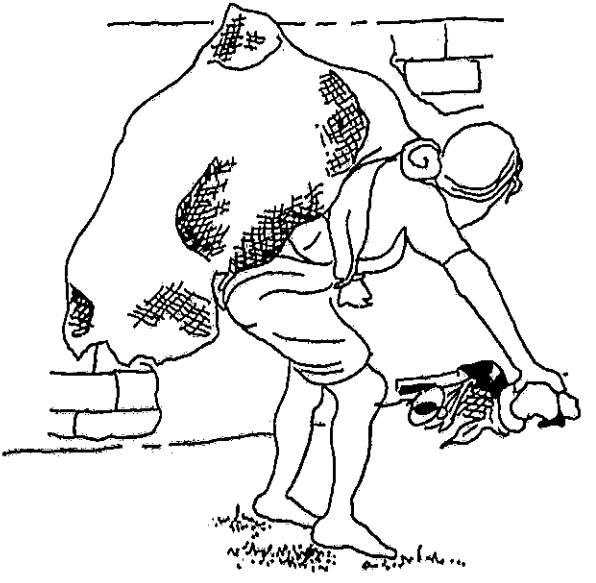
THE WEALTH OF WASTE

WASTE PICKERS, SOLID WASTES AND URBAN DEVELOPMENT

SANDHYA VENKATESWARAN



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Sandhya Venkateswaran

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FOREWORD

The negative impacts of rapid urbanisation processes in developing countries are one of the most important issues today. Many people are leaving rural areas in order to seek employment opportunities in the cities. It is estimated that e.g. in Delhi 250,000 migrants are arriving in Delhi every year.

Waste picking is one of the major occupations in the informal sector taken up by the migrants due to lack of alternatives. Out of the total workers in the urban informal sector 75 per cent are women. 90 per cent of the waste picking population in India are women and children. This work contributes considerably to the removal of waste which could not be collected by the limited capacities of the respective municipal authorities.

In this book "The Wealth of Waste", Sandhya Venkateswaran analyses the socio-economic situation of ragpickers, the majority of whom are women and children, and various initiatives by Non-Governmental Organisations to improve their working and living conditions. She reports about ragpickers in various cities in India and other countries.

The Friedrich-Ebert-Stiftung (Friedrich Ebert Foundation) is a non-profit research and education institution, committed to the cocepts and basic values of social democracy. Its wide-ranging activities in the field of political education and assistance to partners in developing countries include, inter alia, comprehensive projects in the areas of societal development, labour unions, political structures, business, science, scholarships and culture.

In order to facilitate the discussion of vital themes related to the developmental process in India, the Friedrich-Ebert-Stiftung publishes a series of Indian contributions, of which this volume is a part. The views expressed in this volume do not necessarily reflect those of the Friedrich-Ebert-Stiftung.

Beate Martin
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New Delhi
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This study would not have been possible without the help and cooperation of several women, children and men who make a living from waste picking, in the slums of Motia Khan, Jahangirpuri and Rashtriya Camp, Pusa Road in Delhi. Thanks are also due to the NGOs Street Survivors and Chetanalaya, working in these areas, who provided support in numerous ways.

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DEVELOPMENT TRENDS AND URBANISATION

Development priorities in India, over the past decades, have been reflected by increasing industrialisation and the consequent, real or perceived, creation of jobs in urban areas on the one hand and increasing unemployment and the seeming lack of income generating options through most of rural India on the other. Urban growth, in such a situation, has proved to be one of the most consistent characteristics of development trends in India. Be it large metropolitan cities, medium towns or small/semi-urban townships, the tempo of urbanisation has not faltered over the past several decades.

The result reflects itself in a population demographics which displays a somewhat lopsided rural-urban distribution. Whereas in 1911, only 10.29 percent of the total population lived in urban areas, at present, the urban population represents over 25 percent of the country's total population (see Table 1.1). India's urban population is in fact, one of the largest in the world.

