PLAN THE BAN

ELIMINATING SINGLE USE PLASTICS IN INDIA WITHOUT DISPLACING PEOPLE

A REPORT: 2021

chintan
environmental research and action group

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PLASTIC SOLUTIONS FUND

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Chintan Environmental Research and Action Group is an independent, non-profit, non-government organisation working in the field of sustainability and environmental justice for the past twenty years. Our aim is to ensure that consumption is responsible and mindful such that it doesn't impact the environment and the marginalised. Chintan has won several national and international recognition over the years for its work, including the U.S. Innovation Award by the former Secretary of State, Hillary Clinton, the United Nations Climate Solutions Award in 2015, and the FICCI Women Icon Award by the President of India in 2018..

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List of Abbreviations and Glossary

BTP	Bata Plastic
DB	Dabba Plastic
DL	Delhi
HDPE	High Density Polyethylene
HM	Polyethylene polybags
IN	Indore
LDPE	Low Density Polyethylene
LLDPE	Linear Low density Polyethylene
ML	Multi-Layered polyester or polyethylene
NDLB	Natural Dabba Plastic
NL2	Natural Plastic
NN	Nainital
PA	Polyacrylamide
PE	Polyethylene
PET	Polyethylene Terephthalate
PN	Pune
PP	Polypropylene
PU	Polyurethane
PVC	Polyvinyl Chloride
SPP	Super Polypropylene
Besan	gram flour
Dabba	box
Dahi	curd
Dhaga	thread
Dhakkan	cover
Godown	warehouse
Kabadiwala	junk dealer
Kadak	stiff
Katta	bag
Pani	water
Pheri	round trip
Rangeen	coloured
Rs.	Rupees

Preface

Plastic pollution is a well-documented global crisis. In many parts of the world, particularly within wealthy nations without a robust informal recycling sector, bans on some kinds of plastics, like single use plastics, are often seen as the solution.

India's environmentalism is different: Resources and people are closely interconnected. Indian forests have been traditionally nurtured by communities who live nearby, or inside them. They appreciate the forests as sources of food, medicine, water and several other necessities. In modern times, the poor are among those who consume the least, but pay the highest price for environmental damage. India must safeguard not only its rivers, air, wilderness and biodiversity but also simultaneously protect its most vulnerable citizens from various aspects of poverty. Such notions of environmental justice are also true in the case of plastic pollution.

India – and many other countries - are deeply dependent for their recycling on the informal sector, most notably, waste pickers. This sector collects, segregates, washes and trades in the waste before it is turned into a feedstock for a new product. Waste pickers are also poor. In India, most live within sub-standard housing, with little access to decent amenities, food and social security. If the Western notion of a plain vanilla ban was applied here, wouldn't the waste pickers experience income-loss? And would it be enough to push them steeply into further poverty?

Given our complex challenges, what solutions shall we seek to India's plastic pollution? We know we must: the Ganges alone is the 7th largest carrier of plastics into the oceans in the world and image after image of plastic on its waters haunts us.

Chintan, along with several partners, gathered primary and secondary data from 4 cities-Delhi, Pune, Indore and Nainital, backed by consultations-to understand the reality on the ground. The final report, Plan the Ban, is based on this rich, collaborative research.

India is home to 10% of the world's waste pickers. They cannot be expected to bear the brunt of plastic bans. It would be disastrous, with inter-generational inequity exacerbated. In fact, the little recycling taking place today is on account of the services and infrastructure predominantly provided by the informal sector. But if India doesn't rein in its plastic consumption, the country's rivers and biodiversity will be devastated. Globally, plastics are part of the challenge of climate change.

Plan the Ban identifies the systemic path ahead. A path strewn with bans on some single use plastics, putting some plastics under the extended producer responsibility regime and rapidly expanding livelihood opportunities for waste pickers in both the circular economy space and within de-centralised solid waste management. This win-win model is our best bet for a just transition to a low-plastics economy.

Bharati Chaturvedi
Founder & Director,
Chintan Environmental Research and Action Group
New Delhi.


Dream With
Cream

Executive Summary

Background

India will completely phase out single-use plastics by 2022, the Honorable Prime Minister Narendra Modi had announced in 2018. The challenge for a complex, informal-enterprise based economy like India is to identify how to combat both plastic pollution as well as prevent waste pickers from losing plastic waste-based incomes.

Chintan collaborated with partners to carry out extensive research in four cities of India — Delhi, Pune, Indore and Nainital, to understand which plastics were recycled – and conversely, not recycled. It included surveys, plastics audits, group discussions and a review of the relevant literature. Chintan's plastics report identifies a pathway to handle single-use plastics, keeping in mind the issues of pollution, inclusion and livelihoods of some of the most vulnerable people involved in and dependent on plastic waste recycling.

Key Findings

1. Waste pickers are deeply dependent on plastic waste. It forms a major part of their income, ranging from 40% to 60%.

2. Some plastics are more valuable than others. For instance, Polyethylene Terephthalate (PET) is the highest value plastic for waste pickers. According to the research, they were found to collect around 20 to 25 kilos of plastic waste daily, of which around 50% to 60% was PET plastic. Low Density Polyethylene (LPDE), especially packaging materials, are also valuable. In third place were mixed hard plastics and transparent Polypropylene (PP). Examples of such items include plastic storage containers used in household kitchens and in online food delivery. The average income share of these plastics are as follows:

Income share of most valuable plastic (Avg.) in percentage	
Polymer	Income Share %
Polyethylene Terephthalate (PET)	29.19
Polyethene (PE)	20.39
Polypropelene (PP)	10.45
Bata Plastic (BTP)	8.44

3. Some plastics are not recycled. These leak into and pollute the environment. Examples of these include:

- Multi-layered packaging, notably single-use plastics (SUPs): Examples include packets of chips, sachets of hair oil, detergent, soap and shampoo, toothpaste tubes, beauty products and medicinal tubes, plastic-lined paper cups
- Low Density Polyethylene (LDPE): non-woven bags and wet wipes for cosmetic and hygiene products, plastic bags
- Polystyrene (PS, also called thermocol): Examples include disposable cutlery, crockery, food containers, and packaging materials
- PVC flex items such as used for banners and hoardings
- Nylon and Polyester materials, used in clothing, and ropes, and twine
- Polycarbonate: Vehicle indicator lights
- Polypropylene: Woven bags such as for cement, clothes clips, and plastic straws

4. Waste pickers and waste aggregators are aware of the toxicity associated with plastics and its impact on their health. While many of them noted that plastics were important to their livelihoods, they also pointed out that undertaking other, less hazardous work that generates equivalent earnings was in their interest.

Recommendations

The damage plastics have inflicted on the environment is well acknowledged. Plan the Ban supports drastically reducing both single-use plastics and toxic plastics. However, it shows the unintended consequence of this will be a decline of up to 40% of the incomes of almost 1.5 million extremely poor and vulnerable waste workers. This must be simultaneously addressed. The report recommends three important pathways for a win-win. These are plastics elimination, livelihoods expansion, and legal and policy mandates.

A. Elimination of Plastics

The report identified single-use plastics, focused on those not recycled, therefore contributing to pollution. These were divided these into items that can be banned because they are not essential and substitutes are available. A second category identifies plastics under EPR. The report does not recommend banning of PET plastics as it forms 29.19% of the total average income of waste pickers (about Rs 226 per day), followed by PE at 20.39%, and PP at 10.45%.

Plastic products recommended for banning under amended PWM Rules, 2018:

1. Polypropylene (PP): Products include woven bags, plastic straws, wet wipes, ear buds with plastic sticks, sticks used for holding frozen or icy edibles, plastic flags and hotel sized toiletries.
2. Polystyrene (PS): Products include use and throw cutlery and crockery (plates, glasses, spoons, forks, stirrers, knives), thermocol packaging sheets and chips for packing and decoration.

3. Polyvinyl Chloride (PVC): Products include flex banners of all thicknesses, cling film for food and other use, blister wrap for non-essential medicines.
4. Metalized plastics (Multi-layered plastics): Products include wrappers, sachets of cosmetics, creams, lotions, shampoo, including samples or travel-sized sachets and single-use applications of all products.
5. High Density Polyethylene (HDPE): Products include woven shopping bags, grocery bags and woven tissues, including wet wipes.
6. Low Density Polyethylene (LDPE): Products include Polythene bags (colored, white, and black)

Plastics to be covered under EPR:

1. Metalized plastics (Multi-layered plastics): Products include packets of snacks, chips, biscuits, milk pouches. Specifically, additional incentives should be included for EPR in ecologically fragile areas, such as the Himalayas, where quantities are less but potential for ecological damage higher
2. Polycarbonate (PC): Products include indicator lights
3. High Density Polyethylene (HDPE): Products include toothpaste, personal hygiene, pharmaceutical and beauty products in tubes
4. Nylon and Polyester: Products include synthetic clothes, nylon ropes including nets for sports.

B. Livelihoods' Expansion

Livelihoods' expansion refers to new work in the sphere of waste, that can generate comparable or greater income for waste pickers. This should be part of a wider Urban Employment Guarantee Scheme.

1. Reuse as Livelihood

As the concept of resource efficiency and circular economy gains currency, reuse provides an important livelihood opportunity to waste pickers.

Strengthening Local Reuse

Waste pickers frequently retrieve materials that can be reused, either directly or after repair. Sales take place at local weekly markets or Sunday markets in various cities. These contribute to their family income. The report recommends that masterplans, zonal and local plans, along with urban local bodies recognize these are income-generating activities and allocate space for them. Waste pickers can receive training on micro-entrepreneurship to augment this work. Standards should be set if these are seen as causing 'pollution' and they be trained and empowered to meet these standards.

Packaging increasingly designed for reuse

Packaging can be reused if it is designed for this and if a suitable technical and value chain is established. Standards for reuse are also essential. Plan the Ban envisages reuse services as a viable option for waste pickers to engage in a decent, green

livelihood. Examples of this includes collecting containers from larger FMCG, pharma or beauty brands, cleaning them to remove contaminants to the prescribed standards, and returning them for refill.

2. Valorizing Organic Fractions of Waste

As India shifts beyond the landfill paradigm, organic fractions, which comprise almost 50% of the solid waste stream, pose an environmental challenge. If untreated, they are deposited in dumps, rivers and landfills, contributing to air and water pollution. The experience of the Swachh Bharat Mission suggests that decentralized waste management is key to a clean India. Decentralized composting or bio-methanation is part of this model. It is seen that 1 ton of compost creates approximately three livelihoods. The shift to decentralized waste management will enable waste pickers to handle wet waste, substituting earnings from plastics. Similarly, composting horticultural waste will also create new kinds of green livelihoods. To additionally promote this, concessionaires must be contracted only for services related to inert, sanitary and non-recyclable waste instead of all fractions of waste. Existing contracts may be modified.

3. Extending into Housekeeping Services

During the research, several groups of waste pickers prioritized housekeeping services as an extension of their work. Plan the Ban suggests that State Governments mandate at least 50% identified waste pickers on the team of housekeeping companies, at least as a pre-requisite for any contract with the government or quasi-government agency.

Training for these should be provided via various training agencies of the Government, such as the National Safai Karamcharis Finance and Development Corporation, (NSKFDC), the National Urban Livelihood Mission and others. Waste pickers should also occupy more attention of government schemes like Pradhan Mantri Kaushal Vikas Yojana, Skills Acquisition and Knowledge Awareness for Livelihood Promotion (SANKALP), UDAAN and the Green Skill Council.

C. Legal and Policy Approaches

The following approaches are important to achieve the balanced outcome of environment protection and poverty alleviation:

1. Ongoing discussions about the need for an Urban Employment Guarantee Scheme should specifically include waste pickers and wasteworkers. A welfare law for waste pickers and their families, created to dovetail with the plastic ban.
2. **Modification of the Plastic Waste Management Rules, 2018**: The Plastic Waste Management Rules must be amended to reflect the plastics for banning and EPR. States can further add other items as per local data.
3. **Modification of the Municipal Solid Waste Management Rules, 2016:** The MSW Rules should be amended to strengthen expanded livelihoods in the waste processing space. Further, municipal and state orders and central guidelines are essential instruments of support.

Municipal Actions

- Identify waste pickers in the ULB with details of work, skills and geography. This enables them to be matched with composting and other opportunities as well as skilled for these and entrepreneurship. This should be an annual exercise with linkages to the National Urban Livelihood Mission.
- Create incentives for decentralized wet waste composting. This includes capital costs may be made available to those residential and smaller commercial agencies which are able to show how they will include waste pickers and run the composting.
- Thirdly, compost should be procured from such sources at a fixed price and quantity. Additional help to sell it may also be made, as capacity for this may be lacking.

