PLASTICS AND ENVIRONMENT

ZAREENA BEGUM I

DISSEMINATION PAPER - 12

Centre of Excellence in Environmental Economics
(Sponsored by Ministry of Environment and Forests, Government of India)
MADRAS SCHOOL OF ECONOMICS

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Madras School of Economics

Plastics and Environment

Modernization and progress has had its share of disadvantages and one of the main aspects of concern is the pollution it is causing to the earth – be it land, air, and water. With increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. This waste is ultimately thrown into municipal waste collection centres from where it is collected by the local municipalities for further disposal into the landfills and dumps. However, either due to resource crunch or inefficient infrastructure, not all of this waste gets collected and transported to the final dumpsites. Added to this if the management and disposal is improperly done, it can cause serious health impacts.

Plastic waste is a major environmental and public health problem in India, particularly in the urban areas. Plastic shopping or carrier bags are one of the main sources of plastic waste in our country. Plastic bags of all sizes and colours dot the city's landscape due to the problems of misuse and overuse and littering in India. Besides this visual pollution, plastic bag wastes contribute to blockage of drains and gutters, are a threat to aquatic life when they find their way to water bodies, and can cause livestock deaths when the livestock consume them. Furthermore, when filled with rainwater, plastic bags become breeding grounds for mosquitoes, which cause malaria. In addition, plastics take many years (20-1000) to degrade and hence pose a disposal challenge.

We have become so accustomed to the ubiquitous presence of plastic that it is difficult to envision life when woods and metals were the primary materials used for consumer products. Plastic has become prevalent because it is inexpensive and it can be engineered with a wide range of properties. Plastics are strong but lightweight, resistant when degraded by chemicals, sunlight, and bacteria, and are thermally and electrically insulating. Plastics have become a critical material in the modern economy; the annual volume of plastics produced exceeds that volume of steel. The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes today.

1.0 The Lifecycle and Ecological Impact of Plastics

The lifecycle of plastics involves three stages: manufacturing in the first stage, usage in the second, and recycling and/or disposal in the third. The utilization

of plastics ranges from toys to aircrafts, from hosepipes to dolls, from soft drink bottles to refrigerators, from gramophone records to television sets. Packaging represents the largest single sector of plastics use. The sector accounts for 35% of plastic consumption and plastic is the material of choice in nearly half of all packaged goods (Figure 1).

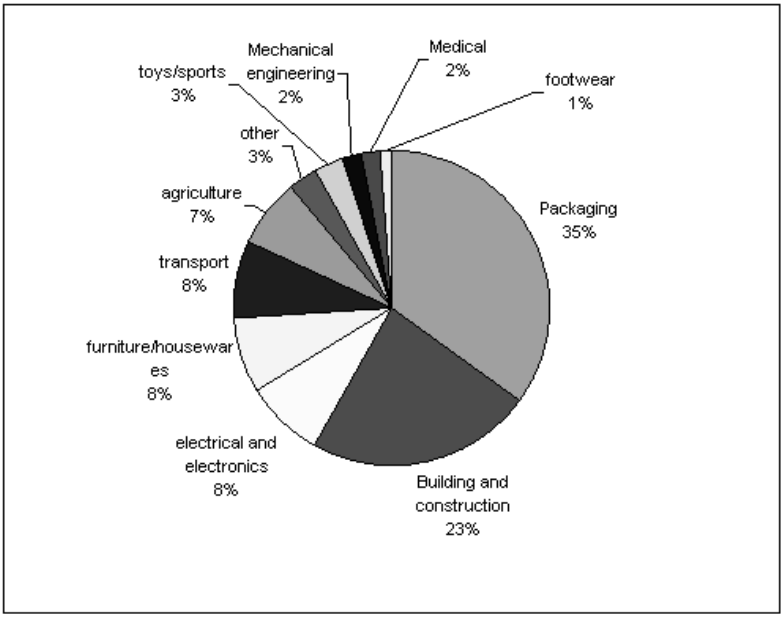

Figure 1: Utilization of plastic in various fields

Manufacturing

The starting point in the production of plastics is the heating of hydrocarbons or the "cracking process". The process involves the conversion of natural gas or crude oil components into monomers like ethene, propene, butene and styrene in the presence of a catalyst [1]. Toxic gases and chemicals are emitted into the air or discharged into the water in the process of producing plastics, which eventually generate negative environmental and human health effects. The kind of emissions or effluents generated and their toxicity varies depending on the type of plastic being made. Nevertheless, the toxic chemicals that are most frequently released during the production of plastics include tri-chloroethane, acetone, methylene chloride, methyl ethyl ketone, styrene,

toluene, benzene. Other major emissions include sulfur oxides, nitrous oxides, methanol, ethylene oxide, and volatile organic compounds. Benzene is believed to cause cancer, styrene has been ranked in the US as "extremely toxic," sulfur oxides are known to harm the respiratory system, nitrous oxides adversely affect the nervous system and child behavioral development and ethylene oxides harm the male and female reproductive capacity [2].

