Annex I

Collection Service Experiment

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I Collection Service Experiment

I.1 Outline of the Project

a. Objectives

Objectives of this pilot project are as follows:

- examining suitability of container collection system in areas where collection service is insufficiently or not at all provided,

- applying findings acquired through this pilot project to a M/P, and

- Technology Transfer.

Areas, where the waste collection service is insufficiently or not at all provided, are generally inaccessible for collection vehicles. The main objective of this pilot project is to examine the suitability of the container collection system to such areas.

Findings, which are acquired through this pilot project, are to be applied to a M/P to make it practical and sustainable.

Technology will be transferred from the Study Team to the C/Ps and vice versa.

b. Pilot Project Sites

Two pilot project sites were selected, one is Maria Auxiliadora in Cuscatancingo, the other is 10 de Octubre in San Marcos. Profiles of the sites are described hereinafter.

Maria Auxiliadora, Cuscatancingo

- The number of houses covered with the container collection system was 190.

- This site is totally inaccessible for vehicles, therefore, containers need to be placed out of the site.

- Spaces at which containers can be position are only upper side of the site. The residents need to climb up for discharging waste into the containers. They used to dump waste into the river, which runs just under the site.

- The longest distance from houses to the containers is around 100m.

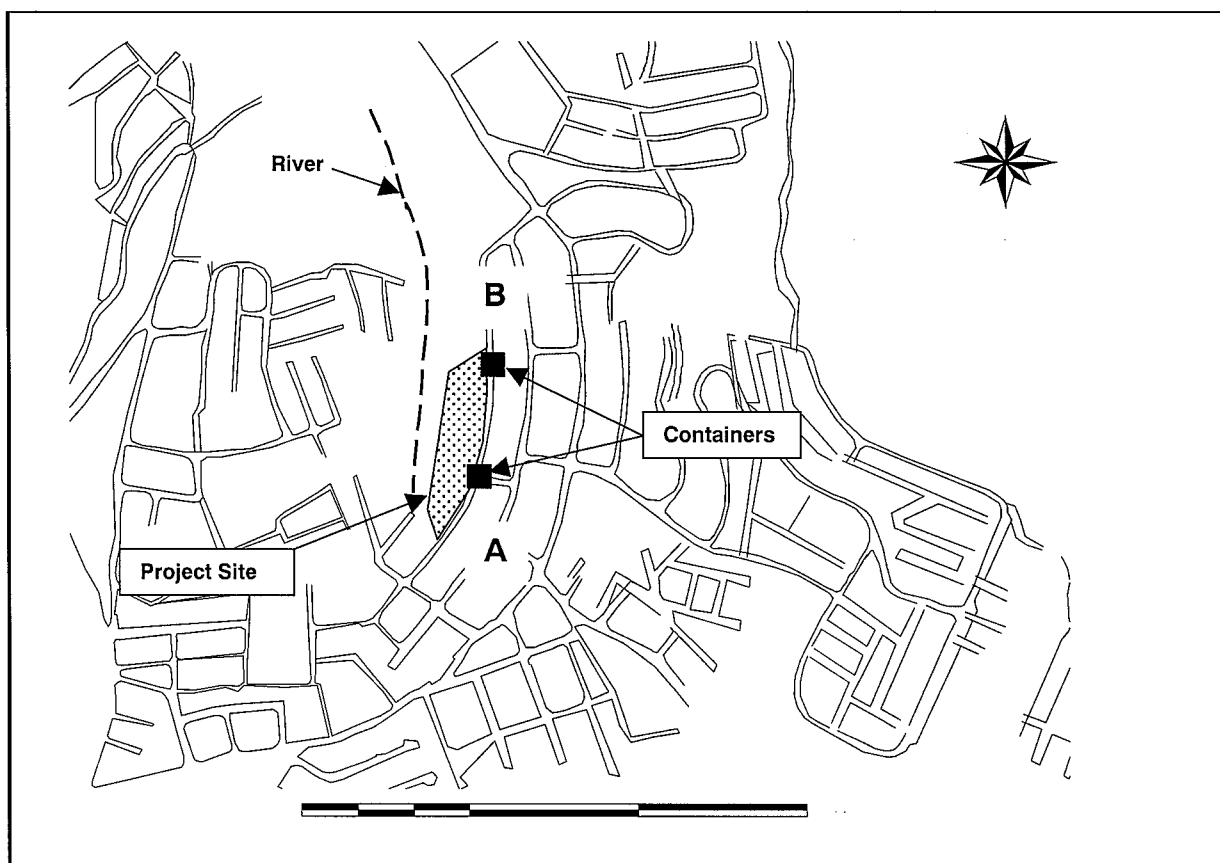- The residents had never received waste collection service before.

