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A Supply Chain Analysis of Plastic Recycling in Pune

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Abstract

In 21st century India, rapid urbanization has become a serious problem – resulting in the active implementation of waste management laws by the government. In 2018, Maharashtra's plastic ban put restrictions on the use of all plastic bags and single-use plastics. Within the city of Pune, institutions like SWaCH Cooperative attempt segregating solid waste into recyclables and non-recyclables in order to realize recycling and effectively managing solid waste. However, the complete supply chain of recycling is not well documented, which adversely affects public awareness. This paper provides an overview of the waste management practices and rules and an analysis of the supply chain of plastic recycling in Pune. Semi-structured interviews were conducted with the people involved at every stage of the recycling process, in order to understand the journey of a recycled item in Pune. This research included interviews with two waste pickers from SWaCH Cooperative engaged in waste collection at doorstep, the owners of a scrap shop in Viman Nagar area of Pune, a scrap wholesaler in Katraj area of Pune, and a representative of a Recycling Plant also located in Katraj. Two methods of plastic recycling were examined in greater details — recycling of low-density plastic materials and *phuga*, which refers to plastic items that have a cavity. The findings highlight the existence of a functioning supply chain of recyclable plastics in Pune and identifies the different kinds of plastics that are recycled in the market as of December 2018. Furthermore, it mentions links in the supply chain where efficiency can be increased as well as the importance of supplementing government policies with awareness about

recycling. Further research is required into the levels of plastics that are safe to reuse, alternatives to plastic as well as the waste management processes followed in the areas that SWaCH Cooperative is not operating.

Abstract

In 21st century India, rapid urbanization has become a serious problem – resulting in the active implementation of waste management laws by the government. In 2018, Maharashtra's plastic ban put restrictions on the use of all plastic bags and single-use plastics. Within the city of Pune, institutions like SWaCH Cooperative attempt segregating solid waste into recyclables and non-recyclables in order to realize recycling and effectively managing solid waste. However, the complete supply chain of recycling is not well documented, which adversely affects public awareness. This paper provides an overview of the waste management practices and rules and an analysis of the supply chain of plastic recycling in Pune. Semi-structured interviews were conducted with the people involved at every stage of the recycling process, in order to understand the journey of a recycled item in Pune. This research included interviews with two waste pickers from SWaCH Cooperative engaged in waste collection at doorstep, the owners of a scrap shop in Viman Nagar area of Pune, a scrap wholesaler in Katraj area of Pune, and a representative of a Recycling Plant also located in Katraj. Two methods of plastic recycling were examined in greater details — recycling of low-density plastic materials and *phuga*, which refers to plastic items that have a cavity. The findings highlight the existence of a functioning supply chain of recyclable plastics in Pune and identifies the different kinds of plastics that are recycled in the market as of December 2018. Furthermore, it mentions links in the supply chain where efficiency can be increased as well as the importance of supplementing government policies with awareness about recycling. Further research is required into the levels of plastics that are safe to reuse, alternatives to plastic as well as the waste management processes followed in the areas that SWaCH Cooperative is not operating.

Introduction

In India, due to rapid urbanization, the amount of non-biodegradable waste created increased from 60,00,000 tons in 1947 to 4,80,00,000 tons in 1997 (Gupta, Yadhav & Kumar, 2015). This forced the government to implement laws for waste management. Examples of this would be the 2018 Maharashtra plastic ban, which forbids the use of single-use plastics, The Recycled Plastics Manufacture and Usage Rules (1999), and The Plastic Waste Management Rules (2016) (Environment Department of Maharashtra, 2018). However, the efficacy of these laws has been questioned. For example, "Hindustan Times" featured an article highlighting the inadequacy of the 2006 plastic ban, which placed restrictions on use of plastic bags of above 50-micron thickness (Malik, 2018).

The annual reports, produced by the Central Pollution Control Board (CPCB), estimate that the plastic waste for Maharashtra has increased from 1,045.24 tonnes per annum in 2011-12 to 4,69,098 tonnes per annum in 2015-16. (CPCB, 2016). However, while the CPCB report gives us information about the amount of plastic waste, it does not further segregate this data into quantity of recyclables and non-recyclables. The Environment Protection Agency, Government of United States of America refers to recycling as "the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products." (Recycling Basics). The CPCB (2017), in their report titled *Consolidated Guidelines for Segregation, Collection and Disposal of Plastic Waste*, provides a table with a list of the different types of recyclable plastics (p. 1). The city of Pune has institutions like SWaCH Cooperative (SWaCH) and the Adar Poonawala Clean City Initiative (APCCI) that have attempted to help reduce this waste. In accordance with the General Body of the Pune Municipal Corporation (PMC), August 2015, SWaCH has been formally assigned for the primary collection of waste in Pune city, and have been given permission to extract recyclables from the waste they collect and earn income via these recyclables (Pune Municipal Corporation [PMC], 2016). SWaCH attempts at further segregating the collected solid waste into recyclables and non-recyclables in order to effectively manage the solid waste. However, there is a lack of transparency regarding the next steps that are followed to complete the process of recycling. Using battery-powered vacuum machines, the APCCI collects nearly 75 tonnes of garbage daily from the roads of Pune. Through this initiative, they have brought dignity to the task of waste picking by providing their employees with uniforms, facemasks, gloves, etc. as well as helping reduce the roadside garbage (Bari, 2018).

Given the magnitude of the problem at hand, the citizens must be made aware of the recycling process that their produced garbage follows, if any, in order to help make the process more efficient. Keeping this in mind, this research aims at answering the question:

How does the process of recycling, aided by SWaCH Cooperative, help reduce the dumping of plastic waste in the city of Pune?

Overview of Waste Management

Waste Management in India

The Press Information Bureau (PIB) states that 62 million tons of waste, including organic, dry or recyclable and biomedical or sanitary waste, is created every year in India; it is estimated that this figure is likely to grow by 4% every year. Of the total waste, less than 20% is treated (Press Information Bureau [PIB], 2016). In order to effectively manage this waste, the solid waste management (SWM) practices that some cities are carrying out must be initiated and

implemented in other cities as well. This task is essential due to the estimated growth of the garbage problem in India.

A study conducted in 2015 evaluated the municipal SWM in cities in India (Gupta, Yadhav, & Kumar, 2015). This study highlighted some composting (aerobic as well as vermi-composting) and waste-to-energy (WTE) projects that are underway and are likely to come up within the next few years in India. However, this research does not focus on the topic of recovery and recycling. Kaushal et al. (2012) on the other hand mentions Gujarat's idea of establishing a 'Recycling industry park' as an entirely new economic sector (Kaushal & Chabukdhara, 2012, p. 1487).

As of 2009, the main practice under SWM is community bin collection (PMC, 2016). In this method, the waste is rarely segregated. During the monsoon, the compostable materials make the recyclables increasingly wet and therefore, unable to be recycled (Kumar et al. 2009). Although many governments have made it essential to execute door-to-door collection (DTDC), waste collectors still face problems with segregation of waste. This highlights the need for there to be a proper procedure in place and space allocated for sorting and drying of recyclables. Chattopadhyay, Dutta, and Ray (2009) mention that the Kolkata Municipal Corporation spends "less than 5% [of their allotted budget] on final disposal arrangements" (p. 1449), which poses as a problem due to the amount of incoming garbage they have. Pattnaik and Reddy have similarly assessed SWM in Puducherry (Pattnaik & Reddy, 2010).

