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Emerging Transformations in Material Use and Waste Practices in the Global South: Plastic-Free and Zero Waste in India

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Abstract: This study uses a qualitative approach to address limitations and blockages to current plastics reduction via semi-structured interviews with zero waste business practitioners in India. Although they are nascent, India is home to a budding zero waste community that is grappling with how to reduce plastics—via trial and error—and these stakeholders hold insights from lived experience on how plastic reduction can actualize in the Indian subcontinent. This research involved interviewing zero waste businesses and consultants and makers of plastic alternatives in India to understand their experiences with plastic reduction strategies. The key stakeholder interviews reveal key insights for moving forward with plastic reduction initiatives, including challenges faced at government, business, and social levels; considerations regarding plastic waste generation; motivations for starting zero waste businesses and organizations; how it will be possible to operationalize plastic bans in India; appropriate actions for plastic waste reduction; elements that would help India shift into a more circular, regenerative economy; and locally appropriate alternatives to plastics. The discussion further delves into caveats with various alternatives to plastic materials, economic considerations, and characteristics of the zero waste network, and provides next steps for action at the government, business, and civil levels for reducing plastic waste generation in India and minimizing plastic pollution.

Keywords: zero waste; India; plastic waste; plastic reduction; circular economy; regenerative economy; waste management



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1. Introduction

In a country of nearly 1.4 billion inhabitants, plastics pose a critical challenge to the long-term health and wellbeing of both humans and the environment. Every day, approximately 26,000 TPD (tons per day) of plastic waste is generated in India. We can think about this amount in visual terms: The population of all the elephants in the state of Kerala, for instance, is recorded at 5706 elephants, and 15,000 tons is equivalent to 3750 male elephants (at roughly 4 tons each). Thus, in two days, the nation dwarfs the population of Kerala elephants in the generation of waste, and in just one week, the nation creates an equivalent plastic waste mass of all of the 27,000 elephants in India—approximately 9.4 million TPA (tons per annum). Due to the highly active informal sector, it is estimated that 60% of this is collected for recovery, meaning the residual 10,400 TPD are unaccounted for in the environment [1]. At every stage of their lifecycle—from extraction to production to transportation to use and disposal—plastics create both carbon impacts as well as health impacts [2]. Over 99% of plastics are produced from fossil fuels, and are, thus, linked to carbon (which is also why they can be made back into fuel via pyrolysis) [3]. The more plastic that is produced, the greater the chance of plastics entering the environment [2,4].

Plastics are linked to health problems via the chemical additives used in their production, such as endocrine disruptors that are linked to fertility and other health impacts [5]. Human and ecological health also bear the brunt of ubiquitous primary and secondary microplastics (“any plastic particle <5 mm in diameter, which includes particles in the nano-size range”) [6]. Microplastics are found in food [7], water [8], and rain [9]; are

absorbed by the roots of plants into fruits and vegetables [10]; are ingested by marine species [11,12]; and are even in our bodies [13]. The damage to human health and the environment is unfolding every year. For example, a recent study shows that microplastics adsorb and concentrate existing water pollutants and can be a toxicity vector for humans once ingested [14,15]. Rather than continue to witness more degradation, scientists are calling to label plastics as hazardous [16,17]. In May 2021, the Government of Canada labeled plastic manufactured items as toxic within the Canadian Environmental Protection Act, so that this material could be better regulated [18]. Similarly, the government of California passed the world's first regulations for testing microplastics in drinking water [19]. Furthermore, following attempts to manage plastics via recycling, it is being revealed that this method is not a suitable answer for plastic waste management; rather, recycling was never meant to be an answer, but was meant to be a way to continue production [20].

Cities comprise around 3% of total global land use, are home to over 50% of the world's population (and reach 80% by 2050), consume between 60–80% of resources, and generate more than 50% of waste [21,22]. Materials use and consumption patterns in cities are critical to cutting carbon emissions, creating healthy cities, reducing ecological harms from extraction, and living within the resource constraints of the planet [21]. FMCG is the fourth largest sector in the Indian economy, and packaged food sales alone are expected to reach USD 470 billion by 2025, up from USD 263 billion in 2020–2021 [23], a rise that increases alongside the generation of plastic waste.

In recent years, India has launched a number of policies to reduce the challenges of plastic waste generation, including a nationwide, single-use ban in July 2022, as part of the *Swacch Bharat Abhiyaan* (Clean India Mission). Plastic bans have been one method for reducing the growing social-environmental ills of plastic pollution, yet one of the greatest criticisms is that there is not a system of alternative materials and practices to fill the void once certain plastics are banned [24]. Moreover, the politics of India have historically underprioritized matters of waste management, designated little physical space to the management of such materials [25,26], and overlooked this sector that has primarily functioned via the informal work of the marginalized of society, such as the lowest caste [27]. Recent critiques of plastic pollution even go as far as to call out pollution as a form of colonialism [28]. Growing pressures rising from the changing aesthetics of a globalized economy [29] and the influence of NRIs (nonresident Indians) [26] have allowed a newfound emphasis on waste issues.

Furthermore, as the Indian economy has grown in recent decades, so have consumption patterns [29], and, especially, patterns of Western consumption norms that reach across all levels of society [30]. Although increased consumption is linked with the rising affluence of the middle class [29], when it comes to goods packaged in plastics, fast moving consumer goods (FMCG) are specifically designed to be lower cost and accessible to all levels of society [31]. In the 2022 Government of India plastic ban, 18 items were banned [32], which means that many single-use plastic items were left out of the ban. Many say the lack of alternatives to plastic is hurting existing policies' ability to restrict single-use plastic in India [33].

In order to understand how the single-use, plastic-free national shift can happen, consulting the network of current practitioners of zero waste and the makers of plastic alternatives can provide insights as to how the phase down of plastic can realistically (and unrealistically) occur. When a material is banned, a space of possibility opens up for new practices and materials. Without proper foresight into the potentialities, there can be unintended setbacks including policy failure via noncompliance [34]; shifts to similarly destructive materials, as seen with the variation of bag thickness rules in which thicker bags require even more plastic use and subsequent disposal [33]; greenwashing via other plastic alternatives such as woven polypropylene bags that look like cloth but are really made of plastic [35]; and other considerations that will hinder the overall effort to reduce plastic waste and pollution. Through interviews with zero waste stakeholders in India, this

research compiles insights and ground truths on how plastic reduction and zero waste can be actualized.

2. Background

2.1. Zero Waste

Zero Waste (ZW) is an ethical mindset and practice, which aims to close the resource loop and move beyond the cultural habits of ‘throwaway,’ and increasing waste-generation. “Zero Waste is a goal that is both pragmatic and visionary, to guide people to emulate sustainable natural cycles, where all discarded materials are resources for others to use. Zero Waste means designing and managing products and processes to reduce the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. Implementing Zero Waste will eliminate all discharges to land, water or air that may be a threat to planetary, human, animal or plant health” [36]. Within the zero waste framework, all materials are seen as an integrated part of the chain of resource flows. The ‘use value’ of resources does not stop at the human use level, and considerations are made for an integrated whole of nutrients and resource flows. In such a holistic system, plastic and materials that cannot be broken down by nature and/or cause harm to nature are consciously avoided [37]. Zero waste efforts require a foundation in environmental awareness, as well as advanced research on waste [38]. Zero waste goes beyond the ‘three R’ concept of reduce, reuse, recycle, and follows a materials hierarchy, that is ranked, as follows, [36] from most to least desired: avoid/refuse; refill/reuse (i.e., repair, second-hand shops, and tool libraries); recycle; recover (EPR); and, for materials without other options, landfill, incineration, waste-to-energy, pyrolysis, etc.

A circular economy and zero waste are not the same concept. A circular economy focuses on how to “make plastic never become waste” [39], and the circular economy as currently envisioned is dependent on plastic as a material of use. If one were to add the concept of a circular economy into the hierarchy of zero waste, circular economy practices enter the list of actions below the first priority of avoid/refuse material. One of the criticisms of the circular economy is that it is designed to perpetuate rather than reduce plastics [40].

In a zero waste lens, waste is not a noun but a verb, re-envisioned through the mindful redesign of systems and the recovery of material. Zero waste also moves beyond the aesthetics of waste management, not just cleaning up waste with a focus on the “spatial reorganization of plastic pollution,” [41] as seen, for instance, in well-intentioned, but ill-thought-out, beach cleanups that move waste from the beach to the landfill. Waste avoidance, material efficiency, and resource recovery are three key aspects of zero waste practice [42]. Examples of these practices include waste avoidance via the refusal of single-use items (i.e., bringing one’s own bottle instead of taking a cup) or reusable packaging; materials efficiency via the making of biofuel or compost with organics; and the recovery of materials, such as glass, that can be infinitely recycled, or of valuable trace minerals in electronics that would otherwise be dumped in a landfill.

Ref. [43], from a review of zero waste literature, identifies four key phases along the path to zero waste:

- Phase 1: waste prevention via redesign and greater efficiency in production processes.
- Phase 2: waste avoidance via sustainable consumption and responsible purchasing behaviors.
- Phase 3: waste reduction via diversion and minimization.
- Phase 4: regulations and policies based on evaluations of waste processes.