Figure I-1: Map of Project Site (Maria Auxiliadora, Cuscatancingo)

10 de Octubre, San Marcos

• The number of houses covered with the container collection system was 300.

• An accessible road for collection vehicles passes through the site. There are spaces for placing containers along the road, i.e., in the site.

• The containers are placed in the central part of the site. The upper part of the site is steeper than the lower part. The residents in the upper part can come down for carrying waste to the containers.

• The longest distance from houses to containers is around 150m.

• Half of the residents have been covered with collection service since before. One container was placed, but waste was almost always spilt from and scattered around it.
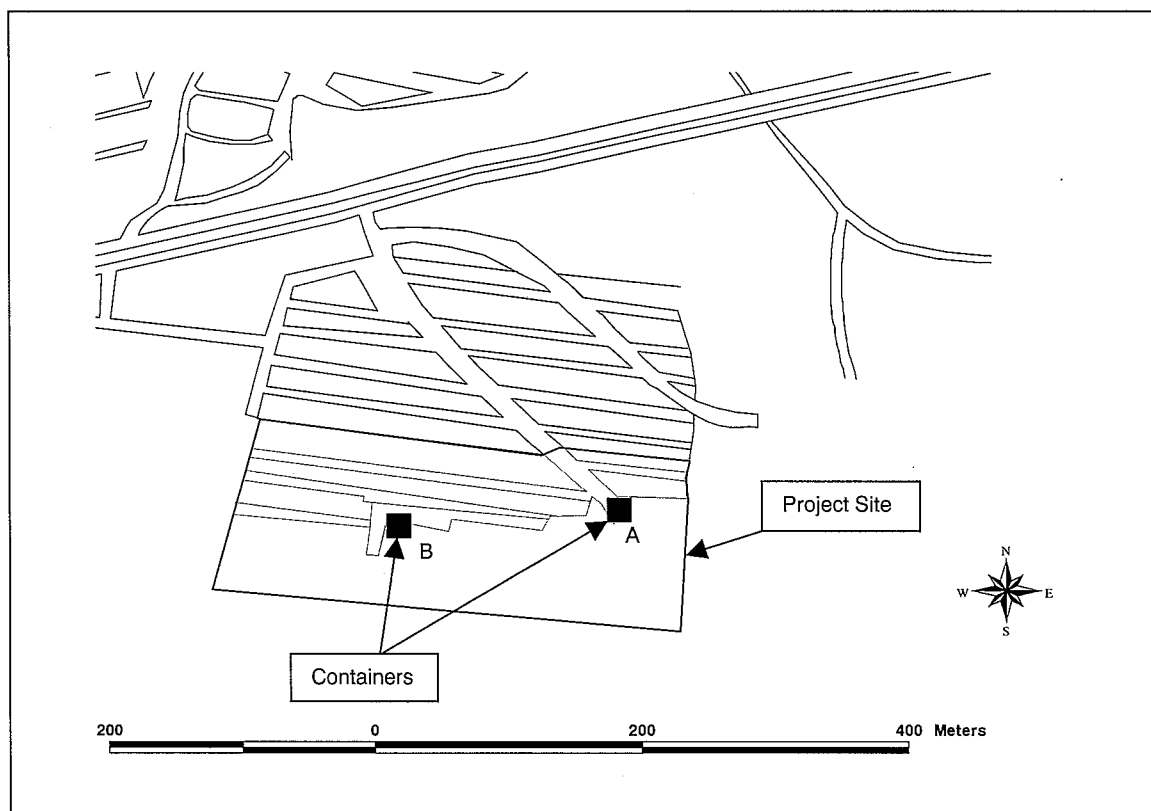

Figure I-2: Map of Project Site (10 de Octubre, San Marcos)

c.   Schedule

This pilot project was carried out according to the schedule below.

