COVID19 WASTE COLLECTION

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Abstract
SARS CoV-2, known as corona virus spread rapidly to every part of the world and posed an unprecedented threat to all. The pandemic started by spread of corona virus, has given rise to many new problems, one of which is the collection of waste. The waste generated from covid positive homes, covid care centers and other places needs to be separately collected and disposed. The problems involved in this process have to be analyzed and solutions have to be designed.
Introduction

SARS CoV-2, known as corona virus spread rapidly to every part of the world and posed an unprecedented threat to all. The pandemic started by spread of corona virus, has given rise to many new problems, one of which is the collection of waste. The waste generated from covid positive homes, covid care centers and other places needs to be separately collected and disposed. The problems involved in this process have to be analyzed and solutions have to be designed. Our team tried to figure out all aspects of this process and its problems and have tried to propose a solution for proper segregation of waste during household waste collection.
Acknowledgements

We would like to thank Prof. Anil Gupta and SRISTI Summer School for giving us this opportunity to create solutions for grassroots problems faced in COVID 19 Waste Segregation. Also, we would sincerely like to thank all the coordinators who not only motivated us but also shared their ideas for further development of the prototype. Special thanks to all the mentors who helped the team through their valuable insights and knowledge. Members of other teams also deserve a special mention for providing valuable suggestions for converting the idea into prototype.
Problem Statement

COVID-19 Waste Collection system for domestic waste collectors.

Mission

Our mission is to provide effective COVID waste collection system for the domestic waste collectors and sanitary workers for safe and segregated collection of waste.

Summary

The project of covid-19 waste collection includes the study of problems involved in handling of covid specific waste and its proper disposal. This project was aimed at creating awareness among people for the disposal of covid waste and also to design solutions for the same. This project started with the identification of problems involved in covid waste collection in India. A mind map was generated upon the topic of covid waste collection. Then, its various aspects were studied in detail and the problem statement was defined. To dig deeper into this, field visits were performed and the municipal waste collectors were addressed so as to study the problem at ground level. Similarly, data about covid waste disposal from homes of various common people was collected through google form. Then through data analysis and interpretation, a solution was designed. This was proposed as a prototype of collection bin for separate collection of household waste, including the covid-specific waste.
Previous art searches

For studying any topic, the current scenario has to be studied thoroughly. To achieve this, we made use of available literature, news reports and survey data. We studied available review papers upon the solid waste management in India and also certain possible solutions.

We found out how the biomedical waste related to corona virus, such as masks, gloves, PPE kits and so on, is handled by the household waste collection workers in various parts of the world. The impact of covid-19 on normal waste collection was found out.

Apart from this we also studied the rules and guidelines issued by authorities, for handling of waste related to covid positive houses. The waste collection workers have to be at minimum risk and to ensure that, we must design solutions for the current problems.

Previous searches revealed that the problems have been addressed but not yet solved fully. Also, certain challenges need to be dealt with, otherwise the virus will continue to spread within the waste collection workers. Problems such as improper segregation of usual solid waste and covid positive waste, open collection and transportation leads to more spreading of the virus, so on and so forth. The available solutions like, use of yellow bags for separate collection of covid related waste, use of PPE kits and other safety equipment by the workers, etc. are available.

For this purpose, the first thing that was done is collecting information of guidelines for collection of covid-specific waste and also, getting to know about the current scenario.
The guidelines of covid waste collection in India:

- Keep separate color-coded bins (with foot operated lids)2 /bags/containers in wards and maintain proper segregation of waste

- double layered bags (using 2 bags) should be used for collection of waste from COVID-19 isolation wards.

- Use a collection bin labelled as “COVID-19” to store COVID-19 waste

- BMW and covid waste directly given to CBWTF collection van.

- The wet and dry solid waste bags to be tied securely in leak-proof bags, sprayed with sodium hypo-chlorite solution and hand over to authorized waste collector of ULB’s on daily basis

- The (inner and outer) surface of containers/bins/trolleys used for storage of COVID-19 waste should be disinfected with 1% sodium hypochlorite solution daily.

