083,235.29
2034	576,000.00	207,000.00	255,000.00	-	-	33,333.33	-	1,071,333.33
2035	648,000.00	225,000.00	255,000.00	-	-	50,000.00	-	1,178,000.00
Total	5,148,000.00	1,683,000.00	2,295,000.00	262,381.35	298,039.22	483,333.33	264,705.88	10,434,459.78

Table 31 Comparison of total yearly CAPEX

Year	LIXIL (PHP)	LIXIL (USD)	Loowatt (PHP)	Loowatt (USD)
2018	34,773,849.02	681,840.18	40,408,449.02	792,322.53
2019	5,440,000.00	106,666.67	4,284,000.00	84,000.00
2020	8,585,000.00	168,333.33	10,540,000.00	206,666.67
2021	8,738,000.00	171,333.33	7,582,000.00	148,666.67
2022	11,951,000.00	234,333.33	13,294,000.00	260,666.67
2023	17,085,000.00	335,000.00	14,518,000.00	284,666.67
2024	16,847,000.00	330,333.33	16,048,000.00	314,666.67
2025	24,361,000.00	477,666.67	18,428,000.00	361,333.33
2026	24,276,000.00	476,000.00	20,791,000.00	407,666.67
2027	31,093,000.00	609,666.67	25,160,000.00	493,333.33
2028	35,530,000.00	696,666.67	36,596,000.00	717,568.63
2029	42,478,000.00	832,901.96	34,544,000.00	677,333.33
2030	46,784,000.00	917,333.33	37,298,000.00	731,333.33
2031	47,090,000.00	923,333.33	40,052,000.00	785,333.33
2032	56,049,000.00	1,099,000.00	42,653,000.00	836,333.33
2033	61,166,000.00	1,199,333.33	55,245,000.00	1,083,235.29
2034	67,677,000.00	1,327,000.00	54,638,000.00	1,071,333.33
2035	79,759,000.00	1,563,901.96	60,078,000.00	1,178,000.00
Subtotal	619,682,849.02	12,150,644.10	532,157,449.02	10,434,459.78

5.3.4 OPEX

The annual OPEX was computed as the sum of annual expenses on water consumption, labor, electric consumption (for the AS/IBS), gas (for the multicabs and vacuum trucks), hauling and treatment, maintenance, and additives and disposables (Appendix Q). The assumed values and data for this computation is presented in Table 32 and Table 34.

Water consumption for operations was computed as the sum of the volume of water used for cleaning and additive dilution. Its OPEX, subsequently, was computed by multiplying the cost of water from Laguna Water (PHP 24.00 (USD 0.47) per m^3) to the volume of water required per year. The volume of water was based on the number of PTS to be rolled out and the total water needed for cleaning and additive dilution for LIXIL (1.71 L/cartridge) and Loowatt (0.30 L/barrel).

Two operators, both of whom will be working 8 hours per day, 6 days a week, are allotted per AS/IBS and per multicab. The OPEX on manpower was then computed by multiplying the daily minimum wage (PHP 343 =USD 7 per day) to the number of required operators and portable toilet units. In this aspect, it is worth noting that since cartridges will have to be returned within the same day for LIXIL, twice the amount of multicabs and its corresponding operators will be needed during the operation. To reduce waiting time while cleaning, separate multicabs are assigned for the collection and return of cartridges. Loowatt, on the other hand, does not entail this kind of arrangement as the household has two barrels, one of which could be used while the other is being cleaned.

The OPEX related to electric consumption was based on the cost of electricity, the number of AS/IBS in operation, daily electricity consumption, and the number of days in a year that it is in operation. The cost of electricity was assumed to be at PHP 8.00 (USD 0.16) per kWh[16], while the daily power consumption varies depending on the machine, with the AS consuming 198 kWh/ day and the IBS

[16] Value supplied by Laguna Water

consuming 120 kWh/day. Similar to the operators, the AS/IBS will be operating 8 hours a day, 6 days a week.

As for the multicab, an allotment of PHP 1,000 (USD 20) per day was assumed for its gas allowance. Its OPEX was computed by multiplying these values to the number of multicabs and the days per year that it is in operation. Operational costs for the vacuum truck were computed in the same manner, with an allotment of PHP 2,000 (USD 40) per day for its gas allowance. Hauling costs were also considered by taking into account the same assumptions as the vacuum truck in terms of roll out and daily gas expense. In addition to the hauling cost, the OPEX for waste treatment was also reported by applying a treatment cost of PHP 11 (USD 0.22) per m^3 to the septage volume projections.

Items that need maintenance include the portable toilet units, AS/IBS, multicabs and trucks. Maintenance cost of both the portable toilet units and the AS/IBS were assumed to be 10% of its CAPEX, while the maintenance of the multicab and trucks were computed to be 5% of its CAPEX. The maintenance cost for each asset, then, was a product of its corresponding cost multiplied by the allotted percentage for its maintenance.

Other OPEX items include additives for LIXIL, and additives and disposables for Loowatt. For LIXIL, 2.42 mL of the additive (priced at PHP 20 (USD 0.39) per litre) was added per cartridge, whereas, for Loowatt, 2.96 mL of bleach and 3.16 mL of oil (priced at PHP 20 (USD 0.39) and PHP 100 (USD 2) per litre, respectively) were added per barrel. In addition, Loowatt had disposables priced at PHP 380.64 (USD 7.46) per portable toilet unit per month. The additives and disposables used are dependent on the number of portable toilet units purchased.

Table 32 to Table 35 summarizes and compares the yearly OPEX for LIXIL and Loowatt. Looking into the yearly OPEX, the bulk of the cost of operations is spent on manpower for LIXIL and disposables for Loowatt. It is notable, however, that there are high costs for maintenance (preventive) during the first few years of operation for Loowatt as it is based on a percentage of the CAPEX for the portable toilet unit and IBS, which are relatively high for the first few years.

The total OPEX from 2018 to 2035 spent for LIXIL (PHP 851,189,555.39 = USD 16,689,991.28) is higher than the total OPEX for Loowatt (PHP 756,778,580.61 = USD 14,838,795.70) due to the number of personnel needed and gas needed for the projected number of multicabs. In addition, the higher electric consumption of the AS (LIXIL) compared to the IBS (Loowatt) also had an impact on expenditures for utilities.

Table 32 OPEX for LIXIL (PHP)

Year	Water (PHP)	AS, manpower, and utilities (electricity) (PHP)	Multicab, manpower, and gas expense (PHP)	Vacuum truck, manpower, gas expense, and treatment (PHP)	Maintenance (PHP)	Additives (PHP)	Total (PHP)
2018	393.98	653,760.00	485,568.00	774,579.04	481,700	255,465	2,651,466
2019	1,181.95	1,307,520.00	971,136.00	776,601.13	799,600	766,394	4,622,433
2020	2,166.91	2,615,040.00	1,942,272.00	779,128.75	1,343,600	1,405,056	8,087,263
2021	3,348.86	3,268,800.00	2,913,408.00	782,161.88	1,765,200	2,171,449	10,904,368
2022	4,727.81	4,576,320.00	3,884,544.00	785,700.53	2,370,400	3,065,576	14,687,268
2023	6,303.74	6,537,600.00	5,341,248.00	789,744.71	3,201,700	4,087,434	19,964,031
2024	8,076.67	7,845,120.00	6,312,384.00	794,294.41	3,868,100	5,237,025	24,065,000
2025	10,046.59	9,806,400.00	8,254,656.00	799,349.64	4,803,100	6,514,348	30,187,901
2026	12,213.50	11,767,680.00	9,711,360.00	804,910.38	5,726,200	7,919,404	35,941,768
2027	14,577.41	14,382,720.00	11,653,632.00	810,976.65	6,875,400	9,452,192	43,189,498
2028	17,138.30	16,344,000.00	13,595,904.00	817,548.44	7,902,200	11,112,712	49,789,503
2029	19,896.19	18,959,040.00	15,538,176.00	1,598,193.75	9,337,600	12,900,964	58,353,870
2030	22,851.07	22,227,840.00	17,966,016.00	1,605,776.59	10,774,100	14,816,949	67,413,533
2031	26,002.94	24,842,880.00	20,393,856.00	1,613,864.94	12,088,200	16,860,666	75,825,470
2032	29,351.81	28,111,680.00	23,307,264.00	1,622,458.82	13,628,400	19,032,116	85,731,270
2033	32,897.66	31,380,480.00	25,735,104.00	1,631,558.22	15,156,700	21,331,297	95,268,037
2034	36,640.51	35,303,040.00	28,648,512.00	1,641,163.15	16,911,100	23,758,212	106,298,667
2035	40,580.35	38,571,840.00	32,047,488.00	2,424,841.59	18,810,600	26,312,858	118,208,208
Total	288,396.25	278,501,760.00	228,702,528.00	20,852,852.63	135,843,900.00	187,000,116.48	851,189,555.39

In US Dollar

Table 33 OPEX for LIXIL (USD)

Year	Water (USD)	AS, manpower, and utilities (electricity) (USD)	Multicab, manpower, and gas expense (USD)	Vacuum truck, manpower, gas expense, and treatment (USD)	Maintenance (USD)	Additives (USD)	Total (USD)
2018	7.73	12,818.82	9,520.94	15,187.82	9,445.10	5,009.12	51,989.53
2019	23.18	25,637.65	19,041.88	15,227.47	15,678.43	15,027.33	90,635.94
2020	42.49	51,275.29	38,083.76	15,277.03	26,345.10	27,550.12	158,573.78
2021	65.66	64,094.12	57,125.65	15,336.51	34,611.76	42,577.43	213,811.14
2022	92.70	89,731.76	76,167.53	15,405.89	46,478.43	60,109.33	287,985.65
2023	123.60	128,188.24	104,730.35	15,485.19	62,778.43	80,145.76	391,451.59
2024	158.37	153,825.88	123,772.24	15,574.40	75,845.10	102,686.76	471,862.75
2025	196.99	192,282.35	161,856.00	15,673.52	94,178.43	127,732.31	591,919.63
2026	239.48	230,738.82	190,418.82	15,782.56	112,278.43	155,282.43	704,740.55
2027	285.83	282,014.12	228,502.59	15,901.50	134,811.76	185,337.10	846,852.90
2028	336.05	320,470.59	266,586.35	16,030.36	154,945.10	217,896.31	976,264.76
2029	390.12	371,745.88	304,670.12	31,337.13	183,090.20	252,960.08	1,144,193.53
2030	448.06	435,840.00	352,274.82	31,485.82	211,256.86	290,528.41	1,321,833.98
2031	509.86	487,115.29	399,879.53	31,644.41	237,023.53	330,601.29	1,486,773.92
2032	575.53	551,209.41	457,005.18	31,812.92	267,223.53	373,178.75	1,681,005.29
2033	645.05	615,303.53	504,609.88	31,991.34	297,190.20	418,260.73	1,868,000.73
2034	718.44	692,216.47	561,735.53	32,179.67	331,590.20	465,847.29	2,084,287.59
2035	795.69	756,310.59	628,382.12	47,545.91	368,835.29	515,938.39	2,317,808.00
Total	5,654.83	5,460,818.82	4,484,363.29	408,879.46	2,663,605.88	3,666,668.95	16,689,991.28

Table 34 OPEX for Loowatt

Year	Water (PHP)	IBS (Manpower and Utility) (PHP)	Multicab (Manpower and Gas Expense) (PHP)	Vacuum Truck (Manpower, Gas Expense, Treatment Cost) (PHP)	Maintenance Expenses (MC, AS, PTS, Truck) (PHP)	Additives and Disposables (PHP)	Total (PHP)
2018	69.12	474,048.00	485,568.00	774,786.50	884,600	460,370	3,079,442
2019	207.36	474,048.00	485,568.00	777,223.50	1,251,800	1,381,110	4,369,957
2020	380.16	948,096.00	971,136.00	780,269.74	2,186,800	2,532,035	7,418,716
2021	587.52	948,096.00	1,456,704.00	783,925.24	2,780,100	3,913,144	9,882,557
2022	829.44	1,422,144.00	1,942,272.00	788,189.99	3,898,700	5,524,439	13,576,574
2023	1,105.92	1,896,192.00	2,427,840.00	793,063.99	5,109,100	7,365,919	17,593,221
2024	1,416.96	2,370,240.00	2,913,408.00	798,547.23	6,411,300	9,437,583	21,932,496
2025	1,762.56	2,844,288.00	3,884,544.00	804,639.73	7,847,800	11,739,433	27,122,467
2026	2,142.72	3,318,336.00	4,370,112.00	811,341.47	9,333,600	14,271,468	32,107,000
2027	2,557.44	3,792,384.00	5,341,248.00	818,652.47	10,953,700	17,033,687	37,942,229
2028	3,006.72	4,266,432.00	6,312,384.00	1,600,140.71	12,890,600	20,026,092	45,098,655
2029	3,490.56	5,214,528.00	7,283,520.00	1,608,670.20	15,127,800	23,248,681	52,486,690
2030	4,008.96	5,688,576.00	8,254,656.00	1,617,808.95	17,023,300	26,701,455	59,289,805
2031	4,561.92	6,636,672.00	9,225,792.00	1,627,556.94	19,444,100	30,384,415	67,323,098
2032	5,149.44	7,110,720.00	10,196,928.00	1,637,914.18	21,523,200	34,297,559	74,771,471
2033	5,771.52	8,058,816.00	11,653,632.00	2,422,448.67	24,395,100	38,440,888	84,976,657
2034	6,428.16	9,006,912.00	12,624,768.00	2,434,024.42	27,091,300	42,814,403	93,977,835
2035	7,119.36	9,955,008.00	14,081,472.00	2,446,209.41	29,921,800	47,418,102	103,829,711
Total	50,595.84	74,425,536.00	103,911,552.00	23,325,413.33	218,074,700.00	336,990,781.44	756,778,580.61