Table I-1: Schedule of Collection Service Experiment

Date		Activities	Community	Municipality	Study Team
CT	SM				
May 8 - 13	May 5	Explanation of discharge manner (from municipalities to community leaders) The municipalities had meetings with the community leaders to explain how to discharge waste into the containers and ask them to convey it to the residents of the project sites (communities).	●	●	○
May 15 -May 26	May 8 -14	Explanation of discharge manner (from community leaders to residents) The community leaders conveyed the manner of how to discharge waste to the residents of the communities.	●	○	
May 27	May 14	Placement of the containers JICA Study Team provided containers to the municipalities, and they placed the containers at the sites.		●	●
May 29	May 15	Commencement of collection service The residents started to dispose of waste according to the manner and the municipalities began to provide the waste collection service.	●	●	
May 29 - June 18	May 15 - June 18	Observation The municipalities observed and recorded collection amount, collection time, and waste scattering around the containers.		●	
June 12 - 16	May 29 - June 2	Questionnaire on the container collection system The municipalities' personnel interviewed the residents of the communities in order to obtain their opinion on the container collection system.	○	●	

●: main
○: support

I.2   Methodology

Methodology applied to the pilot project is as follows:

i.   Installation of Proper Number of Containers

- 2 m³ capacity of containers were selected for this pilot project, which can be lifted by the 18yd³ compactor truck that has a winch.

- In order to install proper number of containers, the houses to be covered with the collection service has been clearly defined. And the number of houses was counted.

- Waste generation amount was estimated on the basis of the number of houses and the results of WACS carried out in this Study.

- The number of containers to be required was estimated from the waste generation amount. This calculation is presented in Table I-2 and Table I-3. Consequently, 4 containers in Maria Auxiliadora, Cuscatancingo and 6 containers in 10 de Octubre, San Marcos have been placed. Each site has two places for containers, therefore, 2 containers in each place in Maria Auxiliadora and 3 containers in each place in 10 de Octubre were installed.

ii.   Encouragement of Proper Discharge

- In order to encourage proper discharge, which is:

  > "to put waste into the containers not to leave it around the containers or any other places."

  The manner was conveyed to the residents before the placement of the containers.

- Besides the principal manner, in order to avoid adverse impacts of the containers on the surroundings such as odor, an instruction that is:

  > "to put waste in the morning on the days when the collection vehicle passes,"

  is also given.

- The discharge manner was basically conveyed as follows:

  from municipal personnel to community leaders, and

  from community leaders to residents in the sites.

iii.   Evaluation

- Evaluation of the pilot project was carried out based on the results of:

  – observation of collection amount, collection time and waste scattering around the containers, and

  – questionnaire survey conducted after the implementation of the collection service.

Table I-2: Calculation of Required Number of Containers (Maria Auxiliadora, Cuscatancingo)

Estimation of waste generation amount

a) The target population: about 1,000 persons
   The target site has 190 houses, 190 houses x 5 persons/house = 950 persons (it is assumed that a family has five persons).
b) Waste generation ratio: 0.475 kg/person/day
   0.475kg/person/day is the result of the WACS
c) Waste generation amount (ton/day): 0.475 x 950 / 1,000 = 0.45 ton/day
d) Bulk density of household waste: 0.2 ton/m³
   0.2 ton/m³ is the result of the WACS
e) Waste generation amount: 0.45 / 0.2 = 2.25 m³/day
f) Collection waste amount per collection time: 2.25 x 3 days = 6.75 m³
   When collection frequency is 3 times a week, the longest duration where the collection vehicle does not come is for 3 days.
g) Volume of container: 2 m³
h) Required number of containers: 6.75 / 2 = 3.375
   4 containers are required.

Table I-3: Calculation of Required Number of Containers (10 de Octubre, San Marcos)

1. Estimation of waste generated from the area

a) The target population: about 1,500 person
   The target area has 300 houses, 300 houses x 5 persons/house = 1,500 persons (it is assumed that a family has five persons).
b) Waste generation ratio: 0.475 kg/person/day
   0.475kg/person/day is the result of the WACS
c) Waste generation amount (ton/day): 0.475 x 1,500 / 1,000 = 0.71 ton/day
d) Bulk density of household waste: 0.2 ton/m³
   0.2 ton/m³ is the result of the WACS
e) Waste generation amount: 0.71 / 0.2 = 3.55 m³/day
f) Collection waste amount per collection time: 3.55 x 3 days = 10.65 m³
   When collection frequency is 3 times a week, the longest duration where the collection vehicle does not come is for 3 days.
g) Volume of container: 2 m³
h) Required number of containers: 10.65 / 2 = 5.325
   6 containers are required.