In September 2017, the CPCB came up with certain rules regarding the management of plastic waste. These rules mentioned "apply to every Waste Generator, Local Body, Gram Panchayat, Manufacturer, Importer, Producer and Brand Owner" and highlight instructions for the thickness of plastic bags, littering of plastic waste, segregation of waste, etc. (CPCB, 2017, p. 4). They have strict instructions for the management of "the plastic waste generated due to their products" (p. 4).

Waste Management in Pune

As reported by the PMC, "Pune generates 1600-1700 tons of solid waste per day" (PMC, 2016). Over 1300 tons of waste collected every day is not treated (PIB, 2016). There have been many attempts by companies to aid Pune in the process of waste reduction via waste management of different kinds. One such example is that of Hanjer Bio-tech Energies Pvt. Ltd., a waste-to energy plant, which was shut down since their compost had 30 times the amount of mercury than what was permissible (Chikarmane, 2016). Rochem Separation Systems (India) Pvt. Ltd. claimed that they would use "Concord Blue gasification systems to generate electricity from municipal solid waste" (Chikarmane, 2016, p. 249) This project was unsuccessful since their promised capacity per day was not reached. (Maharashtra Pollution Control Board, 2014).

The absence of formalized waste segregation practices has led to an emergence of recycling (Ghosh, 2016). On seeing the failure of waste disposal projects in Pune, SWaCH decided to enter the informal recycling market as a worker-owned cooperative of waste pickers, waste buyers and waste collectors (PMC, 2016).

SWaCH and waste management practices

Of the measures that have been taken up by the state and central governments of India, SWaCH employs the method of recycling with scrap collection and trade playing a crucial role. A study conducted by International Labour Organisation (2001) has outlined the recycling process in Pune. Here they describe a recycling supply chain that moves from waste pickers to scrap collectors, scrap traders and finally scrap reprocessors who transform "the scrap into intermediate or final products" (Chikarmane, Deshpande, & Narayan, 2001). While this study clearly outlines the supply chain, it is nearly 20 years old, therefore, requiring an update.

Research Design

For the purpose of this research, a supply chain analysis was found to be the best method. Semi-structured interviews were conducted with at least one individual involved in the major steps of recycling in order to gain an understanding of the product's life at that stage. The researcher followed next step in the supply chain based on the leads received from the individual interviewed at the previous stage.

The researcher began by speaking to the SWaCH waste pickers. These waste pickers led them forward to the scrap shop, the scrap wholesaler and the recycling plant. Figure 1 illustrates the supply chain identified by the researcher.

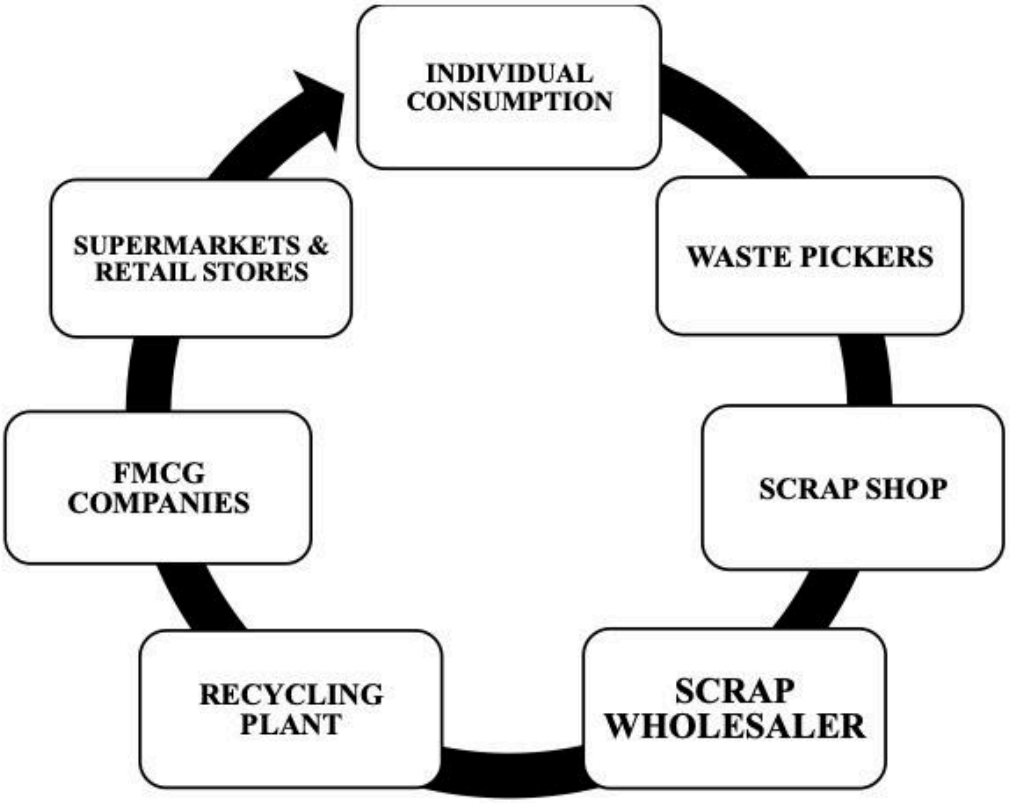


Figure 1: Supply Chain Analysis of Plastic Recycling in Pune

Data Collection

Handling of Waste by SWaCH Cooperative Members

At the Yamuna Nagar slum, waste pickers, Rani and Vandana, collect the waste and segregate it into wet waste, non-recyclables and recyclables. The wet and non-recyclable waste is handed over to the PMC trucks while the recyclables are kept in a storage space. Despite being collected separately, all of this waste is put in one dumping yard in the Hadapsar area, owned by Rochem Separation Systems (India) Pvt. Ltd. Every 2-3 days, the local scrap shop owner sends a truck to collect these recyclables. They weigh the scrap at the shop and the waste pickers get around Rs. 15 per kg of mixed scrap.

Handling of Waste by the Viman Nagar Scrap Shop

The Scrap Shop in Viman Nagar consists of a garage with mixed scrap materials stored in huge bags and a weighing machine. The scrap collected from various waste pickers by the shop is

handed over to a wholesaler who then sends the segregated scrap to a recycling plant. The mixed scrap contains a variety of materials including plastic, cartons, glass, bottles, metals and paper.

Handling of Waste by the Katraj Scrap Wholesaler and Recycling Plant At the scrap wholesaler shop in Katraj, the manager, Mr Lakhan Patole, looks after the scrap materials, right from procuring to reselling of individual scrap products. He organizes the input of mixed scrap materials from several scrap shops around Pune. Segregators are then employed to segregate this scrap (Figure 2) into the different kinds of materials (Figure 3). Once segregated, the materials are collected in huge bags, which are sent to the different recycling centres specific to the different materials after being weighed; only cardboard gets weighed at the recycling centre instead of at the scrap wholesale shop.