Other legal and compliance actions

- Inventory of Plastic Waste and Reuse and Recycling Infrastructure: Data is key for any law or policy to reducing plastic waste to be effective. Urban local bodies can be mandated to maintain an inventory of the dry waste, including plastics, collected, segregated, reused or/and recycled in its jurisdiction, filed with the SPCBs. This inventory can be used by policy makers to prioritize phasing out of certain plastics over others, invest in recycling infrastructure where there is none and allocate fiscal resources for this.
- Research and development to identify suitable alternatives: India should fast-track research and development initiatives to identify suitable alternatives for the most common SUPs not currently covered by bans. Further incentives can include subsidizing those plastic substitutes and alternatives to increase their uptake.
- Uniform definition of single-use plastic: A comprehensive definition of single-use plastic and suggested range is required. This definition must then be adopted by states. A single definition will help in a uniform phase-out of identified plastic material all over the country.

By following this strategy, India can phase out Single Use Plastics while strengthening the livelihoods of the poor.

1 Background

India is drowning in plastic waste. There is regional diversity in the consumption of plastics with western India accounting for 47%, northern India 23%, and southern India for 21%. The bulk of the consumption in northern India is from end-use industries of auto, packaging (including bulk packaging, plasticulture applications, electronic appliances, etc., which are concentrated mostly in Uttar Pradesh and Delhi)[1].

The average Indian uses 10 kg of plastic annually. The plastic packaging industry in India is growing by as much as 16% every year and is valued at INR 2,344 billion. Today, about 26,000 tonnes of plastic waste is discarded every day[2]. Despite a robust informal recycling economy, only 60% of plastic waste in India is recycled. The remaining 40% is dumped - on mountain slopes in the Himalayas, alongside or into rivers and waterways, on the plains, and in landfills. Much of it is single use plastic. Hence, this is the primary focus of this research.

Recycling in India is undertaken primarily by over 1.5 million waste pickers who pull out the plastic from unsorted waste. They sort and sell it to waste dealers. The dealers clean and again sort the waste, selling it on to specialised dealers, who in turn sell it to recyclers. This system, though highly organised, is semi-formal or informal, and often excluded from consideration while plastic bags continue to be developed.

- This study combines ground-level research on plastics and elicits responses from waste workers to understand waste flows that will help in single use plastic elimination. The key elements that Chintan has identified on the ground are:
- The community of waste recyclers (pickers, dealers, re-processors) are concerned about being deprived of livelihoods because of lower consumption and stricter regulation
- Their livelihoods have been hit earlier with lower wastepaper generation from offices as well as GST (goods and services tax) imposed on waste
- Most of them are poor, marginalised and stigmatised and are likely to find it hard to move into other professions, other than avenues of informal labour
- Consultations with informal sector actors are necessary to identify the extent to which they perceive the loss in terms of earnings, social impact and under-employment
- It will also identify the other skills they are willing to learn and options they are able to identify for themselves
- Documentation of good practices to show how widening the work of waste pickers is possible and how to train them in the path towards plastic reduction

2 Methodology

After an orientation in March 2019, a pilot study was launched in Delhi, Pune, Indore and Nainital, in collaboration with Safai Sena, Swach, Frametrics.com, Janvikas, and Deen Bandhu Samaj Sahyog Samiti. Pilot surveys were administered to 69 workers in Delhi, 20 workers in Pune, and 23 waste pickers in Nainital. The survey was unable to be carried out in Indore.

- After analysing the pilot data, the schedule for the final survey was modified in consultation with the partners and a final methodology was adopted as follows, keeping in mind the COVID-19 restrictions. The sample size included:
  - Waste pickers who pick waste from households and do *pheri* (roadside or other places)
  - Waste pickers picking waste from markets and streets, on foot, bicycle, and rickshaw
  - Waste pickers collecting waste from landfills
  - Waste pickers working as waste segregators
- Waste pickers went along their traditional routes of waste collection
- They did this for as many days as they usually do and picked up the waste how they usually collected
- This waste was sorted between plastic and non-plastic at their usual segregation place
- The surveyor was present at the segregation place with a weighing scale
- Segregated non-plastic waste was weighed with their prices and the days of collection
- Surveyors were provided with a visual list of plastic waste for detailed sorting
- Segregated plastic waste was weighed with their prices and days of collection
- A mobile application was developed for cellphones to hasten the process of data collection
- The app was ready by mid-June 2020 and, in the next two weeks, responses of 401 respondents in Delhi, 407 respondents in Pune, 396 respondents in Indore, and 45 respondents in Nainital were recorded

3 How plastic is recycled: Results

This section gives an overview of the study findings. The social background of respondents and their work context is summarised, along with an idea of the hazards they face, the income they earn from different kinds of waste, and the possible alternatives to plastics from their perspective.

A total of 1,249 respondents provided information to surveyors (See Table 1).

Table 1: Number of respondents

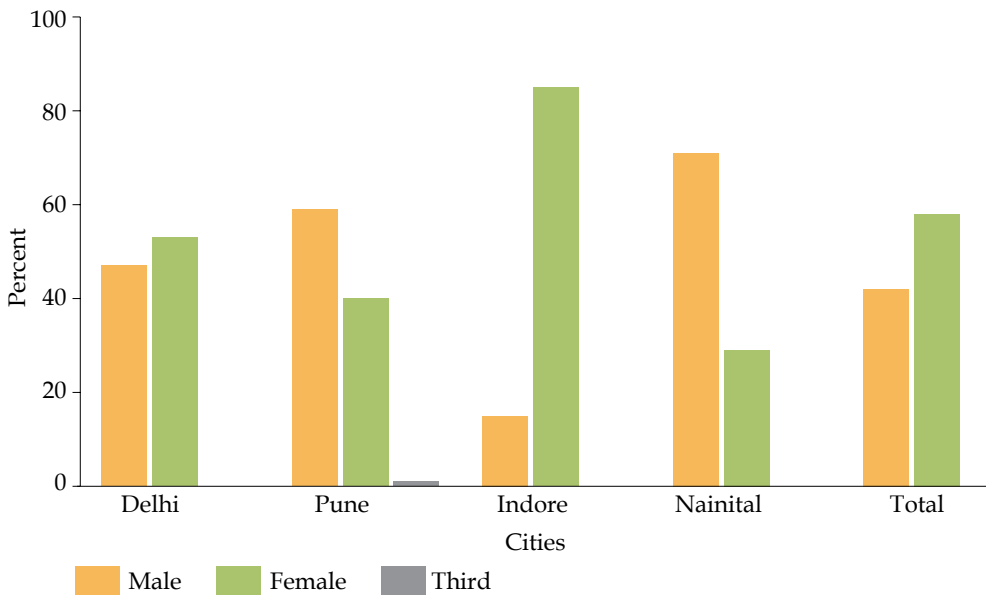
DELHI (DL)	PUNE (IN)	INDORE (IN)	NAINITAL (NN)	Total (Tot)
401	407	396	45	1249

3.1 Who are the waste pickers?

Fifty eight percent of all respondents were women (Fig.1)

While women outnumbered men by 16 percentage points in total, in Delhi, they

Fig. 1: Sex of respondents



were almost equally divided with 53% women. In Pune, 41% were women. There were only 29% in Nainital but 85% in Indore. Pune had four transgenders.

The age distribution was similar across cities. However, Delhi had a higher percentage (35%) in the lower age group (16-25 years), and a lower percentage (10%) in the higher age groups (>45 years). Indore had a large (14%) number of blank replies. (Fig. 2)

About 73% did not have any schooling and only 9% had remained in school beyond the primary level (Fig.3).

About 68-84% did not have any schooling in Delhi, Pune, and Indore. Nainital had 89% of its waste pickers with primary schooling. Access to education beyond primary was restricted between 2% (Indore) to 18% (Pune).

Fig. 2: Age of respondents

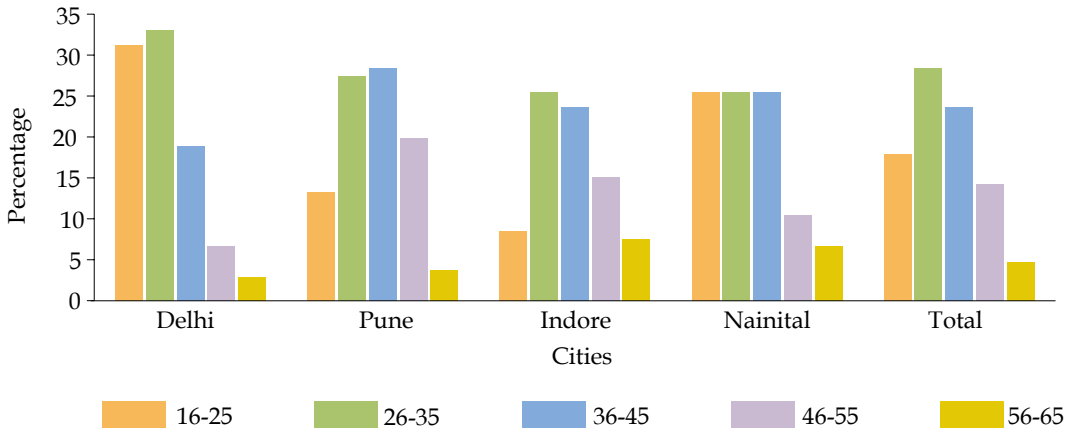
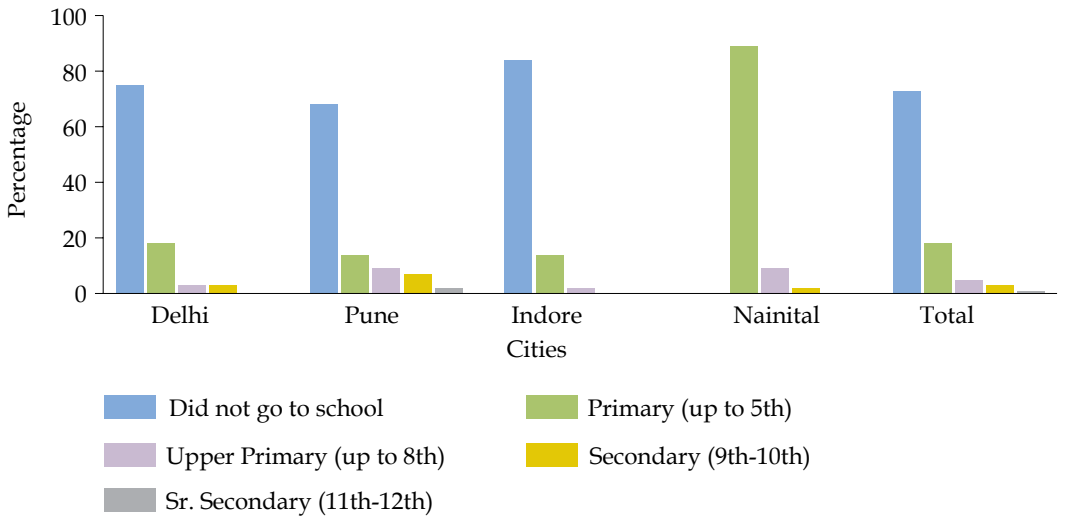


Fig. 3: Educational qualification of respondents



3.2 Work background

The respondents were asked whether their priority was waste collection or segregation. Some 70% said their priority was waste collection.

The site of collection for 36% of workers was street collection (Fig. 4), followed by 25% at landfills, and 24% from households.

A large percentage of the respondents (over 40%) said they had been working in this profession for more than 16 years. As many as 24% had been working for more than 20 years and eighty-five percent said they worked 5-7 days a week (Fig. 5).