Zero waste is “responding to perceptions of crisis and failure around traditional waste management” [44]. Waste awareness includes greater awareness of the overall urban metabolism or the flows of materials, nutrients, water, and energy in, throughout, and outside of a city [45]. On the micro-level, businesses around the globe are identifying as practitioners of zero waste (including the establishment in 2012 of the US-based Zero Waste Business Council). On the meso-level, cities around the globe have adopted zero waste goals and strategy, such as Vancouver, BC; San Francisco; Adelaide, AU; Flanders,

Belgium, Dubai, and Buenos Aires [46]. On a macro-scale, New Zealand in 2002, Taiwan in 2003, and Guam in 2012, for instance, committed to the path of zero waste [46]. Drivers committed to enabling a zero-waste city and/or context have several social, infrastructure, and policy considerations, including 1. awareness, education, and research on enabling sustainable consumption and behavior; 2. new insights on infrastructure and systems to enable transformed industrial design; and 3. 100% recycling and recovery to enable zero depletion legislation and policies [38].

Zero waste is a means to decouple economic growth from resource depletion and pollution. It is a means not only to value materials that in linear waste processes are 'wasted' (highlighting the cultural factors between waste as a noun and as a verb) but also to redesign the system so that harmful materials—such as multilayer, single-use plastics that are designed to become waste—are kept out of the system [47]. The Zero Waste Solution [47] outlines the following ten steps for moving towards a zero-waste system: 1. source separation; 2. door-to-door collection; 3. composting; 4. recycling; 5. reuse, repair, and deconstruction; 6. waste reduction incentives; 7. economic incentives; 8. residual separation and research facility; 9. better industrial design; and 10. interim landfills (until new solutions can be derived for the material).

2.2. Waste Challenges in the Indian Context

In a review of zero waste studies in 2015, India was reported as one of the leading geographic regions for zero waste publications [43], indicating a front-running interest in zero-waste practices. However, a study conducted on the waste of 60 major cities in India reports waste growing at the rate of 2.5 times the GDP growth. The demand for plastic raw material has been climbing steeply over the past few decades, which is attributed mainly to rapid urbanization, the spread of retail chains, and the packaging of plastics in groceries, cosmetics, and consumer items [48]. The total waste generated in India per day as of 2016–2017 was estimated by the Ministry of Housing and Urban Affairs at 150,000 tons. Of this amount, 90% is estimated to be collected, and from this collected percentage, 20% is estimated to be processed. The rest is going to landfills or ending up in the environment [49]. To address rising waste challenges, there are an estimated 2.2 million informal waste workers in India who are the backbone of the recovery economy [50] (although the actual number of workers is probably far higher, as this is based on official reporting). However, despite a strong informal recovery sector in India, secondary markets are a factor in the collection of waste material, its processing, and what ends up in the landfill or waterways.

For instance, in terms of designing for circularity, multilayer plastic (MLPs)—plastic with more than one layer that can also be laminated with paper and/or aluminum—is designed only for single-use and not reuse or recovery. MLP, in terms of material lifecycles, is a material that has a short 'use' lifecycle before quickly becoming waste. However, "At present, no system exists with Urban & Rural Municipal Bodies for collection, segregation, & transportation of all kind of plastic waste including multilayer plastic waste" [51] (p.4). The CPCB also remarks that recycling—even if this material is collected—is not desired, as,

"recycled plastics are more harmful to the environment than virgin plastics due to mixing of color, additives, stabilizers, flame retardants, etc. Further the recycling of a virgin plastic material can only be done 2–3 times only, because after every recycling, the strength of plastic material is reduced due to thermal degradation" [51] (p.2).

In other words, even recycled plastic ends up in landfills or the environment after 1–2 more (usually) short lifecycles. Thus, the MLP 'waste' often morphs into the identity of 'pollution' in waterways and is dumped on the road because there is no formal collection. Even for waste pickers, the effort to collect negates any monetary value for collection. In addition, even if MLP is recovered, such as for road paving, there are regularly overlooked ecological and human health considerations regarding this practice [52]. Despite this, the Ministry of Road Transportation & Highways has guidelines "to encourage the use of plastic waste" in road paving [53].

Furthermore, increasing plastic use is coupled with virtually invisible microplastic and nanoplastic pollution. Researchers have recently highlighted the extent of microplastic pollution, such as the authors of [54], who estimate that, daily, 1–3 billion pieces of microplastics flow out of the Ganges into the Bay of Bengal. The authors of [55] trace Delhi’s air pollution back to contributing factors of plastic burning. Another study discovered microplastics above the 8000 m level in the Himalayas [9], which highlights the ubiquitousness of this material that only came into widespread use a few decades ago. The authors of [26] illuminate the historical perspective on materials use in India, stating that, “Until the 1990s, disposable consumer goods in urban India were limited; plastics were rare,” and continuing, “By the mid 1990s, however, towns and cities spread out to encircle what once were dumping grounds, and the volume of things-needing-to-be-dumped grew” [26] (p.809).

Plastic consumption in India has nearly doubled in the last decade according to the Central Pollution Control Board (CPCB) [56]. In a 2018–2019 report on the state of overall waste generated, the CPCB assessed approximately 3,360,043 metric tons per year, and calculated about 9200 metric tons of plastic waste generated in India every day [51]. However, a Ministry of Housing and Urban Affairs report estimates that India generates around 25,940 tons of plastics waste a day, and that around 15,600 tons (60%) is recycled and more than 9400 tons ends up piling up in landfills or lost to the environment [1,57]. Reliable statistics on waste generation in India, however, are challenging, as there are many conflicting reports. In addition, the fact that the majority of wastes are processed via the informal economy can further complicate reliable data on generation and processing. Of the plastic waste generated, it is estimated that around 70% ends up as waste in a relatively short time span. In particular, most single-use plastics become waste after merely a few minutes [48]. Another report estimated that 43% of the plastics used in India is used for packaging purposes [58]. Table 1 highlights treatment methods for the fraction of waste that is collected.

Table 1. Current treatment methods for managing plastic waste in India as per [59].

Method	Process	Externalized Social and Environmental Harms
Landfilling	Engineered and haphazard methods of disposing mixed wastes on a plot of land. The oldest method for dealing with wastes. Modern considerations include chemical and hazardous leachate, fires, and running out of capacity [60].	The degradation of land; leaching of waste toxins into groundwater, such as cadmium and endocrine disrupting chemicals; the release of methane (potent greenhouse gas); harmful for neighboring communities; the attraction of wildlife (ingestion, sickness); disease vector (mosquitoes, bacteria); responsibility of municipality collection and citizen taxes and cooperation (not producers) [52].
Mechanical Recycling	Collection and segregation; cleaning and drying; sizing; pelletizing; and fabrication. This process often results in the downcycling of plastics, meaning conversion into a lesser quality of plastic product (which could end up in the landfill after its second life) [60]	Multilayer packaging clogs machines and is not recyclable; plastic is predominantly downcycled, and virgin plastic is combined to make the recycled product; depending on location of infrastructure, waste plastic can be transported long distances (CO ₂ emissions); responsibility of municipality collection and citizen taxes and cooperation (not producers). [52]
Chemical recycling (depolymerization):		

Table 1. Cont.

Method	Process	Externalized Social and Environmental Harms
Pyrolysis (i.e., making fuel)	This technology is used for extracting fuel (syngas) from non-recyclable plastics (heating waste to temperatures as high as 2800F within a limited oxygen environment) [61,62]	Expensive; releases dioxins, mercury, and other heavy metals; harmful ash residue; difficult to maintain stable temperatures for operation (safety compromised); difficult to maintain stable temperatures for operation (increases emissions and burns recoverable waste streams such as organics); Responsibility of municipality collection and citizen taxes and cooperation (not producers).
Gasification/Waste-to-Energy	Gasification is a recycling method where plastics are processed into gases, such as carbon monoxide (CO), Hydrogen (H ₂), and Hydrogen chloride (heating waste to temperatures as high as 2800F within a limited oxygen environment) [62].	Expensive; energy intensive (CO ₂ Emissions); releases dioxins, mercury, and other heavy metals; harmful ash residue; difficult to maintain stable temperatures for operation (increases emissions and burns recoverable waste streams such as organics); responsibility of municipality collection and citizen taxes and cooperation (not producers).
Incineration	Combustion and reduction to an inert residue (at least 850 degrees Celsius). "Incineration is not usually favored as a method of disposal because of very high capital, maintenance and operating costs, unreliability and adverse environmental impact." [48]	Expensive; energy intensive (CO ₂ Emissions); releases other harmful health emissions such as dioxins; toxic ash residual; difficult to maintain stable temperatures for operation (increases emissions and burns recoverable waste streams such as organics); harmful to neighboring community; responsibility of municipality collection and citizen taxes and cooperation (not producers).
Other Methods:		
Paving with Plastics (for road building)	Paving with plastics concerns the addition of shredded plastic to the hot granite mixture (170C), which melts and mixes with the road paving mixture [52].	Transfer of chemicals from plastic into land or air; harmful for road workers; not a long-term solution to increasing plastic production [52]; responsibility of municipality collection and citizen taxes and cooperation (not producers).
Coprocessing	Plastics are sent to cement kilns where they are used as an alternative fuel (kilns operate at 1500 °C or more) [63].	Energy intensive (CO ₂ Emissions); depending on location of infrastructure, waste plastic can be transported long distances (CO ₂ emissions); responsibility of municipality collection and citizen taxes and cooperation (not producers).
Biomining	Biomining concerns recovering material dumped in existing landfills. For instance, Delhi's Bhalswa landfill was mined for plastics that were then sent to a waste-to-energy plant [59].	Expensive; subsequent use creates CO ₂ emissions, contributing to climate change; hazardous to waste workers mining the landfill; responsibility of municipality collection and citizen taxes and cooperation (not producers).
EPR	A system where the producer of plastic is responsible to take back their product for recycling [60].	At the producer's discretion how the material is recycled; producers often work off of quotas from which they collect a certain amount of material, which does not necessarily comprise all their material and prioritizes geographically accessible locations to collect and omits remote areas/those most needing waste collection, i.e., collection from Mumbai but not from the Himalayas. Social and environmental harms of the above processes still apply.