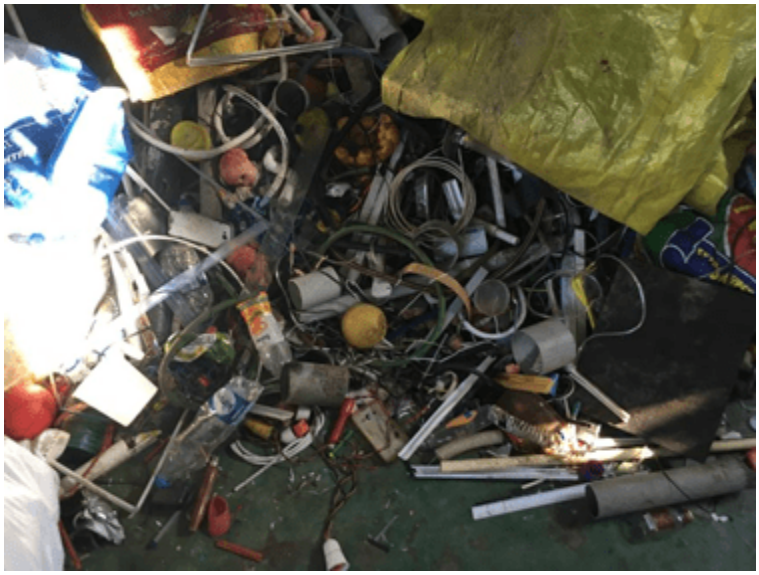


Figure 2. Assorted scrap material

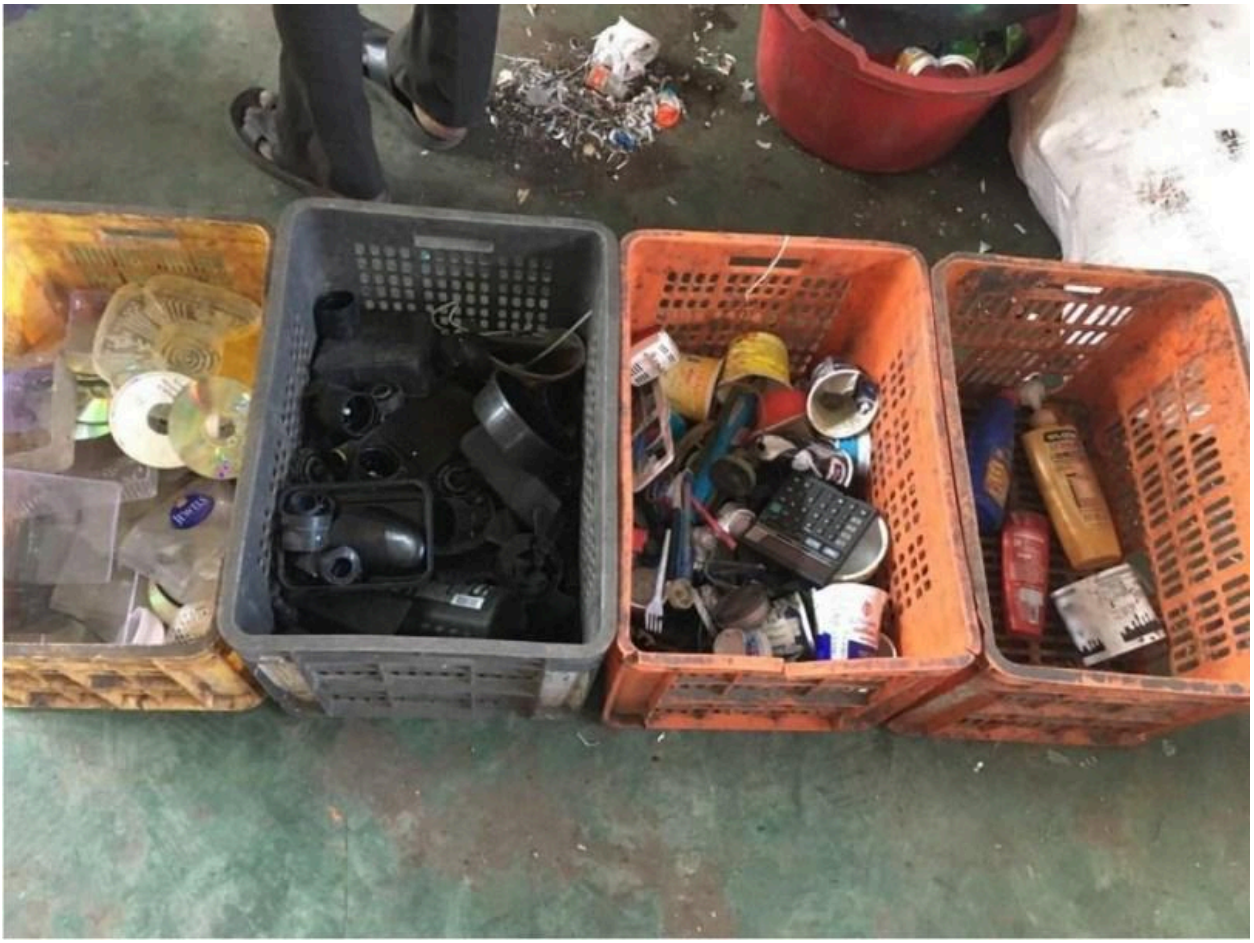
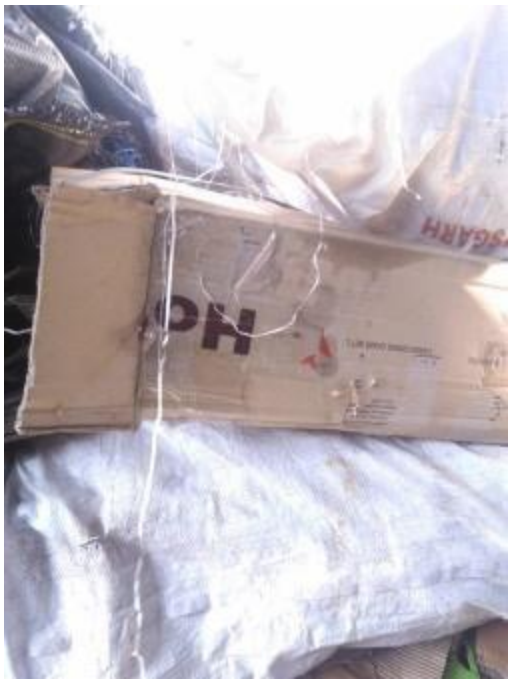
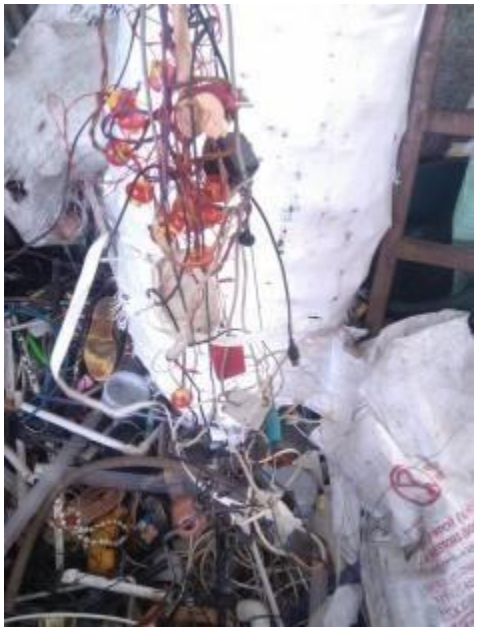