I.3 Results of the Project

a. Observation

The municipal personnel, i.e., drivers of collection vehicles, observed and recorded collection amount, collection time, and waste scattering around the containers.

The results are shown in Table I-4 and Table I-5.

Table I-4: Results of the Observation of Collection Service Experiment (Maria Auxiliadora, Cuscatancingo)

Date	Day	Place	Collection amount			Collection time			Observation
			Full	Half	ton*	Arr.	Dep.	Min.	
29-May	Mon	A	2		0.8	10:10	10:30	20	No waste scattered on the platforms and around.
29-May	Mon	B		2	0.4	10:30	10:50	20	"
31-May	Wed	A	2		0.8	10:25	11:40	15	"
31-May	Wed	B		2	0.4	10:50	11:05	15	"
2-Jun	Fri	A	2		0.8	10:25	10:40	15	"
2-Jun	Fri	B		2	0.4	10:50	11:05	15	"
5-Jun	Mon	A	2		0.8	11:00	11:15	15	"
5-Jun	Mon	B		2	0.4	11:25	11:40	15	"
7-Jun	Wed	A	2		0.8	10:25	10:40	15	"
7-Jun	Wed	B		2	0.4	10:50	11:05	15	"
9-Jun	Fri	A	2		0.8	10:25	10:40	15	"
9-Jun	Fri	B		2	0.4	10:50	11:05	15	"
12-Jun	Mon	A	2		0.8	11:45	12:00	15	"
12-Jun	Mon	B		2	0.4	12:10	12:25	15	"
14-Jun	Wed	A	2		0.8	10:25	10:40	15	"
14-Jun	Wed	B		2	0.4	10:50	11:05	15	"
Ave.					0.6			16	

Note: *Collection amount (ton) is calculated as follows:
((1 full container)+(1 half container)/2) x 2m³ x 0.2 ton/m³ = 0.6 ton

Table I-5: Results of the Observation of Collection Service Experiment (10 de Octubre, San Marcos)

Date	Day	Place	Collection amount			Collection time			Observation
			Full	Half	ton*	Arr.	Dep.	Min.	
15-May	Mon	A	1	2	0.8	8:00	8:20	20	Kept clean
15-May	Mon	B	3		1.2	8:25	9:05	40	A little waste is scattered around the containers
17-May	Wed	A	2	1	1.0	10:45	11:05	20	No waste is scattered. The place is kept clean. All the waste is inside the containers.
17-May	Wed	B	2	1	1.0	11:10	11:35	25	No waste is scattered. The place is kept clean. All the waste is inside the containers.
19-May	Fri	A	2	1	1.0	10:20	10:40	20	Kept clean
19-May	Fri	B	2	1	1.0	10:45	11:10	25	Kept clean
22-May	Mon	A	3		1.2	11:30	11:50	20	Kept clean
22-May	Mon	B	3		1.2	11:55	12:15	20	Kept clean
24-May	Wed	A	2	1	1.0	10:50	11:10	20	Kept clean
24-May	Wed	B	2	1	1.0	11:15	11:35	20	Kept clean
29-May	Mon	A	3		1.2	10:45	11:05	20	Kept clean
29-May	Mon	B	3		1.2	11:10	11:30	20	Kept clean
31-May	Wed	A	2	1	1.0	10:45	11:05	20	Kept clean
31-May	Wed	B	2	1	1.0	11:10	11:30	20	Kept clean
5-Jun	Mon	A	3		1.2	10:45	11:05	20	Kept clean
5-Jun	Mon	B	3		1.2	11:10	11:30	20	Kept clean
7-Jun	Wed	A	2	1	1.0	10:45	11:05	20	Kept clean
7-Jun	Wed	B	2	1	1.0	11:10	11:30	20	Kept clean
9-Jun	Fri	A	2	1	1.0	10:45	11:05	20	Kept clean
9-Jun	Fri	B	2	1	1.0	11:10	11:30	20	Kept clean
12-Jun	Mon	A	3		1.2	10:45	11:05	20	Kept clean
12-Jun	Mon	B	3		1.2	11:10	11:30	20	Kept clean
14-Jun	Wed	A	2	1	1.0	10:45	11:05	20	Kept clean
14-Jun	Wed	B	2	1	1.0	11:10	11:30	20	Kept clean
16-Jun	Fri	A	2	1	1.0	10:45	11:05	20	Kept clean
16-Jun	Fri	B	2	1	1.0	11:10	11:30	20	Kept clean
19-Jun	Mon	A	3		1.2	10:45	11:05	20	Kept clean
19-Jun	Mon	B	3		1.2	11:10	11:30	20	Kept clean
Ave.					1.07			21	