Fig. 4: Priority of work

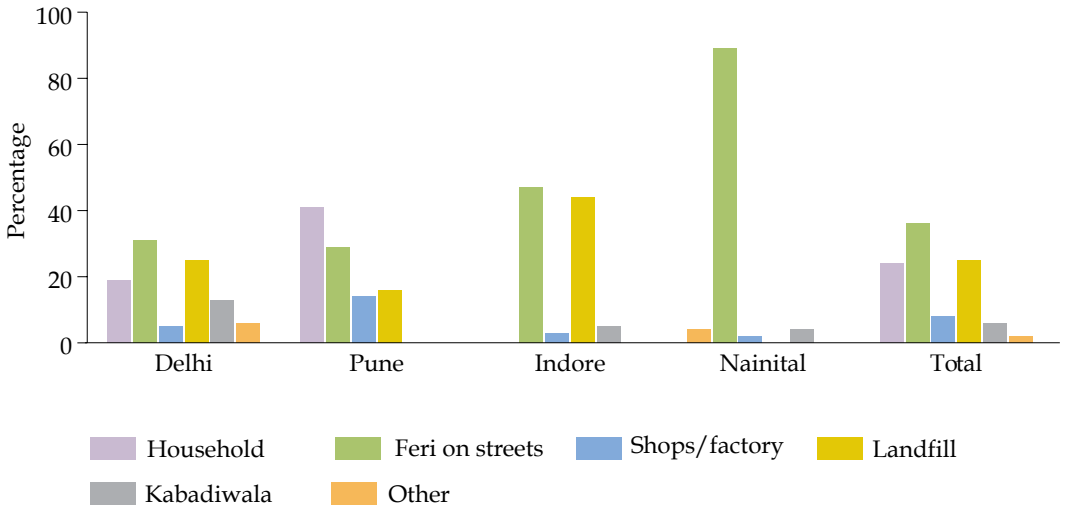
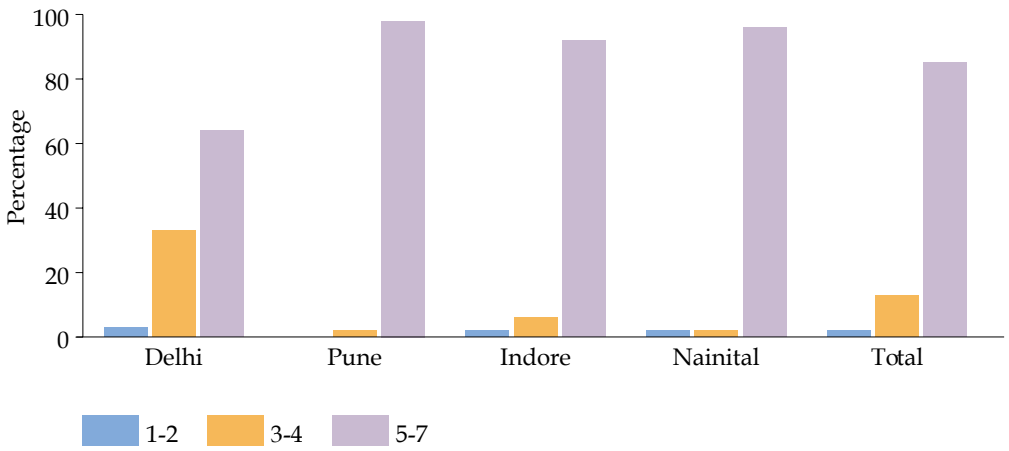


Fig. 5: Duration of work



For waste collection, 37% of waste pickers travelled for less than 5 km, another 37% travelled 5-10 km, 14% for 10-15 km, and 11% went beyond 15 km (Fig. 6).

These waste workers were not organised. Some 92% were not members of any organisation.

a. Hazards at work

Forty-two percent said that they face obstacles in their work (Fig. 7).

Fig. 6: Kms of distance travelled

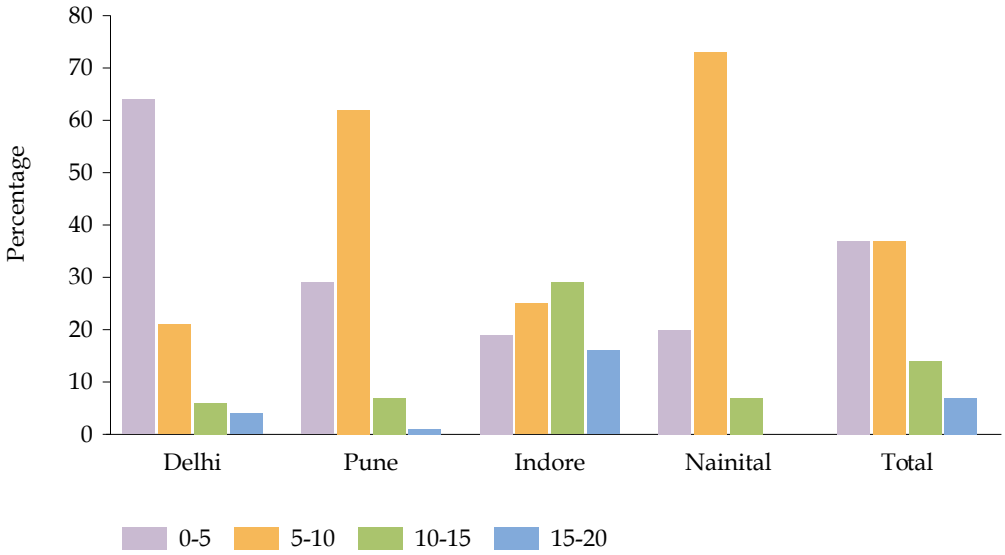
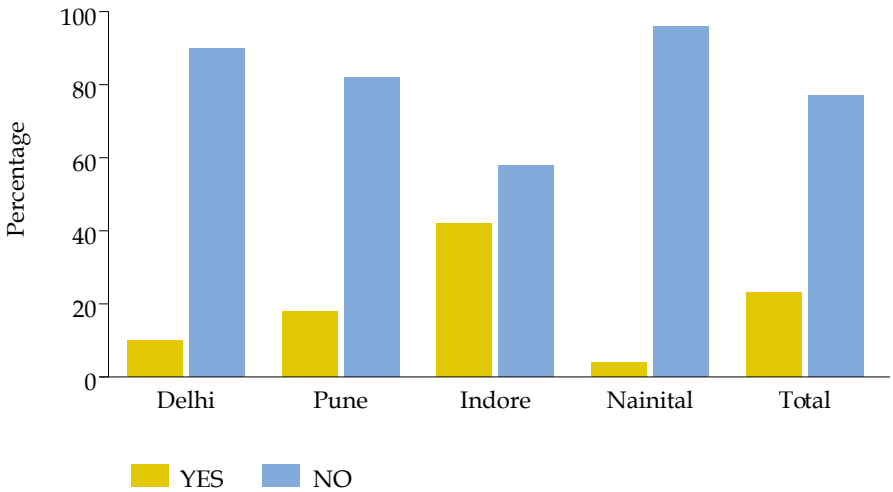


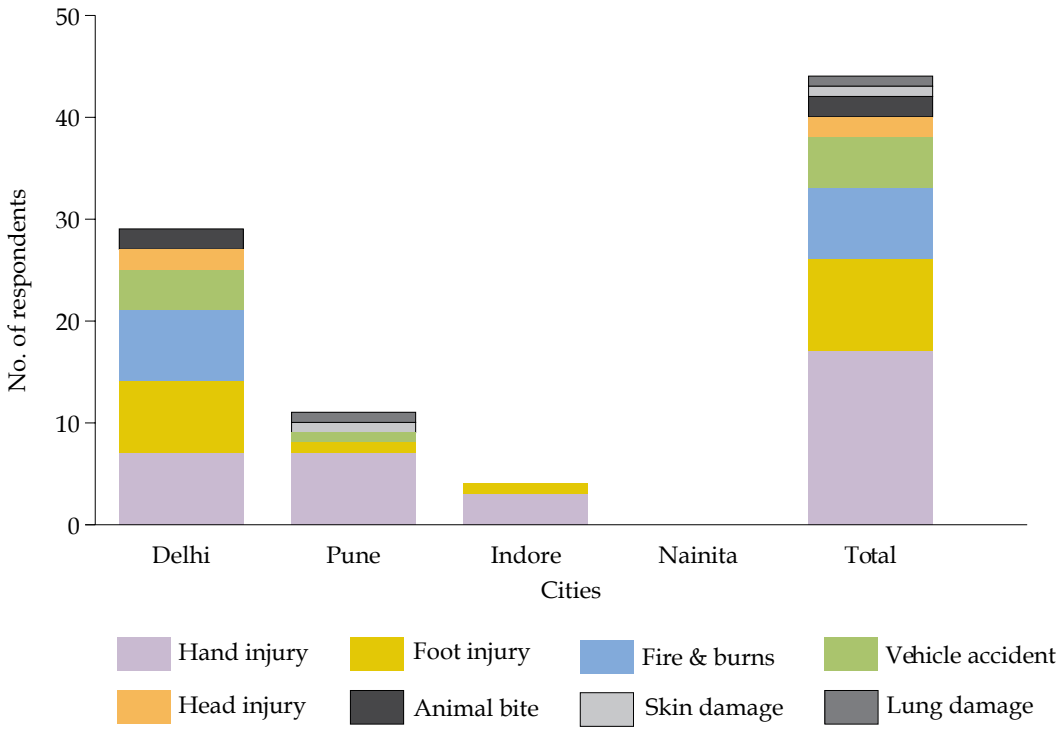
Fig. 7: Obstacles in work



Conflicts with authorities and residents appeared to be a common grouse. A large percentage said they were harassed by authorities.

As with other informal sector workers, waste workers do not have adequate access to healthcare when they suffer from accidents (Fig. 8)

Fig. 8: Type of accidents



b. Economics of waste picking

The livelihoods of waste pickers were severely affected by the COVID-19 pandemic when the severe lockdown[3] stopped the informal sector from working. It indicates how waste pickers could be affected if plastics are reduced from the waste stream. Policy measures are needed to protect their livelihoods and increase their incomes.

About 41% of the earnings of waste pickers and dealers come from plastic waste. As a result, they have expressed concerns about bans and reduction. For India's transition to a low plastic economy, it is crucial to work with waste pickers and dealers, and integrate them with and into the waste management ecosystem, so that the transition is safe, fair and agreeable to them.

The average income from sale of all waste (at the beginning of the lockdown period) for the entire sample was Rs. 226 per day, but it varied significantly across cities (Fig. 9 and Table 2)

Table 2: Percent distribution of daily earnings from sale of waste

Rs./day	<50	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	Avg. income
DELHI	3	10	25	12	15	16	4	2	5	1	3	2	229
PUNE	37	34	3	6	6	4	2	0	1	1	1	1	122
INDORE	3	3	5	12	21	13	12	7	10	9	3	0	288
NAINITAL	2	9	2	4	20	24	11	2	7	0	7	0	322
Total	**14**	**16**	**10**	**10**	**14**	**11**	**6**	**3**	**5**	**4**	**2**	**2**	**226**

The average daily earning from plastics was Rs. 93 and from non-plastics Rs. 133 (Table 3).

The change in income because of the lockdown was felt deeply by most respondents, with 73% saying income had decreased from sale of plastic waste and 81% saying earnings declined from non-plastics as well (Table 4).

Fig. 9: Daily earnings from waste

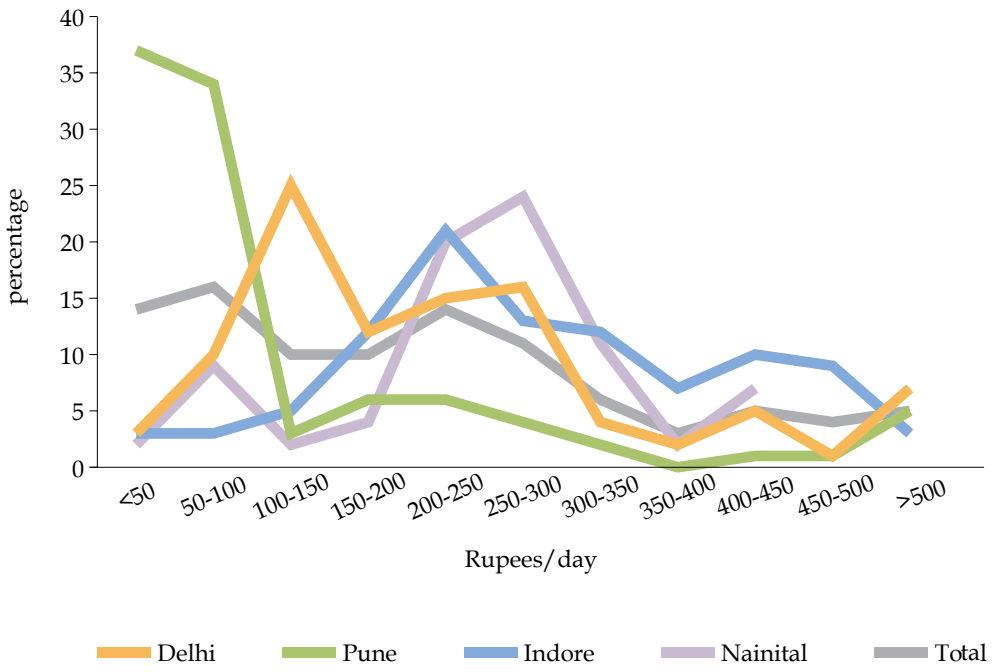


Table 3: Av. daily collection and income from waste

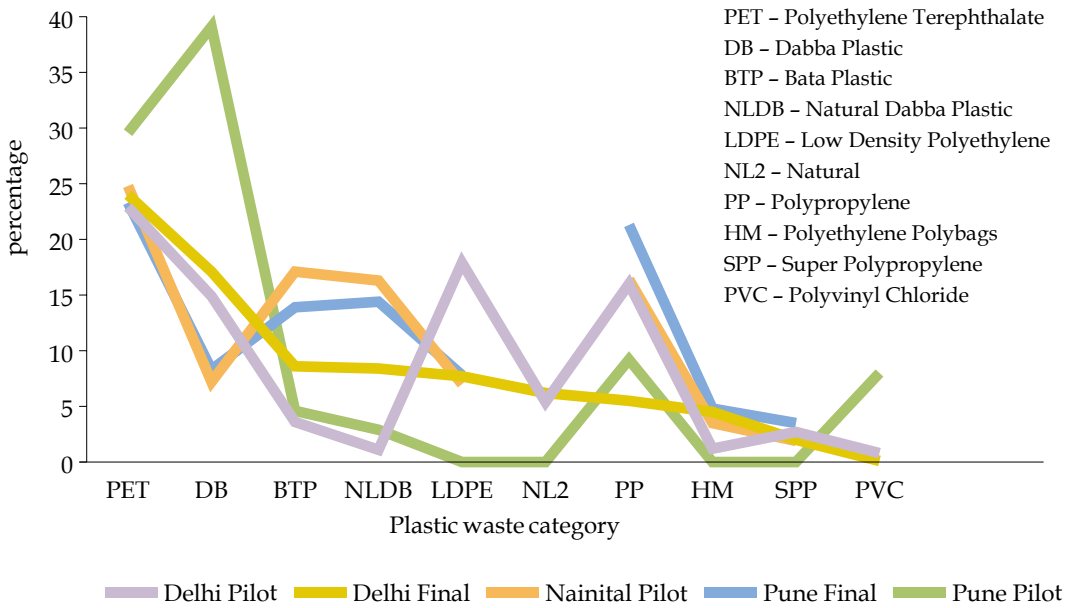
Plastic quantity collected	11 kg
Income from plastic sale	Rs. 93
Rate of plastic (Rs./kg)	8.20
Non-plastic quantity collected	12 kg
Income from non-plastic sale	Rs. 133
Rate of non-plastic (Rs./kg)	10.71
% Income from plastic	**41**