Figure 3. Segregated scrap material

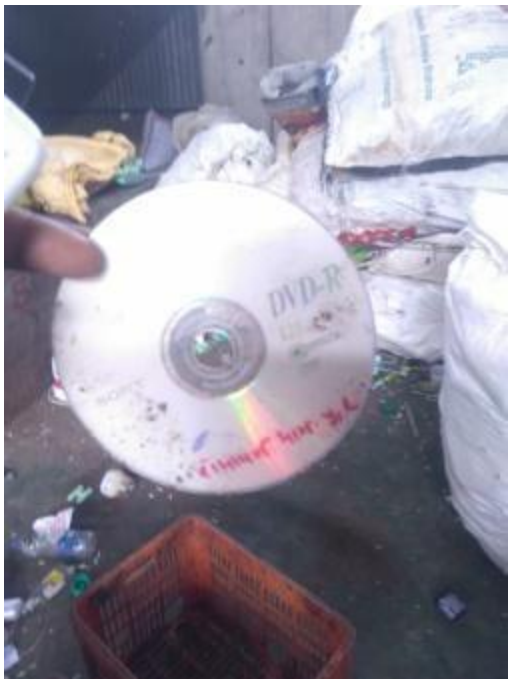
From all the scrap that comes in everyday, the scrap segregators need to sort out around 15 categories of items. There are some local-language names given to each of these items, in order to make it easier for the segregators to identify. Since this research is conducted in Maharashtra, many of these names are in Marathi, the local language. This research describes and identifies each of these items below:



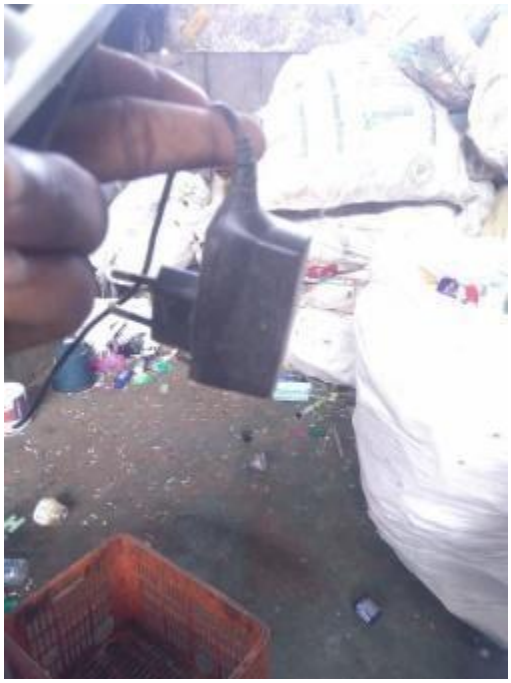
i. Putha (Cardboard)



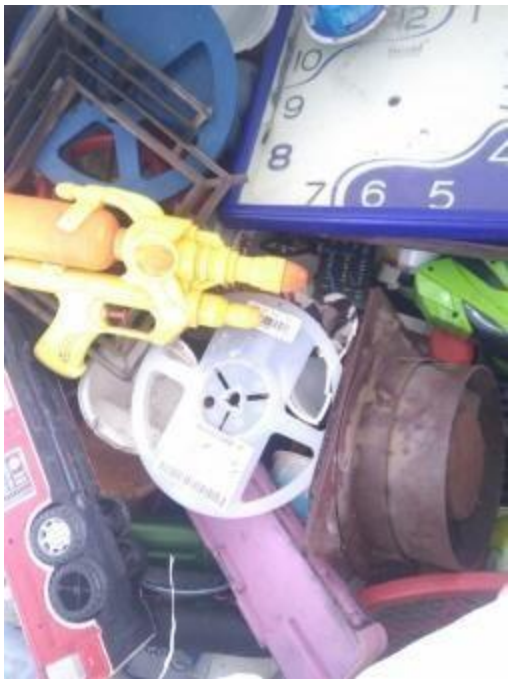
ii. Cable (Any type of cable or wires)



iii. CD Cassettes (Compact discs or cassettes)



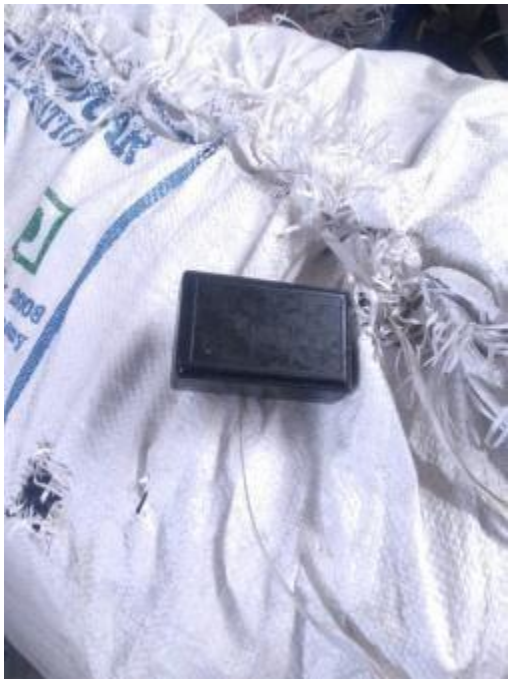
iv. Charger (Any type of electric charger. This would go as electronic waste)



v. Kadak (Plastic items that do not have a cavity within them — solid plastic items such as children's toys)

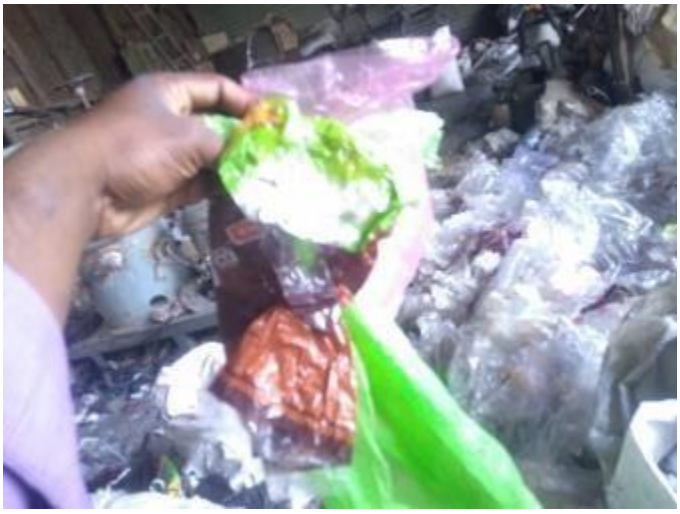
vi. Panee Kadak (Clear plastic items that are not hollow)

vii. Phuga (Plastic items that have a cavity within them such as shampoo bottles)

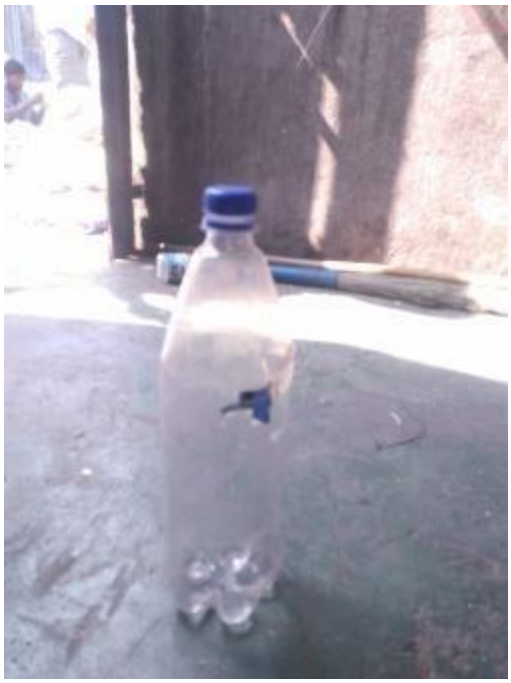


viii. Kala Phuga (Black coloured plastic items that have a cavity within them)

ix. L.D main number 1 (Low-density plastic bags or sheets that are mainly white (some may be blue)