Recycling

The kind of recycling practiced in India is quite different from what is practiced in the rest of the world, in that state-of-the-art technologies are not employed here. The entire process of recycling is done on the basis of experience. The starting point is the sorting of plastic waste. This is done on the basis of colour, transparency, hardness, density and opacity of the scrap. The sorted waste is then sent to the granulators. The technology employed is mechanical with the traditional grinding and extrusion to obtain granules. The final stage is reprocessing. The reprocessing sector can be divided into the granulators and the converters. The granulators make granules from the plastic scrap and sell these granules to the converters. The converters use these to make plastic products. A majority of the units in the informal sector are the granulators that utilize their storage shed in the houses to carry out the grinding. Such units are often located in slums, and function with stolen power and single machine extruding units. Scrap storage is done in the backyards, and washing is done in open drums. These activities are often termed as backyard recycling. Conversion units are small industrial units that process the granules into finished products. The technologies used in these industries are also old and local [3]. The rate of recycling in India is extremely high. About 40 percent of the total plastics manufactured are sorted, collected and recycled as opposed to only 10-15 percent in developed countries. Of the types of plastics recycled in India, PVC (polyvinyl chloride) accounts for 45 percent, LDPE (low density polyethylene) for 25 percent, HDPE (high density polyethylene) for 20 percent, PP (polypropylene) for 7.6 percent and other polymers such as PS (polystyrene) for 2.4 percent. According to manufacturers, almost all these types of waste can be recycled up to four or five times. However, the quality of the recyclate deteriorates as additives and virgin material are added to give it strength [4].

The recycling of plastics is not always green. Recycling usually results in the down cycling of plastics into lower-quality products that have higher and more

leachable levels of toxic additives [5]. In addition, the incomplete combustion of polyethylene during recycling releases carbon monoxide. But a recycling plant generates the largest amounts of effluents during washing and cleaning. During recycling, the plastic scrap is cleaned to remove the dirt and foreign matter adhering to it. It is usually soap solution that is used for this purpose, and it is reused several times before it is finally disposed of into open drains. This way wastewater is generated. The quantity and the characteristics of wastewater generated cannot be generalized, and depends to a large extent on the contents of the plastic scrap. Nevertheless, this wastewater has high pollution load in terms of BOD, COD, and TSS. This water needs treatment before proper disposal into the drains. As of today, recycling units in the country release the wastewater into open drains without prior treatment [3].

Disposal

The final stage in the life cycle of plastics is disposal. In India, there are three common ways of getting rid off plastics - by dumping them in landfills, by burning them in incinerators or by littering them. In the case of littering, plastic wastes fail to reach landfills or incinerators. It is the improper way of disposing plastics and is identified as the cause of manifold ecological problems. Incineration is a process in which plastic and other wastes are burnt and the energy produced, as a result, is tapped. In Sweden, 95 percent of the heat generated from incineration is used for district central heating thereby covering roughly ten per cent of the country's total need [6]. Policy makers in India too advocate it as a sound option. Several big cities like Mumbai and Chennai have entered into agreements for constructing waste to energy plants. In Chennai, for instance, a 14.85 MW waste to energy plant will be set up in the next two years where 6,000 tones per day of municipal solid waste would be converted to electricity [7]. Incineration of plastic wastes also significantly reduces the volume of waste requiring disposal. It is believed that the volume reduction brought about by incineration ranges from 80 to 95%. It is also a suitable option for disposing waste that cannot be recycled further or is non-recyclable [8].