Plastic waste generation is linked to affluence, and India's richest state, Goa, is leading plastic waste generation per capita [48]. As the rest of the country strives for development, we can expect other states' generation rates to increase along with GDP increases. Approximately 10% of Delhi's waste is from plastic, and Chennai, Bangalore, Kolkata, Ahmadabad, Pune, Surat, Indore, Faridabad, Coimbatore, Agra, Bhubaneswar, Visakhapatnam, Rajkot, Raipur, Aizwal, Portblair, Gangtok, Kavarati, and Dwarka all have plastic generation rates above 7.5% [48]. Moreover, the "majority of the plastics waste (PW) obtained about 66% generated by HDPE/LPDE materials which is of mixed plastic wastes like polybags, multilayer pouches used for packing food items," and this requires "extensive sorting & separation, cleaning of waste are done effectively before putting into mechanical recycling by which granules/pellets can be produced" [48] (p.80). Furthermore, plastics can only be recycled two to three times before the plastic quality deteriorates, and then they enter the landfill, are burnt, or end up in the environment. Because of this, CPCB has prescribed that recycling is not a permanent solution for plastic waste disposal [48].

The above table highlights the various ways that plastic waste is currently managed in India. The CPCB provides guidelines for technological ways to utilize plastic waste, which include road construction [64], coprocessing in kilns, chemical recycling into oil and gas, as well as pyrolysis disposal [65]. However, in a zero waste system, these management solutions would all be considered 'end of pipe' and at the bottom of the waste hierarchy of management options. In zero waste systems, upstream solutions are prioritized, including refusing/avoiding, redesigning (to design out waste), and reusing (including not only refillable containers, but also tool libraries, second-hand goods etc.) [66].

In recent years, there has been much eagerness to set plastic reduction goals and bans, with mixed results. Multilayer packaging was supposed to be phased out as of 2018, but the law was amended and the phase out did not occur. Similarly, many states have tried to ban plastic carry bags; however, the mixed enforcement of this law coupled with alternatives such as woven-polypropylene (which looks like cloth, but is really plastic) and oxy-biodegradable bags, which are marketed as degradable but are currently made from fossil fuel derivatives in the Indian marketplace, have lessened the bans' effects. Even with clarified definitions on plastic carrying bags—such as "compostable plastics", which "undergoes degradation by biological processes during composting to yield CO₂, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and does not leave visible, distinguishable or toxic residue," as provided by the Ministry of the Environment [67]—there are challenges brought about by a rapidly changing materials marketplace. For instance, confusion regarding compostability also arises as many materials require industrial composting (using pressure and heat), which is not achievable in home composting units.

On World Environment Day, 5 June 2018, the Indian Minister for Environment, Forest and Climate Change announced that single-use plastics would be phased out by 2020 [68]; this policy was later revised to 2022. Pushing back the date of implementation of plastic bans has been criticized as a routine practice ever since the first nationwide plastic policy was initiated in September 1999 (the state of Sikkim initiated the first bag ban in India in 1998), which regulated the use of plastic bags to those of less than 20 microns, with amendments in 2003, 2011, 2016, and 2018 [68]. In March 2019, at the fourth session of UN Environment Assembly in Nairobi, India announced a resolution to phase out single use plastics by 2025 [69]. Subsequently, in June 2018, Prime Minister Modi called for the phasing out of all single-use plastics to be initiated in 2022. "Let us all join together to beat plastic pollution and make this planet a better place to live," remarked Modi [70].

In the most recent July 2022 ban, the government has made the following statement about what classifies as single-use:

"The Government of India has taken resolute steps for mitigation of pollution caused by littered Single Use Plastics. The list of banned items includes -ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene (Thermocol) for decoration, plastic plates, cups, glasses, cutlery such as forks, spoons,

knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, cigarette packets, plastic or PVC banners less than 100 micron, stirrers” [65].

Yet, what is plastic pollution, if not the multilayer plastic, bottles, TetraPak, synthetic clothes, diapers, and all other forms of single-use plastic that end up in the environment and piled in dumps and landfills for centuries, leaching chemicals, shedding microplastics, and degrading ecosystems? Although the 2022 ban is a step in shifting away from single-use, current definitions of single-use omit some of the most significant contributors to pollution. Thus, this ban will not be sufficient to address plastic food packaging waste generation (waste sent to landfill) or plastic pollution that ends up in the environment via littering and illegal dumping, and/or in cities and towns with little or inadequate collection services.

In the absence of a cohesive national plan, plastic reduction efforts are happening at more localized city, town, business, school, community, and individual levels [71]. To classify as a ‘Zero Waste City,’ Zero Waste Europe, for instance, monitors a city’s clearly defined targets, such as having organics recovery by a set date; reducing waste by a certain percentage within 10 years; conducting audits every 5 years; having commitments to incentivize the redesign of materials, etc. [72,73]. However, even if a zero-waste city or a zero-waste business is desired, no such monitoring network exists in India, and actions are adapted for the local context. For instance, the ward of Kumbarakoppal in Mysore is implementing a zero waste-to-landfill aligned system for the segregation of wastes [74]. At AIMS University in Kerala, students have worked on a zero-waste strategy that includes the segregation of all university wastes, composting, vermiculture, and bioremediation of the site where wastes were previously burned [75]. In another case, Ref. [76] demonstrates how a zero-waste strategy can be successfully applied to urban contexts in the global south with both environmental and economic benefits. Studying the existing network of zero-waste businesses and practices on the ground in India can reveal methods for how zero waste practices and plastic reduction can be further actualized.

3. Methodology

3.1. Method

This research set out with the following questions: How can the single-use, plastic-free national shift be actualized? Furthermore, what are the practices happening on the ground that can shift the existing practices of plastic use? This paper draws mainly on detailed semi-structured interviews [77], conducted with the zero waste business stakeholder group between March and April 2021, with 20 individuals who self-identified as those who are actively running a business or organization that focuses on zero waste or plastic reduction. An interview approach with key-stakeholders allows for nuanced information to emerge on social opportunities and blockages that might be overlooked in more generalized studies [78,79].

Qualitative research “enhances communication with the society and the world” [80], and is suited for analyzing the process of social change, such as the the shifting behavior and policy involving plastics use [75,81]. Key consultant semi-structured interviews are one of the standard means of data collection in qualitative research. In this process, the researcher compiles a list of questions in advance, and allows the interviewee to elaborate on their personal understanding of the topics that goes beyond true or false or yes and no questions [82]. Through active listening [83], these interviews allow an in-depth look at current successes and limitations in plastic reduction; potential blockages to plastic bans; and leverage points for success of the policy.

In order to understand emergent worldviews and attitudes and to generate knowledge of social leverage points for change, in-depth dialogue is necessary [84]. Interviews are a method useful for expanding narratives in emergent fields such as zero waste. In other studies, interviews have been used for in-depth qualitative research aims, including to analyze policy and practice in agriculture for emergent water challenges due to climate change [48]; to shift understandings of sustainability [85]; to understand values and moti-

variations that factor into the adoption of low-carbon lifestyles [86]; and to identify behavioral interventions for the palm oil industry [87].

3.2. Participants

The 20 interviewees were selected as current practitioners of zero waste and makers of plastics alternatives in India. Stakeholders were compiled from a process of targeted outreach and online searches as well as snowball sampling from those selected [88]. Several times, a business was identified, but, upon further inspection, was no longer operational (as was the case with so many smaller businesses and startups during the COVID-19 crisis). Interviewees included:

- Six zero waste businesses/stores;
- Two zero waste stores and consultants;
- Five companies making alternatives to plastic;
- Two alternative service models within zero waste businesses;
- Three environmental organizations that are focused on reducing plastics;
- One zero waste consultant; and
- One environmental organization that is both focused on waste reduction as well as an upcycling social enterprise.

The twenty interviews revealed a diverse context of stakeholders concerned and acting on the plastics issue across India. Respondents are geographically dispersed across India, providing a range of experience in Delhi (3), Mumbai, Bangalore (5), Chennai, Hyderabad, Pune, Ladakh, Odisha, Darjeeling (2), Kerala (2), Sikkim, and Goa. Predominantly, stakeholders interviewed have started these plastics reduction businesses and organizations within the last three years (seven started in 2019 and five started in 2018) with the exception of a few longstanding businesses and organizations, the earliest one starting their zero waste efforts in 2001.