A look at the factors determining the composition of the country's population point to the significant role played by rural-urban migration. The National Commission on Urbanisation, in 1988, estimated that as much as 40 percent of urban growth is accounted for by rural-urban migration. Natural increase, on the other hand, accounted for another 41 percent and the remaining 19 percent was attributed to reclassification. Clearly, migration constitutes a key determinant of urban dynamics. The pace of migration (see Figure 1.1) is reflected by the rate of increase of migrants to urban places, which during 1971-1981 was 48 percent (NIUA, 1988).

Whereas the determinants for rural-urban migration are many (see Table 1.2) : employment being the prime cause of male migration and marriage and associational migration being the dominant considerations for females, the resultant situation in urban centres is largely the same. Pressures on housing, employment, public transport and other basic services have emerged as the key characteristics of most urban centres.

Pressures on housing have given rise to vast slum settlements whereas a dearth of employment opportunities within the formal sector have created an

TABLE 1.1 Trend of Urbanisation in India

Census years	Total Population	Urban Population	No. of towns/UAs	Percentage of urban population to total population	Decadal urban growth rate (%)	Tempo of urbanisation (person per year)		
						Annual exponential growth rate	Annual gain in percentage of urban population	Annual rate of gain in percentage of urban population
1901	238,396,327	25,851,873	1,827	10.84	0.00	0.00	0.00	0.00
1911	252,093,390	25,941,633	1,815	10.29	0.35	0.03	-0.06	-0.51
1921	251,321,213	28,086,167	1,949	11.18	8.27	0.79	0.09	0.86
1931	278,977,238	33,455,989	2,072	11.99	19.12	1.75	0.08	0.72
1941	318,660,580	44,153,297	2,250	13.86	31.97	2.77	0.19	1.56
1951	361,088,090	62,443,709	2,843	17.29	41.42	3.47	0.34	2.47
1961	439,234,771	78,936,603	2,365	17.97	26.41	2.34	0.07	0.41
1971	548,159,652	109,113,977	2,590	19.91	38.23	3.21	0.19	1.08
1981	683,329,097	159,462,547	3,378	23.34	46.14	3.83	0.34	1.72
1991	844,324,222	217,177,625	3,768	25.72	36.19	3.09	0.24	1.02

Note : 1. Including Projected Population of Assam, 1981.
2. Including Projected Population of Jammu & Kashmir, 1991.

Source : Census of India, 1991 (Provisional Population Total) Paper-2 Rural-Urban Distribution.

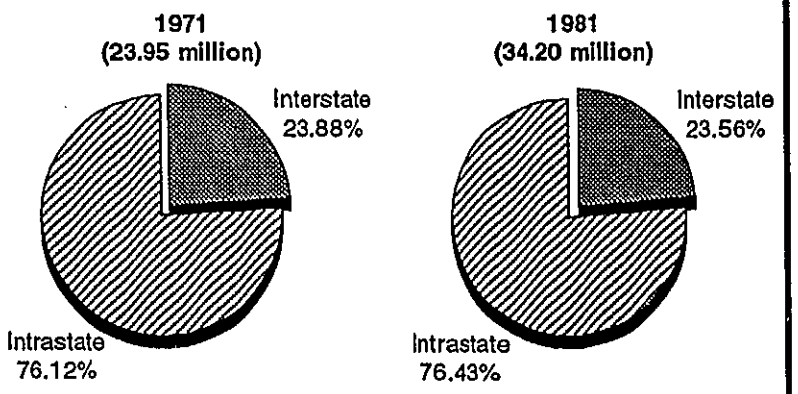
in NIUA, 1993.

TABLE 1.2 Reasons for Migration to Urban Areas, 1981

Place of last residence	Reasons for migration											
	Total migrants		Employment		Education		Family Moved		Marriage		Others	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Total migrants	100	100	43.14	4.20	6.61	2.36	27.31	32.51	1.06	46.61	21.88	14.32
Last residence elsewhere in India other than the place of enumeration	100	100	44.87	4.31	6.89	2.42	26.76	32.08	1.09	48.07	20.39	13.12
Within the state of enumeration	100	100	40.50	4.08	7.99	2.45	28.52	30.46	1.30	49.92	21.69	13.09
States of India beyond the state of enumeration	100	100	55.49	5.13	4.12	2.31	22.48	37.83	0.60	41.53	17.22	13.20
Other countries	100	100	15.24	1.96	2.08	1.10	36.26	14.44	0.46	16.47	45.96	39.03