The pollution that occurs in the disposal stage is largely during incineration and when plastic wastes fail to reach landfills or incinerators. Given the limited re-cyclability of plastics, a large amount of plastic wastes is burnt in incinerators. Even in the villages in India, plastic and other portions of the waste stream are frequently burned in "back-yard" fires. But the burning of

these chlorine-containing substances releases toxic heavy metals and emits noxious gasses like dioxins and furans. The latter two are two of the most toxic and poisonous substances on earth and can cause a variety of health problems including damage to the reproductive and immune system, respiratory difficulties and cancer. In fact, dioxin has been shown to have hormonal activity and is an endocrine disruptor [5].

It has been observed that due to an inefficient and faulty waste collection and transit system, a large amount of plastic waste fails to reach landfills or incinerators. Instead they are left behind to find their way into the soil, the sewage system and the water bodies. They choke the gutters and drains and during the monsoons flood streets causing severe health problems [9]. When plastic wastes get dispersed in urban fringes or in rural zones, they clog the soil preventing the free flow of water through it and depleting its fertility [2]. It is also said that when plastics reach the rivers, seas and oceans, they pose a serious threat to marine animals like sea turtles, seabirds and fish. If marine animals mistaking them to be authentic food consume plastic objects and pellets, they can clog their intestines leading to death out of starvation or malnutrition. This discomforting effect of plastics on marine life came to fore in the late 1970s when scientists from the National Marine Mammal Laboratory concluded that plastic entanglement was killing up to 40,000 seals a year. Annually, this amounted to a four to six percent drop in seal population beginning in 1976 [10].

2.0 Benefits of Plastics

Having examined the lifecycle and the environmental impact of plastics, the next step is to assess the principal benefits from plastics and their inevitability to India.

The virgin plastic industry in India is touted and advertised as the country's Sunrise Industry [11]. In 1999, it was valued at Rs 3,000 crore [4]. Over the years, the industry has registered a phenomenal expansion growing at an average annual rate of 17%, higher than for the plastic industry anywhere else in the world [12]. The industry has also exhibited a consistent export growth in the past. Not only the virgin plastic industry but also the recycling industry is emerging as a principal force in India. The industry, as of now, encompasses more than 2500 recycling units that generate an average output of 350 tones per annum. These 2500 recycling units are responsible for the recycling of 60%

of the plastic waste generated in the country. The turn over of this industry is estimated to be Rs 26 billion up to the granulation stage. In the post granulation stage, the turnover is estimated to be Rs 39 billion. The industry as a whole provides gainful employment to about 250,000 people [3]. Hence, plastic is not just any other chemical substance in this country but the cornerstone of one of the most promising industries. It is a prominent source of income and livelihood for multitudes of people. This best reveals the inexorable character of plastics in India.

3.0 Management of Plastic

Having established the inevitability of plastics in India and also having accepted the few environmental harms and health hazards caused by them, the question that has to be tackled now is - how should the environmental problems caused by plastics be addressed, given that they cannot be completely done away with?

Overview of policy instruments used for pollution and waste management

A number of policy instruments exist in the field of pollution and waste management (Figure 2), including [13]:

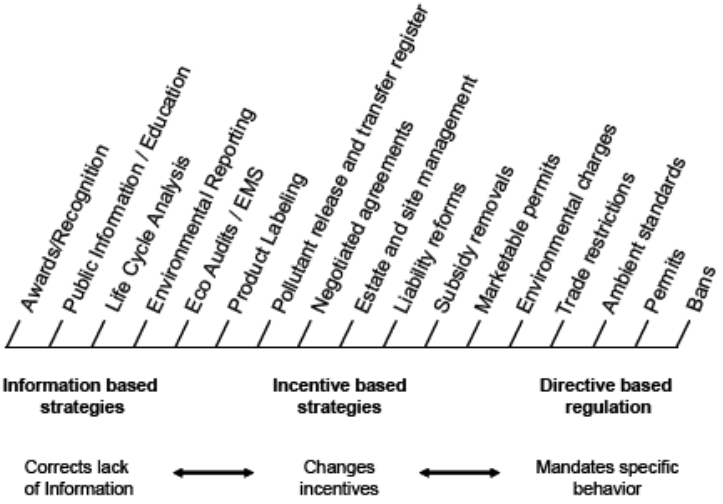

Figure 2: Range of instruments for environmental policy (from Bosman, 2005)

Command-and-control instruments (directive-based regulation) involve direct regulation and rely primarily on the application of regulatory instruments, such as standards, authorisations (licences/permits) and land-use controls.