3.3. Procedure

The process for the interviews included contacting the potential interviewees; obtaining consent from the interviewees; conducting the interviews (comprised of 28 semi-structured questions); transcribing and coding for thematic analysis [89]; and interpreting results [88,90]. Each interview was approximately 2 h long and held over the phone due to the COVID-19 constraints of the interviewees, as well as the geographical spread of India (however, the researcher was physically present in India for the duration of the study).

Once all the interviews were conducted, all the interviews were reread and analyzed for key themes. Key themes deduced from the thematic analysis included concerns about plastic waste; motivation for starting a zero waste practice; challenges of a zero waste business/practice; how to help shift India into a more circular economy; interventions for reducing plastics; how to operationalize plastics bans; and appropriate alternatives for plastics. These themes were chosen as they reflect leverage points for understanding ways to reduce plastic waste in India as well as to support the country's evolving zero waste efforts, such as plastics bans. In the results section and discussion, key quotes that signify certain themes are highlighted to provide examples of these themes and are represented in the text by the stakeholder anonymous identifications of S1–S20.

4. Results

4.1. Motivation

Motivation to start on the path of a circular economy and zero waste started from a push–pull mix of personal experiences with waste issues in India (push), as well as firsthand experiences with practices of zero waste (pull). For instance, on the push side, several stakeholders reported working on waste and plastic pollution firsthand, and then realized how bad the situation was, which prompted them to start a more formal business (S3, S5, and S15). One came to a new awareness of the fragility of the ecosystem's balance during backpacking, another on an Arctic expedition (S9, S4). One stakeholder shared a

feeling of “sudden motivation,” when they realized that “lifestyles are completely taken over by plastics” (S2). Another was motivated by experiencing the health consequences and difficulty breathing from the waste burning at a local landfill (S20).

One interesting pattern revealed that zero waste stakeholders all had their own ‘ah-ha!’ moments, in which they arrived individually with an awareness of the urgent need to devote their work towards waste reduction and some form of stewarding for the environment. Over and over again in the interviews, the researcher heard stories of ‘ah-ha!’ moments leading to career changes, more questioning, and a deeper practice. The majority of stakeholders were working in other domains, such as business, finance, and accounting, when they suddenly realized they needed to align their work with environmental action (S1, S2, S3, S4, S5, S6, S7, S8, S9, S11, S12, S18, S19, and S20). For instance, one interviewee was an accountant before starting a zero-waste business (S6). The change was prompted when they were auditing a farmers’ field, and, as described by the stakeholder, they told the farmer that 90% of the field looked healthy (big, plump eggplants), but that 10% of the field looked like a wasted crop (smaller and imperfect). The farmer corrected them, and said that 10% of the field was healthy and 90% was bad. The farmer elaborated and explained that on 90% of the fields he sprayed heavy pesticides and 10% of the field he kept organic for his family (S6). From this ‘ah-ha!’ moment, the accountant decided to quit their career and start an organic food business. Continuous questioning and prompts from customers then led them to ask, ‘How could I sell organic food wrapped in plastic?!’ (S6). This led to the start of their zero-waste organic store.

Figure 1 shows reasons for opting for alternatives to plastics, such as pollution, carbon reduction, or economic reasons. Figure 2 highlights the push factor. Pollution is a primary concern in India for reducing plastic use; reusability and economic impact are also key considerations. Figure 3 highlights interventions and approaches for promoting plastic reduction. Figure 4 shows what methods the stakeholders have used for plastics reduction. A total of 90% have focused on alternatives to plastics, and education, workshops, and civic outreach are also popular methods for aiming to quell plastics use. Figure 5 highlights the current shared goals of the interviewees, of which nearly all are primarily focused on changing the narrative, followed by building zero waste communities, and, thirdly, building a movement of others who align with the values of minimizing plastic use.

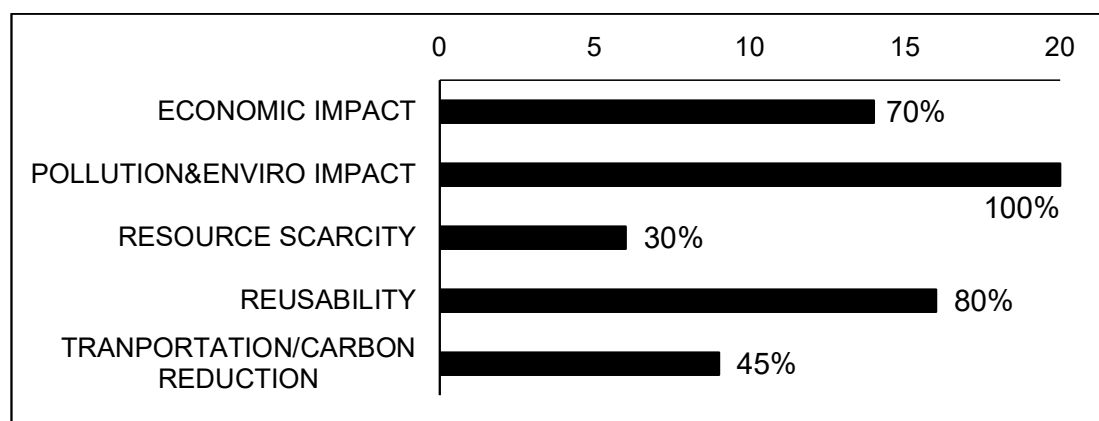


Figure 1. Why do you choose alternatives to plastic?

For pull factors, several of those interviewed discussed seeing first-hand zero-waste stores in Europe and other parts of the West, and realizing that something similar could be created in India too (S6, S8, S11). One respondent was even inside a zero-waste store in Europe and flipped over a product and saw that it was ‘made in India;’ upon which they realized the possibility (and felt an urgency) to start up a store back home in India (S8). Other interviewees were initiated in their first visit to a zero-waste store in India, and then were inspired to start their own (S12, S18).

4.2. Concerns for Plastic Waste

All stakeholders discussed their concerns around the increasing generation of plastic waste in India. One stakeholder even noted that plastic waste in India is so ubiquitous that this “waste is part of the background of India” (S20). Concerns can be grouped into those related to the governance of plastics waste, those related to how businesses are dealing with plastics, and those related to how this waste is impacting the environment.

These responses are grouped in a way that highlight key areas of concern and the levels at which they can be addressed—via government management, via business, or by implementing and enforcing environmental policy. This reinforces the point that waste is an issue that cannot be addressed unilaterally, but that needs varying approaches and responsibility at various levels such as in government, business, the civic sector, etc.

4.2.1. Government Management

- Differences in facilities between cities and rural areas (i.e., people dumping or burning at night because of the lack of collection) (S11); difference in facilities between regions (i.e., the difficult to reach Himalayan region that is not accessible enough for recovery options) (S2, S13).
- Policy vs. implementation. “Even cities like Bangalore that are designated as ‘Smart Cities’ have these waste blight spots where kids play on or adjacent to waste and waste piles attract animals” (S5). This also includes ineffective bans and implementations (S9, S13, S15, S20).
- “Decision makers with limited vision and capacity” (S16) Zero waste stakeholders realize the need for more than an incremental shift, “saying no to plastics is a course correct, not a band-aid” (S5).
- “India has so many issues, that zero waste gets sidelined” (S2)
- High levels of PET are being recycled, but other types of plastics are not (S1); multilayer plastic has no value, not even for roads (S9); recycling is not a solution as it only happens for 1–2 lifecycles and then ends up as waste (S11).
- “Culture of burning flowing from government ‘cleanliness,’ we need to hear more things from the top, not just ‘look clean’” (S12). This refers to that cleanliness that involves not just sweeping all the waste away, or burning it, but taking a more critical look at waste generated.
- The downstream management of plastic waste is not working [insight from visiting plastic centers], “turning off the tap is what we need to do” (S9).

4.2.2. Business

- Relaxed product regulation, a lack of awareness, and rampant greenwashing and misinformation. In general, ambiguity around the eco-friendliness of products, such as, for instance, falsely claimed biodegradable products (which also hurt the market for those selling truly biodegradable and compostable products) (S7, S14). Non-woven (polypropylene) bags are passed off as cloth bags (S14). Paper straws often have a petroleum wax coating, and they are also single-use and dependent on felling trees (S19). Products should not be able to be labeled ‘organic’ if not ‘plastic-free’ (S6).
- Lack of incentives to start a zero-waste business (S1, S14, S19).
- Most industries are still dependent on plastic packaging. Previous bans were ineffective (A large grey area and no legal action) (S8).
- A steep learning curve for how to start a zero-waste business with no support or training (i.e., for how to ship zero waste items without conventional bubble-wrap; how to store foods without damage; how to source products and work with supply chains, etc.) (S6, S11, S12, S18).
- Large supermarkets in India currently do not feel any pressure to offer zero-waste alternatives. First, they need customer demand, such as customers shopping with reusable containers (S11).