Note: *Collection amount (ton) is calculated as follows:
((2 full containers)+(1 half container)/2) x 2m³ x 0.2 ton/m³ = 1.0 ton

b. Questionnaire Survey

The questionnaire survey was carried out by the municipal personnel. The number of samples was 50 houses in each site. This means that 26% of the target houses in Maria Auxiliadora (50/190), and 17% in 10 de Octubre (50/300) were interviewed.
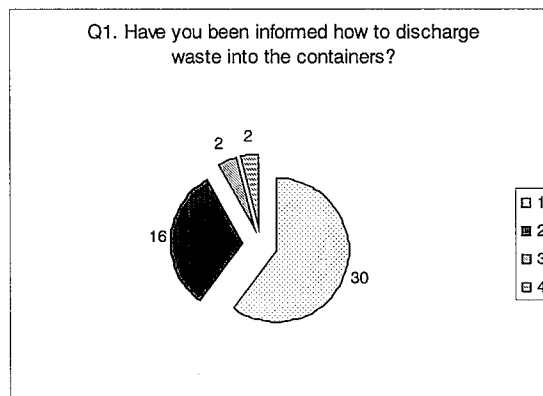
The results are shown below.

b.1. Maria Auxiliadora, Cuscatancingo

Q1   Have you been informed how to discharge waste into the containers?

1. Yes, by the municipal personnel.
2. Yes, by the community leaders.
3. Yes, by the pamphlet.
4. Yes, by other way. Please specify.

Answer

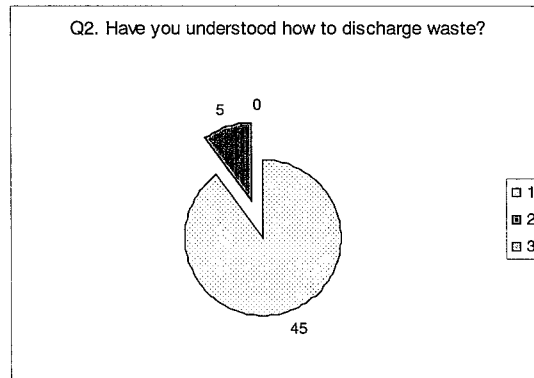| 1	2	3	4	Total
30	16	2	2	50

Q1. Have you been informed how to discharge waste into the containers?

Q2   Have you understood how to discharge waste?

1. Yes, very well
2. Yes, so-so.
3. No. Please specify the reason.
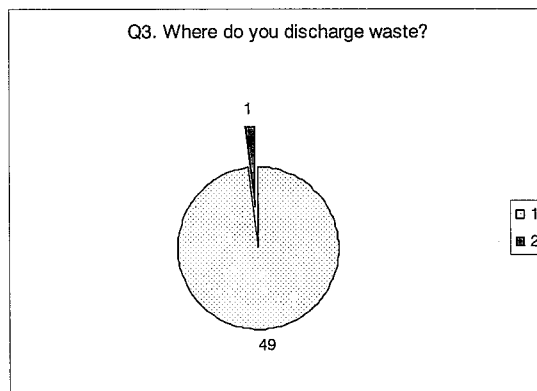
Answer

1	2	3	Total
45	5	0	50

Q2. Have you understood how to discharge waste?

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Q3   Where do you discharge of the waste?

1. In the container.
2. Not in the container. Please specify.

Answer

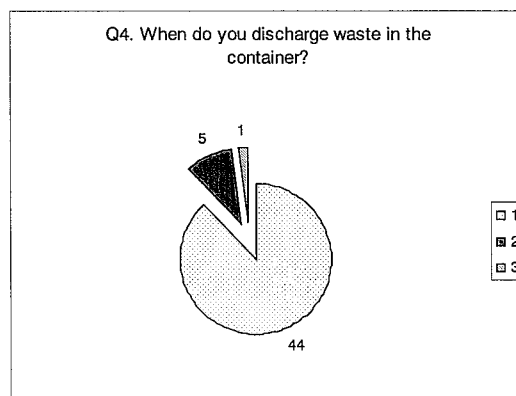| 1	2	Total
49	1	50

Q4   When do you discharge of the waste in the container?