Environmental regulation is a relatively young approach to waste and pollution control, with most environmental legislation having been passed in the past 20-30 years in developed countries, and even more recently in developing countries [14]. While regulatory controls have historically been the predominant approach to controlling pollution in developed and developing countries, a shift in governance away from 'policing' to one of co-operation has seen the introduction in developed countries of a number of 'softer', alternative, policy instruments. This has been partly due to the failure of traditional command-and-control approaches. In developing countries, regulatory controls remain the principle means of waste and pollution control; however, failures in compliance and in the enforcement of waste legislation have generally resulted in deterioration in the management of waste [15].

- *Economic instruments* (economic incentive-based strategies) – defined as policy instruments which seek to ensure that the economic costs of environmental damage are internalised by those responsible for causing the damage through the market mechanism (polluter-pays principle) [16].
- *Voluntary agreements* (moral incentive-based strategies) - adopted by industry; have been used in many countries as an important complementary approach to pollution reduction, but seldom as a replacement for direct government control.
- *Information instruments* (information-based strategies) - information has emerged as a policy or regulatory instrument over the past two decades, capable of *'eliciting'* or *'inducing'* desired policy outcomes [17-19].

Table 1: Summarizes variety of Policy Instruments used in the management of plastics

Category of Instrument	Type	Policy Instrument	Remarks
Regulatory (Command and Control)	Regulation of Standard	Minimum Thickness Standard	Introduction of a phased minimum thickness standard starting with 20 microns and moving to 30 microns. As the experience of many countries has shown, such a standard is the most effective way to deal with very thin bags considering their high vulnerability to littering, single-use character, low price, and poor recycling feasibility.
Economic Instruments - The main essence of the application of economic instruments is to facilitate private sector involvement	Price-Based	Subsidy	Targeted subsidies to support development of environmentally friendly alternative bags. The development of more durable, reusable, recyclable bags should be supported.
	Price-Based	Subsidy	Support for development of an effective plastic bags recycling system. The support should be directed at strengthening and expanding this sub—sector, especially in segregation, collection and supply mechanisms. Innovative financing products for promoting investment in the sector should be established preferably by the micro finance institutions. Investment tax allowances, differential power and water tariffs and zero-rating of recycled products should be encouraged.

Category of Instrument	Type	Policy Instrument	Remarks
	Price-Based	Subsidy	Support for development of a managed disposal system to cater for the plastic bags that will eventually enter the waste stream. Since some plastic bags will eventually reach the disposal stage despite the measures taken, it is prudent to have proper guidelines on disposal of plastic bags since they take very long period (20 to 1000 years) to degrade. Financial incentives such as tax holidays, public land provision, and reduced corporate taxes to promote private-public partnerships in the development and management of sanitary landfills should be encouraged.
	Price-Based	Levy	A plastic bag levy collected from the suppliers and shifted to the shoppers. A levy on plastic bags rationalizes the consumption and production of plastic bags, as has been shown from the experience of several countries.
Voluntary /Information – Based Instruments	Information based	Consumer awareness and anti-littering campaign.	Active support to be extended to the existing consumer awareness and anti-littering campaigns, with special emphasis on management of plastic bags.
	Voluntary Agreement	A National Code of Practice	Promotion of voluntary schemes such as a national code of practice for retailers and manufacturers. Such a code will commit retailers to reduce use of bags by voluntarily declaring the number of plastic bags issued within a specified period, increase the usage of plastic bags made from recycled material, and provision of convenient and accessible recycling stations to customers among others.

Policy Instruments used in Management of Plastic Bags Waste

Numerous instruments have been used around the world to manage the problem associated with plastic bags, with various degrees of success. The instruments range from such command and control tools as outright bans, economic instruments like a levy, to voluntary schemes such as codes of practice and promotion of alternative bags [20]. The experiences of few developing and developed countries are summarized below.

Developing Countries

Table 2 presents a summary of the policy instruments that have been used to manage the plastic bags pollution problem in developing countries. As the table shows, there are not very many developing countries to learn from and there is not much information on the success or otherwise of the instruments. Nevertheless, developing countries appear to favour bans and minimum thickness standards, perhaps because of ease of enforcement and the need to address the most visible dimension of the problem: littering. Outright bans are politically costly (e.g., Nairobi), because there is already a thriving industry producing the bags and employing a considerable number of people.