Source : Census of India, 1981, Report and Tables based on Five Percent Sample Data in NIUA, 1988

Figure 1.1
Rural to Urban Migration



Source: NIUA, 1988

ever increasing, parallel, informal sector of employment. The provision of public services and infrastructure, moreover, being the responsibility of the government, have not only been inadequate for the increasing urban population but unevenly distributed, bypassing those without a clout or an ability to pay. Potable water is not available to a significant proportion of the urban population; more than half of the same population is not covered by sanitation and increasing quantities of solid wastes litter the streets as the current systems prove inadequate in efficient collection and disposal.

Availability of basic amenities

Currently the urban housing shortage in the country has been estimated at 6.9 million houses (NIUA, 1993). The absence of clear policies on low cost housing to address,specially, the needs of the ever increasing migrants into the city has created such large slum settlements across the country that the sheer magnitude of the settlements now inhibit the formulation of any alternatives. Although the precise slum populations have not been worked out after 1981, the 1990 estimates for the same revealed that more than 21 percent of the total urban population comprised slum inhabitants whereas in 1981 this percentage was about 17.5 (TCPO, 1985). The same estimates revealed that for most metropolitan cities the slum population exceeded 30 percent, and in some cases was as much as 35 percent (see Table 1.3).

TABLE 1.3 Slum Population in Selected Metropolitan Cities – 1981 & 1990

(Population in lakhs)

Cities	Urban pop (1981)	Slum Population (1981)		Estimated Urban pop. (1990)	Estimated slum population (1990)	
		No.	%		No.	%
Calcutta	91.94	30.280	32.9	125.33	43.86	35.00
Greater Bombay	82.43	28.314	34.3	117.89	41.26	35.00
Delhi	57.29	18.000	31.4	97.67	32.08	32.85
Madras	42.89	13.630	32.1	60.22	21.08	35.00
Bangalore	29.21	3.050	10.4	51.86	10.37	20.00
Hyderabad	25.45	5.000	19.6	37.07	11.12	29.45
Ahmedabad	25.48	5.363	20.3	37.76	11.33	30.01
Kanpur	16.39	6.140	37.5	22.84	8.00	35.03
Pune	16.86	2.743	16.3	25.73	5.15	20.02
Nagpur	13.02	4.161	31.9	18.82	5.64	30.00
Lucknow	10.07	2.850	28.3	13.12	3.94	30.03
Jaipur	10.15	2.960	29.1	16.34	4.90	29.99

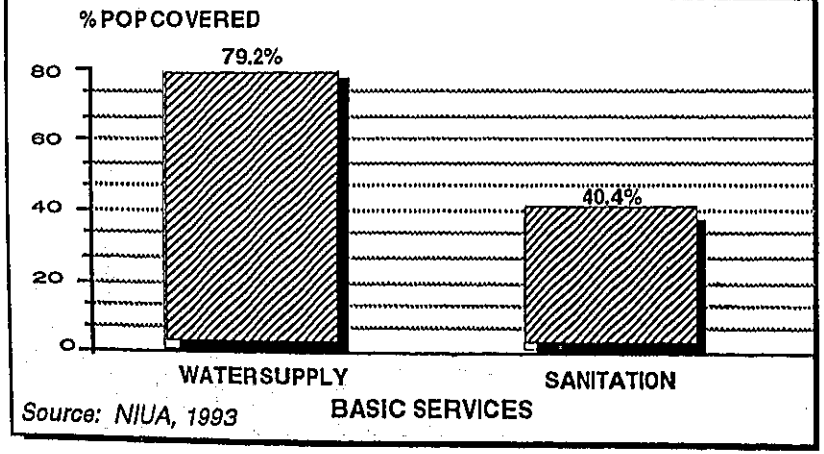
Source : A compendium of Indian slums, TCPO, September, 1985 in NIUA, 1993

Increasing urban populations demand a corresponding increase in public services, which the government authorities are seldom able to provide adequately. It is estimated that 79.2 percent of the total urban population is covered by water supply schemes (see Figure 1.2) and only 40.4 percent of the same is covered under sanitation (NIUA, 1993). Rough estimates reveal that as much as 30 percent of municipal wastes are left uncollected in urban centres. The situation is much worse when this data is viewed in the context of the spatial distribution of these services, which reflects large intra-city variations in the level of services provided.