Table 35 OPEX for Loowatt (USD)

Year	Water (USD)	IBS (Manpower and Utility) (USD)	Multicab (Manpower and Gas Expense) (USD)	Vacuum Truck (Manpower, Gas Expense, Treatment Cost) (USD)	Maintenance Expenses (MC, AS, PTS, Truck) (USD)	Additives and Disposables (USD)	Total (USD)
2018	1.36	9,295.06	9,520.94	15,191.89	17,345.10	9,026.86	60,381.22
2019	4.07	9,295.06	9,520.94	15,239.68	24,545.10	27,080.59	85,685.43
2020	7.45	18,590.12	19,041.88	15,299.41	42,878.43	49,647.75	145,465.02
2021	11.52	18,590.12	28,562.82	15,371.08	54,511.76	76,728.31	193,775.63
2022	16.26	27,885.18	38,083.76	15,454.71	76,445.10	108,322.33	266,207.33
2023	21.68	37,180.24	47,604.71	15,550.27	100,178.43	144,429.78	344,965.12
2024	27.78	46,475.29	57,125.65	15,657.79	125,711.76	185,050.65	430,048.94
2025	34.56	55,770.35	76,167.53	15,777.25	153,878.43	230,184.96	531,813.08
2026	42.01	65,065.41	85,688.47	15,908.66	183,011.76	279,832.71	629,549.02
2027	50.15	74,360.47	104,730.35	16,052.01	214,778.43	333,993.86	743,965.27
2028	58.96	83,655.53	123,772.24	31,375.31	252,756.86	392,668.47	884,287.35
2029	68.44	102,245.65	142,814.12	31,542.55	296,623.53	455,856.49	1,029,150.78
2030	78.61	111,540.71	161,856.00	31,721.74	333,790.20	523,557.94	1,162,545.20
2031	89.45	130,130.82	180,897.88	31,912.88	381,256.86	595,772.84	1,320,060.75
2032	100.97	139,425.88	199,939.76	32,115.96	422,023.53	672,501.16	1,466,107.27
2033	113.17	158,016.00	228,502.59	47,498.99	478,335.29	753,742.90	1,666,208.96
2034	126.04	176,606.12	247,544.47	47,725.97	531,201.96	839,498.10	1,842,702.65
2035	139.60	195,196.24	276,107.29	47,964.89	586,701.96	929,766.71	2,035,876.69
Total	992.08	1,459,324.24	2,037,481.41	457,361.05	4,275,974.51	6,607,662.38	14,838,795.70

Table 36 Comparison of total yearly OPEX

Year	LIXIL (PHP)	LIXIL (USD)	Loowatt (PHP)	Loowatt (USD)
2018	2,651,466	51,990	3,079,442	60,381
2019	4,622,433	90,636	4,369,957	85,685
2020	8,087,263	158,574	7,418,716	145,465
2021	10,904,368	213,811	9,882,557	193,776
2022	14,687,268	287,986	13,576,574	266,207
2023	19,964,031	391,452	17,593,221	344,965
2024	24,065,000	471,863	21,932,496	430,049
2025	30,187,901	591,920	27,122,467	531,813
2026	35,941,768	704,741	32,107,000	629,549
2027	43,189,498	846,853	37,942,229	743,965
2028	49,789,503	976,265	45,098,655	884,287
2029	58,353,870	1,144,194	52,486,690	1,029,151
2030	67,413,533	1,321,834	59,289,805	1,162,545
2031	75,825,470	1,486,774	67,323,098	1,320,061
2032	85,731,270	1,681,005	74,771,471	1,466,107
2033	95,268,037	1,868,001	84,976,657	1,666,209
2034	106,298,667	2,084,288	93,977,835	1,842,703
2035	118,208,208	2,317,808	103,829,711	2,035,877
Total	851,189,555	16,689,991	756,778,581	14,838,796

5.3.5 Total expenditures

The results of CAPEX and OPEX per year are shown in Appendix R, Table 37 and Table 38. It was observed that both the total CAPEX (PHP 619.68 million = USD 12.15 million) and OPEX (PHP 851.19 million= USD 16.69 million) is higher for LIXIL's portable toilet system compared to Loowatt's portable toilet system's total CAPEX (PHP 532.16 million = USD 10.43 million) and OPEX (PHP 756.78 million = USD 14.84 million). The high capital cost of LIXIL's system can be attributed to the shorter lifespan of its portable toilet unit and the higher cost of its cartridge. On the other hand, the higher operating cost of LIXIL's system can be attributed to its longer processing time, higher electricity consumption and higher amounts of water required for additive dilution and cleaning. In total, the entire expenditures for LIXIL's portable toilet system (PHP 1,470.87 million= USD 28.84 million) is higher than that of Loowatt's portable toilet system (PHP 1,288.94 million= USD 25.27 million).

Table 37 Total expenditure (CAPEX and OPEX) in PHP

	LIXIL (million PHP)			Loowatt (million PHP)		
Year	CAPEX	OPEX	Total	CAPEX	OPEX	Total
2018	34.77	2.65	37.43	40.41	3.08	43.49
2019	5.44	4.62	10.06	4.28	4.37	8.65
2020	8.59	8.09	16.67	10.54	7.42	17.96
2021	8.74	10.90	19.64	7.58	9.88	17.46
2022	11.95	14.69	26.64	13.29	13.58	26.87
2023	17.09	19.96	37.05	14.52	17.59	32.11
2024	16.85	24.07	40.91	16.05	21.93	37.98
2025	24.36	30.19	54.55	18.43	27.12	45.55
2026	24.28	35.94	60.22	20.79	32.11	52.90
2027	31.09	43.19	74.28	25.16	37.94	63.10
2028	35.53	49.79	85.32	36.60	45.10	81.69
2029	42.48	58.35	100.83	34.54	52.49	87.03
2030	46.78	67.41	114.20	37.30	59.29	96.59
2031	47.09	75.83	122.92	40.05	67.32	107.38
2032	56.05	85.73	141.78	42.65	74.77	117.42
2033	61.17	95.27	156.43	55.25	84.98	140.22
2034	67.68	106.30	173.98	54.64	93.98	148.62
2035	79.76	118.21	197.97	60.08	103.83	163.91
Total	619.68	851.19	1470.87	532.16	756.78	1288.94

Table 38 Total expenditure (CAPEX snd OPEX) in USD

	LIXIL (million USD)			Loowatt (million USD)		
Year	CAPEX	OPEX	Total	CAPEX	OPEX	Total
2018	0.68	0.05	0.73	0.79	0.06	0.85
2019	0.11	0.09	0.20	0.08	0.09	0.17
2020	0.17	0.16	0.33	0.21	0.15	0.35
2021	0.17	0.21	0.39	0.15	0.19	0.34
2022	0.23	0.29	0.52	0.26	0.27	0.53
2023	0.34	0.39	0.73	0.28	0.34	0.63
2024	0.33	0.47	0.80	0.31	0.43	0.74
2025	0.48	0.59	1.07	0.36	0.53	0.89
2026	0.48	0.70	1.18	0.41	0.63	1.04
2027	0.61	0.85	1.46	0.49	0.74	1.24
2028	0.70	0.98	1.67	0.72	0.88	1.60
2029	0.83	1.14	1.98	0.68	1.03	1.71
2030	0.92	1.32	2.24	0.73	1.16	1.89
2031	0.92	1.49	2.41	0.79	1.32	2.11
2032	1.10	1.68	2.78	0.84	1.47	2.30
2033	1.20	1.87	3.07	1.08	1.67	2.75
2034	1.33	2.08	3.41	1.07	1.84	2.91
2035	1.56	2.32	3.88	1.18	2.04	3.21

Year	LIXIL (million USD)			Loowatt (million USD)		
	CAPEX	OPEX	Total	CAPEX	OPEX	Total
Total	12.15	16.69	28.84	10.43	14.84	25.27

5.3.6 Net present value

For the purposes of comparing the two toilet systems in terms of its viability, a financial assessment covering the capital costs, operational and maintenance (O&M) costs, and revenues were evaluated over a period of 15 years (Appendix S). Capital and O&M costs and were obtained by adjusting the annual total CAPEX and OPEX, respectively, using inflation rates given in Table 14.[17]

The Net Present Value (NPV) returns the equivalent current value of the project based on a discount rate and a series of future payments and income. Discount rate for this model is at 9.40% weighted average cost of capital (WACC) for 2018. Future payments are based on the sum of capital cost and O&M cost, which is already inclusive of the CAPEX and OPEX until 2035. The payment terms are shown as financial indicators in Table 39. Income is based on the base case revenues over the 15-year period, as discussed above.

Table 39 Key financial indicators

	LIXIL	Loowatt
Debt amortization		
Repayment starts in year	2	2
Number of yearly installments	4	4
Tenor of debt (years)	5	5
Debt service coverage ratio		
Minimum DSCR	1.36	1.66
Average DSCR	6.74	7.82
IRR and NPV		
Project IRR (post tax)	13.82%	21.42%
Project NPV @ 9.40% (million PHP)	11.56	51.36
Project NPV @ 9.40% (million USD)	0.23	1.01
Equity IRR	15.00%	22.39%
Equity NPV @ 15% (million PHP)	-0.00	19.79
Equity NPV @ 15% (million USD)	0.00	0.39

NPV results show that the 2018 NPV value for Loowatt (PHP 51.36 million = USD 1.01 million) is higher than the NPV value of LIXIL (PHP 11.56 million = USD 0.23 million). The significant difference of PHP 39.80 million (USD 0.78 million) is correlated to the difference in component costs, product lifespan for components, number of portable toilets that can fit in the multicab, power consumption, and processing time. This is also reflected in the lower CAPEX and OPEX needed for Loowatt's system. Moreover, the internal rate of return (IRR), which estimates the profitability of potential investments, is also higher for Loowatt (21.42%) compared to LIXIL (13.82%).

It is worth noting that aside from the higher NPV value of Loowatt's system, more households prefer it as well. The households are also generally more willing to pay more for the Loowatt portable toilet, despite the fact that its purchase cost was perceived to be more expensive.

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[17] In the context of comparing the two toilet systems for the MCA, note that the NPV was only computed for the PTS without taking into account the utility business model (i.e. cross-subsidies) with other water-related services. An analysis on the effect of the PTS on the NPV of the business is detailed in Section 6.1.

Financial criterion is given a high amount of weight for this MCA. In fact, a major portion (83.59%) of the calculated difference between the total scores of the two toilet systems is due to the difference in this criterion. Financial considerations are deemed to have a major influence in the difference of the scores obtained for this MCA.

5.3.7 Willingness to pay

The analysis on willingness to pay was based on information obtained from the 26 households that were able to use both portable toilet models throughout the pilot study period (Appendix T.). This allows for a comparative evaluation between the two portable toilet systems.

Value perception

Households were asked to evaluate the two portable toilet models by giving an estimate of their perceived price (Table 40). It was observed that a majority of households (22 out of 26) put either an equal price or a higher perceived value on their preferred portable toilet model. Based on the average perceived prices for both portable toilet models throughout all households, Loowatt's model was perceived to be more expensive than LIXIL's model by around PHP 1,000 (USD 20). This may be partly due to the fact that most households preferred Loowatt's model (22 out of 26) compared to LIXIL's model. It is worth noting, however, that the market price supplied by the vendors for both toilets is still three to four times higher than the households' perceived price value.

Table 40 Perceived value compared with actual market value

	LIXIL (PHP)	LIXIL (USD)	Loowatt (PHP)	Loowatt (USD)
Average perceived value	4,156.52	81.50	5,111.54	100.23
Actual market value as supplied by the vendor	15,300.00	300	21,420.00	420

Price willing to pay and percentage of households willing to pay

Monthly willingness to pay was determined by separating the different types of services offered by the operational model, namely: the toilet, its collection system, and connection to the water meter. Willingness to pay for LIXIL's model and Loowatt's model were made by filtering the number of households that preferred the said portable toilet models and averaging the prices they dictated per type of service. A summary of responses is presented in Table 41.