4.2.3. Environmental Policy Implementation and Enforcement

- “Most people do not realize the long-term effects of waste” (S17).
- “Waste is part of the background of India” (S20).
- “If you want to plant a tree, and start to dig, you realize how much plastic is there and can’t just forget about it anymore” (S11).
- Shock at the sheer amount of plastic generated every day in India (S1, S13, S16).
- Concern for clogged drains, waterways, polluted soil, and polluted rivers (S17).
- Impact of waste fires and air quality (S17, S20).
- “We’re eating 5 g of microplastics a week . . . we have to change. It’s for our next generation. If she [my daughter] can’t live here, what is the point of making money for my kids?” (S11).

4.3. Challenges in Plastic Reduction

4.3.1. Governance Level

Many stakeholders voiced concern over the government not supporting them in their zero-waste efforts (S1, S7, S8, S11, S14, S16, S17, S19, and S20). For instance, one maker of alternatives to plastics expressed frustration in the lack of incentives as well as the lack of support, “GST [tax] is 18% for my business as well as plastics [manufacturers] . . . the government itself does not follow their rules [on plastics reduction], they could start purchasing plastics alternatives” (C14). In another example, wheat straw, the waste from wheat agriculture—which can be used as an alternative to fossil fuel based plastic—is burned by farmers in India. Circular pathways have not been created for this material’s recovery, so currently it is easier to import products made from wheat waste from Vietnam (S8). Bamboo toothbrushes are also bought from other Asian countries (S8). In other ways, laws prevent zero-waste businesses from using recycled material. For example, in India, using recycled material in food grade material is prohibited (S1).

4.3.2. Business Level

Upstream challenges were highlighted by the zero waste businesses. Currently, the network of zero waste actors is, for the most part, divergent, and these individual efforts are “unable to stop the onslaught of multilayered plastic packaging” (S13). Small, single stores are not at the scale to which they have the leverage to shift upstream producers (S4, S6, S8, S11, S12, and S18). It is difficult to buy plastic-free goods from the supply chain and shop owners currently are either refusing to buy certain items (like the shop owner that refused to buy walnuts in shrink wrap until they found a seller that sold this item loose (S12)) or are buying in bulk (with plastic) and then repackaging (S2, S6, S8, S11, S12, and S18).

4.3.3. Social Level

People look for convenience and the lowest price product. It is hard to compete with plastics without policy that can incentivize the alternatives (S2, S6, S8, S11, S12, and S18). “India is super price conscious, not brand conscious. People go with a good product that is cheaper -even if they like the brand, will switch if the price is not right. And, if something comes without a wrapper [people expect it to] be cheaper” (S11). It is an uphill battle to prompt Indian customers to switch purchasing habits, especially away from those products that are perceived to be cheaper and convenient. Even if zero waste stores have, for instance, 200–300 loyal customers, prices can start to be reduced (S2).

Zero waste businesses and organizations are, by default, civic educators because they are enacting change within the existing system, and, therefore, have to explain how and why they are doing things differently. Barriers to enacting change in plastic use is something they have all pondered extensively, as their business models and practices bump up against this every day. “Unless people feel the plastic problem is personal, they will not do anything to bring any change. We need to make them realize how personal this problem is” (S8). There is an awareness barrier: many people do not know what zero waste is yet, or

do not know what it is in modern practice. “The more people are aware, the more we can have open conversations with policymakers” (S4). The general public also faces challenges with understanding the current recycling possibilities: “People think everything can be recycled, they think they can give to *kabariwala* [waste workers] and they’ll deal with, they don’t realize that single-use goes straight to landfill” (S2). The COVID-19 pandemic has also been challenging due to the rollback of plastic bans and the decrease in foot traffic for stores (S2, S6, S8, S11, S12, S18); however, it has also meant a deepened online connection between zero waste businesses and their customers, and an expanded online presence for the training of individuals and corporations (S4, S5).

For those that think in systems and realize the severity of the plastics crisis, this can be frustrating: “Why isn’t plastic pollution and climate change as big as the pandemic? Because this is killing us slowly?” (S8). Right now, for the most part, “No one thinks a small chocolate in plastics causes any harm” (S12). Zero waste stakeholders are ready for people’s excuses. For instance, one respondent enjoys saying to people who complain about carrying a reusable grocery bag (or a refillable bottle, etc.), “If you can carry your phone, you can carry a bag” (S6).

Despite the history of reuse and refill initiatives in India, the emergent zero waste efforts in India have also been critiqued as elitist (not unlike in the West) (S11, S18). However, in India there is more of an awareness that zero waste solutions need to be at the level of the population, and accessible to general Indian families. The zero waste shops in the cities have benefited from having higher-income clientele, which also helps them enter the market. One of the zero waste shops specifically started in a village, and, from this context, had to make the products accessible at the village level, including with lower prices than branded goods, so they could make the case for people to opt for zero waste practices (B11). Although the majority are not environmentally conscious, economic savings spark the interest of most shoppers.

4.4. What Would Help Shift India into a More Circular Economy?

As shown in Figure 3, supporting plastic-free alternatives is of critical importance for operationalizing plastic bans in India. It is also the key strategy practiced by zero waste stakeholders, as shown in Figure 4. Concerning practical alternatives to be made for the general public, accessibility, convenience, and price were shared repeatedly as challenges to overcome for helping Indians shift to plastic-free, zero waste practices (S2, S6, S8, S11, S12, and S18). In a country of nearly 1.4 billion people, zero waste needs to be where the people are, and made into the default option (convenience)—not something that people have to go out of their way for. This could account for why “everyone knows everything [about the environment and plastic], but is not ready to change” (S15). Moreover, in non-COVID-19 times, India has a very mobile culture. It is one thing to practice zero waste at home, but options for the mobile population that frequently use bottled water and packaged foods (i.e., on trains, in offices, etc.) need to be developed (S5). Concurrently with accessibility and price, the makers of plastic-free alternatives could also benefit greatly from government financial assistance and help with R&D to gain the technology needed to swap plastics for other materials—funds mandated for CSR could, for instance, go towards innovation and a circular economy (S5, S14, and S19). Currently, most plastic alternatives are at a smaller scale, but government assistance could help standardize and scale these operations to have more of a market impact (S7, S14, and S19).

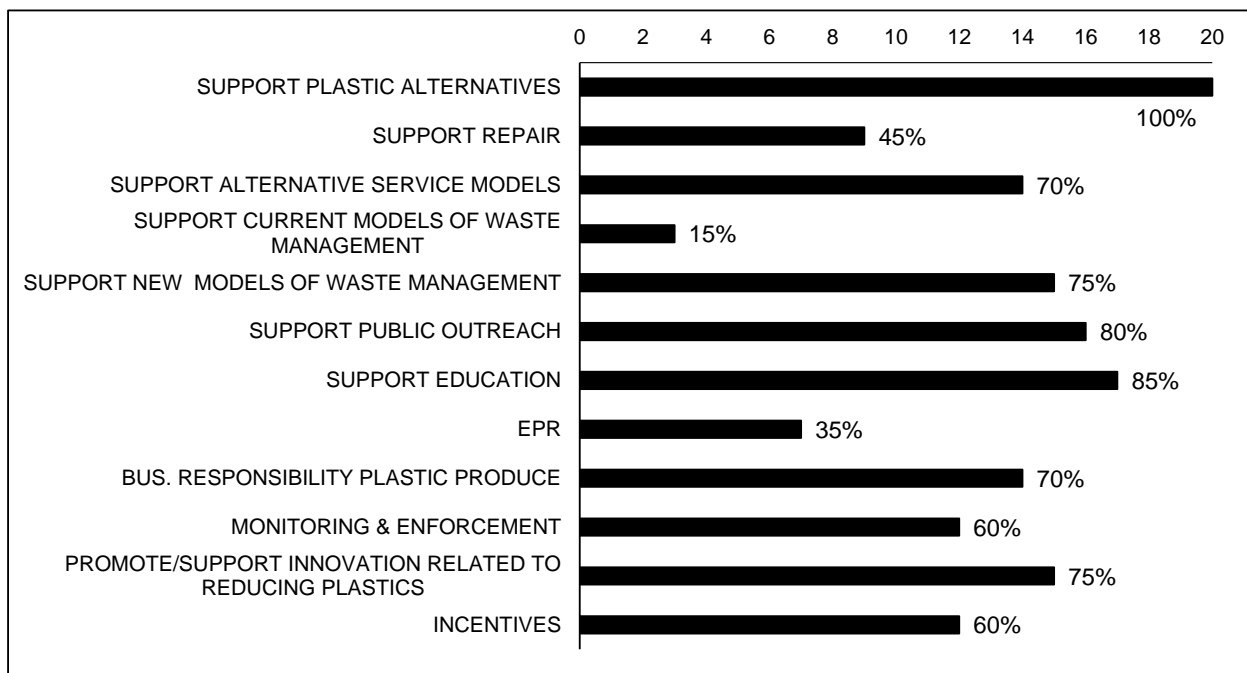


Figure 2. How will it be possible to operationalize plastic bans in India?