In such a situation it is the urban poor who are deprived of these most basic services. An extensive survey conducted by the National Institute of Urban Affairs during 1988 in 589 slums across the country found that only 41 percent of the slums had rubbish depots, less than 30 percent had any community toilets and that the average number of people serviced by each handpump in the slum exceeded 1500 whereas for the tap it exceeded 300 (NIUA, 1991 b).

These slums are then typically characterised by an excessive lack of basic services leading to unimaginably unhygienic living conditions, where several people are cramped into extremely small living spaces. Ill health and disease are rampant, there is no security of accomodation as the settlements are illegal, exploitation from local leaders abounds, compounding the vulnerability of the most vulnerable of the urban population.

Figure 1.2
Provision of Basic Services (All India)



Source: NIUA, 1993

Despite industrial growth, the nature of development has been such that an increasing proportion of the urban population lives at the margin of existence, often in acute poverty, and despite the reasons for changing residence to urban centres, their quality of life in these urban cities is abysmal. Planning Commission estimates (in 1983-84) for urban poverty revealed that more than 28 percent of the country's urban population lived below the poverty line (NIUA, 1988).

Employment opportunities and the informal sector

Even though industrialisation has created jobs, the expansion in employment opportunities has not been in balance with the additions to the labour force; the demand for jobs has in fact far outweighed supply. It was estimated that out of the five million people added to the labour force of urban areas every year in India (1985 data), only 10 percent were able to find employment in the organised sector (National Productivity Council in NIUA, 1991). Once again then, it is the poor, and specifically the migrants, who have found it increasingly difficult to enter the formal systems of employment. Lack of skills and education, absence of references and 'contacts', the inability to pay securities or their way into jobs are only some of the factors that contribute to the marginalisation of this segment of society from the visible economy.

The need for survival, however, on the one hand and the growing needs of urban centres on the other, have created parallel informal sectors within the economy. These informal sectors are estimated to engage anywhere between 50 percent to 75 percent of the urban workers (NIUA, 1990). The significance of these parallel sectors within the economy is somewhat illustrated by calculations made during 1971-1981 which found that during that period the unorganised sector had grown by 84.5 percent whereas the organised sector merely by 42.2 percent (Deshpande and Deshpande in NIUA, 1991). Unable to find their place in the formal systems, the poor are then found dominating the informal sector, as most activities within this sector do not require much skill or education.

Even though the informal sector activities account for more than 60 percent of the total transactions in urban areas, urban planning has mainly concerned itself with formal economic activities (ILO and NIUA, 1990). Consequently, the informal/unorganised sectors, which could range from self employment, casual labour, piece rate work to regular wage labour, are typically characterised by abysmal working conditions, with little security of

work or wages, irregular and long hours, excessive exploitation and no support structures.

Despite these different forms of employment, as also the abysmal conditions surrounding much of the work in this sector, even the informal sector is not always adequately able to fullfil the employment/income needs of the population. Out of such situations, when even the regular or casual/contract wage work within the informal sector is out of reach of considerable segments of the urban population, as also self employment which may require investments, are born occupations such as waste picking or rag picking as it is commonly called.