Table 41 Price willing to pay

	LIXIL	Loowatt
Number of households with preference for the portable toilet model	4	22
Average value perception *	PHP 5,000 (USD 98)	PHP 4,677.27 (USD 92)
Portable toilet fee (per month) *	PHP 212.50 (USD 4)	PHP 314.55 (USD 6)
Collection service fee (per month) *	PHP 275.00 (USD 5)	PHP 331.82 (USD 7)
Connection to water meter (per month) *	PHP 280.00 (USD 5)	PHP 447.73 (USD 8)
Total for the three services (per month) *	PHP 767.50 (USD 15)	PHP 1094.09 (USD 21)
Households willing to pay for total monthly fee (%) *	75% (3 out of 4)	73% (16 out of 22)

* Only for households with preference for the portable toilet model

Unlike perceived price for the portable toilet unit, the actual price households were willing to pay on a monthly basis was lower, and this may be affected by a number of other factors such as monthly income, family size, and existing debt and loan repayments. The four respondents who preferred the LIXIL model indicated on average lower amounts that they would be willing to pay. Although these four households were not below the poverty line, it was determined that their budget per person was below average compared to the rest of the community. As such, even if they valuated the toilet a little higher in terms of price, monthly willingness to pay is still smaller compared to their counterparts who prefer Loowatt's model.

As for the percentage of households willing to become PTS customers of Laguna Water, only 3 out of 33 (9%) of households were unwilling to become PTS customers due to the following reasons:

- **Relocation.** One household had transferred to another house with an existing toilet structure. They said they do not see the need to avail of a portable toilet, especially if the family will inhabit the house for good. The household left their toilet in their old housing structure for Laguna Water to pick-up during the retrieval period.
- **Toilet leakage.** One of the households pulled out from the pilot study and was adamant at not being a customer for the portable toilet service due to instances of leakage of the portable toilet unit while they were using it inside the home. The toilet, due to the lack of space, was beside the dining area, and the household viewed the portable toilet as a risk to their health and safety.
- **Installation of a permanent toilet.** Another household was not willing to become a PTS customer as they said that they have plans on installing a permanent toilet inside their home. It is also worth noting that, aside from such plans, the same household was also doubtful on having a portable toilet installed at the beginning of the study due to having an infant. This specific household sees the portable toilet as a risk to the health and safety of very young children. Although such is the case, it is worth noting that the household still continued to use the portable toilet models throughout the duration of the pilot study.

It is worth noting, however, that not all those that were willing to become PTS customers were also willing to avail of the three collective services (toilet, collection, water meter) framed in the operational model. It may be inferred that availing one service at a time may be sustainable, but such might not be the case when all three have to be paid together by the household. It was evident that the majority of households would prioritise payment for connection to the water meter before the portable toilet and its corresponding collection system. In this resepect, it was also found that 73-75% of households were willing to pay PHP 767.50 (USD 15)- PHP 1094.09 (USD 21) for all three services, which is roughly 5%-8% of their monthly income (Table 41). A relatively similar percentage (8% of the monthly income) was obtained by crosschecking the numbers with the monthly willingness to pay vs. income ratio of households. Given that most households have different needs and variable incomes per month, these estimates need to be subject to further studies for validation.

5.4 Customer satisfaction

5.4.1 Odour

According to results from Phase I, odour was one of the main concerns of the participants when choosing a preferred portable toilet model. In a way, odour may also serve as an indicator of risk for a certain product, which, in the case of portable toilets, would be the exposure and leakage of waste. For Phase I, the majority of households commented that a strong, foul smell, which intensifies with heat and humidity, comes out of LIXIL's model unit. The odour was a combination of rubber, waste and chemical scents in a mixture that the households call "kulob", which, roughly translated in English, is a way of describing a smell of something trapped inside a tightly sealed container without proper ventilation. Loowatt's Phase I model unit, on the other hand, also released foul odour from its barrel after two to three days of usage without the exhaust. Despite the presence of foul odour from both portable toilet models, it was evident that households found the odour from the Loowatt portable toilet model more tolerable compared to LIXIL's model, especially as it was effectively minimised by using the exhaust fan.

Phase II exit interviews with participants reveal almost the same feedback, with the improved Loowatt model unit scoring higher in terms of general odour (less odour) compared to LIXIL's model (Table 42).

Table 42 MCA values for odour

		LIXIL		Loowatt	
		Raw score*	Composite weight (%)	Raw score*	Composite weight (%)
While using	Frequency (2%)	55	1.06	68	1.31
	Intensity (2%)	73	1.40	87	1.67
After using	Frequency (2%)	79	1.52	85	1.63
	Intensity (2%)	80	1.54	93	1.79
	TOTAL	287	5.52	333	6.40

* A higher raw score pertains to fewer instances (frequency) and/milder intensity of odour.

The difference in scores seemed to be attributed primarily to the stronger intensity of foul odour while using LIXIL's portable toilet model (i.e. lid was open), rather than the intensity of foul odour after using the toilets (i.e. lid was closed).

While using the toilet, 8 out of 26 households felt that LIXIL's model was unpleasant to be around, some even wanting to move the portable toilet outside the house or nearly wanting to pull out of the study. Loowatt's model, on the other hand, had two households with similar feedback, with the majority agreeing that the smell while using was only evident after one to two days of use. The difference between the two toilet models in terms of odour during usage may be reflective of the effectiveness of the Loowatt's model's sealing mechanism with respect to separating the toilet user from their waste.

On the other hand, odour after usage refers to the smell being emitted by the portable toilet unit after stocking waste for a few days prior to collection. In the same way as odour during usage, it was observed that almost all households, even without the use of the exhaust, found that Loowatt's model had tolerable smells to no odour at all (25 out of 26 households) after usage. LIXIL's model had 20 out of 26 households with similar feedback.

As for the intensity of odour coming from LIXIL's model after usage, three households felt like they had to move their toilets outside after use. Even for new households, it was noted that their descriptions for the odour of both toilets were still relatively similar to Phase I, with LIXIL's model smelling "*kulob*" (waste trapped without proper ventilation) and Loowatt's model smelling like a mixture of chemicals and waste. Most households stated that smells coming from both portable toilets were partly addressed by spraying or wiping the unit with soap or fabric conditioner diluted in water.

On a positive note, households that had participated in Phase I had fewer complaints with the odours from LIXIL's improved model during Phase II compared to the Phase I prototype. Although it might be claimed that these households had become accustomed to the use of the portable toilet, Phase II new households also had relatively similar feedback regarding smells from LIXIL's improved model, with more than half (6 out of 10 new households) saying that there were no smells at all coming from the toilet.

Despite this, there were still unique instances of odour-related observations coming from the participants that were mentioned during the interview. One of which was a comment regarding Loowatt's unit, where one household observed that the odour tends to "stick" to the wall of their house, especially during humid weather. For LIXIL's model, on the other hand, three households mentioned that a version of the model supplied with a light button had a milder odour compared to the model without the button. Operators also observed that the acceptance station was not necessarily able to clean some areas inside the LIXIL cartridge, which may have left some remnants that could increase foul odour, even after cleaning.

5.4.2 Comfort

Comfort was evaluated through the households' rating on sitting position and the size of the toilet opening. It was observed during the exit interviews that in terms of comfort the households prioritized the sitting position over the size of the portable toilets' opening (Table 43).

Table 43 MCA values for comfort

		LIXIL		Loowatt	
		Raw score	Composite weight (%)	Raw score	Composite weight (%)
Sitting position (4%)	Adult male	44	2.31	80	3.76
	Adult female	56		100	
	Child male	56		72	
	Child female	40		68	
Size of opening (4%)	Adult male	72	3.40	80	3.86
	Adult female	100		100	
	Child male	68		80	
	Child female	52		64	
	TOTAL	488	5.70	644	7.62

The recommended sitting position for LIXIL's model was that of a saddleback riding position, which was reported to be unfamiliar to the majority of the households, whereas, Loowatt;s model, on the other hand, recommends a normal sitting position similar to sitting in a chair. Both models' Phase II prototypes used the same recommended sitting position as they had during Phase I, hence comments regarding sitting position were similar to those reported in Phase I.

For LIXIL's model, participants reported that they found it difficult to spread their legs to assume a saddleback riding position as the rim of the portable toilet strains the back of their thighs when sitting. A few women, including users from new households, reported that they found themselves removing all lower clothing; otherwise, they found that they stretched their underwear while using the toilet, which had added implications on the general lack of privacy in their homes and for the portable toilet. Moreover, the majority of adult males either did not use or were not able to follow the recommended sitting position for LIXIL's model as they found it more comfortable to stand up than sit down on the portable toilet when micturating. The behaviour change required for the LIXIL model was perhaps more difficult as the act of sitting down on a toilet to micturate is stigmatised in the study area, with the participants stating that school aged males in particular were called terms that can be considered derogatory in the local context (e.g. *bakla* (gay), *maarte* (picky), and *magmamalinis* (clean freak)). Participants also reported that the height of LIXIL's portable toilet model made it difficult for young children to assume the recommended sitting position on their own. As a result, the majority of households stated that they preferred using Loowatt's model more due to the comfort of its sitting position, especially as the materials of the sitting/standing platform are perceived to be much more durable than during Phase I and the height is not as high as before. It is worth noting, however, that young children still need some assistance in climbing up onto the platform of Loowatt's model, despite the fact that they were less scared of using it by themselves.

Comfort, in terms of the size of the toilets' opening, did not have much of a difference between portable toilet models compared to the stark contrast in scores for sitting position. Opening size was perceived to be sufficient for both portable toilet models, except for the observation that the shape of LIXIL's model was rather narrower and smaller compared to that of Loowatt's model. According to some households, this has an effect on waste sticking on the walls of the opening, which had implications on the ease of use when clearing waste from view.

5.4.3 Ease of use

Ease of use was defined as the amount of effort needed for the portable toilet user to accomplish the basic tasks required for using and cleaning the toilet. It was assessed through the ease of understanding and following instructions, directing waste into the hole, clearing waste from view, and changing the barrel (Loowatt) or knowing when the cartridge was full (LIXIL) (Table 44).

Table 44 MCA values for ease of use

	LIXIL		Loowatt	
	Raw score*	Composite weight (%)	Raw score*	Composite weight (%)
Following instructions (2%)	94	1.81	82	1.58
Directing waste (2%)	169	1.63	201	1.93
Clearing waste (2%)	66	1.27	94	1.81
Changing barrel/ knowing fullness of the cartridge (2%)	78	1.50	85	1.63
TOTAL	407	6.20	462	6.95

* The higher the raw score the easier the portable toilet model was to use.

Loowatt's model scored higher than LIXIL's model for most of the parameters under ease of use, except for following instructions. Due to the number of steps and the complexity of usage, especially when changing the barrel, households found it more difficult to follow the instructions of the Loowatt toilet system. Households who were not able to follow instructions end up with messy toilets components/barrels, with operators cleaning up or doing the necessary steps, which should have been done by the household prior to collection. Difficulties in following instructions, in the case of Loowatt's model, resulted in one pull-out from the pilot study during Phase II. The was because the household ended up spilling waste on both the portable toilet unit and the barrel, mainly due to children using the portable toilet unmonitored, and missing certain steps in the instructions with regard to changing the barrel. Even when given another chance to learn the system through the conduct of another demonstration, the household was still not able to follow the necessary steps required to use the portable toilet effectively. The case of the abovementioned household was not necessarily unique, as there were at least two other households that relied on the operators to change the barrel due to difficulties in following instructions. There were also households that did not follow the prescribed water usage (dippers) and ended up filling the barrel with more waste and water than it could accommodate. As such, the amount of flushes done and plastic-liner used did not necessarily correspond to the amount of waste inside the barrel. Participants reported that LIXIL's model, on the other hand, was simpler to use, as there were no complex steps involved in the changing the cartridge.

Although following instructions was quite tedious in the case of Loowatt's model, households found it relatively easy to change its barrel once they have been accustomed to doing it after a few tries on the first several days of usage. Participants found the line indicator on the plastic-liner particularly useful as they do not have to estimate if the barrel is about to be full. Households thought that changing the barrel was easy; so much so, that the entire barrel changing process was scored a little bit higher compared to the inability to know if the LIXIL model's cartridge was already actually full. Although LIXIL provided a light to help determine if the cartridge was already full, it was agreed upon with Laguna Water that this version of the prototype model will not be evaluated using this feature as not all prototypes during Phase II were supplied with this feature and, as such, not all participant households had the opportunity to test it.

Due to certain limitations, each household was given only one LIXIL cartridge for every collection period and were not able to try changing the cartridge themselves during the pilot study. Nonetheless, some of the households that were able to try the light on the cartridge appreciated that there was an indicator to show if the cartridge was almost full. There were instances, however, where the light indicator failed to work.

As for directing and clearing waste into the hole, it was evident that Loowatt's model had a much higher score compared to LIXIL's model due to Loowatt's larger hole size and flushing mechanism, respectively. Loowatt's model had a bigger hole and rim compared to LIXIL's model, which could be adjusted depending on whether or not the user would be an adult or a child. Although households did not find it necessarily uncomfortable to direct waste into the toilet hole using LIXIL's model, it may be inferred that they generally found Loowatt's model a bit more comfortable and easy to use, especially as the sitting position is quite similar to their usual practice or habit.