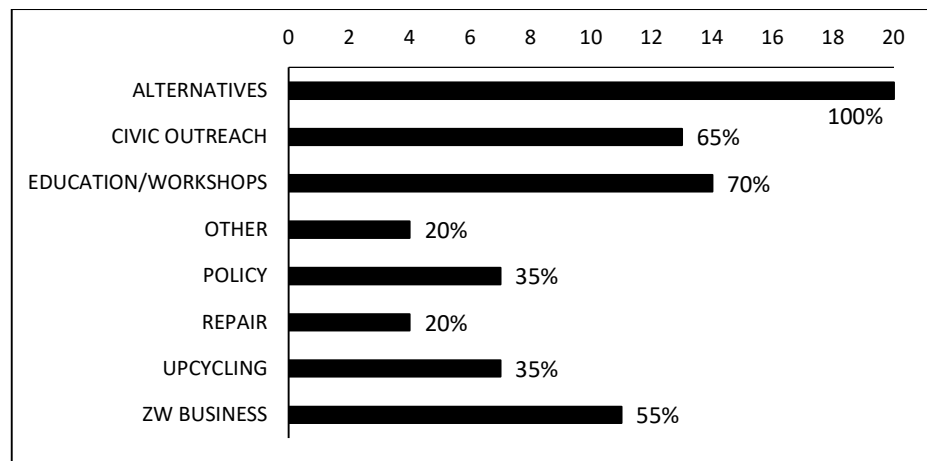


Figure 3. What interventions and approaches do you promote and use for plastic reduction?

With respect to spreading the emerging narrative on zero waste, 100% of respondents are receiving information about plastics alternatives, recycling, upcycling, and zero waste from social media. An especially effective way of messaging is DMs to WhatsApp (S1, S2), while less than a quarter of respondents said they receive information from either schools, university, or from local news. This highlights the relevance of social media; however, more importantly, there is a great need to move the narrative past the echo-chamber of those who are already interested in plastic reduction and zero waste and into the public sphere.

4.5. Alternative Materials

Certain key items that zero waste stakeholders in India promote reflect global trends such as metal and leaf straws, refillable cups, biodegradable cutlery and plates, refillable glass jars, reusable menstrual products, cotton bags and pouches, recycled paper, etc. Alternatives to plastics from within the Indian context also include banana fiber bags, door mats, coconut husk (coir) planting pots, cleaning brushes, bamboo paper, areca containers and plates, jute carry and store bags, coconut leaf straws, and bagasse. At present, plastic-free and ecofriendly alternatives in the Indian market that are especially

challenging to find include toothpaste (tubes), biscuits and alternatives to multilayer packaging, alternatives to plastic film, pasta (no bulk suppliers), PET bottles (alternatives), health food bars (wrappers), and condoms.

One of the advantages of India is that it has a wealth of alternative materials to plastics (S15) and there is much opportunity for innovation and entrepreneurship. “Refillables have always existed in India, but this was not marketed as ‘the way forward’” (S1), and “the solution is only reusables..no matter what the material, if it is single-use it is undervalued” (S11). Secondly, India also has the labor force needed for making alternative materials to plastic (S19). Thirdly, the plastics shift is within recent memory. One only has to go back one generation to reimagine an economy in which the cultural norm is sustainable, reusable, refillable, and organic practices. “Zero waste was followed generation after generation in India, it’s [an opportunity to] tap into the pre-existing culture” (S6). Another stakeholder echoed this, stating, “Our culture does promote circular economy. It is important to understand and figure out how we bring it back” (S8). Similarly, one only has to think about how people used to use materials 20 years ago, even “ask granny how she used to do it, rather than trying to show off like you’re so modern” (S2). Essentially, the throwaway culture is a recent introduction to the cultural habits of Indians, and with the right motivation it will not be difficult to shift to other more earth-friendly practices (S3, S4, S6, S9, S8, S11, S13, S15, and S16).

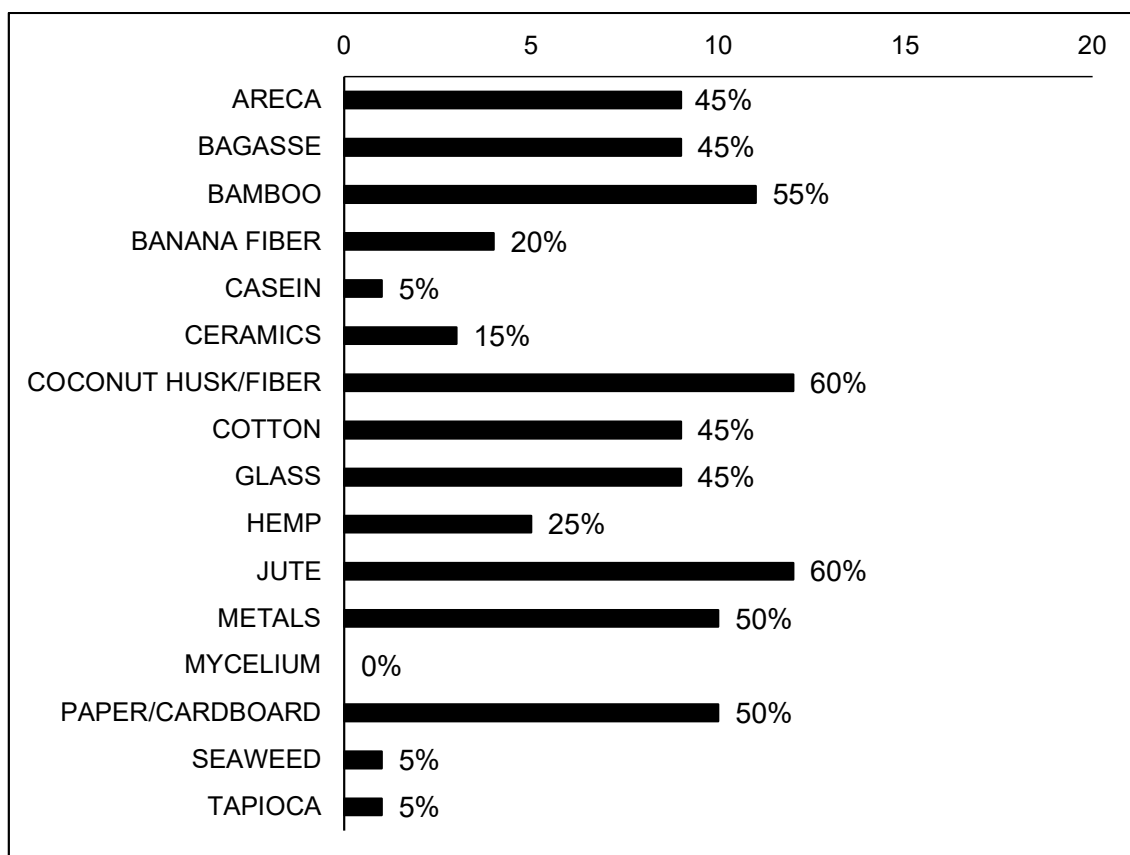


Figure 4. Currently used and promoted alternatives to single-use plastics in the Indian context.

The materials chart in Figure 5 shows alternatives to plastic currently available in the Indian marketplace. The most used materials are paper, metals, cotton, glass, jute, coconut, and bamboo, with paper being a single-use application, metal–jute being reusable and refillable options, and coconut and bamboo being either single-use or reusable. Other materials such as ceramics and bagasse are highly available in India; however, there are some caveats to their usage. Although a few options exist on the market that are

biodegradable, bagasse bags (as a replacement for plastic bags) are often mixed with fossil fuels and/or chemicals and are not truly biodegradable. The new products that are biodegradable face an uphill battle against companies greenwashing similar products that are not as they are claimed to be. Ceramics—promoted now, for instance, as traditional single-use chai cups by India’s national railways—deplete the soil and do not decompose. If used beyond single-use chai cups, this is a better option. Materials such as hemp, seaweed, casein (for plastic bag alternatives), and mycelium could provide alternative ways to package products, are highly suited for the local context, and are non-damaging to the environment (hemp and seaweed are regenerative crops). Currently, however, there is little attention to these materials as possibilities.

4.6. Zero Waste and Circularity as a Process

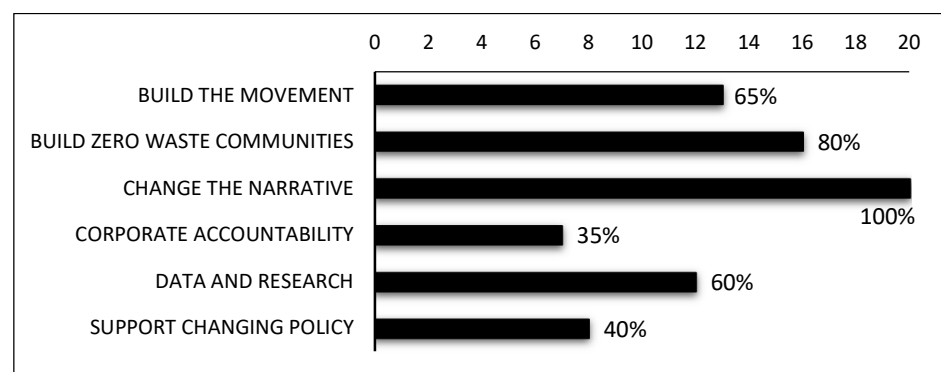


Figure 5. What meta-goals apply to your business/organization?