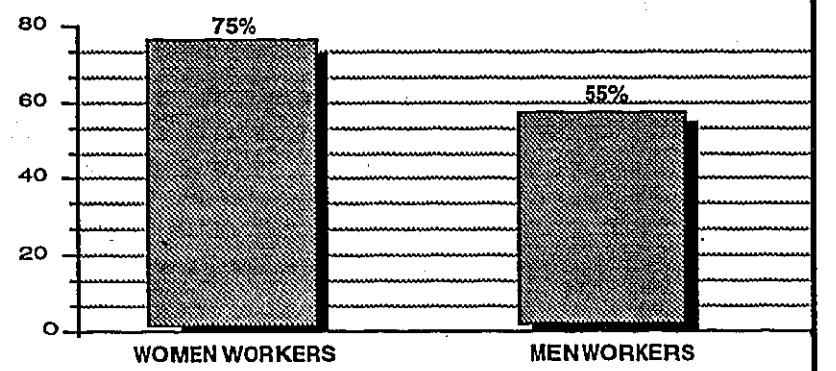
Involving the retrieval of recyclable items from mounds of refuse or dirty street sides, it is not surprising that waste picking finds its place at the bottom of the social and economic hierarchy of activities within the informal sector. Despite this status, it is commonly adopted as a survival mechanism, linking in the process, the distinct situations created by adopting a specific development/growth path. For, on the one hand, this activity is born out of a complete absence of options and a desperate need to survive in an overwhelmingly overcrowded labour market; and on the other, deflecting resource which create the need for recycling coupled with inadequately provided public services create the scope for such an activity.

To understand who precisely constitutes the backbone of this activity, it would serve to take a look at the larger informal sector to identify the dominant participants. Contrary to common belief that women and children, who comprise more than 60 percent of the urban population, do not constitute any significant percentage of the work force, the informal sector in fact, includes a high percentage of both women and children.

WOMEN AND CHILDREN AS WORKERS

It has been fairly well established that as production gets mechanised/industrialised, the demand for male skilled labour increases, forcing women to take up jobs not usually preferred by men (NIUA, 1991). As a result men are likely to have a greater mobility out of the informal sector while women tend to remain embedded in it. Lack of education and skill formation, among other reasons, most often constrain women from entry into the formal sectors. Thus it has been found that women who work are mainly concentrated in informal sector activities (ibid). National Sample Survey estimates reveal that as much as 75 percent of women workers are 'casually employed' or self

Figure 1.3
Percentage of Workers Employed in Informal Sector



Source: NIUA, 1990

employed (see Figure 1.3), whereas for men 55 percent constitute this category (NIUA, 1990).

Moreover, it has been observed that whereas the economic participation of men in low income households is comparable to the average urban male participation rate, in case of females the former is four times higher than the latter, suggesting that the income level of households affects the economic participation of women (NIUA, 1991). Studies have placed the participation rate of women in low income households anywhere between 42 percent and 93 percent (NIUA, 1990). And since the low income households are predominantly engaged in the informal sector, the largest percentage of women workers are likely to be found in this sector.

Similarly, estimates of working children reveal that India has the largest number of working children in the world and accounts for more than 33 percent of the child labour force throughout the world (ICFTU-APRO, not dated). Within India, more than 20 percent of the Gross National Product (GNP) of the country is estimated to be contributed by child labour (ibid). These statistics however, as well as other government data on the number of child workers in the country, lose their meaning in view of the partial coverage of government figures - usually including only those children in regular/formal employment, ignoring the marginal, irregular, non paid or self employed workers all of whom constitute a very high proportion of the child work force. As labour and other organisations concern themselves with

working children, they focus their attention on issues of age of employment, working conditions, wages etc. - most of which relate to children employed by an external employer. What usually escapes the attention of such organisations is the multitude of children that are self employed in a wide range of activities.

Specifically, it has been pointed out that as much as 90 percent of India's child workers are engaged in the unorganised sector (NLI, 1992). Associated with growing urbanisation is not only migration but also a breakdown of the traditional family and community structures, which have all combined to create a vulnerable group of urban children called 'street children', the majority of whom work within the informal sector to survive.

Significantly, and again contrary to what is commonly believed, the contribution of women and children to the household, from their activities within the informal sector, is not marginal but crucial to the survival of the households. Women in the informal sector do not work merely on a part time basis, to supplement family income but work nearly as long as men and contribute as much to family resources as men do; in some cases being the main earners in the family (NIUA, 1991). Moreover, a large proportion of them work, or rather have to work, every single day of the year, which further reinforces the critical role of their income within the household. A large proportion of children similarly, not only work full time but their income constitutes as much as 30 to 40 percent of total family income.