- Register in CPCB mobile application namely ‘COVID19 BWM’ to update the details of COVID-19 biomedical waste generation.
Figure 1: Categories of biomedical waste

- **YELLOW**
  - Used masks, head covers, shoe covers, disposable linen grown, non-plastic or semi-plastic coveralls
  - Diaper having faecal matter collected from COVID-19 positive patient
  - Disposable plates, leftover food, glasses, tissue papers etc. used by COVID-19 patients
  - Waste contaminated with body fluids/blood of COVID-19 patients
  - **Treatment:**
    - Plasma pyrolysis
    - Incineration
    - Deep Burial

- **RED**
  - Used PPE like face-shields, nitrile gloves, goggles, aprons, plastic coveralls
  - **Treatment:**
    - Disinfection or autoclaving
    - Microwaving
    - Hydroclaving (sent for recycling)

- **WHITE**
  - Metallic wastes
  - **Treatment:**
    - Autoclaving
    - Hydroclaving/Microwaving (sent for recycling not landfilling)
  - Sterilisation followed by mutilation
Isolation ward – nursing station, patient area

All colour coded trolleys – designated route
- **Mind mapping**

Mind map focused on the root cause of COVID 19 waste including sources, stages of segregation, difficulties in separation, type of wastes et al. It also focused on different guidelines which were issued by institutions and the awareness aspect. We tried to focus on 3 Major Aspects:

- What is the problem?
- How can we diversify the problem?
- What are different perspectives?
- What grassroots issue must be solved?

From the above questions, the problems of Waste segregation were identified.

Based upon various aspects and considering different perspectives, a mind map was generated.
Mind map: Covid-19 Waste Collection
Segregation Of Wastes

The amount of waste produced today cause huge problem so segregating our wastes is necessary.

Waste can be divided into two categories: Biodegradable and Non-biodegradable. Organic waste, such as kitchen waste, vegetables, fruits, flowers, garden leaves, and paper, are examples of biodegradable waste whereas Non-biodegradable waste is divided into various categories:

a) Recyclable waste (plastics, paper, glass, metal, and so on).

b) Toxic waste, which includes old medicines, paints, chemicals, bulbs, spray cans, fertilizer and pesticide containers, batteries, and shoe polish.

c) Soiled – hospital waste, such as blood-stained cloth or other bodily fluids.

Toxic and soiled waste must be handled with extreme caution.

![Diagram: Categories of waste](image)

Figure 2: Shows the categories of the municipal solid waste

Daily, separate household waste put into different bags for different types of waste, such as wet and dry waste, which must be disposed of separately. Another method of waste segregation is door-to-door collection. Waste-segregation is critical for waste reduction and effective waste management.
Figure 3: Shows the Segregation of Hospital Bio-Medical Waste\textsuperscript{7}
Insights Problems and Observations

Unscientific treatment, improper waste collection, and ethical issues are the major issues affecting waste management. As a result, hazards such as environmental degradation, water pollution, soil pollution, and air pollution arise.

Our Mission to provide safe mechanisms for sanitation workers for collecting of COVID related waste from homes but some problem associated with this are as follow:

1. No segregation of COVID waste from normal waste. gloves, masks, and all are often, mixed with normal blue and green bins.
2. Open garbage collection by municipal vehicles, which increases the virus spreading throughout the neighborhood.
3. Safai Karmchari doesn’t have adequate PPE which prevents them from the virus & Lack of supply of safety equipment to collection staff and they are not properly trained to handle such waste.
4. Lack of information and training related to covid waste collection.
5. Quarantine centers or positive patients home quarantined mix their covid waste with the normal waste thus spreading the virus.
6. The Government has no tie up with the firm for collecting biomedical waste related to Covid from home isolation, patients have to dispose of the waste carefully.
7. Wastewater discharging from the health care facilities may have the virus and so staff working at treatment plant of the wastewater may at the high risk. Appropriate usage and removal of the PPEs among sanitary workers.

