# Design of Garbage Collecting System for Residential Application

**Ganesh Laxman Bhat, *Srinivasa, Vignesh Ravichandran**

Faculty of Art and Design, M. S. Ramaiah University of Applied Sciences, Bangalore 560 054

*Contact Author e-mail: srinivasa.id.ad@msruas.ac.in

## Abstract

*Waste is a continually growing problem at global and regional levels. Solid waste arises from human and animal activities that are normally discarded. Solid wastes are the organic and inorganic waste materials produced by various activities of the society and which have lost their value to the first user. Though there is a system defined to manage waste, it is challenging to operate in same manner due to many factors. User friendly products are essential for garbage collectors and residents to improve the accessibility and usability.*

*In this paper an attempt is made to design a product which solves and improves the garbage management system for current scenario. Few main concerns are considered like garbage segregation, storage, and transportation, access to residents, mobility and ergonomics. To understand more in depth primary and secondary researches were done to collect the data regarding existing products and processes. Quality Function Deployment (QFD) was done by considering customer voice and technical voice obtained as a result of research. Product Design Specification (PDS) is generated based on QFD. Mind mapping was used to create the ideas. Four concepts were created based on PDS from which one concept is taken forward for development. Mock up model was created with scale of 1:4 for product validation.*

*The new garbage bin product, tweaks the existing collection process. Any point of time the bins are available and provide easy access to residents to dump the segregated wastes (wet & dry). The new bins can be easily transported to compost pit by connecting existing auto tipper and can easily unload the wastes. The bins can be cleaned efficiently at designated Municipal areas and can transport back to community area. The scissor lift mechanism helps to increase the height of the bin while transferring the waste into truck compactor.*

**Key Words:** Garbage System, Collection, Ergonomics, Usability, Transportation

## 1. INTRODUCTION:

India is developing country and urbanizing is happening in rapid speed. Over the years there has been a continuous migration of people from rural and semi-urban areas to towns and cities. Due to this migration the population in the cities crossed the limits. The uncontrolled growth in urban cities has left many Indian cities deficient in infrastructural services such as water, sewerage and solid waste management. Most of the urban areas in the country are facing with acute problems related to solid waste.

### 1.1 Solid Waste Management (SWM)

It is management of waste which is associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health and environmental considerations.

Solid wastes are categorized based on source.

1. Agricultural (Field or row crops, orchards, vineyards, diaries and farms)
2. Industrial (Construction, chemical plants, fabrication and manufacturing)
3. Commercial & Institutional (Restaurants, stores, markets, office buildings)
4. Municipal Solid waste (Residential, commercial)

### 1.2 Municipal Solid Waste (MSW)

The term municipal solid waste refers to solid waste from houses, apartments, streets and public places and shops. Below are high level issues related to waste management.

- Improper waste segregation
- No control on street dumping
- Land scarcity for land filling.
- Increase in air and soil pollution

## 2. LITERATURE REVIEW

### 2.1 Improving Municipal Solid waste [1]

The article tells that, in urban areas solid waste is generated by domestic households, small scale & large scale hotels, commercial enterprises. Streets are used dumping area for all the wastes. The equipment and containers lead to very rapid deterioration as domestic wastes contains large amount of inert materials such as sand, ash, dust, stones. Also it has high moisture levels because of the high usage of fresh fruits and vegetables. These factors make wastes very dense and increase the weight.

As per survey, urban population in Indian cities had increased 19.8% in 1970 and 28.7% in 2005. In 2015 it is estimated to increase by 32.2%.

### 2.2 BBMP Notice [2]

As per BBMP direction the wastes are segregated in to 4 categories.

- Wet waste
- Dry waste
- Sanitary waste
- Hazardous House hold waste

## 2.3 Technology for processing existing waste [3]

As per report waste is mixture of different elements. The analysis of the existing waste reveals large percentage of organic content as shown in Fig 1.
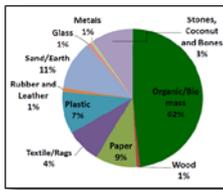


**Fig. 1 Types of waste availabe in urban**

As per survey every day in Bangalore generates around 4000 tons of garbage. Below are the estimated garbage generations likely to grow over the coming years shown in Table 1.

**Table 1. Projected quantity of waste generated in Bangalore per day**

| Year | Average Total Quantity Generated per day (t) |
|------|----------------------------------------------|
| 2012 | 4000 |
| 2017 | 5600 |
| 2022 | 7100 |
| 2027 | 9100 |
| 2032 | 11600 |

## 3. PRODUCT STUDY

### 3.1 Products used at home

Fig. 2 shows most common bins in home and office areas.



**Fig. 2 Bins used in office and homes**

### 3.2 Community bins

Cement bins are most commonly used across the city. These bins are heavy, open to atmosphere. It is difficult to empty the garbage from this bin shown in Fig. 3.



**Fig. 3 Waste collection bin used in Bangalore**

### 3.3 Push cart

Push cart is simple and mobile product to collect the garbage. Typically cart is used by street sweepers to store the garden wastes and street wastes like paper, tree leaves, plastics and other wastes.