The reasons for pursuing activities in the informal sector, and for a specific activity within this sector, are usually based on a lack of options. The lack of education and skill on the one hand, and the need for flexible hours of work within the demands of their gender determined responsibilities on the other, most often constrain women to the informal sector. Within the informal sector, lack of capital, lack of work space and absence of skills often determines the specific activity they can pursue. Moreover, government interventions for the poor have been such that usually men have benefitted from subsidised credit schemes, whereas women, in the absence of collateral, which is specially so for the majority of migrant women, have had no access to credit. In such a situation even if they are provided training for production related activities, they are unable to take them up. Activities such as waste picking, which require neither skill, education nor capital, then provide one of the few real options. Occupational mobility is found to be extremely low amongst women in the urban informal sector (NIUA, 1991) and

this would hold specially so for activities such as waste picking where no skill formation takes place in the process of performing the activity.

The conditions of work within the unorganised sector and the potential for exploitation assume far greater significance/proportion in the context of the vulnerability of women and children. Women for example, are constrained at two levels, one arising on account of the nature of the sector and the other, on account of their sex. Gender based discriminations within the informal sector abound, both in terms of the kind of activities that men and women perform (or even tasks within an activity) and in terms of the wages they are paid.

NEED FOR AN ALTERNATE MODEL FOR URBAN DEVELOPMENT

Clearly, the existing patterns of development are unlikely to arrest the pace of urbanisation. It is in fact projected that by the turn of the century urban population would constitute more than 30 percent of the total population of the country (see table 1.4). This would undoubtedly lead to far greater pressures on urban employment, basic services and infrastructure and resources than at present. Within such a situation, urban development needs to be viewed holistically, where issues of urban employment need to be viewed in the context of sectoral goals.

Table 1.4 Urban Population Projection - India, 1991-2001

Year	Total urban population (in million)		% urban population		% share of million plus cities to urban population*
	Committee of experts (A)	Now projected (B)	(A)	(B)	
1991	235	217	27.5	25.7	32.5 (23)
1997	-	267	-	28.3	-
2001	332	307	33.0	30.5	35.8 (40)

*Note : *Figures in the bracket indicate number of million plus cities.*

Source: Eighth Five Year Plan, 1992-97, Vol.II, Govt. of India, Planning Commission, New Delhi in NIUA, 1993

This study then, attempts to look at how the larger goals of urban development could be addressed by identifying a meeting point for sectoral goals and needs of urban employment. Specifically, the study looks at waste picking: its context and the extent and nature of its contribution within the urban economy; and at waste pickers : their composition and profile, the conditions under which they work, specifically the gender based and other considerations, the reasons for adopting such an activity and their role within the waste economy as also the larger urban economy. In addition to the social aspects of waste picking, the study focusses on the economic and ecological contribution of waste pickers within the urban economy. It attempts to analyse how issues of solid waste management have been linked with the needs of the informal sector and examines the potential of addressing, simultaneously, social, economic and ecological issues by a collaboration of formal waste management systems and informal waste picking.

The study restricts itself to municipal wastes. Based on a combination of secondary information from different parts of the country and on individual and group discussions with several waste pickers in the slums of Delhi, this study does not attempt to provide precise or scientific data on the current situation. It merely attempts to provide, through case studies, impressions and rough calculations, a broad assessment of the situation; the context of the situation and the many forces working to create it, as also the key issues that emerge out of it. This then acts as a pointer in a direction which could subsequently form the basis for further research.

SOLID WASTE MANAGEMENT IN INDIA – PRACTICES AND ISSUES

An acceptance of the possible linkages between urban development and the nature and extent of solid waste management, specially in developing countries, has seen a growing focus on issues relating to solid wastes. Clearly, the generation and management of solid wastes in urban cities and towns, has a bearing on three distinct aspects - environmental, sociological and economic. The wide range of people who are involved in and get affected by solid waste management, because of varying degrees of interests in and dependence on solid wastes, points to the multidimensional role of solid wastes within the urban economy.

As urbanisation grows, so also the extent and dimension of the solid waste problem. The quantum and type of waste generated in any urban centre is a function of the size and character of the urban centre. For example, industrial towns would generate large quantities of industrial waste, which could be in solid, liquid or gaseous form. As a broad categorisation, the different forms of waste generated in any urban centre would be:

(a) Household/Commercial refuse
(b) Street sweepings
(c) Construction and demolition debris
(d) Hospital waste
(e) Industrial waste.