Table 2: Policy Instruments for Plastic Bags Management in Developing Countries

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
India **(**www.mindfully.org/Plastic/Ban-Polybags, www.atimes.com, www.planetark.com, UNEP (2005))		
The Indian plastic industry is undergoing growth at a rate of about 17%, with the total consumption of plastics being about four million tons per annum. Current estimates put per capita consumption of plastics for India at 4kg/year compared with 80-100kg/year for developed countries. India is reported to have a relatively high plastic recycling rate of 60% as compared to the world average of 20%. The bags responsible for creating most of the littering in India have thickness of 5-10 microns.	**Ban** on use of plastic bags and containers made of recycled plastic for storing, carrying, and packaging of foodstuffs **Technology standard** that demands bags for storing, carrying, and packaging of foodstuffs be in their natural shade or white **Minimum Thickness Standard** of 20 microns on plastic bags made of virgin- or recycled material. **Technology standard** that requires carry bags and containers made of recycled plastic and used for purposes other than storing and packaging foodstuffs be manufactured using pigments as per Bureau of Indian Standard (BIS) specifications. Manufacturers of recycled plastic carry bags are required to mark them according to BIS specifications, including stating the percentage of recycled material used.	The minimum thickness standard of 20microns on bags alleviated the 'fluttering' problem but not littering. The 20microns bags remained unattractive to the waste pickers and continued to litter. Success has been achieved in discouraging coloured bag use in food packing. Re-use of plastic bags by consumers has not become habitual. The desired fall in wasteful consumption has not been achieved. In general, the policy instruments had an inherent limitation in bringing about waste and litter minimization as they primarily sought to achieve this by promoting re-use and recycling. On the contrary, the

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
\	Since provinces in India are empowered to take measures independently, some states tried to address the plastic waste menace by formulating their own initiatives.	root causes of littering, namely profligate consumption, indiscriminate use and disposal and effective waste management system were not adequately addressed. However, some improvements in recent years have been reported in cities and towns that have initiated strong anti-litter programs.
South Africa *(UNEP (2005), www.abc.net.au, www.lib.uct.ac.za/govpubs/plasticbags, www.mindfully.org/Plastic/S_Africa-Plastic-Bag)*		
Before introduction of the policy instruments, the plastic bag littering problem in South Africa was so grave that the bags had come to be known as new national flowers competing with the true national flower, protea. About 8 billion plastic bags are consumed annually in South Africa; of this, large retailers account for 2.6 billion and smaller retailers the balance.	**Minimum Thickness Standard.** Ban on the manufacture, trade and commercial distribution of plastic bags made of plastic film for use within South Africa and having a wall thickness of less than 30microns **A levy**. Plastic bags attract a levy of 10 Rands (1.7 USD) per kilogram. The levy is targeted at the manufacturers who are expected to pass it on to the consumers. The revenue collected is targeted to, among other environmental projects, the establishment of a plastic bag recycling company. **A legal instrument** providing penalties for	Before the regulation, the cost of plastic bags was hidden in food prices; hence, even if consumers did not get a bag, they were still made to pay for it. With more transparency and consumers now given the choice to buy a bag or not, it is reported that consumers benefited from lower food prices. The coming into force of the regulation resulted in a drop in wasteful consumption of bags, especially in stores where bags are charged for.

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
	non-compliance, i.e. any violator is made liable to (1) a fine of South African Rand (R) 100 000, or (2) imprisonment for a period of up to ten years, (3) or both; and (4) a fine not exceeding three times the commercial value of the good to which the offence was linked. **Technology Standard** that stipulates a 'recyclable-friendly' ink to be used for marking and printing of plastic bags and whose quantity, on dry basis, should not be above 2.25% of the weight of the bag. The regulation applies to plastic bags given to a shopper at the point of sale (secondary packaging) and hence excludes bags used for primary packaging of loose goods, e.g. rice, flour, etc	The regulation also improved public understanding as the negotiations were given wide coverage in the national and international media. Although this was not intentional, it reportedly contributed to increased environmental awareness and a significant reduction in profligate consumption of bags.
Bangladesh *(www.enviroliteracy.org, www.abc.net.au/science/features/bags/, www.zerowaste.co.nz, UNEP (2005))*		
Serious and repeated flooding in the country, which resulted in major loss of life, was linked to blockage of drains by plastic bags.	**Ban**. The Bangladesh government imposed a complete ban on the sale and use of polyethylene bags in March 2002 applicable to the capital city, Dhaka. **Awareness Campaign**. The ban is complimented by a massive public awareness	Prior to the ban about 9 million plastic bags were thrown away in the capital of which only 10-15% were put in dustbins while the rest ended in drains, sewage channels and open spaces.