### 3.4 Auto tipper

Auto tipper is used for door to door collection and carries waste to the disposal location. This product is used to pick the wet and dry wastes separately. Tipper has pneumatic cylinder which opens the waste container shown in Fig 4.



**Fig. 4 Dry and wet waste collection vehicle**

## 4. MARKET STUDY

Few products available in market as garbage collecting system as it is specific and unique requirement of the society. As a case study in city like Mumbai to collect garbage auto tippers are used. Plastic bins are used of volume capacity of about 120, 240 and 360 litres shown in Fig 5.



**Fig. 5 Waste collection bin in Mumbai**

**Ahmedabad:** Closed body vehicles used for transporting the solid waste shown in Fig 6.



**Fig. 6 Waste transportation vehicle in Ahamedabad**

**Vienna, Austria [4]:** Wheel mounted bins are placed in designated location of the city to store the garbage. Bins have top lids which prevents the rain water to enter inside the bin as shown in Fig 7.



**Fig. 7 Wheel mounted bins in Vienna Austria**

**Barcelona, Spain [5]:** Five colored containers are used.
**Yellow container**: To store plastic packaging, tetra packs and other ploy coat cartons, cans.
**Blue container:** Newspapers, text books, cardboards, paper bags and unused toilet papers.
**Grey container:** General household wastes like nappies, sweepings, cottons, hair, pens and pencils.
**Brown container:** Meat, fish, bread, fruits, vegetables, eggshells, tea bags, coffee grounds.
**Green container:** Glass materials like containers and bottles.

## 5. ETHNOGRAPHY STUDY

### 5.1 Garbage collection from home

Every day in the morning BBMP collectors arrive in auto tipper to collect the wet waste and twice in a week to collect dry waste. Collected wet wastes are transported to compost pit area. Pit is made in BBMP premises in most of the locations to dump wet wastes. These pits are of size 1524 mm x 3050 mm x 1828 mm.

### 5.2 Garbage collection from Apartment

Wastes are placed next to door by residents every morning. These wet and dry wastes are collected by apartment servants. Maid servants re-segregate wastes before storing in community bin. These bins are placed

near the main gate. BBMP collectors transfer this garbage in auto tipper.

## 5.3 Street dumping

Most of the residents especially from individual houses dump their garbage on the streets. This garbage is mixture of all kind of wet & dry wastes. BBMP collectors transfer these garbage in big compactor truck which goes to landfill for disposal.

## 5.4 User Study

User has to climb auto tipper to view and arrange the garbage in bin. This is difficult task for women staff to perform. User has to lift the garbage bin to put it inside the auto tipper shown in Fig 8.



**Fig. 8 Arrange the garbage in tipper**

## 5.5 Scope of Improvement

- Provision for wet and dry waste storage
- Easy to carry from primary collection to secondary collection
- Easy access to store the garbage
- Easy to unload from bin
- Minimum human effort in product usage
- Environmental protection to collected garbage

## 5.6 Quality Function Deployment (QFD)

QFD is done to convert customer needs into technical requirements. QFD helped to prioritize the customer needs which are identified during research shown in Table 2.

**Table 2. QFD chart**



## 5.7 Product Design Specification (PDS)

PDS is derived based on QFD matrix and analysis. PDS converts required features into targeted values and numbers to design develop the require product to meet customer requirements shown in Table 3.

## 6. CONCEPT GENERATION AND SELECTION

Based on PDS, many concepts were generated to meet the design requirements. Below are some of the doodles and sketches of the product.

**Table 3. PDS Chart**

| SL.NO | FACTORS | SPECIFICATIONS |
|---|---|---|
| 1 | Environment | Streets, road ways, different atmospheric conditions |
| 2 | Maintenance | Once in 6months |
| 3 | Weight | Bin =12 to 15 kgs, Trolley = 25 to 30 kgs |
| 4 | Size (Bin) | Aprox 1000mm x 900mm x 650mm |
| 5 | Volume | 500 to 800 liters |
| 6 | Cost | Rs.30000 to Rs.40000 |
| 7 | Installation | Easy installation with minimum man power |
| 8 | Aesthetic | Simple form, pleasant colour and finish |
| 9 | Ergonomics | Easy usability and accessibility |
| 10 | Materials | Sheet metal and Plastic |
| 11 | Life span | 5 to 7 years |
| 12 | Safety | No sharp edges on the product |
| 13 | Customer | Garbage collectors and residents |
| 14 | Manufacturing Process | Fabrication, moulding |
| 15 | Load Capacity | Maximum 100 Kgs |
| 16 | Mode of Usage | Standard =Manual, Optional = Auto |
| 17 | Quality | Durable, requires minimum maintanence |
| 18 | Features | Modular, easy attachment |

## 6.1 Doodles (Fig. 9)



**Fig. 9 Idea generated sketches**

## 6.2 Concept-1

Concept-1 consists of two major parts, bin assembly and trolley. Top lid contains small opening to allow user to dump the garbage in the bin. The bin is mounted on the trolley. Trolley has connecting point which connects auto tipper and transports bin to BBMP dump pit. Garbage is unloaded from by tilting the bin which is pivoted with trolley frame shown in Fig 10.
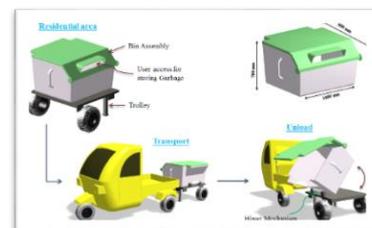


**Fig. 10 Concept -1**

## 6.3 Concept-2

Concept-2 consists of two major parts, bin assembly and trolley as shown in Fig. 11. The base trolley is similar to concept-1 but, user access to dump the garbage is give on side of the bin with a lid to close the access after use. The bin assembly consists of four major parts.