Table 4: Impact of lockdown on income (% respondents)

Income	Increased	Decreased	No change
From plastics	2.7	72.5	24.7
From non-plastics	3.4	80.7	15.8

The survey also found out about the categories of plastic waste that contributed most to the earnings of waste pickers. The categories used for this analysis are the ones that waste pickers use. This was later related to the chemical categories of the different polymers. The limited data illustrates some patterns, divergences and commonalities (Fig. 10). The major income generating plastics in the waste stream were PET, DB, BTP, PP and LDPE.

Fig. 10: Income share from different plastics



4 Validation and Toxicity

This section validates the study findings by comparing the data within cities with national studies to check for consistency as well as identifying significant differences. In addition, toxicity data of plastics from secondary literature is presented based on their chemical composition, lifecycle impacts and carbon dioxide emissions during production from cradle-to-resin. This is then used to design a ranking of plastics whose reduction would benefit the environment, and the possible impact on waste-picker incomes. We also flag those plastics that appear in the waste stream but which are not picked up by waste pickers and are detrimental to the environment.

4.1 Cross-checks across cities

To examine the consistency of the data across cities and its representative character, we have plotted all the 'yes' responses to a set of 16 yes-no questions.

When the type of work (collection or segregation) is compared with the distance travelled to work (Fig. 11), then Delhi (for collection) and Pune (for segregation) stand apart from the average distance travelled in the other cities. Otherwise, the data suggests distance travelled remains well within 10 km for collection and 5 km for segregation.

When the problems reported by workers is separated between those collecting waste and those segregating waste, then a pattern becomes slightly clearer. It may be seen that the problems with authority prevail everywhere but those of transportation, along with low rates, are much more pronounced in Pune and Indore than the other cities. Overall, the data across cities remains quite consistent.

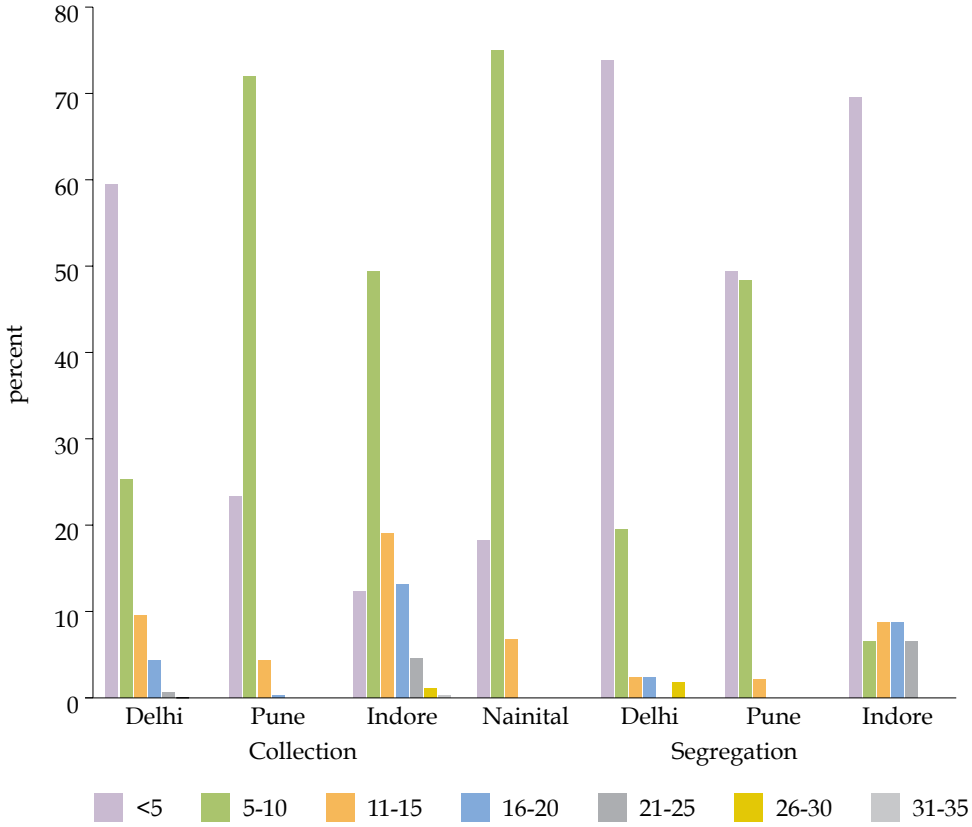
4.2 Comparing with national data

Some plastics enjoy commanding positions in the Indian market[4]. These are PE, PP and PVC[5]. The commodity plastics (PE, PP, PVC, and PS) accounted for 83% of the total plastics consumption in India in 2000-01. LLDPE was the material with the strongest growth rate, followed by PP, HDPE, PVC, PS and LDPE.

We look at the data on waste collected in this study to see if there is much difference from national data on the production of plastics and those that have been found in waste streams through larger and more comprehensive studies. For this, we must develop a linkage between the technical categories for plastics and the ones used by waste pickers (Table 8). The conclusions may be briefly summarised as:

- Most of the categories used by the trade and waste pickers overlap
- The main polymers are PP, PE, PVC, PS and PET
- Easily recycled plastics, such as PVC and PET, are known as such by both
- Some waste categories do not conform as the products are a mix of two or more polymers

Fig. 11: Kms. of distance travelled by type of work



The plastic composition of the collected wastes in all the cities (Fig. 12) is similar. Indore did not segregate and measure the waste, and hence is not included. The data from landfills in 60 cities and Delhi, as measured by CPCB-CIPET[6], broadly follows the same peaks and troughs but the percentage of PE is much higher. On the other hand, the data from the manufacturers' association Plastindia[7], gives a lower percentage of PE and slightly higher ones for PVC and PP.

- About 20% of the plastic produced in India is PVC, but only 1.4% is found in landfills, perhaps because 70% of it is used for making water and sewage pipes that have an estimated service life of between 100 to 300 years[8]
- Thirty percent of the plastic produced in India is PE, but 66-76% of the waste found in landfills is HDPE and LDPE. Even the waste collected and segregated by waste pickers has around 42% PE. This can be because PE is difficult to recycle, especially if it is laminated or soiled
- 8% of the production stream is PET, but only 3% of the overall is found in landfills and 18%-30% in waste collection. 80% of the PET bottles get recycled or downcycled[9].

About 5-10% collected in landfills is PS because it is used in consumer durables, insulation and packaging. So, even though it's partially recyclable, it is not picked up by waste pickers. Therefore, banning might be required for certain items like disposable cutlery and thermocol (PS) packaging.

4.3 Toxicity

We examined the short-term and long-term toxicities of these polymers to determine their impacts on environment and livelihoods and explored whether their reduction would have co-benefits that are dismissed as externalities in present pricing. Lithner et al[10] have given toxicity rankings to plastics based on their chemical composition (summary in Table 5, details in Appendix 5) and identify PVC products as the most toxic, whether plasticised or rigid. They are followed by PS, especially the high impact ones. In third rank comes PE, whether low density (LDPE) or high density (HDPE) or linear low density (LLDPE). Lowest in rank are PET and PP. BTP (Bata plastic) is classified at the end as it is a mix of PVC, PE, and PP and its exact ranking is unknown.

Fig. 12: Waste vs. landfills & production

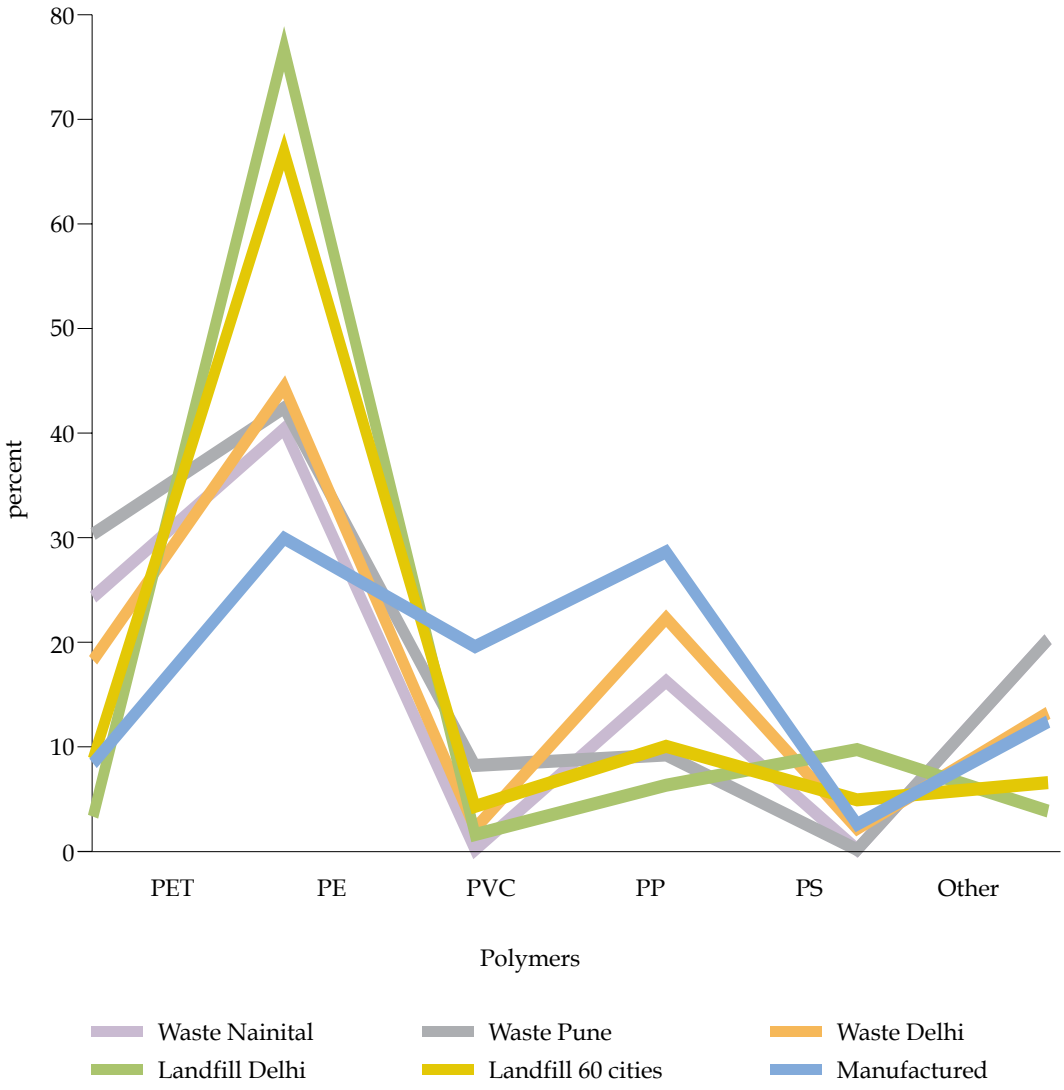


Table 5: Toxicity, quantity, and value of different waste products

S.n	Toxicity score-Lithner	Polymer	Waste data (%)			
			Delhi		Nainital	
			Quantity	Income	Quantity	Income
1	5,001-V	PVC, 50% non-classified plasticiser	0.7	1.4		
2	1,628-V	High impact polystyrene (HIPS)	0.4	1		
3	44-III	Expanded polystyrene (EPS)	0.6	0.6		
4	30-II	Polystyrene (PS)	1.0	1.1		
5	11-II	Low density polyethylene (LDPE)	22.8	16.2	14.5	12.6
6	11-II	High density polyethylene (HDPE)	21.2	25.6	25.3	22.7
7	4-II	PET, with dimethyl terephthalate	17.6	24.0	23.9	23.3
8	1-I	Polypropylene (PP)	21.7	20.4	16.3	27.5
9		BTP - mix of PE, PP, PVC	12.4	8.6	20.2	13.9

Source: [1] Lithner, D., A. Larsson, G. Dave, Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition, Science of the Total Environment, 2011, https://www.researchgate.net/publication/51210349_Environmental_and_health_hazard_ranking_and_assessment_of_plastic_polymers_based_on_chemical_composition

Only PE is significant in moderate toxicity as well as quantity and value for both cities. The PET and PP products represent high value but low toxicity. The main item of concern, therefore, may be the BTP, which is a mix of PVC, PE, and PP, and could, therefore, be quite toxic. It makes for 9-14% of the waste value.