1. In the morning before the collection vehicle comes.
2. One day before the collection days.
3. Other. Please specify the reason.

Answer

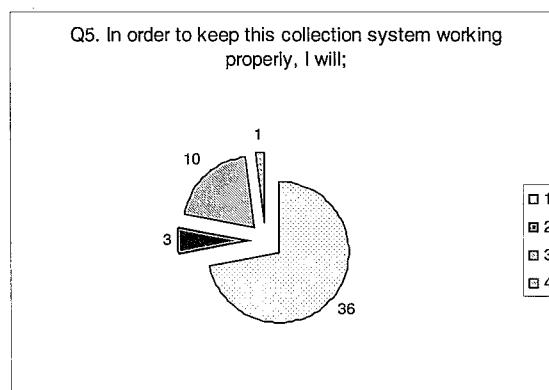| 1	2	3	Total
44	5	1	50

Q5   In order to keep this collection system working properly, I will

1. keep the waste discharge manner as required.
2. clean around the container.
3. keep the waste discharge manner and clean around the container.
4. not cooperate for the collection system.

Answer

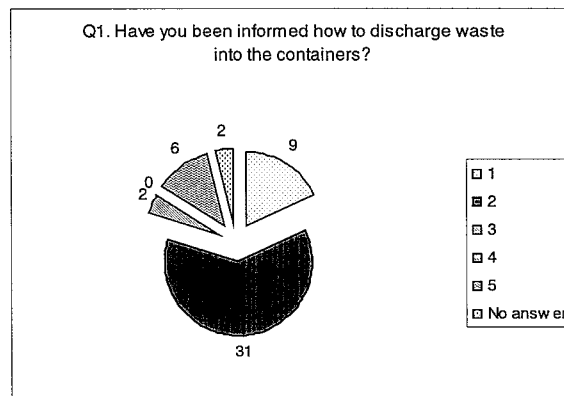| 1	2	3	4	Total
36	3	10	1	50

I-10

b.2. 10 de Octubre, San Marcos

Q1 Have you been informed how to discharge waste into the containers?

1. Yes, by the municipal personnel.
2. Yes, by the community leaders.
3. Yes, by the pamphlet.
4. Yes, by other way. Please specify.

Answer

1	2	3	4	5	No answer	Total
9	31	2	0	6	2	50

Q1. Have you been informed how to discharge waste into the containers?
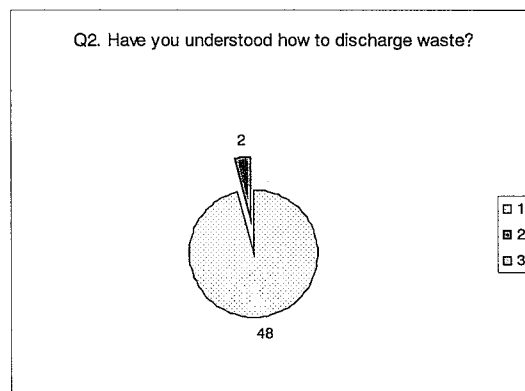
Q2 Have you understood how to discharge waste?

1. Yes, very well
2. Yes, so-so.
3. No. Please specify the reason.

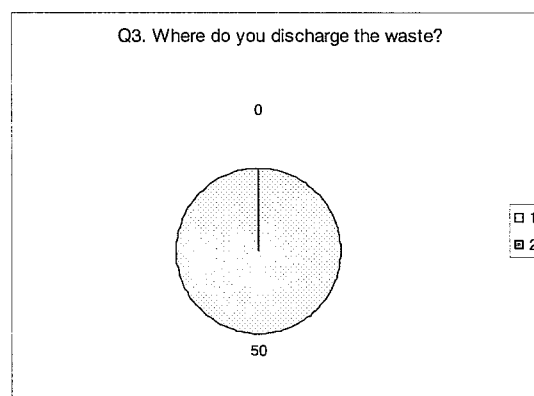**Answer**

1	2	3	Total
48	2	0	50

Q2. Have you understood how to discharge waste?

Q3 Where do you discharge of the waste?