## 6.4 Concept-3

Concept-3 consists of two major parts, bin assembly and trolley. The base trolley is similar to concept-1 but, there is additional base frame is provided to mount the garbage

bin with fasteners. The user access lid is given on the top cover of the bin shown in Fig 12.
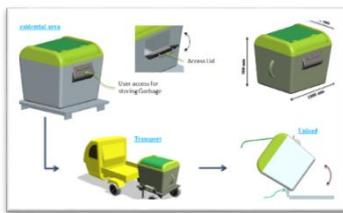


**Fig. 11 Concept -2**



**Fig. 12 Concept -3**

### 6.5 Concept-4

Concept has scissor lift trolley to lift the garbage bin while transferring garbage to compactor. This trolley serves both the purposes, transferring garbage to compactor by lifting to required height and dumping the garbage in compost pit without lifting the trolley shown in Fig 13.



**Fig. 13 Concept -4**

### 6.6 Concept selection

Concept selection is done based on weighted ranking method as shown in Table 4.

**Table 4. Method of concept selection**

| Better | 3 | | | | |
|---|---|---|---|---|---|
| Good | 2 | | | | |
| Worse | 0 | | | | |
| Key Criteria | | Concept-1 | Concept-2 | Concept-3 | Concept-4 |
| Ergonomics | | 2 | 2 | 2 | 3 |
| Easy to operate | | 2 | 2 | 2 | 3 |
| Safety | | 2 | 2 | 2 | 3 |
| Space usage | | 0 | 0 | 3 | 3 |
| Cleaning | | 2 | 2 | 3 | 3 |
| Weight | | 2 | 2 | 0 | 0 |
| User access | | 0 | 2 | 2 | 3 |
| Total Points | | 10 | 12 | 14 | 18 |

### 6.7 Final Concept

Final concept was selected based on the weighted ranking method to make a 1:4 scaled mockup model along with drawings. There are a few additional features added to final concept to make it efficient.

- Hydraulic cylinder with manual pedal is provided to actuate the scissor lift
- Four wheels are added for easy transport.
- Additional base is provided to support the bin and to make initial rotation to move the garbage from one end to other as shown in Fig 14
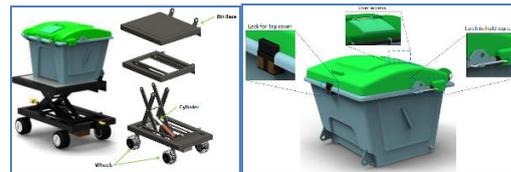


**Fig. 14 Final concept**

## 7. NEW PROCESSES FOR GARBAGE COLLECTION

Scenario is the process to transfer wet and dry waste from residential areas to nearest compost pit to dump the garbage shown in Fig 15.



**Fig. 15 Processing of garbage collection method using new concept**

## 8. CONCLUSIONS

- New process, rotation of bins helps to carry the garbage periodically without much effort. This improves the efficiency of collection system and keeps the neighborhood clean and pollution free.
- At any point of time garbage bins are available at residential areas to dump the garbage, no need to wait for auto tipper or push cart.
- Additional transport mechanism is not required as new bins can be attached to existing auto tipper.
- Segregated garbage can easily dumped in separate designated bins which also reduce the time and effort for garbage collections.
- Multiple bins can be attached to auto tipper to transport the garbage.
- Scissor lifting mechanism helps to lift the bin while transferring garbage to Truck-compactors.

Overall this product helps to reduce the time and effort in collection of garbage from residential and apartment areas.

## REFERENCES

[1] Da Zhu, Asnani P.U., Chris Zurbugg, Sebastian Anapolsky, Shyamala Mani (2008) *Improving Municipal Solid Waste Management in India*, The International Bank for Reconstruction and Development / The World Bank, Washington DC.

[2] Anonymous, (2013) Retrieved March 20, 2013, from http://bbmp.gov.in/web/swm/welcome /waste-notice.pdf.

[3] Anonymous, (2013) *Recommendations of Technical Advisory Committee Report*. Retrieved March 20, 2013, from http://bbmp.gov.in/web/swm/welcome/.

[4] Anonymous, (2014) *Overview of Household Collection Systems in Different Cities and Regions*, ISWA working group.

[5] Anonymous, (2013) Retrieved March 20, 2013, from http://w110.bcn.cat/portal/site/.