In a similar manner, participants also generally prefer the Loowatt model in terms of clearing waste as it had a flush mechanism that made waste go down into the barrel in an efficient and effective manner. The majority of households (18 out of 26 households) commented that the process for clearing waste out of view was very easy for Loowatt's model. Contrary to Phase I feedback for LIXIL's model, on the other hand, there were less complaints regarding the Phase II model in terms of clearing waste, as the valve did not swell nor did most of the households need to push the waste into the cartridge using an improvised stick. Nonetheless, it was still difficult for some of the households (8 out of 26 households) to clear waste out of view using just water or soap spray, especially when the waste stuck to the walls of the valve or portable toilet.

5.4.4 Durability

Durability was evaluated in terms of both the exterior appearance (material degradation) and internal mechanisms (technology degradation) of the portable toilet models.

Table 45 MCA values for durability

	LIXIL		Loowatt	
	Raw score	Composite weight (%)	Raw score	Composite weight (%)
Material degradation (2.4%)	66	1.52	69	1.59
Technology degradation (2.4%)	48	1.11	48	1.11
TOTAL	114	2.63	117	2.70

There was hardly any difference between the participants' perception of durability between the two portable toilet models, however, it was observed that they perceived that the external materials used would last longer than the portable toilets' mechanisms. For LIXIL's model, 11 out of 26 households estimated that the materials would degrade after four years of use, whereas only four households thought the same for its internal mechanisms (e.g. valve and cartridge). In contrast, 8 out of 26 households thought that Loowatt's model would begin to degrade after four years of use, four of which thought it would be the same time period for its internal mechanisms (e.g. flush). Due to wood being used for the Loowatt model's platform and base, households perceived it to have a shorter lifespan compared to LIXIL's model, which uses hard plastic for the whole portable toilet. Their perception, despite the thickness of wood used, may be an effect of their proposed location for the portable toilet. Due to the lack of space inside the home, it was observed that often households have a common area located outside the home for bathing and toileting and, as such, the portable toilet may get wet most of the time. Plastic, which is more resistant to degradation from being wet, therefore, is perceived to be a more durable material to use.

On the other hand, it was noted that the sanitation technology mechanisms of both portable toilets were perceived to have a shorter lifespan compared to the external materials used, due to its exposure to waste and chemical-intensive cleaning. Unlike operators, households have minimal background on how the system works and, as such, could only make conclusions based on what they normally see as part of their toileting routine. The lack of difference from the households' perspective in terms of exposure to degrading agents may account for the similarity between ratings of the two portable toilet models for this specific parameter.

5.4.5 Size

Size was evaluated based on participant's perceptions and judgements on the size (width, height and depth) of the portable toilet models (Table 46).

Table 46 MCA values for size

	LIXIL		Loowatt	
	Raw score	Composite weight (%)	Raw score	Composite weight (%)
Size (5.20%)	90	4.50	86	4.30

LIXIL's model scored slightly higher than Loowatt's model due to its smaller size, which makes it easier to fit and move around in the households. Although the majority of participants did not express any issues with regard to the size of the portable toilet models, it is still worth noting that 2 out of 26 households had an issue with the size of LIXIL's model, and 3 out 26 households said they encountered difficulties given the floor space and height required of the Loowatt model. The two households that had difficulties with LIXIL's model expressed issues regarding size, not because of space, but rather because of its corresponding weight. These households wanted to rotate the toilet (due to sitting position) or move the toilet within the house structure, but found it too heavy to have a single person move it by themselves. For Loowatt's model, on the other hand, size was considered more of an issue rather than its weight. Issues with Loowatt's model include, but are not limited to, fitting the toilet through the door of the house and occupying a large space in the bathing area. It was also observed that some households had to detach a part of the wall of their home to have the toilet installed inside the housing structure.

The above issues highlighted are those expressed by pilot study participants. These participants were selected as the portable toilets models were able to be accommodated inside their house. It is worth noting, however, that during the process of recruitment of participants, at least 10 potential participants of the pilot study could not be considered as the inside of their house was too small to accommodate the larger of the two portable toilet models (Loowatt's model). In some of these situations, there was land adjacent to the house to build a structure for the portable toilets, but this expectation of pilot study participants was deemed unfeasible for a two-month study. Instead, GHD decided to recruit participants who had enough space inside their home to accommodate the portable toilet models. Regardless, three of the pilot study participants decided to pull-out of the study in the middle of Phase II due to the size of Loowatt's model.

5.4.6 Aesthetics

Aesthetics was evaluated using general appearance, materials and colour as parameters. It was noted that, for aesthetic, the parameter that defined the difference between the two portable toilets in terms of household preference would be its colour (Table 47).

Table 47 MCA values for aesthetics

	LIXIL		Loowatt	
	Raw score	Composite weight (%)	Raw score	Composite weight (%)
General appearance (2%)	82	1.58	82	1.58
Material appearance (2%)	70	1.35	76	1.46
Colour appearance (2%)	88	1.69	77	1.48
TOTAL	240	4.62	235	4.52

In terms of general appearance, the two portable toilet models are at par with one another, each due to different reasons. For LIXIL's model, it was noted that households appreciated the uniqueness and the innovation in terms of the toilet's design and colour. Although two households did not appreciate the overall look of the portable toilet due to its lack of semblance to the common toilet. Nonetheless, 15 households commented that the LIXIL model is exactly what they want it to look like.

On the other hand, 15 households also stated that they like the appearance of the Loowatt model, with only one household saying that they do not like what the toilet looks like due to the materials used.

Although Loowatt's model scored lower in terms of material degradation, it scored a bit higher compared to LIXIL's model when it came to the aesthetics of the materials used. Participants from the Phase I study appreciated that the improved wooden platform of Loowatt's Phase II model seemed to be "more finished" due to its thickness and "water-proofing" varnish, whereas new participants of the pilot study during Phase II thought that both Loowatt's plastic and wood components were good enough. For LIXIL's model, on the other hand, households appreciated that the plastic used looked durable enough to withstand wet conditions (e.g. bathroom).

As for colour, LIXIL's model scored higher than Loowatt's model due to the bright plastic colours that the households found "cute" and unique. Households were generally enthusiastic with the different colours of the portable toiletsavailable (after comparing the colour of their model with their neighbours), so much so, that they wanted to suggest other colours that they would like to have next time there is an opportunity for them to use a portable toilet. On the other hand, households were also generally satisfied with the white plastic being used for Loowatt's model. The higher score for LIXIL's model, however, may show that the participants appreciated the opportunity to be able to choose from a variety of colours for the portable toilet to match personal preferences and existing colours in their homes.

5.5 Environment

The environment category of the MCA was evaluated through a partial life-cycle analysis to assess potential environmental impacts associated with stages of the product's life from production to its operations to its end-of-life disposal. The parameters used to evaluate these are listed in Table 48 with: (1) water, chemicals, petrol, energy and by-products used during operations, and (2) materials being a simplified parameter to assess the product in terms of its operation and end-of-life disposal.

Table 48 MCA values for environment

		LIXIL		Loowatt	
		Actual value	Composite weight (%)	Actual value	Composite weight (%)
Water	Average contents weight of barrel/ cartridge (kg)	7.34	1.25	9.71	1.76
	Volume of water required to clean toilet (L)	1.21		0.30	
Chemicals	Volume of chemicals used in operations (additives/ cleaning agents) (mL)	2.42	1.00	6.12	0.40
Petrol	Number of barrels/ cartridges than can it in one collection truck	11	0.99	30	2.00
	Average weight of full barrel/ cartridge (kg)	15.64		10.81	
Energy	Energy consumed during the cleaning process (kwh/day)	198.0	0.97	120.0	2.00

		LIXIL		Loowatt	
		Actual value	Composite weight (%)	Actual value	Composite weight (%)
	Machine run-time (mins)	7.09		2.61	
By-products	Generation of solid by-products (excluding human waste)	0.00	1.00	1.00	0.00
Materials	Total weight of toilet materials (kg)	18.00	0.50	26.85	0.34
	Average lifetime of toilet (years)	5.00	0.31	8.00	0.50
	Percentage of environmentally friendly materials	11%	0.14	78%	1.00
	TOTAL	6.17	6.16	7.99	8.00

5.5.1 Operation

LIXIL's model, in terms of household usage, required approximately 10 mL of the spray flush per use. Full cartridges are transported by a multicab, which can carry up to 22 cartridges that have an average combined weight of 15.64 kg when used. For this specific category, it was assumed that the weight of the cartridges have an effect on gasoline consumption of the vehicle. The used cartridge is then cleaned at an acceptance station, which consumes 1.21 L of water and 2.42 mL of additive per cartridge, and requires 198 kwh/day of energy of processing wastes.

Loowatt's model, in contrast, promotes a waterless flush and, as such, users can opt not to use water at all when utilising the portable toilet model. Nonetheless, findings during Phase I highlighted that participants in the pilot study preferred to use water to clean themselves over the portable toilet after defecation. Upon looking at the data from Phase I, Loowatt recommended that portable toilets users could use up to 0.5 L of water for cleaning themselves after defecation, if they wished to do so. The higher waste contents of Loowatt's model versus LIXIL's model during the pilot study indicated that indeed most households used water to clean themselves after defecation when the Loowatt toilet was in their home. When the plastic-liner was depleted, the households were able to change barrels by themselves prior to a collection day. The full barrels were collected twice a week using a multicab, which could carry up to 30 barrels, each having an average combined weight of 10.81 kg. The industrial bag shredder, which processed the waste, consumed 120 kwh/day of energy, while the cleaning process required approximately 0.30 L of water and 6.21 mL of bleach and antibacterial oil for each barrel. Whereas LIXIL's model does not have solid by-products, it is worth noting that Loowatt's model has shredded plastic as a by-product while the barrel contents are processed in the IBS. The plastics, which were turned into dry compacted film, were removed from the site as solid waste.

To compare the two portable toilet models during operations, LIXIL's model uses more water and less chemicals for its cleaning process. Loowatt's model, alternatively, requires less water and more chemicals for the cleaning process. In terms of using each models respective cleaning machines, Loowatt's IBS consumes much less energy at only 120 kwh/day compared to LIXIL's AS, which consumes 198 kwh/day.

In totality, Loowatt's model was considered to be more environmentally-friendly in terms of operations as, despite the usage of more chemicals and the generation of solid by-products, it scored higher than LIXIL's model in all other operational environmental categories. The difference between the two portable toilet systems was defined mostly by energy and petrol consumption.

5.5.2 Production and disposal

Both vendors advised Laguna Water and GHD that their portable toilet units would need to be disposed after the unit's end-of-life in accordance with Republic Act 9003 or the Ecological Solid Waste Management Act 2000. Aside from the method of disposal, the environmental impact of the portable toilet units was evaluated according to the weight and type of materials to be disposed, while also considering if the materials would biodegrade at a faster rate than others.

Loowatt's model was made up of 21 kg of plywood, 5.5 kg of varying plastics, 350 g of stainless steel and 140 g of aluminium. Material processing for these materials includes cutting of wood, injection moulding of plastics and casting of metals. Wood by-products are biodegradable. On the other hand, LIXIL's model was made up of 15.5 kg of high-density polyethylene plastic, 2 kg of silicone, 0.5 kg of elastomer and 1 kg of steel. Material processing are separate injection moulding of plastics, silicone and elastomer, and casting of metals. Additional processing such as rubber compounding and additional additives are needed to achieve the properties of silicone and elastomer. At the time of disposal, plastic and metal by-products from both models could in theory be re-used as raw materials. Environmental impacts of manufacturing processes are mainly air contaminants from the exhaust of injection moulding and casting as well as increased chemical oxygen demand in water, if not properly treated.

Loowatt's model was assessed to be more environmentally friendly in terms of its production and disposal, due primarily to the amount of biodegradable materials (wood) used for components. However, LIXIL's model may require less processing given that Loowatt's model is made up of varying plastics. Nonetheless, both products will pollute the environment if air exhaust and wastewater are not treated and managed properly.

Both products are currently manufactured outside the country. For example, some parts of Loowatt are from UK and parts of LIXIL are from Japan. However, both products are considering local manufacturing to minimize environmental effect of shipping.

5.6 Health and safety

The results of the health and safety risk assessment are shown in Appendix U- and Table 49. The assessment found there was less health and safety risks with LIXIL's model when compared to Loowatt's model. There is not a lot of difference in the scores of the two models.

Table 49 MCA values for health and safety risks

Health & Safety Risks	LIXIL Composite weight (%)	Loowatt Composite weight (%)
Health & Safety Risks (Customer)	2.92%	2.63%
Health & Safety Risks (Collectors)	0.77%	0.88%
Health & Safety Risks (Cleaning operators)	1.42%	1.42%
TOTAL	5.10%	4.92%

5.6.1 Customer health and safety

For customer health and safety, LIXIL's model scored better (2.92%) than Loowatt's model (2.63%) mainly because of the potential risk of fire that could be caused by the exhaust fan of Loowatt's model.

The assessment found a high risk of exposure to infectious wastes from both models, due to leaks, faulty air-lock [18] and the occurrence of cartridges/barrels being overfilled (instances were reported during the pilot study).