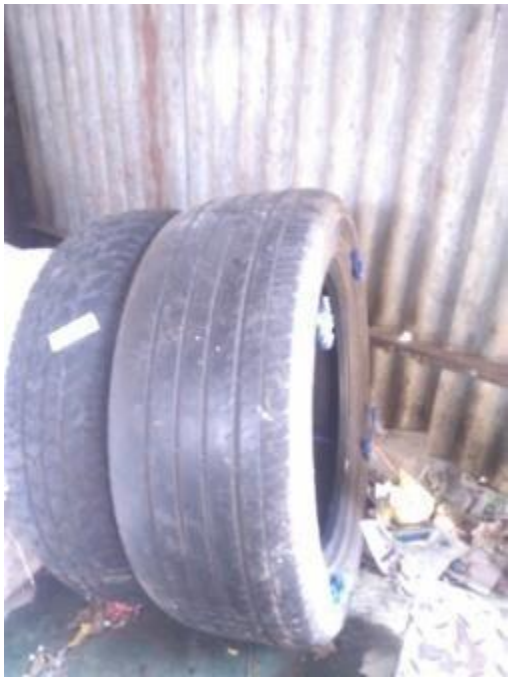
x. L.D main mixed (Low-density plastic bags or sheets that are of all colours, other than white or blue)



xi. *Kadkare* (PET bottles)

xii. PVC (Polyvinyl Chloride pipes)

xiii. Roadside (Any waste that is found on the side of the road)



xiv. Tyre (Used tyres)

There are separate recycling methods for each of these items. This shop was located next to a recycling plant where the researcher was able to observe the methods of recycling for the low-density main number 1 (L.D. main number 1), low-density mixed plastic items and *phuga*items. The end products are sold to companies all over India, but primarily to those in Gujarat.

With the low-density plastics, the items first get cleaned in a machine called the *jhatkani*, which removes any water or labels from the item (Figure 4). This plastic item then gets ground and forms shreds, which are separated as per different colours — white, green and black (Figures 5 and 6). These shreds are then cooled and put in a machine that heats them to high temperatures sufficient to melt the shreds (Figure 7). This produces the end product, which is slabs of melted plastic that can be further melted and used for various purposes (Figures 8 and 9).

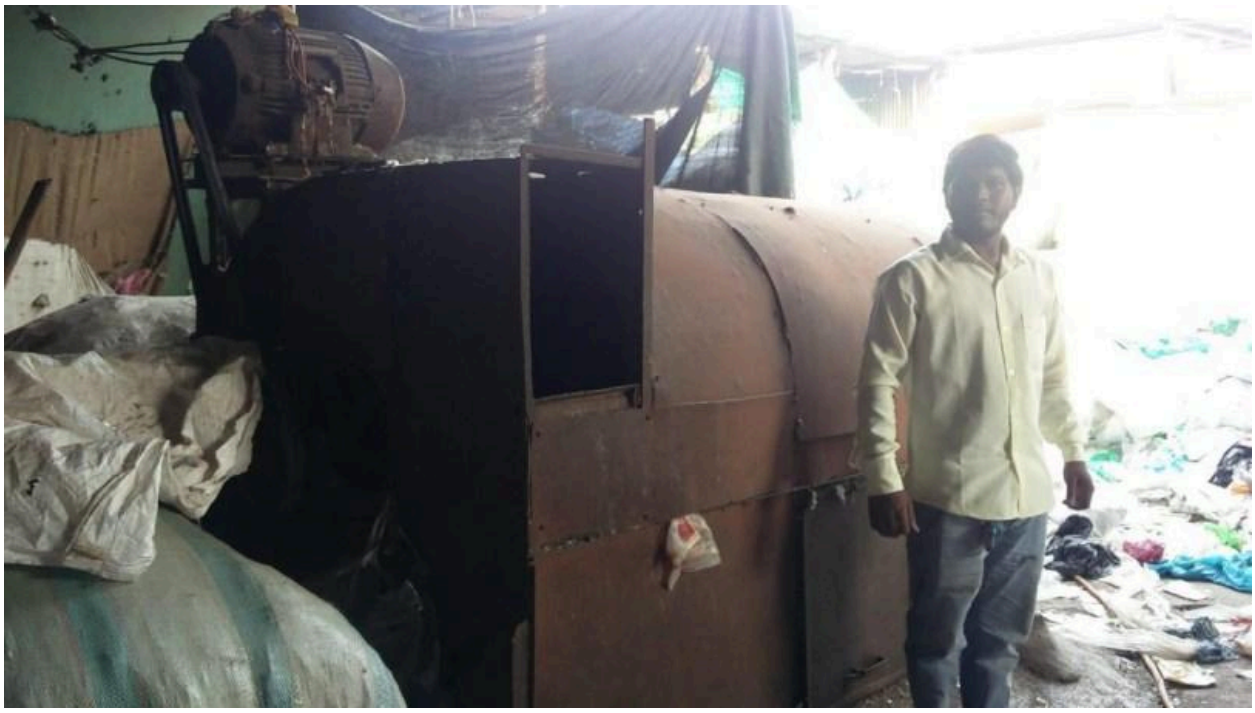


Figure 4. Cleaning machine (*jhatkani*)