In India, municipal corporations are responsible for waste collection, and bins are typically provided for biodegradable and inert waste. Open burning is a common practice when dumping mixed biodegradable and inert waste.
Improvements to India’s waste collection and transportation infrastructure will create jobs, improve public health, and boost tourism.

COVID-waste disinfection strategies:

Figure 4: Shows the Bio-medical waste/ hospital waste generation, disinfection and disposal procedure

Figure 5: Shows the Disinfection technologies for bio-medical and hospital waste treatment
The use of a specific type of disinfection technology should be determined by taking into account all economic and feasible factors, such as the amount of wastewater, safety conditions, disinfectant supply, distance between the wastewater treatment system and the ward as well as the residential area, investment and operation costs, operational management level, and so on.

**Figure 6**: Shows a flowchart illustrating the hospital waste disinfection process.³

**Table 1**: Disinfection technologies for hospital wastes are compared⁴

<table>
<thead>
<tr>
<th>Disinfection technology</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrolysis vaporization incinerator</td>
<td>Complete destruction of toxic and hazardous components</td>
<td>High investment costs and strict demand for heat value of wastes</td>
</tr>
<tr>
<td>Rotary kiln incinerator</td>
<td>High incineration efficiency with wide range of applications and good adaptability</td>
<td>High dust content in the exhaust, high air demand, high investment and maintenance costs, and low investment recovery</td>
</tr>
<tr>
<td>Method</td>
<td>Benefits</td>
<td>Limitations</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Plasma incineration</td>
<td>High energy efficiency with no intermediate products</td>
<td>High requirement of technical personnel and high costs</td>
</tr>
<tr>
<td>Chemical disinfection</td>
<td>Rapid action, stable performance, and broad sterilization spectrum</td>
<td>Residual disinfectants</td>
</tr>
<tr>
<td>Microwave disinfection</td>
<td>Energy saving, low action temperature, slow heat loss, rapid action, light damage, and low environmental pollution with no residues or toxic wastes</td>
<td>Relative narrow disinfection spectrum and complex impact factors of disinfection</td>
</tr>
<tr>
<td>High temperature steam disinfection</td>
<td>Low investment and operation costs, simple operation management, and low secondary pollution</td>
<td>Weak odor control</td>
</tr>
</tbody>
</table>
• **Data collection and field visits**

Communication with Stakeholders to understand policies and work for Residential Areas:

We conducted a survey of local waste collectors at residential areas and also with people to understand problems with waste collection through google form.

Questions asked:

User Based

1. Area of residence and state
2. Are you aware of the covid disposal bag at homes?
   
   If yes then are you aware of the yellow bag for covid disposal
   
   If yes then where did you get the yellow bag/bin from.
3. Where do you dispose gloves /mask and in which dustbin?
4. what is the duration after which you dispose gloves /mask after you have stopped using them (days).
5. Does the municipal vans have yellow bins/bag attached to them?
6. Have the waste collection agents informed you about separate collection bins?
7. Do the waste collection agents have PPEs / gloves /masks?
8. Do you have any idea where covid waste goes?
9. Do you treat the covid waste with NaOCl before disposing?
<table>
<thead>
<tr>
<th>No.</th>
<th>Survey done through google form</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cities</td>
<td>Kharagpur, Indore, Gandhinagar, Thane, Delhi, Kanpur, Raipur, Kota, Bhuj, Kitchener, Amreli, Ahemdabad, Rajkot, Palanpur, Surat, Jaipur, Gurugram, Bhopal, Pune, Nashik, Panvel, Alibag, Sambalpur,</td>
</tr>
<tr>
<td>2.</td>
<td>Awareness</td>
<td>No awareness regarding separate disposal of covid waste.</td>
</tr>
<tr>
<td>3.</td>
<td>Provision of Disposal system</td>
<td>No disposal facility available. all waste collection into collection box which goes to landfill</td>
</tr>
</tbody>
</table>

Table 2: Different Cities and their Feedback tabulated through google form
The responses from 89 persons were gathered, summarized and analyzed to conclude further information.