The long-term environmental impact on the basis of life-cycle assessments, from virgin materials to final disposal, including breakdown into nano-plastics, has to take into account not only the polymers alone but the plasticisers, colourant fillers and reinforcements that are added to give them specific properties as well (See Appendix 6). Tabone et al[11] compared biopolymers along with plastic polymers as per the matrix given in Fig. 13. Further details are given in Appendix 7.

Comparing chemical toxicity with lifecycle assessment (Table 6), according to waste pickers' menu of collectable plastic wastes, places PET as having a much greater impact (brown) of -15.6 as compared to PVC with -10.2, while PE and PP are calculated to have the least negative impacts in the long term.

Fig. 13: Life cycle impact assessment matrix

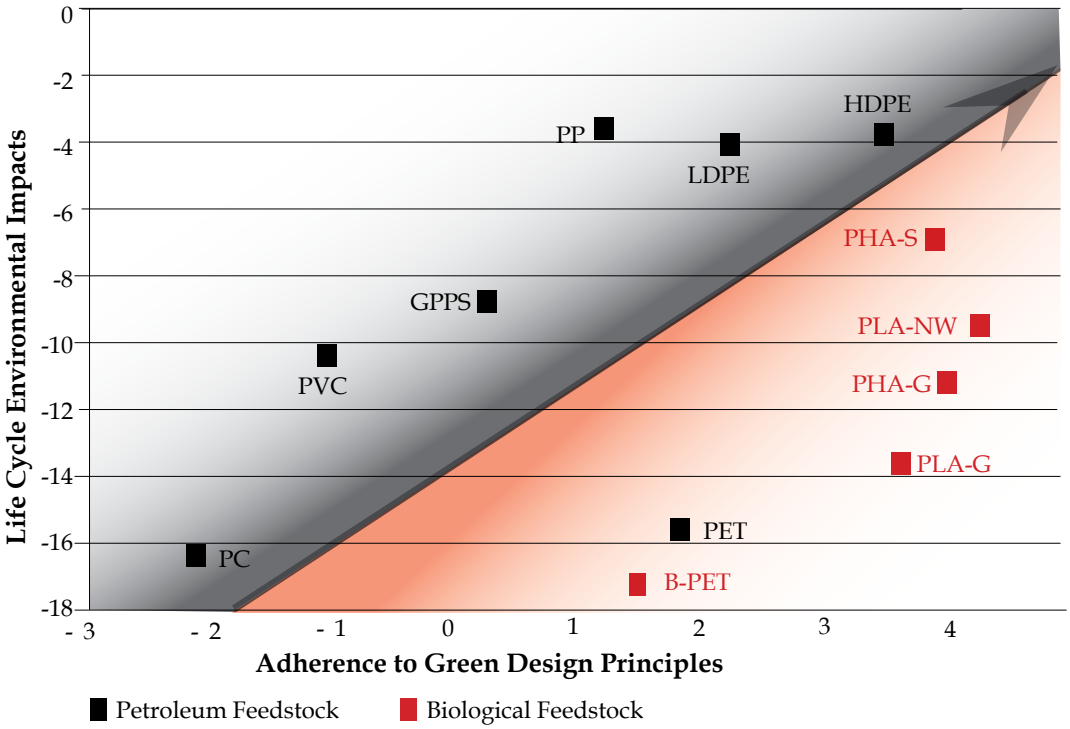


Table 6: Toxicity score and life cycle assessment

Toxicity (Lithner)	Polymer	Life Cycle (Tabone)
5,001	PVC, 50% non-classified plasticiser	-10.2
1,628	Polystyrene (PS)	-8.5
11	Low density polyethylene (LDPE)	-4.1
11	High density polyethylene (HDPE)	-3.9
4	PET, with dimethyl terephthalate	-15.6
1	Polypropylene (PP)	-3.7
?	BTP is mix of PE, PP, PVC	?

While PET is not harmless, it can be treated on par with PVC. This would mean a 18-20% decrease in waste pickers collection and impact their incomes. Therefore, this might not be a plastic that we want to immediately ban.

A Cradle-to-Resin study conducted by CIEL et al[12] for the USA (Table 7) says that the CO2 emissions are the highest for PS and PET, but the actual emissions are highest for PVC, HDPE and PP by virtue of their high level of production.

Table 7: Cradle-to-Resin greenhouse gas emissions estimates for North America, 2015

Resin	Emission factor*	N. America production#	CO_2 Emission@
Polystyrene	3.1	2	6.2
Polyethylene Terephthalate	2.4	2.8	6.7
Polyvinyl Chloride	2.2	6.7	14.7
Low Density Polyethylene	1.8	3.2	5.8
Linear Low Density Polyethylene	1.5	6.6	9.9
High Density Polyethylene	1.5	8.6	12.9
Polypropylene	1.5	7.8	11.6

*CO_2e/unit plastic/year; #million metric tonnes; @million metric tonnes

The same group has incorporated Lithner's ranking of the polymers based on a hazard classification of the monomers (Table 8), wherein PU, PA, and PVC are ranked highest on this classification.

However, this study points to the presence of BTP, which accounts for 12-20% of the quantity of waste collected by waste pickers and does not appear in either of the scores because it is a mix of PVC, PE and PP. It is also present in a range of products from shoes to soles, doormats, bike handle covers, photo frames, mobile charger body, etc. Of the alternative materials that were mentioned by the respondents, only bamboo, cloth and jute can be used to replace BTP, while none of the non-plastic waste materials collected by our sample of respondents fit the bill.

In conclusion, Lithner ranks polymers by chemical composition with PVC being the most toxic followed by PS, PE, PET and PP. Tabone, following a lifecycle assessment, ranks PET as the most toxic, followed by PVC, PS, PE and PP. For CIEL rankings based on CO2 emissions, PS and PET score over PVC, PE and PP. Overall, PVC and PET may be considered to be the plastics that are the most important from the point of view of a waste reduction policy.

4.4 Waste not collected

This research assumes that waste not picked up by waste pickers is highly unlikely to be recycled.

Table 9 compares the amounts of plastic polymers produced by industry to that picked up by waste pickers. The green cells indicate those plastics (PE films and moulds, PP films and bags, PET bottles, PS packaging, food trays and toys) where the percentage recovered in the waste in the two cities of Delhi and Nainital is higher than

Table 8: Ranking of polymers based on monomer hazard classification

Polymer	Monomer/additive	Hazard score
Polyurethane flexible	Propylene oxide	13,844
	Ethylene oxide	
	Toluene diisocyanate	
Polyacrylamide	Acrylonitrile	12,379
	Acrylamide	
	Vinyl acetate	
Polyvinyl chloride plasticised	Plasticiser	10,551
	Benzyl butyl phthalate	
Polyvinyl chloride unplasticised		10,001
Polyurethane rigid	Propylene oxide	7,384
	4,4 Methylene diisocyanate	
	Cyclopentane	
Epoxy resins	Bisphenol A	7,139
	Epichlorohydrin	
	4,4 Methylene dianaline	
Modacrylic	Acrylonitrile	6,957
	Vinylidene chloride	
Acrylonitrile-butadiene-styrene	Styrene	6,552
	Acrylonitrile	
	1,3 Butadiene	
Styrene acrylonitrile	Styrene	2,788
	Acrylonitrile	
High impact polystyrene	Styrene	1,628

the percentage of the plastics in the production basket. In other words, the plastic is being recovered and is coming within the purview of this study.

The blue cells identify those plastics (PE pipes, coatings, PP sacks, moulds, and PVC sheets) that are present in the production basket and are named by waste pickers but are not present in the survey data. The yellow cells are plastics (the rest of the products) that are not named by waste pickers nor present in the survey data. The red outlined cells (engineering polymers and thermosets) are of concern as their percentage in production is higher than 4%.

Table 9: Polymer production compared to polymer recovery from waste

Cate-gory	Product Consumed in 2016-17 [PlastIndia]	Kt. p.a.	% plastic	Delhi (%)		Nainital (%)		Waste-picker categories
				Qty.	Inc.	Qty.	Inc.	
PE 29.8%	Film & lamination	2060	13.3	22.8	16.2	14.5	12.6	LD1, LD2, HM
	Blow moulding	682	7.6	21.0	25.5	25.2	22.7	Dabba, Natural dabba
	Injection moulding	498						
	Raffia and MF	284	1.8					
	Pipe	434	2.8	0.1	0.1			Conduit pipe
	Roto-moulding	155	1.0					
	Wire & cable	150	1.0					
	Extrusion coating	141	0.9	0.2	0.9			Conduit board
	Drips and tubes	140	0.9					
PP 28.5%	Raffia-cement sacks	1427	9.2	0.9	0.7			Katta plastic
	Injection moulding	1640	10.6	6.2	5.7	6.0	6.2	Rangeen/ Kali/Super[i]
	Biaxially Oriented PP[ii]	524	5.2	9.2	5.5	10.2	21.3	PP1, PP2
	Tubular Quench PP[iii]	278						
	Fixtures and Fittings[iv]	359	2.3					
	Extrusion coating	105	0.7					
PVC 19.4%	Pipes	2100	13.6	0.3	0.2			Pani/Dhaga/ garden
	Calendering[v]	270	1.7		0.8			File, Clear PVC
	Wires & cables	150	1.0					
	Films	115	0.7	0.0				
	Fittings	110	0.7					
	Profiles	95	0.6					
	Sheet	40	0.3	0.0				Raincoat plastic

Cate-gory	Product Consumed in 2016-17 [PlastIndia]	Kt. p.a.	% plastic	Delhi (%)		Nainital (%)		Waste-picker categories
				Qty.	Inc.	Qty.	Inc.	
PET 8.1%	Bottle	800	5.2	17.6	24.0	23.9	23.3	Bottle plastic
	Sheet	429	2.8					
PS 2.0%	Consumer durables	96.1	0.6					
	EPS[vi]	65.1	0.4	0.6	0.6			Thermocol
	Food services	43.4	0.3	1.1	2.1			Clear, Rangin, Tray[vii]
	Novelty / gift items	34.1	0.2					
	Writing instruments	21.7	0.1					
	Foamed sheets	21.7	0.1					
	Electronics	12.4	0.1					
	Razor, hangar, toys	15.5	0.1	0.5				Razor, hangar
Not in survey	Engg. Polymers	638	4.1					
	Thermosets	950	6.1					
	Others	303	4.0					
BTP[viii]				12.4	8.6	20.2	13.9	
Grand Total		**15471**	**100**	**100**	101	100	100	

There is also the plastic that has not been picked up by waste pickers and which emerges in the waste stream in marine and riverine ecosystems (Table 10).

Of these, the ones of greater concern (pink) would be packets, bags, packaging, synthetic cloth, tyres and rubber, as well as the micro-beads and nanoparticles that are barely visible and are therefore ignored (see Appendix 3).

Providing context, it has been computed[13] that the Ganges River catchment between India and Bangladesh contributes 0.12 (range 0.10–0.17) million tonnes of plastics per year to the waste entering the rivers. Out of the total waste littered, plastic polybag composes around 50-60%. Plastics found in the aquatic environment are generally categorised[14] as macro-plastics (> 5 mm - disposable cups, bottles, and shipping pallets), micro-plastics (< 5 mm – micro-beads and fishing line fragments), and nano-plastics (<100 nm) and come from sources such as plasticised PVC (artificial leather, bathtub toy, tablecloth), and Polyurethane (floor coating, child's handbag and artificial leather).