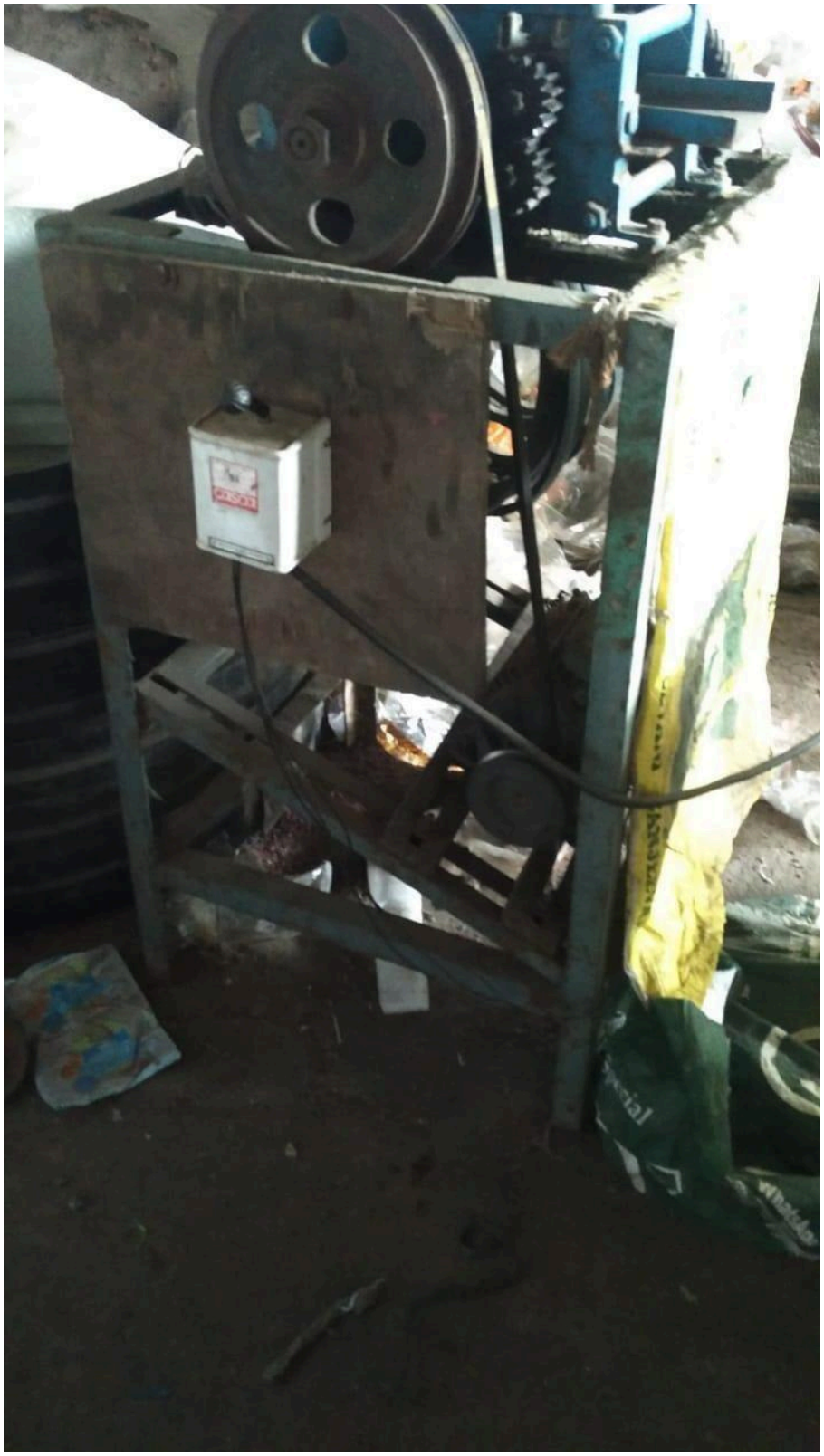


Figure 5. Grinding machine

Figure 6. Grinding output material

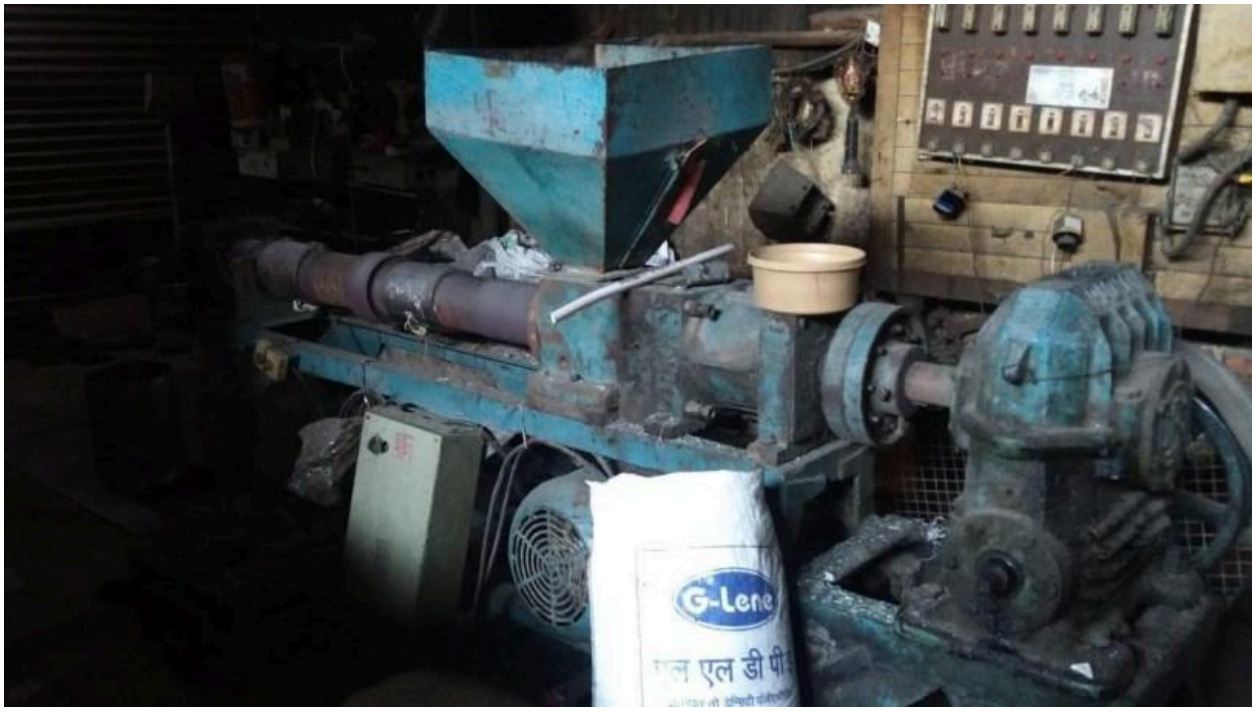


Figure 7. High temperature machine

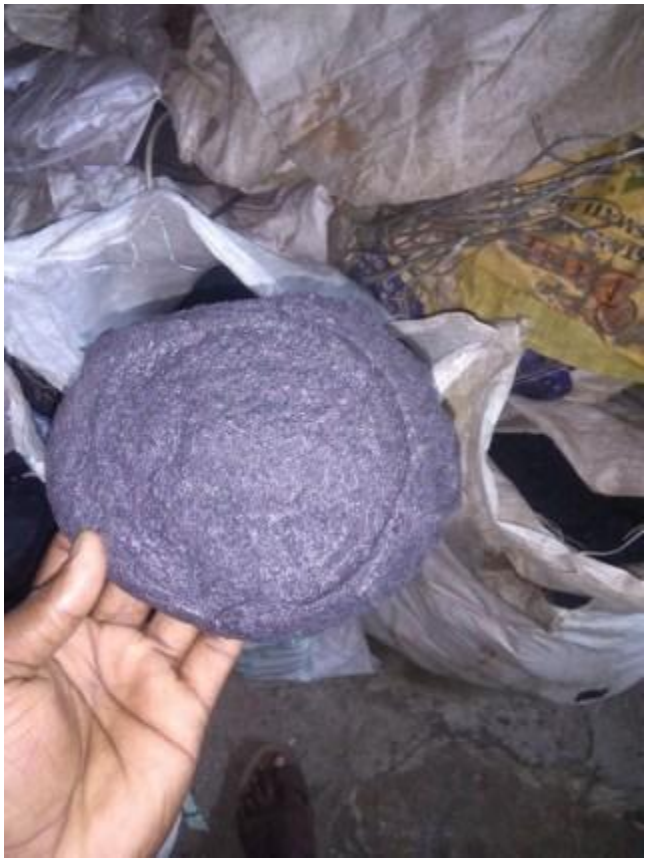


Figure 8. Output material to be sold

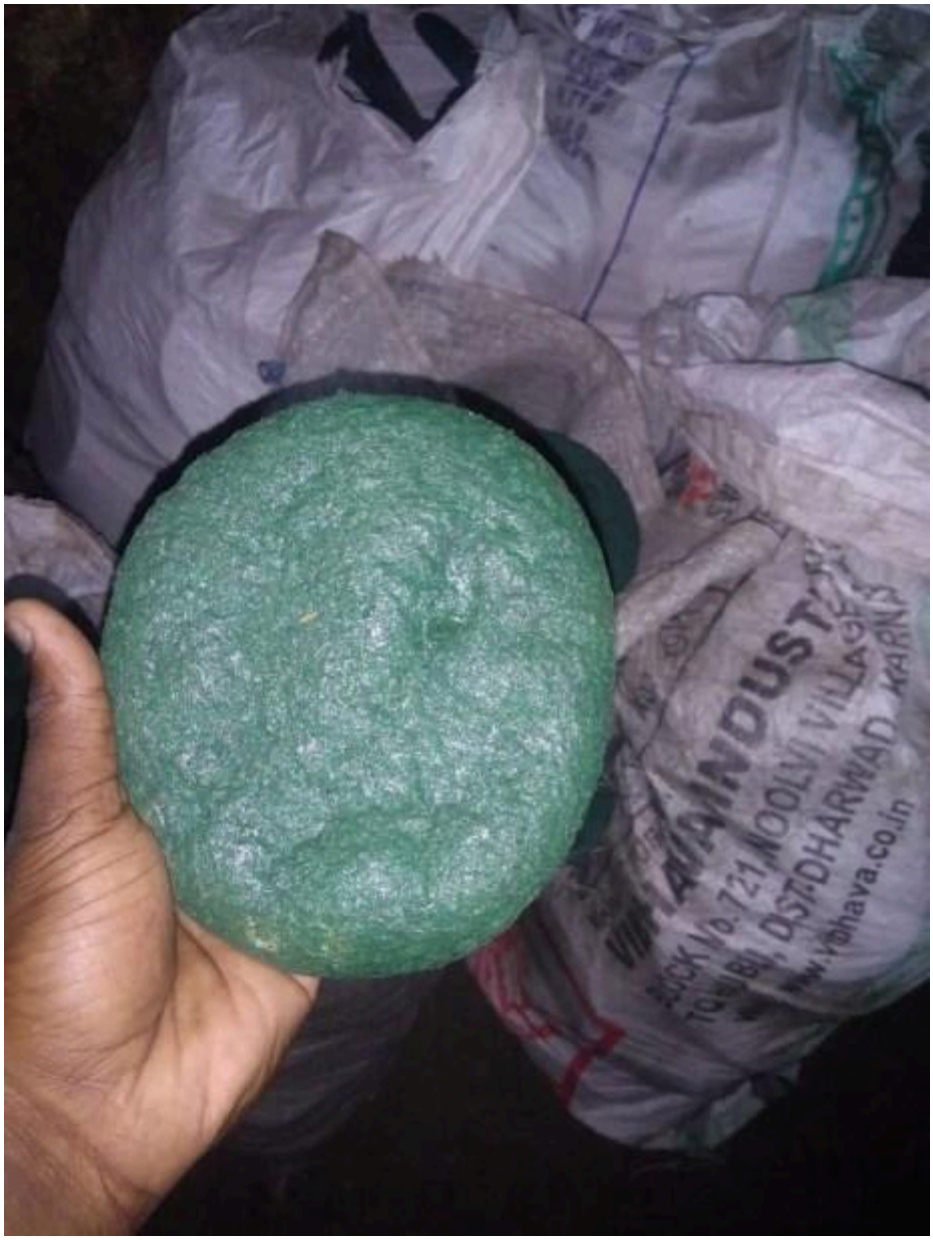


Figure 9. Output material to be sold

On the other hand, the *phuga* follows the first few steps shown earlier (Figures 2-4) and simply gets put into a machine (Figure 10) that melts it into thick strings of plastic (Figure 11), which is cut to form beads (Figures 12 and 13). These beads get sold to companies to form small plastic items like the caps of plastic water bottles.