All zero waste store owners reported an organic process of educating and building the community, learning about people’s needs, identifying what the local economy supplies, and trying to make plastic-free, zero waste practices the appealing option. Changing the narrative is the goal to help the public understand why and how to shift away from plastics, and was identified as a universal overall goal by the stakeholders (Figure 5). To create the means for how to shift away from plastics, the stores first started with a few items and then added more as they found appropriate zero waste items (S2, S6, S8, S11, S12, and S18). “Build zero waste communities” refers to how zero waste businesses listen to what the community needs, such as creating a greater stock of a certain material (Figure 5). By default, in the initial stages, zero waste businesses can only stock the grocery items people need vs. what people want since any stocks that are not circulated quickly will go bad because they do not have preservatives, are not stored in plastics, and face the challenges of humidity, heat, and insects (S6, S11, and S18). There is an emphasis to try to find local needs within the local economy (S11, S12). One of the zero waste store owners said that “almost all [of his products] are less than branded products” (S11). By being able to lessen the price point, they have made zero waste accessible for the everyday Indian shopper and have convinced people that were not swayed by the environmental rationale, but are interested in the economic appeal of shopping zero waste.

One stakeholder reported feeling optimistic about changes they saw in the general public. For instance, they received calls every week about how to start up a zero waste store (S6, S11, S18). In another example, a little girl made her father drive 40 km (the positives stem from the dedication to zero waste, not the increased mileage; ideally, zero waste stores will be more generally accessible) to come to the zero waste store, and proceeded to educate her father about zero waste options (S11). Similarly, another young girl brought her mother into a zero waste store and gave her a lecture about the uses and rationale of all products without the store owner having to say anything (S2). One laborer watched a respected doctor in the community bring his refillables to the zero waste store, and now he feels confident to do the same (S11). A fisherman became aware of plastic pollution and now

starts bringing back plastic every time he goes to sea (S11). Furthermore, loyal customers, even during the COVID-19 pandemic (S2, S6, S8, S11, S12, S18), and other customers are overjoyed to find such a store in India (S2, S6, S8, S11, S12, S18). For non-plastic options, alternatives out of a waste material such as wheat waste, coconut waste, or banana waste are a win–win–win. Materials are recirculated (not in a linear system), crop waste is not burnt (less CO₂ emissions and air pollution), and farm laborers gain additional income for collecting the ‘waste’ material (S1, S19). One biodegradable bags manufacturer has been able to reach beyond their business and help switch several plastic bag manufacturers to biobags, as the conversion in their machines is relatively simple (S14). Experimenting with alternative materials like casein (milk waste) and seaweed also offers potentially promising alternative materials (S14).

The future for zero waste in India sounds promising: “If zero waste stores do well, then even bigger stores will shift. Even if 1% of the market becomes zero waste, a city of several million people like Chennai, Delhi, Hyderabad, Mumbai etc. could easily support 100 stores.” (S12). Another insight for the next decade is that, “in 5–10 years we will have the younger generation with the purchasing power. Now it’s still with the older generation and they’re harder to switch” (S14).

5. Discussion

Do zero waste practices have enough drawing power to help change the course of waste generation in India? Notably, environmental efforts have an uphill battle, as, in 2022, India was reported to be at the very bottom of 180 countries in Yale’s Environmental Performance Index, indicating scant overall efforts in environmental protection in the most populated country in the world [91]. However, businesses implementing zero waste practices appear to be gaining more attention and waste reduction, and zero waste is possible in India with the following considerations: commitment to zero waste values; systems thinking; circularity and alternatives to plastic; materials awareness and leveraging regional waste streams; accessibility to zero waste products.

5.1. Commitment to Zero Waste Values

Zero waste is a practice for which practitioners are dedicated as a core value of their business, and dedication comes from the combined experiences of both pushes (experiences with waste first hand) and pulls (experiences with the possibility of zero waste solutions). Furthermore, ‘ah-ha’ moments play a critical role in adherence to zero waste, in which practitioners feel first the gravity of the waste situation, and then realize the zero waste pathway with which to proactively act on it (without the former, there is no urgency and dedication; without the latter, there is no hope of a constructive solution).

5.2. Systems Thinking

Solutions to waste issues can often lie outside of the waste domain entirely, and zero waste systems thinkers are ready to embrace this complexity rather than brush it off. The majority of the stories recounted from the zero waste stakeholders told of an organic process of questioning, in which they became increasingly aware of waste and environmental issues, following the chain of waste and plastics impacts, and felt the urgency and agency to do something about it. For instance, one of the zero waste stakeholders said that, in discussing zero waste, they regularly borrow the lexicon of permaculture, such as, “the problem is the solution” and “as complex as the problem may seem, the solution is embarrassingly simple” (S9). In another example, we can see the benefit of reframing the problem beyond the normal scope of waste management:

The actual solution to the PET bottle crisis lay not in dealing with the bottles, but in cleaning up the groundwater. If the local water were clean, there would be no need for bottled water. To deal with the crisis of plastic wastes, Zero Waste principles would require resources to be invested in revamping the sewage system, and not in recycling PET bottles. [92]

As discussed by the stakeholders, zero waste does not neatly compartmentalize into one sector, but touches upon governance, business, and environmental and social concerns. In order to enter into this space, one has to first start with a critique: ‘what is wrong with waste?’ Then they must work from downstream to upstream. The zero waste options proposed create new material systems and avenues for circularity. Moreover, zero waste businesses and consultants are by default educators to help people understand the how-tos and the rationale for zero waste practices. For instance, one stakeholder pointed out that if a large chip manufacturer were to close in India (one that is responsible for excessive multilayer plastic snack bag waste), they may lose only one factory, but then hundreds of local chip makers could pop up across the country and create zero waste options locally (S12). Another business has become a working example of how heirloom seeds, with regenerative, organic farming practices and slow processing, can all be fostered via the zero waste model (S6).

Zero waste businesses and practitioners are also systems practitioners in their interactions with others. They realize that collaboration is better than competition, and practitioners are committed to ‘building a movement’ rather than individual success. Most of the stakeholders interviewed were extensively networked beyond their own operations, with connections to local and national governments, NGOs, women’s groups, students, etc. Local solutions also foster relationships of trust, as shown with the local support of zero waste businesses during the COVID-19 crisis. Zero waste businesses interviewed discussed a willingness to teach others how to set up a zero waste business. Some of the consultants offer their services for free to student groups, demonstrating an awareness of social needs beyond their business, with an aim to create a healthy environment for the benefit of us all.

5.3. Circularity and Alternatives to Plastics

Zero waste businesses are on the forefront of material awareness and offer key insights for shifting away from plastic as the main material of production to alternatives, and for creating locally appropriate circular economies. India is awash with potential options for substituting plastic, as most of these alternatives can be sourced within the country, including areca, bagasse, bamboo, banana fiber, sassing, ceramics, coconut husks, cotton, hemp, jute, metals, paper, seaweed, tapioca, etc. In this respect, India has a zero waste advantage.

Mycelia, in particular, were discussed because they are an emerging alternative material in other contexts (i.e., for replacing Styrofoam packaging); however, in the Indian context, none of the stakeholders are working with it yet, or know anyone that is. Similarly, hemp in other contexts is used for innovative alternatives, such as ‘hemp plastic.’ Currently, however, hemp is only being used in India for hemp fiber (i.e., cloth and bags) or mixed into ‘hempcrete’. Although exceedingly abundant in the Himalayan region of India, a lack of hemp applications could partially be due to the stigmatization of growing hemp. Hemp has only recently been legalized to grow in the state of Uttarakhand as of 2018, and Himachal Pradesh as of 2021. In the coming years, there could be booms of innovation with this material. As for the mention of casein, this was a surprising addition to the list, as one of the material innovators noticed it as a waste product and decided to experiment with this material for a plastic film/bag alternative. For seaweed, this material is being used as an alternative plastic film in other geographies (such as Notpla, a sustainable packaging startup in the UK), but is in the nascent stages of experimentation in India. Indian coastlines, however, offer ample opportunities for the production of seaweed, and the benefits of a seaweed industry are multifaceted as it can serve purposes beyond a plastic alternative: It can act as a water purifier, a carbon sink, and a habitat for fish and other marine life; it can provide ecosystem restoration; it is a crop that does not require pesticides and fertilizers; and it ultimately is a regenerative, fast-growing crop that can also create sustainable, marine livelihoods [93,94]. Hemp also has similar potential as it 1. can act as a plastic substitute using its waste (after fiber and oil processing), 2. restores soil health, 3. acts as a carbon sink, 4. is fast growing and endemic to the region (a locally-appropriate

crop), 5. creates livelihoods for Himalayan villages, and 6. does not require pesticides and fertilizers [95].