The risk of injury from the ergonomics of both models was assessed as being low, because both were designed to require minimal physical effort required to use the portable toilet, flushing down the waste with water or pulling the mechanical level and changing the barrel/cartridge.

[18] Faulty air lock technology refers to the capability of the toilet to effectively seal odour inside its waste container.

Table 50 MCA values for customers' health and safety risks

Health and safety risks (customer)	LIXIL		Loowatt	
	Risk level	Composite weight (%)	Risk level	Composite weight (%)
Fire during use	None	1.17%	Moderate	0.88%
Exposure to wastes	High	0.58%	High	0.58%
Product ergonomics	Low	1.17%	Low	1.17%
TOTAL		2.92%		2.63%

5.6.2 Collection operators' health and safety

The risk assessment determined that Loowatt's model imposes less risk in terms of collectors' health and safety than LIXIL's model, mainly because the barrel is lightweight and easy to carry. Hence, the Loowatt model scored higher (0.88%) than LIXIL's model. Loowatt's model requires less physical effort because multiple clean barrels can be carried at the same time, unlike LIXIL's clean cartridges that can only be carried one at a time.

Both models impose a high risk rating of exposure to infectious wastes. For Loowatt's system, collection operators have been exposed to infectious waste when households have experienced faults or did not follow instructions properly, or when collection operators had to change barrels when there has been a punctured plastic-liner. LIXIL's model exposed collection operators to infectious waste when they experienced a damaged silicone valve or leakage that they had to clean up in the multicab.

The risk of a car accident during collection is also considered to be high for both portable toilet systems. Although the likelihood of this occurring may be slightly higher for LIXIL's system as not as many cartridges can fit in a multicab as barrels, resulting in more car trips over the life of the PTS business.

Table 51 MCA values for collectors' health and safety risks

Health and safety risks (collection operators)	LIXIL		Loowatt	
	Risk level	Composite weight (%)	Risk level	Composite weight (%)
Physical demand	Moderate	0.33%	Low	0.44%
Exposure to wastes	High	0.22%	High	0.22%
Car accident during collection	High	0.22%	High	0.22%
	TOTAL	0.77%		0.88%

5.6.3 Cleaning operators' health and safety

Both LIXIL and Loowatt's systems have a rating of 1.42% when it comes to health and safety risks for cleaning operators. Loowatt's system has extreme risk on exposure to infectious wastes and high risk on exposure to chemicals, mainly because more chemicals are used for the IBS machine and it is manually operated. In comparison, LIXIL's machine is fully automated, but the cleaning process is more physically demanding because is the cartridges are heavier and more difficult to carry and there were more instances of machine failure exposing cleaning operators to risks during repairs.

Table 52 MCA values for cleaning operators' health and safety risks

Health and safety risks (cleaning operators)	LIXIL		Loowatt	
	Risk Level	Composite weight (%)	Risk Level	Composite weight (%)
Exposure to wastes	High	0.22%	Extreme	0.11%
Exposure to chemicals	Moderate	0.33%	High	0.22%
Physical demand	Moderate	0.33%	Low	0.44%

Machine failure during cleaning process	High	0.22%	Moderate	0.33%
Fire during cleaning process	Moderate	0.33%	Moderate	0.33%
	TOTAL	1.42%		1.42%

5.7 Capability to scale

The results for the vendors' capability to scale are presented in Appendix V and Table 53. Differences between the two vendors were defined primarily by perceived economic performance, strategic direction, and customer approach – as assessed by Laguna Water employees who have experience in working with both vendors. In terms of capability to scale criterion, LIXIL scored higher than Loowatt.

Table 53 MCA values for capability to scale up

	LIXIL		Loowatt	
	Raw score	Composite weight (%)	Raw score	Composite weight (%)
Strategic direction (0.60%)	40	0.53	31	0.41
Operational capability (0.60%)	129	0.40	145	0.45
Customer approach (0.60%)	70	0.47	54	0.36
Economic performance (0.60%)	66	0.53	46	0.37
Research and development (0.60%)	55	0.44	61	0.49
	TOTAL	2.36		2.08

The economic performance of the vendors was assessed through a survey developed by GHD and completed by Laguna Water employees. The comprehensive survey asked the employees to rate each vendor based on their experience working with the vendors during the pilot study, including questions about general resources (staff, equipment, storage, materials), supply chain, liquid assets, membership in accredited global sanitation organisations, and involvement in other development related projects of each vendor, among many others. It was perceived that LIXIL had a more secure supply chain and more resources as they are a relatively established company supplying products over a longer period compared to Loowatt.

As for the topic of strategic direction, the vendors were assessed in terms of the similarity of workplace values to Laguna Water, management structure and representatives, and the capability to make decisions at the soonest possible time. The results for LIXIL and Loowatt differed primarily in terms of decision making, where LIXIL was perceived to be able to make decisions faster than Loowatt. This parameter is connected to customer approach, where Laguna Water employees indicated that decision-making of the vendors was reflected through the willingness and flexibility to meet the requests of Laguna Water. In addition, customer satisfaction was also assessed in terms of the vendors' ability to follow instructions, quick communications, and supply information when requested. LIXIL was perceived to be more flexible than Loowatt in terms of adjusting to the needs of Laguna Water, as LIXIL were able to provide information and necessary documents to Laguna Water with hardly any delays. Laguna Water employees felt that Loowatt, in contrast, generally took longer to provide information and were not as transparent in terms of releasing information. In addition, employees stated that Loowatt often requested meetings, which, at times, disrupted the workflow of Laguna Water.

Nonetheless, Loowatt had more positive responses in terms of operational capability, and research and development. The instances of product failure (portable toilet and AS) and delivery delays were among the causes that impacted on the perceptions of LIXIL. For research and development, LIXIL was perceived to be weaker in terms of product modification during the pilot study.

5.8 Overall MCA results

The results of the MCA reveal that Loowatt portable toilet system is the leading system. With the current weighting scheme designated to each of the criterion under the MCA, it was determined that the portable toilet systems were mainly differentiated in terms of the financial criterion, specifically, the NPV (Appendix W and Table 54.).

Table 54 Overall MCA Results

		LIXIL composite weight (%)	Loowatt composite weight (%)	Leading prototype per criterion	Absolute difference between LIXIL and Loowatt (%)
Financial	Net Present Value	8.10	36.00	Loowatt	28.62
	Willingness to Pay	3.28	4.00		
Customer satisfaction	Odour	5.52	6.40	Loowatt	3.33
	Comfort	5.70	7.62		
	Ease of Use	6.20	6.95		
	Perception of durability	2.63	2.70		
	Size	4.50	4.30		
	Aesthetic	4.62	4.52		
Environment	Water	1.25	1.76	Loowatt	1.82
	Chemicals	1.00	0.40		
	Petrol	0.99	2.00		
	Energy	0.97	2.00		
	By-products	1.00	0.00		
	Materials	0.95	1.84		
Health and safety	Customer	2.92	2.63	LIXIL	0.18
	Collection operator	0.77	0.88		
	Cleaning operator	1.42	1.42		
Scalability	Strategic direction	0.53	0.41	LIXIL	0.29
	Operational capability	0.40	0.45		
	Customer approach	0.47	0.36		
	Economic performance	0.53	0.37		
	Research and development	0.44	0.49		
	TOTAL	54.18	87.48	Loowatt	34.24

As detailed in section 5.3, the project NPV, which is already inclusive of the CAPEX and OPEX until 2035, is indicative of the value of the business at the time of writing this report, given the assumptions described. The difference between the NPV's of the two portable toilet systems is PHP 39.80 million (USD 0.78 million) with Loowatt's system having an NPV of PHP 51.36 million (USD 1.01 million) and LIXIL's system with PHP 11.56 million. (USD 0.23 million). This variance in NPV between the two portable toilet systems is due to a number of small differences that add up when calculating NPV. These include, but are not limited to, , such as the expenthe expense of the cartridges versus the barrels, the lifespan of the different components, AS/IBS power consumption, cleaning processing times, and even the number of cartridges or barrels that are able to fit into the multicab.

In addition to the larger NPV, households were also generally more willing to pay for the Loowatt model due to preference, despite the fact that it was perceived to be more expensive in terms of cost to purchase per unit.

Given the current weightings, the the Loowatt system's percentage margin lead of 33.30% ahead of LIXIL for the financial criterion, comprises more than three-quarters (83.59%) of the total percentage difference of all of the criterion between the two systems. Hence, the financials were the key differentiator between the two systems.

Customer satisfaction was also allocated equal priority to the financial criterion, as Laguna Water believes that the satisfaction of their customers with the PTS will ensure a more sustainable business and facilitate loyalty among customers who can champion efforts to improve sanitation and health in the community.

Next to financials, customer satisfaction accounts for still a relatively significant portion (9.00%) of the difference between the scores of the two portable toilet models. Similar to Phase 1, it was noted that preference for a specific toilet was largely affected by odour and comfort, both of which were categories where Loowatt's model had a higher score compared to LIXIL's model. Participant households generally preferred Loowatt's model as the intensity of foul odour both during and after using the toilet was effectively minimized by the toilet's sealing/ flush mechanism and exhaust. In addition, the similarity of the Loowatt model's design to the common toilet also had an effect on the households' perception of comfort, especially with regard to sitting position. As for the environment, Loowatt scored higher in the majority of the categories as it consumes less resources (water, petrol) and makes use of more environmentally-friendly materials.

Overall, the higher scores of Loowatt's system compared to LIXIL's system in the top three weighted criterion (financial, customer satisfaction and environment) indicate that the Loowatt system is the leading system for the purposes of this pilot study. It is worth noting, however, that the LIXIL system scored higher than Loowatt in terms of customers' health and safety (due to less risks of fire from overheating equipment) and was the preferred vendor by Laguna Water staff in terms of their perceived ability to scale up production and work effectively with Laguna Water.

In conclusion, Loowatt's portable toilet system scored higher than LIXIL's by a 33.30% margin, largely due to the lower OPEX costs and, subsequently, a higher NPV of the proposed business. Although such is the case for this study, it is to be reiterated that the MCA is only to be used as a tool for evaluation and prioritisation and, as such, the decision on which portable toilet system will be employed will ultimately depend on decisions made by Laguna Water.

The overall MCA results were presented to Laguna Water through a spreadsheet containing weights that could be adjusted according to the needs and priorities of Laguna Water so that they can also perform a sensitivity analysis to determine the robustness of the results of the evaluation (Table 54).

6. Marketing strategy

6.1 Impact of the PTS to the current business model

The net present value (NPV) of the stand-alone PTS is useful in comparing the two toilet models, however, its impact to Laguna Water may be better evaluated by taking into account the utility business model. Revenues coming from other services offered by Laguna Water may be used to cross-subsidise the PTS and vice versa. In addition, the environmental fee also serves as additional revenue, which can be used to subsidise expenditures for Laguna Water's services. The impact of the PTS on the current NPV and Internal Rate of Return (IRR) of Laguna Water were evaluated by comparing values with and without the PTS (Table 55), considering that the PTS will be fully subsidised by Laguna Water.

Table 55 NPV and IRR without and with PTS

	Without PTS	With PTS
Project IRR (post tax)	79.64%	42.47%
Project NPV @ 9.40% (PHP million)	612.49	231.31
Project NPV @9.40% (USD million)	12.01	4.54
Equity IRR (post tax)	110.00%	55.99%
Equity NPV @15% (PHP million)	363.90	124.91
Equity NPV @9.40% (USD million)	7.14	2.45

For the purposes of this section, some assumptions used for calculating the NPV from the stand-alone toilet model in the MCA were changed in accordance to the information provided by Laguna Water:

- Two loans will be taken to cover the capital expenditures in years 2018 and 2019
- Loan term is for 10 years, with a two-year grace period and amortisation of eight years

Although the NPV and IRR of both toilet models were positive, its effect to the overall business model is a decrease to the NPV and IRR of current ongoing operations. This suggests that, although the stand-alone PTS itself generates a positive NPV, getting a subsidy from the revenue of other services and the environmental fee to help support its expenditures does not necessarily generate profitable income for the overall business. For the first ten years of project implementation, only 15% of the total environmental fee will be utilised by the PTS, such that the remaining 85% will be used for other services, which could have more impact in terms of fulfilling wastewater treatment obligations as stated in the concession agreement. In the arrangement that the total costs of the PTS will be fully shouldered by Laguna Water, it is expected that the NPV and IRR of the current system will decrease, as there are no additional revenues. Additional revenues will be realised from the PTS project should LAWC decide to collect fees from PTS households based on the suggested pricing model (Section 6.2), but the PTS project still has to be subsidised through the revenues from environmental fees. As such, adding the PTS as one of the services offered by Laguna Water to the BOP may be considered as an investment in meeting the corporate social responsibilities of the company, but not necessarily as a profitable business venture.