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
	campaign to persuade people not to use plastic bags; the main alternatives being promoted are jute bags.	No results are available on the success of this ban.
Somaliland (www.somali-civilsociety.org, www.greenbeltmovement.org, UNEP (2005)		
The plastic bag pollution in Somaliland is so prevalent that the bags have been labelled the *Hargeysa flowers* [Hargeysa is the capital city]. Bags fluttering from trees and shrubs are common sights. According to government officials, plastic bags have become both an eyesore and a source of environmental problems in Somaliland. Of special concern to the country are the adverse effects on livestock, especially on those that feed on shrubs, and clogging of storm- and sewage drains especially by those bags that are used by *Khat (miraa)* traders.	**Ban.** A ban was issued by the country's Ministry of Trade and Industry on 1st of March 2005 and is entitled "Banning importation, production and use of plastic bags in the country". **Awareness campaign**. The ban is supposed to be backed by an awareness campaign as an additional instrument.	Some assessments indicate that both importation and local production of the bags still continue regardless of the ban. Government acknowledges continuing local production due to lack of alternatives at the time.

Developed Countries

Even among developed countries, there is not much literature on the policy instruments used to manage plastic bags. However, the experiences of two countries, Ireland and Australia, are considerably informative. The two have used economic instruments, combined with awareness campaigns, with substantial success (Table 3).

Table 3: Policy Instruments for Plastic Bags Management in Developed Countries

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
Ireland (UNEP (2005), www.oasis.gov.ie/environment/plastic_bag, www.mindfully.org/Plastic/Laws/Plastic-Bag-Levy-Ireland)		
In Ireland, plastic bag waste was of serious concern, as it constituted most of the visible litter in the rural environment. Ireland being a country of high winds and hedgerows, plastic bags released in the environment easily traveled long distances and often attached themselves to hedges and trees. This unsightly scene became more prominent during winter when deciduous trees shed their leaves.	**A levy** of Euro 0.15 was introduced on all plastic bags including biodegradable bags targeting shoppers at point of sale in retail outlets. Exceptions are made to plastic bags used to contain fresh produce and re-usable ones worth over Euro 0.70. Retailers are legally obliged to pass on the levy directly and itemize it on the consumers' receipt. The revenues from the tax are 'ring fenced' in the Environment Fund for use in various environmental projects,	According to the Irish Department of Environment, Heritage and Local Government (DEHLG) about 1.2 billion plastic bags were used annually in the country prior to the levy. The levy resulted in 90% decrease in the use of disposable plastic bags and has generated close to Euro 20 million to date. In 2003, plastic bags amounted to only 0.3% of the country's litter stream compared to 5% before the introduction of the levy.

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
	including (1) covering the costs of administration of the tax itself; (2) support programmes and R&D for the prevention or reduction of waste; (3) promoting the development of products that are less environmentally harmful; (4) aiding producer-initiatives in designed processes and products that prevent or reduce waste generation; (5) assisting in the enforcement of by-laws related to waste management, litter prevention or protection of the environment in general; and (5) promoting environmental awareness, education and training.	Retailers found the effects on their business to be either neutral or positive. The additional costs of implementation in the form of book-keeping were low and generally less than the savings from not having to purchase bags. In addition, revenue collection and reporting is easily integrated with their VAT collection systems. Overall, households were very much in favour of the levy. The majority felt that the impact of the levy in terms of convenience at checkouts was negligible but that the levy had added to their expense as they have either to pay the levy or buy reusable bags. Prior to the levy, there were four plastic manufacturing firms operating in the country. One of these, with an annual turnover of Euro 2.54 million and employing 26 persons, has gone out of business after the levy. There is uncertainty as to whether this was a direct result of the levy.