1. In the container.
2. Not in the container. Please specify.

Answer

1	2	Total
50	0	50

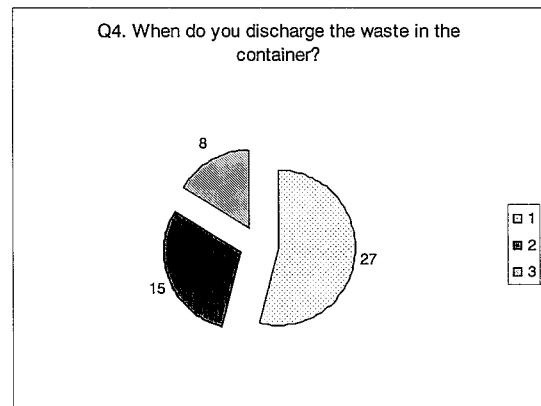Q3. Where do you discharge the waste?

I-11

Q4   When do you discharge of the waste in the container?

1. In the morning before the collection vehicle comes.
2. One day before the collection days.
3. Other. Please specify the reason.

Answer

1	2	3	Total
27	15	8	50

Q4. When do you discharge the waste in the container?

Q5   In order to keep this collection system working properly, I will

1. keep the waste discharge manner as required.
2. clean around the container.
3. keep the waste discharge manner and clean around the container.
4. not cooperate for the collection system.

Answer

1	2	3	4	Total
23	22	5	0	50

Q5. In order to keep this collection system working properly, I will;
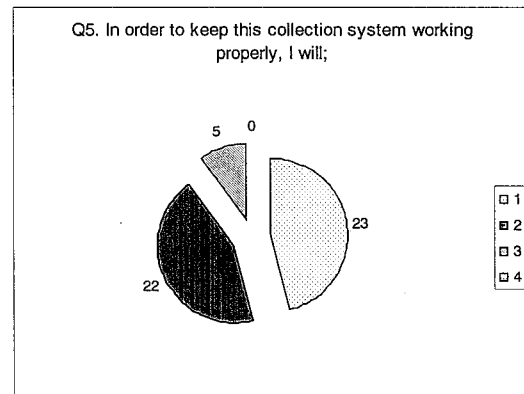
I.4   Evaluation of the Project

a.   Evaluation

Type of Container

The container used for this pilot project is the same as ones that are widespread over 11 municipalities in the Study Area. Its capacity is $2m^3$ ($3yd^3$). And it can be lifted by the $18yd^3$ compactor truck that has a winch. Therefore, the container does not require a new vehicle for emptying or carrying it, i.e., huge investment for purchasing such vehicle is not necessary. Furthermore, the containers are locally available and quality of them is good. Some local factories have experiences to manufacture them and have delivered them to SS or private companies.

Number of Containers

Number of containers was calculated on the basis of waste generation ratio of 475g/person/day and bulk density of 0.2 ton/m^3 that were obtained from the result of WACS in this Study. Density of waste in containers tends to be more than that at generation, as waste is piled and pressed by waste on it. However, the bulk density of 0.2 ton/m^3 at generation was used for safer calculation. That is, to take into account a

certain room for unevenness of collection amount, in order to avoid waste to be spilt from the containers.

In Maria Auxiliadora, estimated number of containers is four (4). Then, two (2) containers each were installed at two places. As Table I-4 shows, the containers at the place A are always full, on the other hand the containers at the place B are always half full. This is because the place A is more accessible than the place B. According to the data observed, three (3) containers might be enough for the site. If three containers were provided, however, the waste would be easily spilt from the containers, as each container is always full.

In 10 de Octubre, estimated average collection amount at one place was 1.07 ton. This is 89 % of the total capacity at one place (3 containers are installed in each place. 3 containers x $2m^3$ x $0.2ton/m^3$ = 1.2 ton/place). Almost of all Mondays, every container was full, meanwhile, there was room on the other days. This would be because that waste for 3 days needs to be collected on Monday, and it for 2 days on the other days.

Consequently, it can be said that it is proper for calculating number of containers to apply the generation ratio of 475g/person/day, the bulk density of 0.2 ton/m^3 and the longest duration for which collection vehicles do not come.

Collection Efficiency

According to the data in Maria Auxiliadora, two (2) containers are emptied in 15 minutes. That is, the waste amount collected by the container collection system is 3.2ton/hour (0.8ton / 15min x 60min = 3.2 ton/hour). The data in 10 de Octubre says that three (3) containers are emptied in 20 minutes. This means that 3.6 ton of waste can be collected in an hour by this container collection system (1.2ton / 15min x 60min = 3.6 ton/hour).