6.2 Pricing model

To establish households' accountability for the toilet unit, Laguna Water is considering scenarios wherein the household will pay for a certain percentage of the PTS costs, especially as the operational model involves an arrangement wherein the portable toilet is still owned by Laguna Water. This "leasing" arrangement between Laguna Water and the household operates under the assumption that the household maintains the toilet, such that it can be used until the end of its proposed lifespan. Aside from accountability, household fees for the portable toilet may also be used by Laguna Water to help shoulder PTS costs or to reduce subsidy from the environmental fee. Although minimal, this may serve as additional revenue, which potentially has an effect on the NPV and IRR of the overall business. A pricing model based on the following possible scenarios were considered:

- Scenario 2[19]: 10% of PTS costs covered by PTS households
- Scenario 3: 25% of PTS costs covered by PTS households
- Scenario 4: 50% of PTS costs covered by PTS households
- Scenario 5: 75% of PTS costs covered by PTS households

To calculate the fee of a PTS household per month, annual revenues were set to the levels computed under the base case (100% of PTS costs shouldered by Laguna Water), which will make the project financially viable. The required levels of revenues from PTS households were computed using the cost-sharing percentages for each scenario. Subsequently, the estimated fee per PTS household per month for each cost-sharing scenario (Table 56) was derived by calculating the required amount to obtain the cost share from the PTS households over the 15-year analysis period.

Table 56 PTS household fee based on different scenarios

	Scenario	PTS Household Fee (PHP/ month)	PTS Household Fee (USD/ month)
1	**Base case** 0% of costs covered by PTS households	0.00	0.00
2	10% of costs covered by PTS households	205.01	4.02
3	25% of costs covered by PTS households	512.53	10.05
4	50% of costs covered by PTS households	1,025.06	20.10
5	75% of costs covered by PTS households	1,537.59	30.15

The impact of the different household fee scenarios to the overall NPV and IRR of the business are detailed in Table 57.

Table 57 NPV and IRR of the different fee scenarios

	LIXIL	Loowatt
SCENARIO 1- 0% of costs covered by PTS households		
Project IRR	42.87%	42.47%
Project NPV (PHP million)	189.94	231.31
Project NPV (USD million)	3.72	4.54
Equity IRR	54.77%	55.99%
Equity NPV (PHP million)	112.86	124.91
Equity NPV (USD million)	2.21	2.45
SCENARIO 2- 10% of costs covered by PTS households		
Project IRR	44.39%	43.86%
Project NPV (PHP million)	219.46	260.83
Project NPV (USD million)	4.30	5.11
Equity IRR	56.78%	57.93%
Equity NPV (PHP million)	130.43	142.48
Equity NPV (USD million)	2.56	2.79
SCENARIO 3- 25% of costs covered by PTS households		

[19] Scenatio 1 considered to be the base case scenario where 100% of PTS costs are covered wholly by Laguna Water.

	LIXIL	Loowatt
Project IRR	46.50%	45.83%
Project NPV (PHP million)	263.73	305.10
Project NPV (USD million)	5.17	5.98
Equity IRR	59.59%	60.65%
Equity NPV (PHP million)	156.80	168.84
Equity NPV (USD million)	3.07	3.31
SCENARIO 4- 50% of costs covered by PTS households		
Project IRR	49.70%	48.83%
Project NPV (PHP million)	337.53	378.90
Project NPV (USD million)	6.62	7.43
Equity IRR	63.85%	64.80%
Equity NPV (PHP million)	200.74	212.78
Equity NPV (USD million)	3.94	4.17
SCENARIO 5- 75% of costs covered by PTS households		
Project IRR	52.60%	51.58%
Project NPV (PHP million)	411.32	452.69
Project NPV (USD million)	8.07	8.88
Equity IRR	67.72%	68.58%
Equity NPV (PHP million)	244.68	256.72
Equity NPV (USD million)	4.80	5.03

The additional revenue from household fees slightly increased the NPV and IRR values compared to the base case scenario, however, it was not enough to increase the NPV to higher values compared to the model without the PTS. As such, although the addition of the PTS has potential to generate income, its effect to the overall business is not necessarily substantial in terms of generating profit. This supports the statement that the PTS may work as a means to fulfil corporate social responsibility. Keeping in mind that the target market is comprised of BOP households, the level of costs covered by PTS households is also limited, especially as PTS fees are still exclusive of other charges such as the water bill and connection to the meter. In this aspect, Scenario 2 would be recommended as this scenario has the lowest level of fees required to PTS households. In addition, it is also known, for instance, that for the 26 households that used both toilets during the study, willingness to pay for the portable toilet was at approximately PHP 200-300 (USD 4-6). Although the number of households is not representative of the entire target population, their willingness to pay may be something to consider, given that these households were actually able to use the portable toilet.[20]

The price model to be used will be the decision of Laguna Water.

6.3 Key issues and data influencing the marketing strategy

Key issues and data, which may influence the development of Laguna Water's marketing strategy, were discussed in the OBP submitted on February 2016. A re-assessment of the core findings and additional insights based on the results of this pilot study are presented below. It is worth noting that the sampling size and methodology of the OBP was different compared to the approach of this pilot study.

6.3.1 Discrepancy between willingness to pay and actual capability to pay

For the OBP, the capacity of households to connect to Laguna Water and their capability to pay for collection services was evaluated through a survey on the monthly income and willingness to pay. Findings showed that some respondents were willing to pay for PTS collection services at less than PHP

[20] Note that *willingness to pay* is different from *capability to pay.*

25 (USD 0.49) per month, while some of them said that they are not willing to pay. The average monthly income for the majority of households was less than PHP 5,000 (USD 98).

In contrast, the majority of households that were able to use at least one portable toilet during the Phase II's study were willing to pay an average of PHP 286.79 (USD 6) per month for PTS collection services. Assuming that the average monthly income is at PHP 13,580.30 (USD 266), the willingness to pay amounts to roughly 2% of the total average income of the participating households. Despite having a sample size of only 30 households, the higher willingness to pay may be due to Laguna Water's establishment of rapport with the potential customers (through workshops, interviews and active recruitment of participants) and the households' actual experience of being able to use a portable toilet. Despite this, however, it should be expected that households' monthly incomes are sometimes subject to change based on the availability of jobs and number of workdays. It was noted that 36% (12 out of 33 households) have also cited budget constraints as one of the main factors hindering their ability to pay for monthly PTS collection bills. As such, households might be willing to pay around PHP 290 (USD 6) per month, but not necessarily be capable to pay for it at all times.

Future activities, which may help address this issue, include, but are not limited to:

- The development of a "pay per use" communal toilet that can temporarily provide for the sanitation needs of households with no toilets and no connection to Laguna Water.
- The formulation of policies passed at the different levels of government that will require all households and establishments to own sanitary toilets and ban open defecation. In this respect, a local ordinance in Laguna is to be implemented in the first quarter of 2018 requiring all residents and commercial establishments to be connected to a sanitation facilities or a service. Implementation of the ordinance will have to be monitored and enforced by Barangay Health Workers (BHWs). The ordinance may encourage households to spend money on sanitation services rather than other incidentals if not doing so results in breaching a law.

6.3.2 Availability of space for the toilet

Similar to findings in the OBP, space is a luxury for most of the households in the target community. The value of having privacy inside a cubicle or an improvised chamber while defecating is a matter for family discussion, as it may impinge on space previously used for sleeping, eating or food preparation.

At least 10 households identified during the recruitment phase of the pilot study expressed interest in installing a portable toilet inside their home, however, they were not considered as participants for the pilot study, as Loowatt's portable toilet unit was unable to fit inside their housing structure. It was observed, however, that a number of households are willing to adjust furniture, even to the extent of removing parts of their wall, just to accommodate a portable toilet inside the home. Nonetheless, space remains to be an important consideration in the homes of the PTS target market, as the potential number of customers may drastically be limited by the size of the product and its ability to fit inside the limited space of the home.

6.3.3 Behaviours/ attitudes towards sanitation and portable toilets

It was reported in the OBP that different barangays seem to have different behaviour in terms of the acceptability of portable toilets as a solution to sanitation. Whereas some households have accepted the present unsanitary conditions, some have also recognized that all households should have sanitary toilets in order to maintain cleanliness.

Both the negative and positive outlook of households towards sanitation were observed again in the different barangays chosen for Phase I and Phase II of the pilot study. The decision of households to avail of a free portable toilet during the pilot study was affected by the presence of other neighbours availing of such services. Among one of the questions frequently asked by households during recruitment included whether or not someone in the same barangay had already participated in the study. As PTS collection is a personal, but not necessarily a hidden, service, some households expressed embarrassment that their neighbours could see their waste collected by someone else and, so much so, were also concerned that the operators gossiped about the differences in wastes belonging to certain households.

In addition, different pull out and retention rates were observed for specific neighbourhoods during Phase II. The contrast between Barangay Macabling and Barangay Pooc, for example, displays the influence of one to two key household influencers whose feedback on the use of the portable toilet served to either motivate or demotivate their neighbours in availing of the service during the pilot study. Although in need of further supporting observations, the proximity of participant households from each other and the presence of a key person may serve as a catalyst for the recruitment of potential customers for the PTS. Sanitation marketing through the cooperation of Laguna Water with barangays in identifying key neighbourhood influencers may be a marketing strategy worth looking at in this respect.

6.3.4 Continuing former toilet practices

Although some have reported digging holes or using plastic bags to defecate, it was observed that the majority of the population in the barangays that do not have a toilet in their home defecate either by using a neighbour's toilet or the chamber pot. Women, as the vulnerable sector of the population, were observed to use the portable toilet more than their male counterparts due to vulnerability in terms of health and safety. Whereas males had the choice to micturate anywhere and defecate in the workplace, these options were usually not available to women. As such, it was observed that women were more adaptable in changing their toilet practices compared to men who were often noted to use the portable toilet sparingly or even not at all. Children were also one of the notable demographics that used the portable toilet. Especially for those who are still not in school, they are still very much exposed to the same options and risks as women.

There are also instances where households pulled-out (4 out of 12 pull-outs) due to unfamiliarity with the portable toilet. Their preference to continue former toilet practices was not uncommon, as there were also other initial recruits that did not push through with participating in the study due to the said reason. The preference for old practices, therefore, presents a legitimate challenge in finding potential customers for the proposed sanitation business.

On the contrary, although the portable toilet service is meant to be a temporary address to the lack of sanitation within the household, it was noted that some participants have had a behaviour change, wherein the portable toilet alternative was preferred as the toileting method of choice compared to the usual ceramic toilet. At least six of the 33 participants have expressed interest in the portable toilet being a permanent means of toileting, some of the primary reasons being that it consumes less water compared to the usual and that there is a perception of having no large upfront costs. It is worth noting that there was one extreme case where one household, despite having installed a permanent unsanitary toilet after Phase I, opted to have the toilet removed just so they could accommodate having a portable toilet inside the home. This kind of behavioural change, although needing further investigation, may take some time to take effect

Similar to findings in the OBP, the behaviour of those participating in the pilot studies seemed to have changed for the better. It was observed that some households have started to construct toilets after the pilot study, instead of going back to their previous practice.

6.3.5 Availability of other sources of water

One of the prerequisites for availing of the portable toilet service is the connection of the household to Laguna Water. The use of other water sources by the target community, according to OBP findings, implies that there is only a small percentage of existing household connections to Laguna Water in the area. It was noted that many have said “no” during the OBP when asked if they had plans to connect to piped water.

Although such is the case, it was noted that, for the 33 total participant households during Phase II, 28 were willing to prioritise payment for the water meter prior to availing of the portable toilet unit and other related sanitation services. Although willing to connect to the water meter, households generally perceive the price of connection to be high or unsustainable given the limitations of their monthly budget. For participant households, most deep well pumps were usually five to ten meters away from the house structure, which, according to households, was not too far of a distance to carry buckets of water for personal or household use.

6.3.6 Recruitment of potential customers based on target market criterion

The target market is defined by Laguna Water to be households (a) belonging to the BOP, (b) connected to Laguna Water, (c) without toilets inside the home. Recruiting potential customers of this nature may be quite challenging, as some who belong to the BOP are illegal settlers who do not own property required for connection to a new service connection. During the pilot study, a majority of households in the study areas where BOP families are known to reside already had a toilet at home, albeit it was often an unsanitary toilet. Those that do not have toilets within the home were usually limited to areas near water bodies where waste disposal is relatively easy. The behavioural shift from the use of unsanitary toilets to sanitary portable toilets may entail stringent law enforcement. As such, it may be difficult to initially locate households to meet all the criteria necessary . Instead of considering only households without toilets inside the home, it is worth noting that a number of participants (6 out of 33) had clogged toilets that were reported not to flush properly anymore. These households may also be included as part of the target market, as members of such households find it inevitable to use something almost similar to their old toilets.

6.3.7 Transient nature of BOP households

The transient nature of BOP households may pose a legitimate concern when it comes to the ownership and accountability for the portable toilet. Two out of the 33 participant households pulled out of the Phase II study precisely because of this reason, with one moving out of their house due to security concerns and the other looking for a better structure to accommodate their family. Aside from these households, it is also worth noting that a number of potential participants during Phase I had to back out of the pilot study, as they had to be relocated by the housing authority to make way for the clean-up and riprapping of the nearby water body.

It was observed that, as these households do not have a permanent address, it was difficult for their former neighbours to point the exact location of their relocation. This is a risk for Laguna Water, as the portable toilet could be carried virtually almost anywhere and its materials be reused for other purposes. Although a connection through a water meter may minimise such instances from happening, it is a risk to consider.