Table 10: Wastes in marine and riverine ecosystems

	Plastic product	Haridwar (% wt)	Prayagraj (% wt)	Agra (% wt)	Mumbai (% wt)
1	Multilayer packets of snacks, chips, biscuits, etc.	17.3	7	4.7	7.3
2	Synthetic woven bags for cement packaging etc.	5.7	1.9	16.1	12
3	HDPE pipes, bottles, tubes, tray, PVC etc.	8.8			
4	Polythene bags (coloured, white, black)	32.8	19.1	45.4	5.7
5	Disposable cups coated with plastic film	3.6		2.1	
6	Packaging used for water, milk etc.	3.2	2.7	3	
7	Garment/ textile packaging material	11.5			
8	Synthetic clothes / clothes	3.8	42.3		9.3
9	Plastic sheet and other thicker plastic bags	2.9		9.3	
10	Laminated disposable plates and bowls	4.1			
11	Monolayer packaging for food, detergent, etc		1.6	8.8	
12	Shopping bags/ grocery bags		2.9		16.3
13	Construction material with plastic component		2.6		
14	Ritual material		1.7	2.4	
15	Idols with synthetic cloth and plastic ornaments		1.8		
16	Tobacco, pan masala sachet/ wrappers			2.7	
17	Tires and rubber				28.5
18	Footwear				7
19	Beverage bottles (plastic) including PET bottles				3
20	Thermocol and other trash				8.4
21	Others	6.3	7.4	3.6	2.5

Source: UNEP, National Productivity Council: "Promotion of Counter Measures against Marine Plastic Litter in Southeast Asia and India

Hence, PE pipes, coatings, PP sacks, moulds, PVC sheets, packets, bags, packaging, synthetic cloth, tyres, rubber, micro-beads and nano-particles are plastic products that are of concern as they do not emerge in this study data and yet are present in the waste.

Segregated data on plastic collection coupled with chemical polymer names are not fully available and many remnants in the waste stream are a mix of polymers. Hence, several assumptions have been made about income shares as well as which is the principal polymer in a particular product (Table 11). As better data becomes available, this matrix can be improved. The shades of pink represent greater harm, while the shades of blue represent the present benefit to the waste picker.

Table 11: Matrix of impact of plastic wastes

Polymer	Life Cycle Tabone[a]	Toxicity Lithner[b]	CO_2 emission[c]	>2% Not picked[d]	Aquatic waste >10%[e]	Income share %[f]
PU		13,844				
PA		12,379				
PET	-15.6	4	6.7	Sheet		29.19%
PVC	-10.2	10,551	14.7			2.76%
PS	-8.5	1,628	6.2		Tyres 28.5%	
PE (DB)	-4.1	11	5.8		Bags 25.8%	4.17%
	-3.9				ML 9.1%	20.39%
			12.9		Garments 29.9%	
PP	-3.7	1	11.6	Fixtures	Bags 18.5%	10.45%
BTP						8.44%

PU – Polyurethane; PA – Polyacrylamide; ML – multi-layered polyester or polyethylene

4.5 CONCLUSIONS: Waste pickers and Plastics

This study finds that the plastic composition of the collected wastes in the three cities of Delhi, Pune, and Nainital is similar. In addition, it corresponds with the data from the landfills in 60 cities – except in a minor way for Polypropylene (PP) and Polystyrene (PS) – as well as the data from the manufacturers, except for a lower percentage of Polyethylene (PE) and slightly higher ones for Polyvinyl Chloride (PVC) and PP

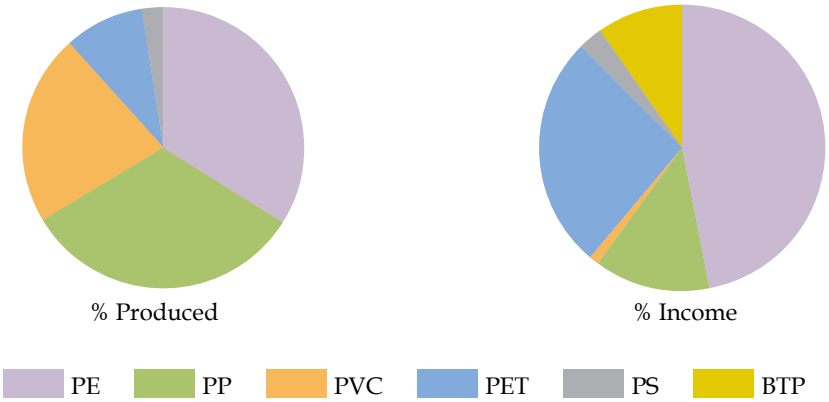
For waste pickers in the four cities of Delhi, Pune, Indore and Nainital, the average income is Rs. 226 per day, to which plastic waste contributes about 41%. The major income-generating plastics in the waste stream (according to segregated data that was available for Delhi and Nainital) are Dabba Plastic (PE), Polyethylene Terephthalate (PET), Bata Plastic (BTP or about 50% PVC mixed with PP and PE), Polypropylene and Low-Density Polyethylene (LDPE).

The literature suggests that PVC (plasticised or rigid) is the most toxic, followed by PS (especially high impact) and PE (all forms). However, in lifecycle assessment, PET has a much greater impact than PVC, while PE and PP are calculated to have the least negative impacts in the long term. Cradle-to-Resin analysis indicates that PVC has the greatest impact on greenhouse gas emissions, followed by High Density Polyethylene (HDPE) and PP.

PVC constitutes 19% of the production of plastics but does not appear much in waste collection or in the aquatic ecosystems; PS is 2% of production and virtually absent in the collected waste as well as the water sinks; PET makes up 8% of total production and is significant in waste collection but not in the rivers and oceans.

Reduction of PET means that the waste picker's income might be reduced by 23-24%. However, BTP (which has 50% PVC) reduction would account for 9% of income. PP removal would affect another 9% of income. The total impact on the waste picker, therefore, could be a reduction of as much as 41% of income. This would be severe unless other materials appear in the product and waste streams to make up for the income loss.

Fig. 14: Plastics produced and corresponding income from wastes



From the perspective of the waste picker, therefore, the following schedule of plastic[15] reduction makes sense:

- Reduce production of highly toxic Polyurethanes (for upholstery), Polyacrylamides (flocculants) and Polystyrenes (disposable food ware) as their impacts on health and environment are high and they are not collected. So, they do not affect waste-picker incomes
- Reduce production of Polyvinyl chloride (films, sheets) which has high toxicity, lifecycle impact and CO2 emissions, but does not significantly impact waste picker earnings (except Bata Plastic).

During the COVID-19 lockdown, there were huge volume reductions, experienced by the value chain, of 65% for informal sector collectors. However, there was a mere 13% price difference between virgin and recycled PET[16]. At the same time, there were fears that brand owners would cut their EPR budgets[17]. The earlier plastic bans have been revoked or kept in abeyance under pressure from manufacturers[18]. Hence, it is not just waste workers but also recyclers and producers who have to be provided financial incentives from the savings that accrue from reducing toxic impacts

Plastics have invaded the market because they are much cheaper than the materials they replaced and even for the new uses they were put to. This is an argument that is often put forward by plastics manufacturers and foundations to defend the industry[19]. However, the critical issue here is that the externalities of environmental and health damage are not included in these costs[20]. If they were, plastics would then arguably become socially and environmentally unacceptable[21].

The perception of waste pickers about the hazards posed by these polymers and their impact on them and their environs was also noted. 65% of all respondents said plastics did not cause any harm (Fig. 15). Those who thought plastic waste was harmful were consistent in their opinion that plastics polluted the air, water and food (Fig. 16).

Furthermore, a shift in design would be necessary for not only substituting materials, but also for looking for products and materials that can be easily repaired. Products that can be repaired will be thrown away less. The repairing and maintenance sector can generate more jobs as well.

Thus, a repair sector for food ware, essential packaging, storage containers, electronic equipment, conveyance pipes, fixtures and fittings, consumer durables, toys, gifts, writing instruments, etc., would not only contribute to a less-waste society but also generate valuable local livelihoods.

This study shows that bans on plastics must take into consideration impacts on incomes of waste pickers, along with data on toxicity, lifecycle impacts, material not recycled, and the waste composition found in aquatic ecosystems. This will have a long-lasting impact on fighting both plastics, especially single use plastics, and poverty.

Fig. 15: Perception of hazards from polymers

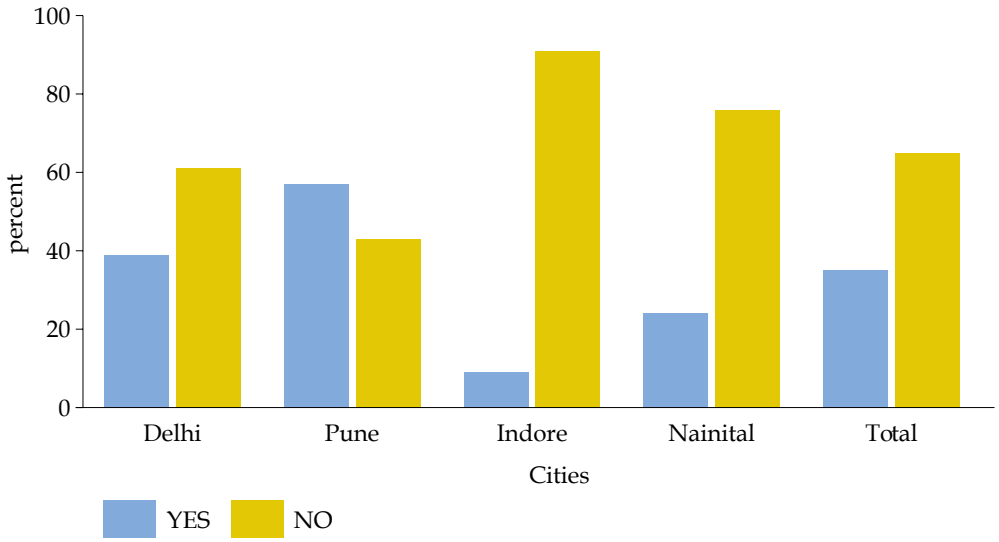
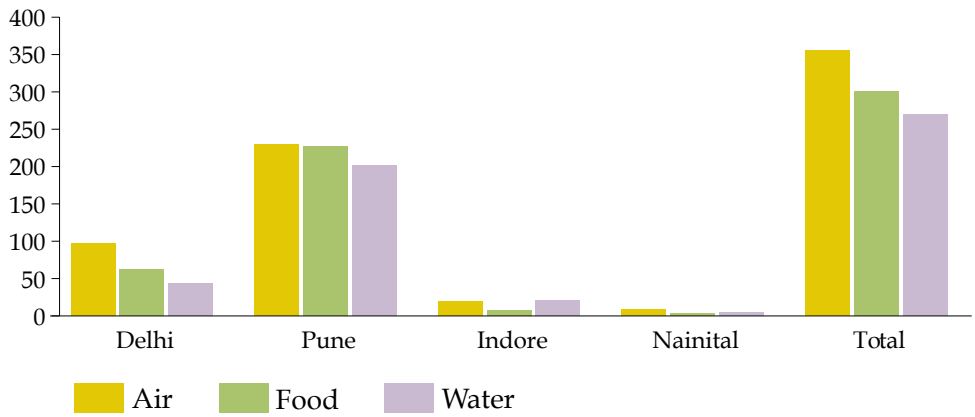


Fig. 16: Opinion about nature of plastic hazards



5 Recommendations

The damage plastics have inflicted on the environment is well acknowledged. Plan the Ban supports drastically reducing both single-use plastics and toxic plastics. However, it shows the unintended consequence of this will be a decline of up to 40% of the incomes of almost 1.5 million extremely poor and vulnerable waste workers. This must be simultaneously addressed. The report recommends three important pathways for a win-win. These are plastics elimination, livelihoods expansion, and legal and policy mandates.

5.1 Elimination of Plastics

The report identified single-use plastics, focused on those not recycled, therefore contributing to pollution. These were divided these into items that can be banned because they are not essential and substitutes are available. A second category identifies plastics under EPR. The report does not recommend banning of PET plastics as it forms 29.19% of the total average income of waste pickers (about Rs 226 per day), followed by PE at 20.39%, and PP at 10.45%.

Plastic products recommended for banning under amended PWM Rules, 2018:

1. **Polypropylene (PP):** Products include woven bags, plastic straws, wet wipes, ear buds with plastic sticks, sticks used for holding frozen or icy edibles, plastic flags and hotel sized toiletries.
2. **Polystyrene (PS):** Products include use and throw cutlery and crockery (plates, glasses, spoons, forks, stirrers, knives), thermocol packaging sheets and chips for packing and decoration.
3. **Polyvinyl Chloride (PVC):** Products include flex banners of all thicknesses, cling film for food and other use, blister wrap for non-essential medicines.
4. **Metalized plastics (Multi-layered plastics):** Products include wrappers, sachets of cosmetics, creams, lotions, shampoo, including samples or travel-sized sachets and single-use applications of all products.
5. **High Density Polyethylene (HDPE):** Products include woven shopping bags, grocery bags and woven tissues, including wet wipes.
6. **Low Density Polyethylene (LDPE):** Products include Polythene bags (colored, white, and black)

Plastics to be covered under EPR:

1. **Metalized plastics (Multi-layered plastics):** Products include packets of snacks, chips, biscuits, milk pouches. Specifically, additional incentives should be included for EPR in ecologically fragile areas, such as the Himalayas, where quantities are less but potential for ecological damage higher
2. **Polycarbonate (PC):** Products include indicator lights
3. **High Density Polyethylene (HDPE):** Products include toothpaste, personal hygiene, pharmaceutical and beauty products in tubes
4. **Nylon and Polyester:** Products include synthetic clothes, nylon ropes including nets for sports.