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
		The costs to government are low, i.e. the costs of set up and annual administration amount to Euro1.2 million and Euro 350,000 respectively. Advertising costs due to publicity campaign to launch the levy amounted to Euro 358,000. On the other hand, projections indicate that an estimated Euro 10 - 11 million per year can be collected in revenues from the tax.
Australia *(UNEP (2005), www.deh.gov.au/settlements/publications/waste/plastic-bags/report-2002.html, www.ephc.gov.au/pdf/Plastic_Bags/ARA_EPHCreportmidyear2004.pdf, ww.ephc.gov.au/ephc/plastic_bags)*		
Before policy instruments were introduced, Australians were using about 6 billion lightweight carry bags annually (2002 figures).	The Australian approach to plastic bag pollution prevention is a **Voluntary Code of Practice**, which aimed at reducing plastic bag consumption by 50% by the end of 2005. If the target is not achieved, the government will impose a tax of 25 Australian cents per bag. This has served as a 'threat' to retailers. **Awareness Campaigns** back the code of practice. For instance, the "Say No to	The number of bags issued in the country has dropped by around 21% since 2002, to about 4.77 billion in 2004.The major contribution to reduction in consumption has been made by supermarkets, which managed a reduction in light-weight plastic bags by a factor of 25%. The commitment rate to the code by supermarkets is relatively high, i.e. 90%. However, the participation of non-supermarket business and small retailers,

Country Overview: Nature of problem before application of instruments	Policy Instruments Applied and Mode of Application	Results achieved
	Plastic Bags" is run by Clean Up Australia in collaboration with retailers and government with a view to encourage consumers to reduce plastic bag consumption and increase recycling. To facilitate the implementation of the Code of Practice, a kit (consisting of guidelines, in-store promotional items and staff training materials) has been developed to help retailers to reduce consumption and increase recycling. The guidelines recommend a hierarchy of refuse-reduce-reuse-recycle. **Cleaner alternatives** are also suggested and made available at stores. These include cloth bags, polypropylene bags, recycled paper bags, string bags, baskets and boxes. Biodegradable bags made of cornstarch are also recommended for some stores.	such as fast-food outlets, liquor stores, pharmacies and newsagents, is very low. Single-use plastic bags from these outlets are estimated to make up over 50% of all plastic bags issued in the country. A Commonwealth Senate Committee was set up to enquire into the possibilities of imposing a levy since it was felt that voluntary approaches and retailers code of practice are unlikely to result in sufficient environmental benefits.

4.0 Case Study: Mumbai's Experience with the Recycled Plastic Manufacture and Usage Rules, 1999

The Recycled Plastic Manufacture and Usage Rule of 1999 was the first central government rule on plastic waste in India. It was passed to control the packaging of food products in recycled plastics and to manage the littering problem. The objective of the Rule was supposedly to protect human health from the risk of colored plastic bags and to minimize the littering problem by encouraging reuse and recycling of polybags. The Rule was based on the recommendations of the Plastic Waste Management Task Force [21].

There were three main specifications in the Rule:

- The use of recycled and virgin colored polybags for non-food applications was allowed but for packaging food items was discouraged
- All carry bags of size less than 20 microns were banned
- The guidelines for the recycling of plastics were made mandatory

The impact of the Recycling Rule on the city of Mumbai can be understood fully by examining the table 4 below. The table presents the effectiveness of the Rule in handling key issues of concern of polybags. It is pretty evident that various critical issues were not be addressed by the Rule despite its effective enforcement [12]

Table 4: Impact of Recycling Rule in Mumbai City

Critical Issues	Has the Union legislation managed to address the following problems
Choked Drains	No
Choked Soil	No
Dying Animals	No
Decreased health risk to the citizens by dyes and pigments	No
Improve collection and disposal	No

Critical Issues	Has the Union legislation managed to address the following problems
of polybags	
Improve recycling practices	No
Encouraging substitutes to polybags	No
Increase awareness of the citizens	Yes to a limited extent to move from coloured plastic bags to colourless plastic bags
Increased reuse of the polybags by the citizens	No

Source: Analyzing Plastic Waste Management in India—Case study of Polybags and PET bottles, Narayan, P. (2001)

The Mumbai case study reveals how even when the government enforces a highly comprehensive legislation with proactive administrative machinery and strong citizen support, it fails to address the problem at hand. In fact, in the case of Mumbai, the governmental regulation to a large extent compounded the problem.

5.0 Concluding Remarks

A minimum thickness standard of 20 microns, public awareness and anti-litter campaigns, improvement of the recycling system including effective source segregation and allocation components, improvements of waste disposal system, and introduction of stakeholder (especially retail and manufacturing) codes of practice should be executed to address the plastic management effectively. Another key element of the policy package becomes the provision of an alternative carrier bag. Availability of alternative carrier bags (more durable, reusable and recyclable) is critical to facilitate consumer behaviour change in response to the proposed policy interventions. The demand for such bags should consequently and automatically lead to development of related industry.

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