It is worth noting, however, that the transiency of BOP households can also be a means to penetrate the market. It was observed that during extreme weather events (such as the flood that occurred on September 2017), quite a number of households had to relocate within the barangay and look for houses that had an available and working toilet.

6.3.8 Utilising used portable toilets

Toilets, being one of the key indicators of sanitation, are considered as personal products that households are quite sensitive to use due to its implications on health and safety. Despite the fact that participants in the pilot study were aware that they were using barrels and cartridges that had been used by other households, the level of acceptance for such a practice may change once users pay for usage of the portable toilet. As such, portable toilets and its appurtenances could be tagged and subject to a monitoring system that enables households ato use their "own" cartridge/barrel.

In addition, it might also be worth noting that portable toilets may not last as long as the lifespan initially proposed by the vendors. As the operational model accounts for the leasing of toilets, the product may end up being overused, especially when transfers happen from household to household. In this aspect, it might be useful to have warranties for the toilet units to ensure the quality of the product made by the vendors.

6.3.9 Constructing a permanent toilet

A number of households estimate that the construction of a permanent unsanitary toilet would cost around PHP 3,000 (USD 59) to PHP 5,000 (USD 98), which is cheaper than the price of a portable toilet. These rough estimates may be itemised into the components shown in Table 58.

Table 58 Cost for permanent toilet

Item	Cost
Toilet	PHP 1,000 (USD 20)- PHP 3,000 (USD 59)
Labour (digging hole)[21]	PHP 1,000 (USD 20)- PHP 2,000 (USD 39)
Other materials (tiles, cement)	PHP 1,000 (USD 20)- PHP 2,000 (USD 39)

One of the challenges in installing permanent, albeit unsanitary toilets is the high upfront cost required once the household decides to build one inside the home. Although presenting an opportunity for the use of portable toilets, these types of unsanitary toilets are the ones BOP households are accustomed to and, as such, are very willing to purchase if they have sufficient funds.

6.3.10 Non-household usage

Several non-household entities expressed interest in the installation of portable toilets inside their establishment. These include, but are not limited to small enterprises (junk shops, billiards, and sari-sari stores) and boarding houses. Due to the number of people using the toilet, it might be useful to note that the portable toilet design may have to vary to cater to this market or there may need to be more frequent collection. More information will also have to be gathered to define clearly the needs of such markets.

6.4 Pull-outs and complaints

Pull-outs, or households that halted participation in the middle of the Phase I and II of the study, were recorded to estimate the possible fall-out rate of potential customers due to various reasons. Reasons which reflect potential implications on marketing the product are detailed in Table 59.

Table 59 Reason for pull-outs

Decision-maker	Reason	Number of households
Household	The toilet was *not used* due to unfamiliarity. Generally, households prefer their old toileting practice over using the portable toilet.	5
	Households had to transfer to another home. They could not bring the portable toilet because their new home already had a permanent toilet or because they were relocating to another province.	2

[21] In the case of some households, labour for building a toilet may be done by adult males in the family.

Decision-maker	Reason	Number of households
	LOOWATT- Households did not have enough space to fit the toilet or enough headroom to use it properly inside the home.	3
	LIXIL- Repeated reports of toilet leakage due to malfunctioning of the acceptance station. Wastes spilled inside the home.	1
Laguna Water	The portable toilet was put in a questionable location where the unit was at risk of being stolen. The proposed location was in an open, unguarded area. As the portable toilets were prototypesmade for the purposes of the pilot study, the portable toilet unit needed to be in a safe and secure location.	1
	LOOWATT- The toilet was used without the plastic-liner. The household had difficulties following instructions. This poses additional risks for the collection and cleaning operators.	1

The frequency of pull-outs was relatively large for the pilot study (26% or 13 out of 45 households). Nonetheless, the majority of the concerns reported (8 out of 13) were not issues with the portable toilet model per se, but with the usage of portable toilets and with behaviour of the community in general. For model-related concerns, Loowatt had more pull-outs due to its size and complexity of instructions, whereas LIXIL had one pull-out due to leakage inside the home.

6.5 Sanitation marketing strategy

Sanitation marketing is an approach that aims to increase demand for sanitation and strengthen private sector's capacity to supply sanitation products and services. The focus on the private sector and the view of households as consumers, rather than beneficiaries, is what sets sanitation marketing apart from conventional approaches to sanitation service provision (WSP, Sanitation Marketing Lessons from Cambodia, 2012).

Sanitation marketing applies the "marketing mix" or the Four Ps: Product, Place, Price, and Promotion. The glue that binds the Four Ps in sanitation marketing is promotion --- communicating details about the product, price, place, and even the behaviour promoted to the target audience (WSP, Introductory Guide to Sanitatrion Marketing). In the case of the portable toilet system, there is a 5th P pertaining to Partnership, a 6th P pertaining to Policy and 7th P pertaining to People.

The World Health Organization (WHO) and the Water Supply and Sanitation Collaborative Council (WSSCC) identified four key drivers of household demands that need to be addressed when it comes to sanitation marketing:

1. awareness of affordable options and their benefits
2. priority for investing in toilets over other potential investments
3. access to a service provider; and
4. influence and ability to make decisions.

Understanding of the business goal, products/services, target sector's demand and delivery model is necessary for the formulation of the sanitation marketing strategy. The vision is to achieve behaviour change in households with regard to sanitation and hygiene using portable toilets. The goal is to place the responsibility of decision-making regarding sanitation and hygiene at the household level. Although a majority still need to be convinced in the study area, it was deemed that home delivery distribution and assistance in product installation was one of the best ways to bring the portable toilets to the household.

Partnership

Need-shaping marketing is the boldest level of marketing that occurs when a company or companies introduce/s a product or service that nobody asked for and often could not even conceive of (Kotler, 1999). Given that the majority of households in the target areas already have *unsanitary* toilets, Laguna Water might need to create new markets with the portable toilet system that will "change the rules of the game". This type of market driving creates new markets, generates significantly new products, services and business formats.

LIXIL and Loowatt have developed their toilet models by focusing on 'product specialization', wherein the portable toilet is specialized and tailored to the market that does not have access to proper facilities involving water, sanitation and hygiene. On the other hand, product positioning will have to be established by Laguna Water being the entity with local presence of the partnership in the communities. The image or identity created in the minds of the target users is Laguna Water's organizational capability, which can be developed by being a ready-access service provider that makes use of hotline and customer service departments that can answer questions, handle complaints, and resolve problems in a satisfactory and timely manner.

Product

With portable toilets being an entirely new type of technology in the country, one will have to market the product such that when people think of household portable toilets, they will think of Laguna Water's chosen portable toilet system. The portable toilet model should be a brand that readily identifies the product so that it will not be viewed as another commodity in the household. The mere mention of portable toilet should be able to create a mental image that the product is safe, clean, easy to use, and does not emit a foul smell. Customers should think that the portable toilet has desirable qualities purposely designed for their comfort and safety.

In this light, branding might serve as a vital aspect in the promotional marketing of the portable toilet. The brand may convey: (1) attributes of the portable toilet, (2) its benefits, (3) the values of the producer; (4) the culture of the producer that conveys quality of the company; and, (5) the user (Kotler, 1999). Since the proposed business will be pioneering in the field of sanitation, there may be a constant threat of imitation and production of a similar type of product at a very low price with few modifications. Brand development, as such, will entail: (1) focus on differentiation, (2) claiming share of the "heart", (3) developing brand charisma, (4) building a brand culture, (5) installing a brand management system, (6) balancing consistency with change, and (5) treating branding as an investment, not a cost.

Price

The factors considered in price setting are inclusive of the value of the permit to use the intellectual property of the product, business costs (direct and indirect), distribution channels and sales turnover. As demand increases, bulk purchase may allow Laguna Water to lower the cost of the unit so that it becomes more affordable to the households.

Process

Process starts from actual product transportation from the place of manufacturing, which may involve special handling and freight forwarding. Although the vendors plan to localise manufacturing of their products, there is still a need for extensive communication and knowledge of the information network between the exporter (vendor) and the forwarder, as well as the recipient (Laguna Water). Labelling and packaging done in a Philippines warehouse may be done with translations to the local language for better understanding of directions or instructions and added details.

The hiring of appropriate manpower, who are later trained for the specialized knowledge about the product and its handling, site familiarization, risk assessment (involving business, people inside [staff] and outside [community]) also contributes to the successful (on time and complete) delivery of the product in all aspects.

Issues within the households may also be a matter of importance as families that are undecided on availing of the portable toilet service may seek advice from Laguna Water or negotiate about certain aspects of the process (e.g. mode of payment).

Promotion

Promotion of the portable toilet solution involves awareness on proper hygiene and sanitation by establishing the link between getting water from deep wells, faecal pollution and disease outbreaks due to groundwater contamination. Clear information passed on through information, education and communication (IEC) campaigns and the use of other materials may help establish a bigger picture mentality in the community. Elaborate visuals (videos, posted advertisements, sponsorships in events) are also usually effective especially in illustrating specific messages. Key influencers in the community can be “product champions” during promotional activities by sharing the testimonials and benefits of using a portable toilet.

The vulnerability of women in terms of acquired ailments during menstruation should be emphasized, as well as the danger of physical/sexual harassment because of the households’ lack of clean and decent toilet. Women’s need for privacy and water to clean up may be used as a “heart route” in promoting the product.

People

Marketing staff, especially those in sales, should have specialized knowledge of the industry. They have the responsibility to give feedback about customers’ needs to those in charge of product development. Moreover, staff involved in sales will also serve the same customers for a long period of time.

As the focus of marketing is the customer, it may be an advantage if Laguna Water can temporarily establish a “pay per use” communal toilet that can temporarily provide for the sanitation needs of households that do not have toilets, but are not necessarily connected to Laguna Water.

Policies

The local government has a significant role to play on policy formulation and compliance monitoring as the new approach to sanitation and hygiene may require fundamental shifts in policies, financing, organizational arrangements and implementation approaches.

There is a need to push and support the development of policies that need to be formulated and passed at the national or regional level/s that will require all households surrounding bodies of water to own toilets and ban open defecation. In this aspect, it is worth noting that the municipality of Laguna has already passed a local ordinance (effective first quarter of April 2018) requiring all households and commercial establishments to be connected to a sanitation service.

7. Project risk assessment

Similar to health and safety, a number of potential risks to the PTS business or 'project' were identified and categorized based on the project phase as follows: pre-construction phase, design phase, construction phase, operation and maintenance phase. The summary table of the risk assessments is presented in Table 60.

The list is not intended to be comprehensive list, but rather, as a starting point for a more formal and thorough risk management approach (including the development of specific risk management plans for high and extreme risks). A number of significant and major risks were assessed in the different phases of the project. A summary of major risks is provided in the succeeding sections below.

Pre-construction

During pre-construction, project related activities relate mostly to compliance with statutory requirements (e.g. building permits, ECC/CNC), funding, difficulty of land acquisition and the social acceptability of the project.

The biggest risks in the implementation of the project are the unavailability of funds, difficulties in land acquisition (for the locations of storage facilities) and right-of-way (ROW) issues (for pipe alignment). These issues should be addressed during the initial phases of the project, as to not delay succeeding investigations and design phases.

The failure of Laguna Water to secure statutory clearances and permits may lead to major legal repercussions such as major breach of regulations resulting in major litigation. Implications of legal dispute may also bring negative attention to the project that may lead to the credentials of Laguna Water being tarnished. The identification of such risks leads to putting emphases on the project acquiring all required permits prior to commencement.

Design

GHD identifies that one of the high-risk items during the design phase is the estimation of households without toilet facilities. Projections have been completed on a theoretical basis with assumptions adopted from the information obtained from one-year CHO data. GHD strongly recommends that these projections be verified and assessed by monitoring the yearly data from CHO of each city.

GHD has noted as well that the design of the portable toilet should be applicable to the local market in order to ensure continuous patronage from the users. It should be made right the first time to prevent a non-repeat acquisition from the potential users.

Construction

Moderate to high risks were identified in the construction of the acceptance stations. These risks include construction of deep excavations, construction in heavily trafficable areas, adverse weather (heat and wet weather) and failure to build the system according to design standards and grade. In cases of deep excavation, the contractor must provide safe construction methodology and adopt suitable trench shoring to support the large excavations. GHD would like to emphasize that it is important that workers that will be hired have appropriate qualifications to prevent the risk of non-performance and negligence of workers to HSE policy that may result in serious injury.

Operation and maintenance

During the operation, risks assessed as high and extreme are associated with the handling and monitoring of the portable toilets. Thus, training should be provided to personnel who will be handling/transporting the cartridges/barrels from households to acceptance stations.