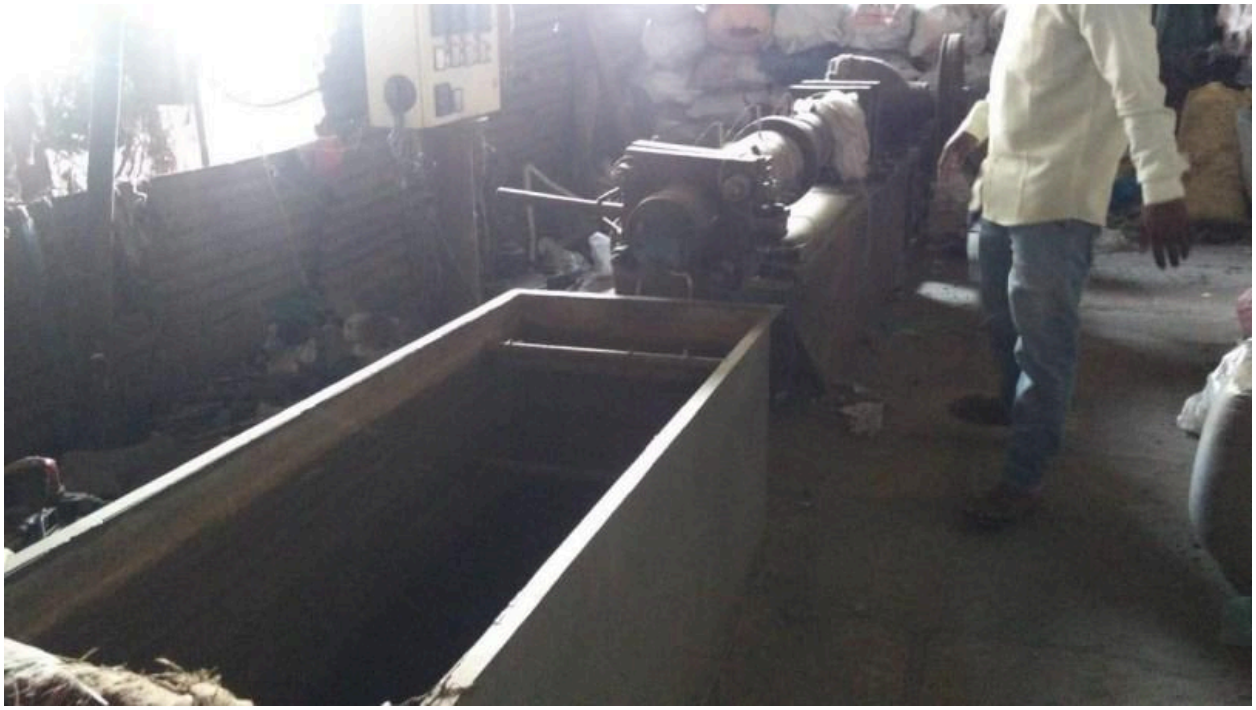


Figure 10. Machine to process *phuga*

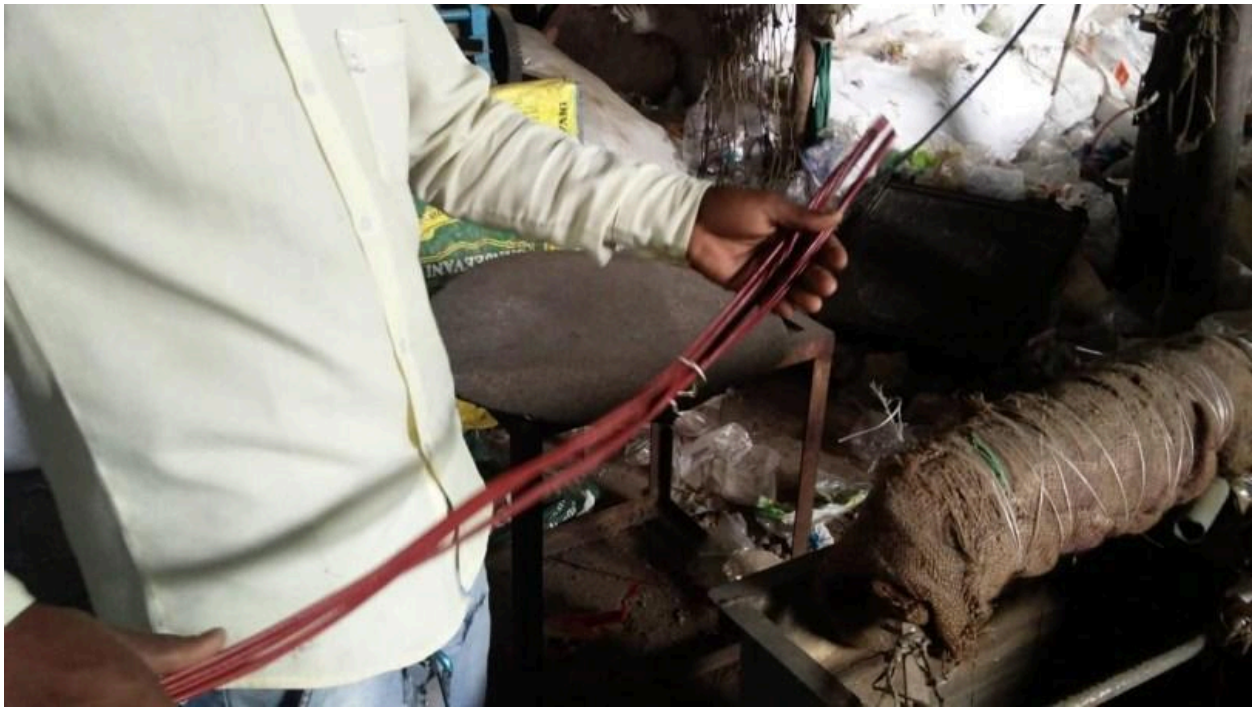


Figure 11. Cables of plastic

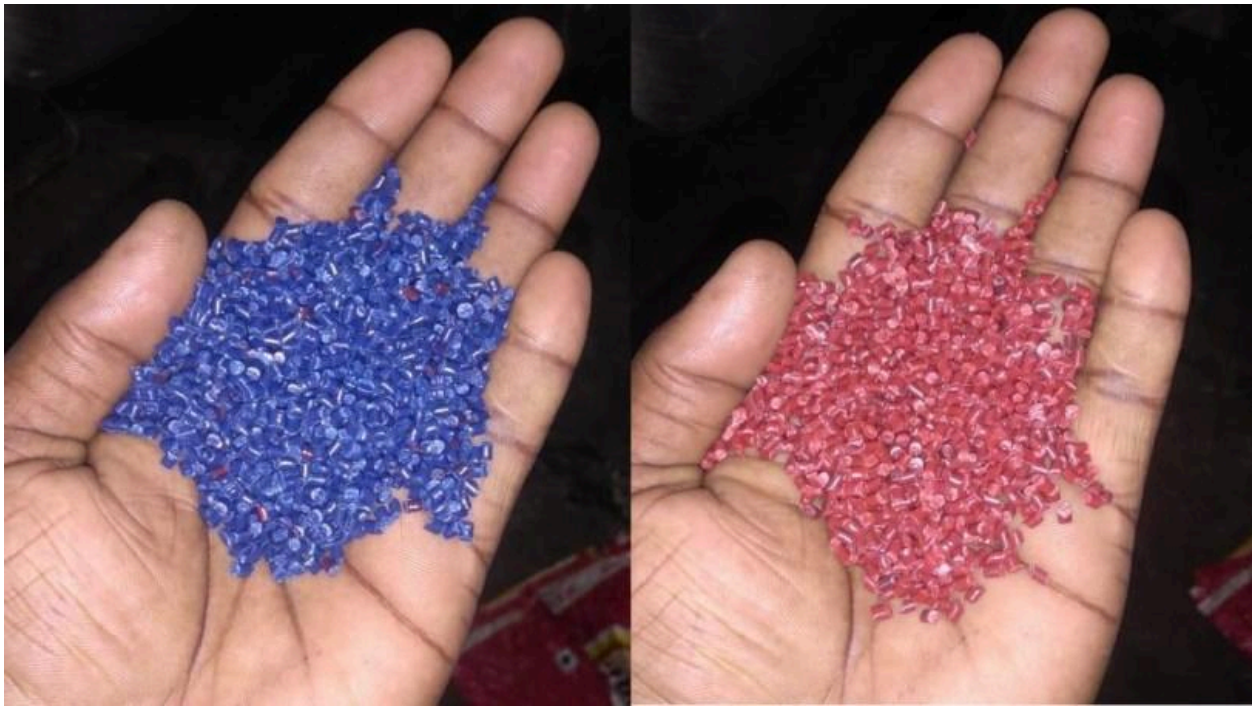


Figure 12 & 13. Final output – beads of plastic

Discussion and Analysis

The processes described in the previous section elucidate how recycling can curb the problem of plastic waste to a certain extent. However, there are a few concerns associated with this process.

Firstly, since recycling requires machines to heat the plastic in order for it to turn into the end product, the toxic fumes released by the chimney may pose a threat to the environment that is more than or equal to the threat that plastic waste discarded in the open environment may pose (Tierney, 2015). As recycling is aiming to be a process that prevents environmental degradation, this factor goes against its very fundamental. One may have to assess which form of environmental degradation is the less damaging choice.

Secondly, the quality of plastic deteriorates every time it gets recycled. Therefore, plastics can only be recycled 3-4 times after which it is no longer safe to recycle and reuse (Central Pollution Control Board, 2017). Currently there is no way to determine if the scrap received is virgin plastic or recycled plastic. The supply chain of plastic recycling may be improved by introducing a machine that checks the grade or quality of the incoming plastic scrap materials. This will help ensure that the plastics are being recycled according to the guidelines of the above-mentioned CPCB rules.

Additionally, while SWaCH has been handed the area under the PMC for operation, Clause 5(f) mentions the presence of excluded areas, wherein DTDC is being carried out by other service providers (PMC, 2016). There is a knowledge gap here regarding what these areas are, and which service providers are handling DTDC and segregation of waste in these locations. The supply chain of plastic wastes from these areas may need to be examined separately.

Conclusion

This research highlights the existence of a functioning supply chain for plastic materials in Pune city. This supply chain highlights the proper management of plastic items, where each item that is segregated and passed down the supply chain is assuredly recycled back into the market. Every day the Katraj Scrap Wholesale alone segregates and sends large amounts of recyclable materials to the recycling plants, of which approximately 3 tons gets recycled and sent forward. Considering the sheer amount of waste that is being prevented from going into the dumping yards in this process, it can be concluded that SWaCH Cooperative, being the initiator of this cycle, has significantly improved the condition of handling plastic waste in Pune. The availability of properly segregated plastic waste due to SWaCH intervention followed by the scrap dealers, has also allowed setting up of processing plants to complete the cycle and ensure that the recycled product is put to good use.

There has been a gradual growth of conscious consumers that are increasingly worried about their impact on the environment (Laroche, Bergeron, & Barbaro-Forleo, 2001). In a world where environmental responsibility on an individual as well as community at large is becoming an everyday conversation, this research has brought out information that allows people to see the real meaning behind an item being ‘recycled’. This is important especially since this term is taken for granted and not understood entirely as a process that does not just eliminate waste from going to the landfill but also possibly lead to the creation of a whole new product using the materials recovered.

With respect to this research, there are certain limitations. Firstly, the researcher was only able to interview the individuals at various levels of the supply chain that were present in Pune. Since the last part of the supply chain existed outside of Pune, there is further scope for research in those locations for a similar study. Secondly, the researcher was able to trace the processes carried out for recycling of two of the many types of recyclable plastics. However, there are many other recyclable plastics that follow a variety of processes of recycling and this can be studied in the future. Lastly, the research brought out the ethical questions related to the toxic fumes let out by the high-temperature machines, as well as the toxicity of plastic on being repeatedly recycled. Further research in this area could highlight the extent of these problems as well as potential solutions.

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