5.4. Materials Awareness and Leveraging Regional Waste Streams

Among the zero waste community, it is worth discussing the appropriate materials to support within the regional and national scale (which limit transportation carbon footprints) and if it makes sense to work with imported alternatives to plastic or to focus on building a more robust local economy. Materials such as coconut, areca, and banana fibers have geographical considerations. In the south of India, these materials are plentiful, but in the north they do not grow. Considering how supply chains in India have been disrupted during COVID-19, if materials can be locally sourced they are more reliable and can reduce transportation miles. For instance, Ladakh does not have coconut fiber, but it has plentiful wheat fiber waste. Kerala does not have wheat fiber waste, but it is awash with coconut waste. Similar but locally appropriate solutions can be created with a lens on geography, while simultaneously supporting the local economy (which is direly needed in post-COVID-19 recovery). Bamboo is also an important material to discuss, as although it is regenerative, and often hailed as an alternative, it is often invasive, and is not a waste product (the production of bamboo could be displacing other forms of agriculture, for instance, for food). Thus, opting for waste fibers from hemp, banana waste, bagasse, or waste coconut fibers is a more circular and less ecological impact option.

5.5. Accessibility to Zero Waste Products

In the Indian context, zero waste practices will struggle to take off if priced expensively. The general public requires economically feasible options that can operate as the new default practice and social reinforcement that these practices are acceptable across society. For instance, the Indian government's ration shops already operate in principle as zero waste, without claiming as such, yet these shops are stigmatized as being old fashioned or for the lower classes of society. The zero waste grocery stores as espoused in the Indian cities, however, currently price goods for those with greater means to purchase (with the exception of one of the zero waste grocers who is located in more of a village setting, so needed to price his goods to fit the local market). Essentially, if zero waste items are too expensive, then zero waste will remain a rural idea and not have the widespread application that practitioners envision. When the price is right, more shops can open, which would lead to greater accessibility. Thus, practices devised in India could be more easily adapted to the context of the global north, rather than emulating the exclusive nature of zero waste shops in the north of India.

6. Implications: Recommendations to Support the Circular and Zero Waste Economy

1: Government level: Amplify the zero waste message by creating zero waste training for government employees to generate support for zero waste policy, practices, and businesses within the government sector. In 2018 and 2022, the government set the stage for action on plastic waste via two bold announcements to ban various single-use items nationwide. Shining the national spotlight on plastic waste emboldened and signaled to Indians that plastic waste is an issue that requires national urgency. Now, the government can help support research to make alternative materials and practices possible. For instance, the government can create a geographical assessment about where certain alternatives are available in India to highlight the plastic-free capabilities across the nation.

Looking at the Indian plastic management policy, currently, none of the plastic waste management mechanisms factor in the environmental impacts of micro- and nanoplastics (which flake off in the use of plastics) nor the chemical impacts of plastics, such as the release of endocrine disrupting chemicals [6]. These environmental and social health considerations remain externalities. Even a system that prioritizes the downstream management of plastics via recycling will continue to create micro/nanoplastics, as well as increase chemical exposure. Government bans or reduction targets coupled with incentives for industries to

shift materials used can be used to pivot the system. For instance, one of the interviewees has the relatively simple converter technology to change plastic bag making machines to be able to make biodegradable, non-plastic bags. Transition is possible, but these shifts need support.

On waste policy, in conventional waste management approaches, none of the linear waste-to-disposal methods are critical of the increasing amount of plastic being used or of subsequent plastic waste generation. The linear waste-making system uses efficiency and increased technology to address waste increases, but it does not tackle the root cause of increasing waste. Thinking about waste from the zero waste perspective can reduce the amount of money and energy that needs to be spent managing wastes, and can instead use ingenuity to redesign and re-envision how a society uses materials—supporting entrepreneurs, small businesses, and research. For instance, the city of Austin, TX in the US has reoriented from the waste management lens to resource recovery with an aim to reduce 90% of waste-to-landfill by 2040, even renaming the waste division of Austin to the Resource Recovery Department [96]. The Resource Recovery Department is coupled with the Materials Marketplace (a hub for the recovery and exchange of materials) and via a multistakeholder engagement between government, business (of all sizes), academia, community organizations, and the Austin community, they have developed a collaborative approach to the systems problem of waste, that has not only minimized waste materials but also generated over USD 1 billion for the local economy, thousands of jobs, and hundreds of new companies that have found new ways to engage with these resource streams [97,98]. The Marketplace inspired a spin-off, zero waste marketplace in Turkey. Could, for instance, Smart Cities in India try a Resource Recovery approach to their waste divisions, or partner to develop a similar material marketplace? Several of those interviewed in this research were initially inspired by seeing zero waste shops and other examples of zero waste prospects in other parts of the globe. Thus, maintaining an eye on zero waste activities around the globe can also catalyze evolving shifts for the Indian zero waste movement.

2: Business level: Zero waste stakeholders noted challenges, such as the GST being the same (18%) for the plastics industry as for those creating alternative materials to plastic. The government also does not have purchasing programs or incentive programs with those making alternatives to plastics, and there is a need for the government to help shift to alternatives to plastics. Some initiatives could be to create a zero waste business lobby and/or business association to be able to collectively approach the government for zero waste incentives, as well as the better regulation of plastics and plastic alternatives. By working together collectively, the zero waste community will have more leverage for approaching the government, coordinating with the upstream supply network, and creating further awareness within the general public. Although the zero waste stakeholders realize the importance of favorable waste policies for their businesses and organizations, engaging with policymakers has not been a frequent activity. Barriers to engagement can be further explored. This lobby/association group could also serve as a knowledge sharing platform for monthly trainings, networking, bulk purchasing, etc.

3: Social level: Normalizing the refill, reuse, recover, and refuse system requires collective storytelling to change the waste narrative. There is a need for champions and spokespeople in the local community. For instance, the example of the doctor championing refillables in front of the unsure village worker was a sufficient signal to the worker that he, too, could change his actions. Zero waste is a practice that is still within the memory of the older generations. Revisiting thrifty and resourceful practices and re-envisioning their application for the current generation could go a long way. Even stores such as the government ration shops operate via a bulk model, which shows that zero waste is culturally within the collective consumption realm of possibilities, and consumers need not abandon these practices with rising income. Quality of food and drink is a concern whenever items are not packaged. In one example, the village of Lachen in Sikkim banned plastic bottled water and they addressed skepticism about the quality of the water by having the water officially tested so that visitors could see the water guarantee. This

would be more difficult for other types of food items, but methods could be devised to maintain quality.

The zero waste lobby/business association group could provide trainings to create a cadre of zero waste advocates, such as with the Zero Waste Himalayas Peer Educator Program (S16). Similarly, in the US, for instance, the Master Recycler program has been a successful way to teach citizens about waste management, create local champions for recycling, and empower a cadre of volunteers to work across town to help the recycling movement [99]. A similar program could be set up to promote effective actions that support the plastic bans.

If having ‘ah-ha!’ moments (as noted above in the interviews) is key to a mindset shift, then another path towards creating more support for plastic reduction efforts could be to help the general public, especially the next generation, have more first-hand experiences with nature (‘pull’ experiences), as well as real-life learning labs on the ill-effects of plastics, chemicals and pollution, and waste (‘push’ experiences). Zero waste initiatives in India that have started from pull factors include SAGG Ecovillage in Kashmir, and TIEEDI Forest Garden near Darjeeling. In both initiatives, the founders found their calling after leaving city life to return back to their village roots, connecting with their local environment. Similarly, Mopungchuket village in Nagaland envisions zero waste as a way to bring villagers closer to nature and reconnect with Naga cultural traditions. One impactful ‘push’ activity is to visit one’s local landfill, dumpsite, or local material collectors and begin to ponder waste pathways—similar to how the curiosity to learn what happens to cellphones when they die, and visiting the place of phone deconstruction in Delhi, sparked the investigation for the book, *Waste of a Nation* [25]. Making the invisible and hidden waste pathways visible can sometimes have profound effect. India has nearly 500 m Generation Z youth (those born between 1995–2012). Gen Z is predicted to soon be the most populous generation, comprising one-third of the global population. This is a generation that is characterized in market studies by an interest in experiences as opposed to shopping. Ethics, social practices, and social impacts are key components of Gen Z’s core values [100]. This youthful energy can be harnessed to support shifting away from the plastics economy, and a first step can be experiences that help them learn first-hand how this is possible.

7. Conclusions

Zero waste businesses in India have the experience necessary to contribute valuable first-hand experience towards national and state level dialogues on plastic reduction. India is a diverse nation with a multitude of ethnicities across 29 states, 7 union territories, and varying geographies. Zero waste businesses and organizations have taken hold across the country. Zero waste unites people in caring for the environment, caring for a healthy society, and caring for the future generations. In order for the zero waste movement to scale up, however, there are considerable challenges to overcome. These interviews reveal challenges faced at the government, business, and social levels for reducing plastics, tackling concerns about the current rate of plastic waste generation, operationalizing plastic bans in India, shifting India into a more circular, regenerative economy, and motivating zero waste businesses and organizations and locally appropriate alternatives to plastics.

Individually, the plastic waste crisis is daunting and disheartening, but collectively, there is leverage when collaborating with those of a similar vision. The zero waste stakeholders in India have already begun changing the waste narrative and building communities around zero waste and plastic reduction. The right support at the government level via incentives, research, and design support, at the business level via a collective lobby or association, and at the social level by reaching out to the next generation and building zero waste champions will facilitate the implementation of plastic bans and create the context for a thriving zero waste movement in India.

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