Table 60 Qualitative risk assessment - Identified risks for PTS project

Risks	Likelihood	Consequence	Category	Mitigation Measures
Pre-construction phase				
Project funding	4	E	Extreme	Include CAPEX and OPEX (thorough cost estimates) in Laguna Water's Business plan
Land acquisition for AS sites	4	E	Extreme	Early negotiations with owners
Right of Way Approval	3	C	High	Early negotiations
LGU endorsements and regulatory permits	3	B	Moderate	Acquire all regulatory permits prior to commencement
Objection of local residents or social non-acceptability of the project	3	C	High	Carry out information and educational campaigns to show benefits of the project
Design phase				
Household projections	4	B	High	Carry out staged developments to provide flexibility of the system for upgrade in the future; obtain historical data on households without toilets in the area. Conduct a survey of existing Laguna Water customers.
Percentage of households without a toilet	4	B	High	
Portable toilet design is not applicable to local market	4	C	High	Thorough market study and design to complement local requirements.
Construction phase				
Absence of contractor QA system	3	B	Moderate	Laguna Water to assess QA systems during bid phase
Weather	3	C	High	Provision of adequate allowance for the construction program; areas prone to flooding to be constructed during the dry season.
Construction adjacent to traffic	3	C	High	Traffic management strategy and plan for approval and implementation
Deep Excavation	3	C	High	Contractor to provide safe work methods statement (methodology)
Pollution of waterways from construction runoffs	3	B	Moderate	Silt fencing and runoff management during construction

Risks	Likelihood	Consequence	Category	Mitigation Measures
Operation and maintenance phase				
Theft and maintenance of AS/IBS and its accessories	3	D	Extreme	Secure the acceptance station through dedicated maintenance personnel and locked facility.
Migration of households	3	D	Extreme	Frequent monitoring of households.
Poor fee collection for services	4	C	High	
Spillage of waste upon transportation	3	C	High	Proper training given to operators
Potential risk for health and safety of operators	4	C	High	

8. Legal and regulatory compliance

Laguna Water and its contractors should comply with all laws, regulations, standards, statutory licenses and other legislative requirements which apply to their construction and operations, and exercise a duty of care with respect to personnel, environment and the communities in which construction and operational activities are conducted. Table 61 outlines the relevant legislation governing the project including applicable environmental permits and licenses.

Table 61 Relevant legislation

National regulations on wastewater management
• RA 9275: Philippine Clean Water Act of 2004 • PD 856: Philippine Clean Water Act and the Sanitation Code • 2004 Revised IRR of Presidential Decree 1096 or revised Implementing Rules and Regulations of the National Building Code of the Philippines
Licenses and permits
• Local government units • Prior to any development activities, Laguna Water should liaise with the Local Government Units (LGUs) to confirm and secure other permits and clearances that may be required, including but not limited to the following: ○ Barangay clearance ○ Building permit ○ Locational/Zoning clearance ○ Sanitation permit ○ Electrical permit ○ Excavation permit ○ Other Ancillary Permits of Building Permit ○ Bureau of Fire Protection Inspection permit ○ DENR permits ○ For the project a CNC or an ECC might be required by the DENR prior to start of the project development ○ Vacuum truck requires EMB registration ○ Tree cutting permit if trees are present on site ○ Permit to operate (PTO) ○ Business permit ○ Permit to transport hazardous waste

The Philippine Clean Water Act of 2004

The Philippine Clean Water Act of 2004 is an act providing for a comprehensive water quality management and for other purposes. *Chapter 1 – General Provisions, Article 1 – Declaration of Principles and Policies, Section 2. Declaration of Policy* states that the State shall pursue a policy of economic growth in a manner consistent with the protection, preservation and revival of the quality of our fresh, brackish and marine waters. To achieve this end, the framework for sustainable development shall be pursued. As such, it shall be the policy of the State:

- To streamline processes and procedures in the prevention, control and abatement of pollution of the country's water resources
- To promote environmental strategies, use of appropriate economic instruments and of control mechanisms for the protection of water resources
- To formulate a holistic national program of water quality management that recognizes that water quality management issues cannot be separated from concerns about water sources and ecological protection, water supply, public health and quality of life
- To formulate an integrated water quality management framework through proper delegation and effective coordination of functions and activities
- Promote commercial and industrial processes and products that are environment friendly and energy efficient
- To encourage cooperation and self-regulation among citizens and industries through the application of incentives and market-based instruments and to promote the role of private industrial enterprises in shaping its regulatory profile within the acceptable boundaries of public health and environment
- To provide for a comprehensive management program for water pollution focusing on pollution prevention
- To promote public information and education and to encourage the participation of an informed and active public in water quality management and monitoring
- To formulate and enforce a system of accountability for short and lon g-term adverse environmental impact of a project, program or activity
- To encourage civil society and other sectors, particularly labour, the academe and business undertaking environment-related activities in their efforts to organize, educate and motivate the people in addressing pertinent environmental issues and problems at the local and national levels

Chapter 2 – Water Quality Management System, Article 1 – General Provision, Section 7. National Sewerage and Septage Management Program states that the Department of Public Works and Highways (DPWH), through its relevant attached agencies, in coordination with the Department, local government units (LGUs) and other concerned agencies, shall, as soon as possible, but in no case exceeding a period of twelve (12) months from the affectivity of this Act, prepare a national program on sewerage and septage management in connection with Section 8 hereof.

Such program shall include a priority listing of sewerage, septage and combined sewerage-septage projects for LGUs based on population density and growth, degradation of water resources, topography, geology, vegetation, program/projects for the rehabilitation of existing facilities and such other factors that the Secretary may deem relevant to the protection of water quality. On the basis of such national listing, the national government may allot, on an annual basis, funds for the construction and rehabilitation of required facilities.

Each LGU shall appropriate the necessary land, including the required rights-of-way/road access to the land for the construction of the sewage and/or septage treatment facilities.

Each LGU may raise funds to subsidize necessary expenses for the operation and maintenance of sewage treatment or septage facility servicing their area of jurisdiction through local property taxes and enforcement of a service fee system.

In *Chapter 2, Article 1, Section 8. Domestic Sewage Collection, Treatment, and Disposal* - within five (5) years following the effectivity of this Act, the Agency vested to provide water supply and sewerage facilities and/or concessionaires in Metro Manila and other highly urbanized cities (HUCs) as defined in Republic Act No. 7160, in coordination with LGUs, shall be required to connect the existing sewerage line found in all subdivisions, condominiums, commercial centers, hotels, sports and recreational facilities, hospitals, market places, public buildings, industrial complex and other similar establishments including households to available sewerage system. Provided, that the said connection shall be subject to sewerage services charge/fees in accordance with existing laws, rules or regulations unless the sources had already utilized their own sewerage system: Provided, further, that all sources of sewage and septage shall comply with the requirements herein.

In areas not considered as HUCs, the DPWH in coordination with the Department, DOH and other concerned agencies, shall employ septage or combined sewerage-septage management system.

For the purpose of this section, the DOH, coordination with other government agencies, shall formulate guidelines and standards for the collection, treatment and disposal of sewage including guidelines for the establishment and operation of centralized sewage treatment system.

Chapter 2, Article 2 – Water Pollution Permits and Charges, Section 13. Wastewater Charge System states that the Department shall implement a wastewater charge system in all management areas including the Laguna Lake Region and Regional Industrial Centers through the collection of wastewater charges/fees. The system shall be established on the basis of payment to the government for discharging wastewater into the water bodies. Wastewater charges shall be established taking into consideration the following:

- To provide strong economic inducement for polluters to modify their production or management processes or to invest in pollution control technology in order to reduce the amount of water pollutants generated
- To cover the cost of administering water quality management or improvement programs
- Reflect damages caused by water pollution on the surrounding environment, including the cost of rehabilitation
- Type of pollutant
- Classification of the receiving water body
- Other special attributes of the water body

In *Chapter 2, Article 2, Section 14. Discharge Permits* - the Department shall require owners or operators of facilities that discharge regulated effluents pursuant to this Act to secure a permit to discharge. The discharge permit shall be the legal authorization granted by the Department to discharge wastewater: provided, that the discharge permit shall specify among others, the quantity and quality of effluent that said facilities are allowed to discharge into a particular water body, compliance schedule and monitoring requirement.

As part of the permitting procedure, the Department shall encourage the adoption of waste minimization and waste treatment technologies when such technologies are deemed cost effective. The Department shall also develop procedures to relate the current water quality guideline or the projected water quality guideline of the receiving water body/ies with total pollution loadings from various sources, so that effluent quotas can be properly allocated in the discharge permits. For industries without any discharge permit, they may be given a period of 12 months after the effectivity of the implementing rules and regulations promulgated pursuant to this Act, to secure a discharge permit.

Effluent trading may be allowed per management area.

The Sanitation Code of the Philippines

In the Sanitation Code of the Philippines, P.D. 856, the pertinent regulations for wastewater management system are in Chapter XVII – Sewage Collection and Disposal, Excreta Disposal and Drainage.

Chapter XVII, Section 75 – Septic Tanks

Where a public sewerage system is not available, sewer outfalls from residences, schools, and other buildings shall be discharged into a septic tank to be constructed in accordance with the following minimum requirements:

- It shall be generally rectangular in shape. When a number of compartments are used, the first compartment shall have a capacity from one-half to two-thirds of the total volume of the tank
- It shall be built of concrete, whether precast or poured in place. Brick, concrete blocks or adobe may be used
- It shall not be constructed under any building and within 25 meters from any source of water supply

Chapter XVII, Section 76 – Disposal of Septic Tank Effluent

The effluent from septic tank shall be discharged into a sub-surface soil, absorption field where applicable or shall be treated with some type of a purification device. The treated effluent may be discharged into a stream or body of water if it conforms to the quality standards prescribed by the National Water and Air Pollution Control Commission.

The Revised Implementing Rules and Regulations of the National Building Code of the Philippines

The relevant regulations in the Revised Implementing Rules and Regulations of the National Building Code of the Philippines, P.D. 1096, are in Rule IX – Sanitation.

Rule IX, Section 901. General Requirements

Subject to the provisions of Book II of the Civil Code of the Philippines on Property, Ownership, and its Modification, all buildings hereafter erected, altered, remodeled, relocated or repaired for human habitation shall be provided with adequate and potable water supply, plumbing installation, and suitable wastewater treatment or disposal system, storm water drainage, pest and vermin control, noise abatement device, and such other measures required for the protection and promotion of health of persons occupying the premises and others living nearby.

Rule IX, Section 903. Wastewater Disposal System

- Sanitary sewage from buildings and neutralized or pre-treated industrial wastewater shall be discharged directly into the nearest street sanitary sewer main of existing municipal or city sanitary sewerage system in accordance with the criteria set by the Code on Sanitation of the Philippines and the DENR.
- All buildings located in areas where there are no available sanitary sewerage system shall dispose their sewage to “Imhoff” or septic tank and subsurface absorption field or to a suitable waste water treatment plant or disposal system in accordance with the Code on Sanitation of the Philippines and the Revised National Plumbing Code of the Philippines.
- Sanitary and industrial plumbing installations inside buildings and premises shall conform to the provisions of the Revised National Plumbing Code of the Philippines.

9. Summary and conclusions

The two Portable Toilet Systems (PTS) were objectively compared using a Multi-Criteria Analysis (MCA) approach that assigned different weightings on identified criterion and parameters. Results show that:

- Overall, Loowatt's system is the recommended PTS with a total MCA score of 87.48% as compared to LIXIL's system with a MCA score of 54.18%.
- Loowatt's system is preferred in terms of financial, environmental and customer satisfaction criterion. LIXIL's system is preferred in terms of health and safety, and ability to scale up criterion.
- The estimated total capital expenditure (CAPEX) amounted to PHP 619.68 million (USD 12.15 million) for LIXIL's system and PHP 532.16 million (USD 10.43 million) for Loowatt's system. The total operational expenditure (OPEX) for both were also computed for 2018 to 2035 and amounted to PHP 851.19 million (USD 16.69 million) for LIXIL's system, and PHP 756.78 million (USD 14.84 million) for Loowatt's system.

Baseline water quality assessment was conducted in relation to the health condition in the area. Additionally, the effects of the PTS operation once it has been rolled out can be verified through comparison with the following baseline results:

- BOD and total coliform were beyond the limit set by DAO 2016-08 water quality guideline in all four sampling stations for both Phase I and Phase II. This can be attributed to the improper disposal and treatment of human excrements in the area. The use of PTS in this area can possibly decrease the level of these parameters.
- There were also exceedances on COD, oil and grease, and TSS levels against the DAO 2016-08 guideline. This can be attributed to the domestic and industrial activities near the sampling sites. Even so, the operation of PTS should prevent worsening the current conditions of these parameters.
- Results for colour and pH levels were all within the DAO 2016-08 guideline value. This has to be kept within guideline value once the PTS is in operation.
- Values were higher on several parameters in Barangay Pooc (NIA 1 and NIA 3) than in Barangay Macabling (Iraq #8 and Jordan #2) likely because of higher population density in Barangay Pooc.

Through a project risk assessment, a number of potential risks to the project were identified and categorized based on the project phase. Extreme risks identified were insufficient funding, difficulty in land acquisition, possible theft of AS/IBS equipment and potential migration or resettlement of households. Recommendations to address these risks include:

- Early negotiation with land owners
- Assignment of dedicated maintenance personnel and provision of locked facility
- Frequent monitoring of households

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