Meanwhile, T&M says that the $18m^3$ compactor truck collects 2.621 ton of waste per hour. Then, it can say that the efficiency of the container collection system is from 22% (3.2/2.621=1.22) to 37% (3.6/2.621=1.37) higher than ones of the ordinary collection.

Communication

The manner of waste discharge was conveyed to the residents by municipal personnel directly or through community leaders as the results of the questionnaire, Q1, shows. In Maria Auxiliadora, mainly the municipal personnel played this role, 30 houses (60%) answered that the manner was informed by the municipal personnel. Meanwhile, 31 houses (62%) answered that it was by the community leaders in 10 de Octubre.

Effects by the difference of the communication ways can not be seen significantly, i.e., degree of understanding the discharge manner were not so different, as the results of Q2 and Q3 shows. 45 samples (90%) answered that they understood the discharge manner and 49 (98%) answered that they discharged waste in the containers in Maria Auxiliadora. 48 (96%) answered that they understood it very well, and 50 (100%) said that they put waste into the containers in 10 de Octubre.

A remarkable difference was found in Q4. 44 samples (88%) replied that they discharged waste on the collection day in Maria Auxiliadora, meanwhile, 15 samples (30%) replied that they did it one day before the collection days in 10 de Octubre. This may show that the instruction of the discharge manner was strictly carried out in Maria Auxiliadora more than in 10 de Octubre.

It should be noted that the health committee in the community of 10 de Octubre played the role to convey the manner to the residents. The committee has relationship with the health unit of the municipality. Establishment of such communication between municipalities and communities must be helpful to make the collection system sustainable, because sound collection system works on the mutual trust between them.

Willingness to Cooperate

Results of the questionnaire, Q5, show the residents' willingness to cooperate with the collection system. Almost all the samples showed their willingness to cooperate, 49 (98%) samples in Maria Auxiliadora and 50 (100%) in 10 de Octubre. Considerable number of samples, 13 (26%) in Maria Auxiliadora and 27 (54%) in 10 de Octubre, indicated their strong willingness to cooperate, they answered that they would not only follow the manner but also clean the surroundings of the containers.

Although the questionnaire did not ask the residents' satisfaction with the collection system directly, the willingness to cooperate would show it.

Neighborhood Consensus

It should be noted that there was opposition to the placement of containers from houses around the place where the containers were to be placed in Maria Auxiliadora. As mentioned in letter b. "Pilot Project Sites", there was no space for the placement of containers in the site, therefore the containers were placed outside, the entrance to, the community (site). The houses around the containers have the accessible road for collection vehicles and have been covered with the ordinary collection service, the curbside collection. Therefore the reasons of the opposition were that they could not bear anticipated adverse effects of containers, such as odor and flies, without getting any benefit from the collection system.

The municipality fully explained to them the necessities of provision of collection service to the site. That is, a certain level of waste collection service is one of basic human needs (BHN) and the elimination of waste from the rivers and its bank around the site leads to improvement of the environment where also they are living. Then, the opponent houses accepted the placement of containers on the conditions that the municipality and/or the community of the project site keep the containers and the surroundings of them clean.

As for 10 de Octubre, no opposition to the placement of the containers has been informed. The reason why would be that there was enough space to keep a certain distance from the containers to houses and the containers were placed within the community that gets benefit from the collection service.

b.   Applicability

The use of the $2m^3$ container is recommendable, as it is locally available and not requires purchase of new type of vehicle.

The calculation to estimate required number of containers was found to be appropriate. However, collection amount tends to be changeable with time and by changes of the surroundings. Therefore, the continuation of the observation is recommended.

Collection efficiency of the container collection system is obviously higher than the curbside collection system. Although the former requires a certain investment for the containers, it leads to fewer costs than the later in a viewpoint of a long term.

However, the people in the Study Area have negative opinion on the container in general, as waste is often scattered around the containers and it makes the place be unpleasant. Even if the container and around it are properly managed, it is impossible to avoid the adverse effects of the container completely, such as odor and its ugly sight. Therefore, the container should be placed in the community that gets benefit from it. They would feel that it is reasonable to compensate the adverse effects of placement of the container for the benefit.

Furthermore, establishment of good communication between communities and responsible municipalities, such as one found in San Marcos, is recommendable in order to make the collection system sustainable.

Consequently, this pilot project found that:

- $2m^3$ ($3yd^3$) container and the compactor truck, which has a winch for lifting it, system is appropriate for the Study Area,

- communities that apply this system should have spaces for the placement of the containers within the communities.