2. Are you aware of the covid disposal bag at homes?
85 responses

(a) If Yes then are you aware of the yellow bag for Covid disposal
72 responses

Most of the people don’t know about covid disposal bag.

4. Where do you dispose used gloves / mask (in which dustbin)
85 responses

50% people dispose covid waste in yellow bins.
Municipal vans do not have any kind of separate bin for covid waste and also they are not trained to handle covid waste in most of the cases.
• **Questions asked to household waste collectors:**

1) Have you been given PPE kits /gloves/masks/sanitizers?

2) Have you been trained to maintain proper sanitation and covid protocol while collecting waste?

3) Are you aware of the yellow bags/bin for waste disposal If yes did you distribute it to users and made them aware about it. If no why? If yes how do you implement it. If yes where does yellow bag go?

4) Are you aware that you can take gloves/masks only in solid waste after minimum how much time?

5) Do you sanitize the van?

6) How do you collect waste from covid positive home?

7) If you know that home is covid positive do other agency come stop collect the waste?

8) Any other problems or complaints?
### Table 3: Analysis of Individual City and its feedback

<table>
<thead>
<tr>
<th>No.</th>
<th>Cities</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pune</td>
<td>● Safety equipment and training to handle waste were given.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● COVID waste was kept separately.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● No knowledge about yellow bins/bags for covid waste.</td>
</tr>
<tr>
<td>2.</td>
<td>Gandhinagar</td>
<td>● Safety equipment and training to handle waste were not given.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● COVID waste was kept with normal waste.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● No knowledge about yellow bins/bags for covid waste.</td>
</tr>
<tr>
<td>3.</td>
<td>Jaipur</td>
<td>● Safety equipment and training to handle waste were not given.</td>
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<td>---</td>
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</tr>
</tbody>
</table>
|   |   | ● COVID waste was kept with normal waste.  
|   |   | ● No knowledge about yellow bins/bags for covid waste. |
• **Ideation, mentor inputs and prototype design**

While thinking of solution for the problem, we analyzed the various aspects of the problem and also the problems with available solutions. The feasibility of the proposed solution also has to taken into consideration. Ease of use by the workers has been the main focus while generating any idea. Similarly, the material for constructing the proposed bin has to be cheap so that the bins can be available in bulk.

For generation of a probable solution, we studied the currently available solutions. For this, we also considered the work done by the team of previous year’s SRISTI summer school program. They had proposed a pick-up tool for safe picking of covid related waste by the workers during waste collection, which has a grabber with rotating claw.

![Previous year suggested pick-up model](image)

**Figure 7: Previous year suggested pick-up model**

This tool seems to be a very useful one for picking specific waste and can further help in segregation.

For safe transport of covid-specific waste, we had initially proposed the model of a two-layered bin with attached sanitizer spray. But this model was very
complicated as it had sensors attached to it. Also, the cost of sanitizer spray being very high, it would not be feasible to have such collections bins at a large scale and to distribute them in every corner of the country.

Model 1: Two-layered bin

To construct and distribute such a bin would be a very difficult task. So, a simpler design had to be suggested. The pick-up tool can only help in picking waste from various sources.

But, the challenge of keeping the waste separated in the collection bins and transporting them in separated manner still persists. This led us into thinking about a large bin, which includes three compartments for separate collection of wet waste, dry waste and covid-related waste. The compartments would be colored with specific colors to mark for specific type of waste. Also, this bin has wheels which make it easy for the workers to carry and move around. The handle on the side of the container gives a grip to hold and carry it around.

In this way, in a systematic manner and after discussing various aspects, the final prototype was designed.
Front view of the prototype of collection bin.

Side view of bin with bottom flaps for easy removal of segregated waste.
The proposed design of collection bin consists of three separate compartments with lids colored according to their use and also has wheels and handle for ease of carrying.
Model 2: collection bin with compartments
References:

1. BMWM in HCFs in context of COVID-19: Implementation. Dr Malini R Capoor. Professor, Microbiology VMMC & Safdarjung Hospital, New Delhi.


11. Challenges and opportunities associated with waste management in India

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