5.2 Livelihoods' Expansion

Livelihoods' expansion refers to new work in the sphere of waste, that can generate comparable or greater income for waste pickers. This should be part of a wider Urban Employment Guarantee Scheme.

1. Reuse as Livelihood

As the concept of resource efficiency and circular economy gains currency, reuse provides an important livelihood opportunity to waste pickers.

Strengthening Local Reuse

Waste pickers frequently retrieve materials that can be reused, either directly or after repair. Sales take place at local weekly markets or Sunday markets in various cities. These contribute to their family income. The report recommends that masterplans, zonal and local plans, along with urban local bodies recognize these are income-generating activities and allocate space for them. Waste pickers can receive training on micro-entrepreneurship to augment this work. Standards should be set if these are seen as causing 'pollution' and they be trained and empowered to meet these standards.

Packaging increasingly designed for reuse

Packaging can be reused if it is designed for this and if a suitable technical and value chain is established. Standards for reuse are also essential. Plan the Ban envisages reuse services as a viable option for waste pickers to engage in a decent, green livelihood. Examples of this includes collecting containers from larger FMCG, pharma or beauty brands, cleaning them to remove contaminants to the prescribed standards, and returning them for refill.

2. Valorizing Organic Fractions of Waste

As India shifts beyond the landfill paradigm, organic fractions, which comprise almost 50% of the solid waste stream, pose an environmental challenge. If untreated, they are deposited in dumps, rivers and landfills, contributing to air and water pollution. The experience of the Swachh Bharat Mission suggests that decentralized waste management is key to a clean India. Decentralized composting or bio-methanation is part of this model. It is seen that 1 ton of compost creates approximately three livelihoods. The shift to decentralized waste management will enable waste pickers

to handle wet waste, substituting earnings from plastics. Similarly, composting horticultural waste will also create new kinds of green livelihoods. To additionally promote this, concessionaires must be contracted only for services related to inert, sanitary and non-recyclable waste instead of all fractions of waste. Existing contracts may be modified.

3. Extending into Housekeeping Services

During the research, several groups of waste pickers prioritized housekeeping services as an extension of their work. Plan the Ban suggests that State Governments mandate at least 50% identified waste pickers on the team of housekeeping companies, at least as a pre-requisite for any contract with the government or quasi-government agency.

Training for these should be provided via various training agencies of the Government, such as the National Safai Karamcharis Finance and Development Corporation, (NSKFDC), the National Urban Livelihood Mission and others. Waste pickers should also occupy more attention of government schemes like Pradhan Mantri Kaushal Vikas Yojana, Skills Acquisition and Knowledge Awareness for Livelihood Promotion (SANKALP), UDAAN and the Green Skill Council and the NSKFDC.

5.3 Legal and Policy Approaches

The following approaches are important to achieve the balanced outcome of environment protection and poverty alleviation:

1. Ongoing discussions about the need for an Urban Employment Guarantee Scheme should specifically include waste pickers and wasteworkers. A welfare law for waste pickers and their families, created to dovetail with the plastic ban.
2. **Modification of the Plastic Waste Management Rules, 2018**: The Plastic Waste Management Rules must be amended to reflect the plastics for banning and EPR. States can further add other items as per local data.
3. **Modification of the Municipal Solid Waste Management Rules, 2016:** The MSW Rules should be amended to strengthen expanded livelihoods in the waste processing space. Further, municipal and state orders and central guidelines are essential instruments of support.

Municipal Actions

- Identify waste pickers in the ULB with details of work, skills and geography. This enables them to be matched with composting and other opportunities as well as skilled for these and entrepreneurship. This should be an annual exercise with linkages to the National Urban Livelihood Mission.
- Create incentives for decentralized wet waste composting. This includes capital costs may be made available to those residential and smaller commercial agencies which are able to show how they will include waste pickers and run the composting.
- Thirdly, compost should be procured from such sources at a fixed price and quantity. Additional help to sell it may also be made, as capacity for this may be lacking.

Other legal and compliance actions

- Inventory of Plastic Waste and Reuse and Recycling Infrastructure: Data is key for any law or policy to reducing plastic waste to be effective. Urban local bodies can be mandated to maintain an inventory of the dry waste, including plastics, collected, segregated, reused or/and recycled in its jurisdiction, filed with the SPCBs. This inventory can be used by policy makers to prioritize phasing out of certain plastics over others, invest in recycling infrastructure where there is none and allocate fiscal resources for this.
- Research and development to identify suitable alternatives: India should fast-track research and development initiatives to identify suitable alternatives for the most common SUPs not currently covered by bans. Further incentives can include subsidizing those plastic substitutes and alternatives to increase their uptake.
- Uniform definition of single-use plastic: A comprehensive definition of single-use plastic and suggested range is required. This definition must then be adopted by states. A single definition will help in a uniform phase-out of identified plastic material all over the country.

By following this strategy, India can phase out Single Use Plastics while strengthening the livelihoods of the poor.

Appendix 1:
Further details on income from plastics

The average income from sale of all waste (during the lockdown period) in different cities (Table 12) varies significantly. Pune has the lowest income of Rs. 122 per day with 71% of the workers earning less than Rs. 100 per day; and Naintal has the highest at Rs. 322 with 71% earning Rs. 100 to 450 per day. Delhi and Indore lie in the middle range earning Rs. 229 and Rs. 288 per day.

Table 12: Per cent distribution of daily earnings from sale of waste

Rs./day	<50	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	Avg. income
DELHI	3	10	25	12	15	16	4	2	5	1	3	2	229
PUNE	37	34	3	6	6	4	2	0	1	1	1	1	122
INDORE	3	3	5	12	21	13	12	7	10	9	3	0	288
NAINITAL	2	9	2	4	20	24	11	2	7	0	7	0	322
Total	14	16	10	10	14	11	6	3	5	4	2	2	226

Comparing the average daily earnings from plastic (Table 13), the lowest collection of 5 kg is in Nainital, the highest is four times more in Indore. However, since the rates for plastic are lowest (Rs. 6.79 per kg) in Indore and are double that in Nainital, the daily earnings of Indore's waste-pickers (Rs. 137) are about twice that of Nainital's (Rs. 78). Pune derives the lowest income (Rs. 50) because both collection and rates are low. For non-plastics, Nainital has the lowest collection and lowest income because the rates are also low. Indore, on the other hand, has the highest collection and maximum daily earnings[23]. The per cent income, therefore, from plastics is lowest in Pune and highest in Nainital, with an average of 41% for all four cities. The average daily earnings from plastics is Rs. 93 and Rs. 133 from non-plastics, giving a total per capita income of Rs. 226.

Table 13: Daily income from plastic and non-plastic

	DELHI	PUNE	INDORE	NAINITAL	Avg.
Plastic quantity (Kg)	9	6	20	5	11
Plastic income (Rs.)	95	50	137	78	93
Rate Plastic (Rs./Kg)	10.89	8.39	6.79	14.49	8.20
Non-plastic quantity (Kg)	11	12	15	5	12
Non-plastic Income (Rs.)	143	102	165	43	133
Rate Non-plastic (Rs./kg)	13.44	8.38	10.87	8.98	10.74
% Income from plastic	40	33	45	65	41

Considering that data was collected in the months of mid-June and July 2020, this income would have been impacted by the COVID pandemic and the subsequent lockdown. When respondents were asked whether their income from wastes had decreased or not (Table 14) 72.5% reported a decrease for plastics and 80.7% said that income from non-plastics had decreased. Less than 4% said there had been any increase for either of the two categories.

Table 14: Impact of lockdown on income (% respondents)

Income	Increased	Decreased	No change
From plastics	2.7	72.5	24.7
From non-plastics	3.4	80.7	15.8

The quantities sold and incomes earned from different categories of non-plastic waste are given in Tables 15 and 16. The highest collections are for aluminium and beer cans in Pune, and cloth in Indore, but the highest incomes are from copper in Delhi and Pune, and from brass in Delhi. Thus, rates matter more than the amount collected and, therefore, steer waste pickers towards wastes that have higher value (or both plastics as well as non-plastics).

Table 15: Sale non-plastic/day (Kg)

	DELHI	PUNE	INDORE	NAINITAL	All
Iron	3.2	3.8	5.4	0.5	4.0
Brass	3.1	1.7	1.1	0.3	2.0
Aluminium	0.1	***18.9***	0.5		1.5
Copper	7.2	0.7	2.8		3.0
Tin	0.3			1.0	0.9
Beer can		***17.3***			17.3
Silver	0.1				0.1

	DELHI	PUNE	INDORE	NAINITAL	All
Cardboard	4.0	3.8	4.8	1.4	3.0
Glass	3.7	7.9	8.9	0.8	6.4
Paper	3.6	3.7	4.1	1.2	3.6
Cloth			***18.0***		18.0
Roti	10.2				10.2
Rubber		3.0			3.0
Leather		2.9			2.9
Mobile		2.0			2.0
Wood		1.2			1.2

Table 16: Income non-plastic/day (Rs.**)**

	DELHI	PUNE	INDORE	NAINITAL	All
Iron	52	58	56	7	53
Brass	634	74	174	29	368
Aluminium	5	189	40		44
Copper	1813	12	669		708
Tin	2			10	9
Beer can		173			173
Silver	8				8
Cardboard	20	36	22	10	26
Glass	11	19	23	6	17
Paper	17	36	18	9	24
Cloth			5		54
Roti	31				31
Rubber		23			23
Leather		26			26
Mobile		200			200
Wood		12			12

Appendix 2:
Challenges at work

A comparison of the problems of access to waste while collecting or segregating is given in Table 17. It shows that all waste pickers in all cities have problems with the authorities, whether they are collecting or segregating. This is a logical consequence of treating waste picking as 'illegal' and not providing either an identity or space for them within urban planning. Hence, both municipal authorities and police have a free hand in harassing and extorting money from waste pickers. This is a matter that needs to be addressed urgently. The two other main problems, marked out by waste pickers in Pune and Indore only, are transportation (for both occupations) and low rates (mainly for collectors). A fourth problem that cuts across cities is of objections by residents.

Table 17: Problems at work when collecting and segregating waste (%)

Problem	DELHI		PUNE		INDORE		NAINITAL	
Occupation	Col.	Seg.	Col.	Seg.	Col.	Seg.	Col.	Seg.
Authority	90.5	77.8	42.6	52.6	31.4	40.0	50.0	0.0
Transport			14.8	26.3	22.6	10.0		
Low rate			22.2	10.5	19.5	10.0		
Residents	4.8	11.1	13.0	5.3	6.3		50.0	
Injury					3.8	20.0		
Pollution					5.0	20.0		
Fatigue		11.1			4.4			
Other	4.8		7.5	5.3	7.0			
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0

In Table 13, we look at what the amount of polymer produced and the percentage that appears in the waste stream are. This helps to further refine the decision-making process for reduction by identifying which polymers have a marginal production presence, which ones are appearing in the waste stream (indicating their quick disposal), and which ones are of value to waste pickers.

i+Dhakkan, Brush, Moulded plastic; iiFilms, Bags, Labels; iiiFilms; ivPlumbing Junctions; vFilms and Sheets; vi75%

Appendix 3:
Toxicity ranking of plastics on the basis of chemical composition

Hazard Score	Polymer	Monomer 1 (wt%)	Monomer 2 (wt%)
10,551 (V)	Polyvinyl Chloride (PVC), plasticised	Vinyl chloride (50 wt.%)	Benzyl butyl phthalate (50 wt.%)
		Carc.1A(V), Flam.Gas 1(I)	Repr.1BFD(V), Aq.Chronic1(IV),
			Aq.Acute1(III)
10,001 (V)	PVC, rigid	Vinyl chloride (100 wt.%)	
		Carc.1A (V), Flam.Gas 1(I)	
5,001 (V)	PVC, 50% non-classified plasticiser	Vinyl chloride (50 wt.%)	Diisodecyl phthalate (50 wt.%)
		Carc.1A(V), Flam.Gas 1(I)	Not classified
1628 (V)	High Impact Polystyrene (HIPS)	Styrene (92 wt.%)	1,3-butadiene (8 wt.%)
		Acute Tox.4 (inhalation)(II), Eye(II), Skin(II)	Carc.1A (V), Muta.1B(V), Flam. Gas 1(I)
44 (III)	Expanded polystyrene (EPS)	Styrene (93 wt.%)	Blowing agent: Pentane (7 wt.%)
		Acute Tox.4 (inhalation)(II), Eye(II), Skin(II)	Aq.Chronic2(III), Asp. Tox.1(III), STOT-SE3dd(II),
			Flam.Liq.2
30 (II)	Polystyrene (PS)	Styrene (100 wt.%)	
		Acute Tox.4 (inhalation)(II), Eye(II),	
		Skin(II)	
11 (II)	Low density polyethylene (LDPE)	Ethylene (100 wt.%)	
		STOT-SE3 (drowsy/dizzy) (II), Flam.Gas 1(I)	

Hazard Score	Polymer	Monomer 1 (wt%)	Monomer 2 (wt%)
11 (II)	High density polyethylene (HDPE)	Ethylene (100 wt.%)	
		STOT-SE3(II), Flam.Gas 1(I)	
10 (II)	Linear-low-density polyethylene (LLDPE)	Ethylene (90 wt.%)	1-butene (10 wt.%)
	LLDPE, with butene	STOT-SE3(II), Flam.Gas 1(I)	Flam. Gas1(I)
10 (II)	LLDPE	Ethylene (90 wt.%)	1-hexene (10 wt.%)
	LLDPE, with hexene	STOT-SE3(II), Flam.Gas 1 (I)	Not classified
10 (II)	LLDPE	Ethylene (90 wt.%)	1-octene (10 wt.%)
	LLDPE, with octene	STOT-SE3(II), Flam.Gas 1(I)	Not classified
4 (II)	Polyethylene terephthalate (PET), with terephthalic acid	Ethylene glycol (37 wt.%)	Terephthalic acid (63 wt.%)
		Acute Tox. 4 (oral)(II)	Not classified
4 (II)	PET, with dimethyl terephthalate	Ethylene glycol (39 wt.%)	Dimethyl terephthalate (61 wt.%)
		Acute Tox.4 (oral)(II)	Not classified
1 (I)	Polypropylene (PP)	Propylene (100 wt.%)	
		Flam.Gas 1(I)	

Appendix 4:
Polymer categories and waste classification by waste-pickers

S. No.	Product	Products sorted by waste-pickers					
PE	Film and lamination	**LD1** clean LDPE	**LD2** dirty LDPE	**HM** polybag			
	Extrusion coating	**CNDG** conduit board	**DSP** disposable paper cup				
	Blow moulding	**DB** *dabba*	**NLDB** natural *dabba*				
	Injection moulding	**DB** *dabba*	cable ties				
	Pipe	**CNDP** conduit pipe					
	Roto-moulding						
	Wire & cable						
	Raffia and MF						
	Drips and tubes						
	Others	**BTP** Bata plastic					
PP	Injection moulding	**RPP** *rangeen* PP	**KPP** *kali* PP	**DKN** *dhakkan*	**SPP** super PP	**MDP** moulding plastic	**BRS** brush handle
	Bi-axially oriented	**PP1** zip lock bags, snacks packaging			**PP2** dirty PP bags		
	Thermoforming	**MKY** milky	**MPP** milky PP				
	Tubular Quench PP	**PP1** cloth packaging					
	KTP *katta* plastic	**Raffia** (cement sacks)					
	Fixtures and Fittings						
	Ext coating						
	Others						

S. No.	Product	Products sorted by waste-pickers					
	Not classified	**NL2** natural	**BTP** Bata plastic				
PVC	Pipes	**PNPE** *pani* pipe	**DHPE** *dhaga* pipe	**GNPE** garden pipe			
	Sheet	**RCP** raincoat plastic					
	Films	**CPVC** clear PVC					
	Calendaring	**FILE** file					
	Fittings						
	Profiles						
	Wires & cables						
	Others	**BTP** Bata plastic					
	Not classified	**CNP** cane plastic	**NL1** natural- biocompatible PVC	**RXN** Rexene	**PVC**		
PET	Bottle	**PET** bottle plastic					
	Sheet						
	Others						
PS	Consumer durables						
	Food services	**CLP** crystal plastic - spoons, forks		**RNC** *rangeen* crystal	**HNP** hanpack	**TRAY** tray	**DH** *dahi*
	Razor, hangar, toys	**RZR** razor	**HNG** hanger				
	EPS (packaging, insulation	**THM** thermocol					
	Novelty / gift items						
	Writing instruments						
	Foamed sheets						
	Electronics						
PC		**KKP** *kadak* plastic	**STP** sheet plastic	**MDP** moulding plastic			

Some information on context:

- Plastic that can be easily recycled gets removed from waste stream before it reaches the landfill
- Brush (code BRS) has been taken as PP, though the handle of brushes can be made of PP or PE
- 20% of plastic produced in India is PVC, but only 1.4% is found in landfills as it has a long life
- 30% of plastic produced in India is PE, but 66-76% is in landfills and 40-44% is picked up
- Waste-pickers pick up about 60% of the total plastic waste generated[24]
- PE in multi-layered plastics cannot be recycled (about 13% of plastic waste.
- Polythene bags, milk pouches, and other soiled food packaging is not picked up.
- 8% produced is PET, 3% is in landfills, and 18-24% is picked up by waste-pickers.
- As per estimates, 80% of PET bottles (that make up 60% of PET produced) get recycled[25]
- 2.4% of the plastic produced is PS, 0-2% is picked up as it is lightweight, and 5-10% is in landfills.

Source: Lithner, D.; Larsson, A.; Dave, G., Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition, Science of the total Environment, 2011

Appendix 5:
Additives to Polymers and their Long-Term Impacts

Additives		Range (%/wt)	Example	Remarks
Plasticiser	Plasticisers	10-70	Short, medium and long chain chlorinated paraffins; diisoheptylphthalate (DIHP); benzyl butyl phthalate (BBP); diheptyl adipate (DHA)	About 80% used in PVC. Rest 20% in cellulose plastic.
	Flame retardants	3-25 (for brominated)	Short, medium and long chain chlorinated paraffins; boric acid; flame retardants with antimony and polybrominated diphenylethers (PBDE); tetrabromobisphenol A (TBBPA)	Three groups: Organic non-reactive – phosphate esters, halogenated hydrocarbons Inorganic non-reactive – antimony oxide, zinc borate Reactive – Br or P containing polyols
		0.7-3		
	Stabilisers, antioxidants and UV stabilisers	0.05-3	Bisphenol A(BPA); Cadmium and lead compounds; nonylphenol compounds; octylphenol	Amount depends on additive and plastic polymer. Phenolic antioxidants used in low amounts and phosphites in high. Low amounts in polyolefins (LLDPE, HDPE), high in HIPS, ABS
Plasticiser	Heat stabilisers	0.5-3	Cadmium and lead compounds; nonylphenol (barium and calcium salts).	Mainly used in PVC. Based on Pb, Sn, Ba, Cd and Zn compounds.
	Slip agents	0.1-3	Fatty acid amides (primary erucamide and oleamide), fatty acid esters, metallic stearates and waxes.	Dependent on the chemical structure of the slip agent and plastic polymer type.
	Lubricants	0.1-3		
	Anti-statics	0.1-1		Most are hydrophilic with the potential to migrate to water.

Additives		Range (%/wt)	Example	Remarks
	Curing agents	0.1-2	4,4′-dimaminodimethylmethane (MDA); 2,2′-dichloro-4,4′-methylenedianiline (MOCA)	Peroxides and other cross-linkers, catalysts, accelerators.
	Blowing agents	Depends on density of foam and gas production of agent.	Azodicaronamide; benzene disulphonyl (BSH); pentane; CO_2.	
	Biocides	0.001-1	Arsenic compounds; organic tin compounds; triclosan.	Mainly in soft PVC and foamed polyurethanes. Include chlorinated nitrogen sulphur heterocycles and compounds based on Sn, Hg, As, Cu, and Sb, e.g. tributyltin and 10,10′-oxybisphenoarsine.
Colorants	Soluble	0.25-5	Azocolourants	Migrate easily and used in highly transparent plastics. They are expensive, with limited light and heat resistance. Mostly used in PS, PMMA, and cellulose plastics.
	Organic pigments	0.001-2.5	Cobalt (II) diacetate	Insoluble with low migration tendency.
	Inorganic pigments	0.01-10	Cadmium, Chromium, Lead compounds. Zinc sulphide, zinc oxide, iron oxide, cadmium-manganese-chromium based, ultramarine and titanium dioxide.	
Colorants	Special effects	Varies with effect and substance	Al and Cu powder; lead carbonate or bismuth oxichlorine and fluorescent substances.	Substances with fluorescence might igrate.
Fillers		Up to 50	Calcium carbonate, chalk, clay, zinc oxide, glimmer, metal powder, asbestos, barium sulphate, glass microspheres, silicious earth.	
Reinforcements		15-30	Glass fibres, carbon fibres, aramide fibres,	15-30% is for glass due to high density.

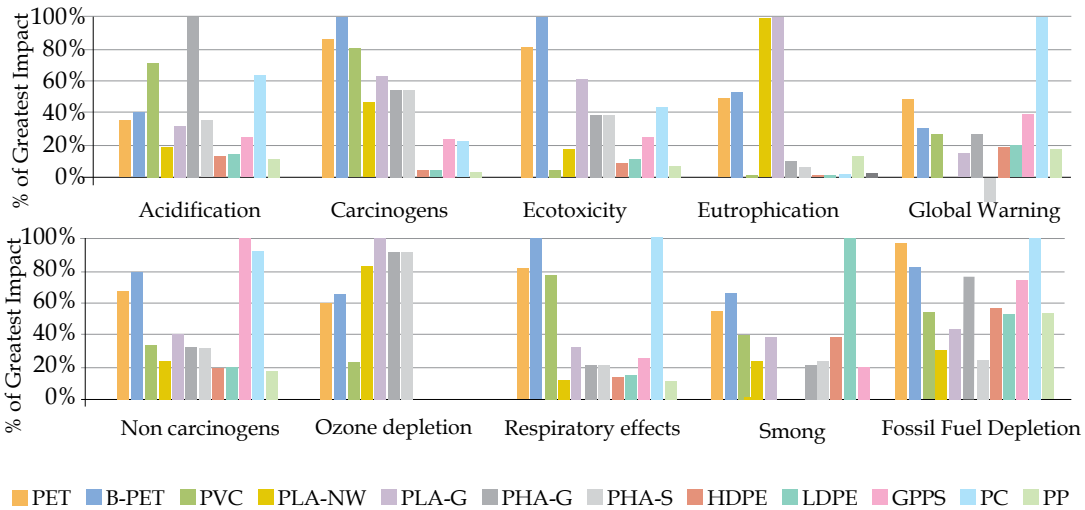
Source: Hahladakis, Overview of chemical additives in plastic - migration, release, fate and environmental impact.

Appendix 6:
Life Cycle Environmental Impact Metrics

Life cycle assessment results are given for each of the polymers in TRACI impact categories. The top chart displays each polymer's relative impact in acidification, carcinogenic health hazards, eco-toxicity, eutrophication, and global warming potential. The bottom chart displays each polymer's relative impact in the non-carcinogenic health hazards, ozone depletion, respiratory effects, photochemical smog, and fossil fuel depletion categories. All impacts are normalized from their original units to their relative impact as compared to the greatest impact exhibited in this study.

This ranking of the polymers is based on monomer classifications. Thus, the composition of LDPE / HDPE here is 100% ethylene, which has specific target organ toxicity (single exposure) that could cause drowsiness or dizziness, and is a flammable gas. PET is 37% ethylene glycol, that is toxic by oral route and 63% terephthalic acid, which is not classified (as per EU regulations). Hence, PET has lower toxicity as compared to PE.

One possible reason for the difference in toxicity as per Lithner and Tabone is that Lithner does not consider toxicity of polymerisation additives as they are added in small amounts. Thus, things like antimony oxide that is added for catalysing the reaction in PET, could have been included in Tabone but not included in Lithner: thus leading to high carcinogenicity and non-carcinogenic impacts, as well as high eco-toxicity.



Source: Lithner, D.; Larsson, A.; Dave, G. Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition, Science of the total Environment. 2011

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NOTES

NOTES

Plastic pollution is a well-documented global crisis. India is no exception. Bans on some kinds of plastics, particularly single use plastics, are one way ahead. But what considerations should guide these bans? This study examined plastic waste in four diverse Indian cities: Delhi, Pune, Indore and Nainital, to understand how plastic waste is managed. The approach included speaking to India's key recyclers-waste pickers-to understand what they did not pick up, and what kinds of plastics were therefore not recycled. Triangulated with secondary data, this report lays out how India can reduce plastics while pre-emptively addressing the issue of inevitable lost incomes for waste pickers and the entire recycling chain. Plan the Ban identifies the plastics to be phased out through suggestions of bans, controlled through EPR and expanded waste picker livelihoods, so that India can move towards a just and fair plastic transition.

chintan
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