Even within this categorisation, there are most likely to be intra city differences in the composition and quantum of waste: slum settlements are likely to have a higher degree of organic matter in household waste and street sweepings than higher or even middle income areas. Refuse generation is a function of consumption, production and growth, which therefore affect not only the quantum but nature of refuse generated.

The domestic and commercial waste is primarily composed of organic matter, recyclables, toxic substances, soiled waste and dust/fine earth. The organic matter comprises food leftover, fruit and vegetable peels, spoiled foods etc. Recyclables comprise paper, plastic, rubber, metal and glass. Toxic substances comprise paints, aerosols, used batteries, medicines etc.

and soiled waste includes soiled cotton, syringes, sanitary napkins and baby nappies.

GENERATION OF WASTE

Clearly, the quantum of waste generated varies across urban centres, depending to some extent on the population, the degree of industrialisation and consumption patterns in the centre (see table 2.1). Whereas for the country as a whole per capita waste generation varies between 0.1 kilograms and 0.6 kilograms per day, with an average of 0.33 kilograms (Bhide, 1990), Bangalore for instance is estimated to generate about 0.5 kilograms per capita per day or 2000 tonnes of waste per day (De Souza, 1991 or Rosario, 1992). Although for Delhi and Bombay precise data for waste generated (as distinct from waste collected) is not available, as a rough estimate based on a daily per capita generation norm of 0.5 kilograms it works out to about 4800 tonnes for Delhi and 6285 tonnes for Bombay. In Delhi, the daily waste generated has been increasing by about 200 tonnes every year.

TABLE 2.1 Typical Refuse Generation Rates In Different Countries

Place	Kg/Person/Day	Volume/Day (litres)
India	0.25	1.0
Ghana	0.25	1.0
Aden	0.25	1.0
Egypt	0.30	1.25
Syria	0.30	1.25
Sri Lanka	0.40	1.6
Phillipines	0.50	2.0
Turkey	0.60	2.4
Malaysia	0.70	3.5
Singapore	0.85	4.25
Arabian Gulf State	1.0	5.00
Europe	1.0	8.00
United States	1.25	12.00

Source : Holmes, 1984

Waste here refers to municipal waste and does not include such industrial waste as is disposed off by the industries themselves. Large industries are required to dispose of their waste seperately. It is in the case of the small scale industries that industrial waste is at times disposed of along with municipal waste. In some cases, when the municipality arranges the transportation of industrial waste, the industries are charged seperately, depending upon the quantity transported (Pienvichitr, 1990). Similarly, hospital waste is required to be treated seperately from general waste, either incinerated or disinfected before dispatching for disposal. It is also required to be distinguished from the general waste and transported seperately to the common landfill site. But in practise, this is rarely found to happen.

Compared with other developing countries in the South East Asian Region (WHO, 1991), the per capita waste generation in India is on the higher side for the large cities, but well below the others for the small cities (see Table 2.2). If waste generation is accepted as one of the indicators of prosperity, standard of living and consumerism, this data reinforces the dichotomy of economic extremes within Indian society.

A comparative analysis of waste composition across the same countries displays the relatively lower organic component and high ash/dust component within Indian waste (see Table 2.3). Compared with developed countries, waste generated in India reflects a much higher proportion of compostable matter and fine earth whereas the former has a higher paper content (see Table 2.4).

TABLE 2.2 Per Capita Waste Generation In Different Countries

Country	Smaller cities (kg/c/d)	Medium cities (kg/c/d)	Large cities/ towns (kg/c/d)
Bangladesh	0.2	0.4	0.4
India	0.1	0.3 – 0.4	0.5
Indonesia	2.6 – 3.3*	2.2 – 5.1*	1.9 – 2.01*
Myanmar	–	0.36	–
Nepal	0.6	0.2 – 0.3	–
Sri Lanka	0.6	0.5	0.2
Thalland	0.8 – 0.9	0.7	0.6

** litres/c/d*

Source : Regional Overview on Solid Waste Management in South East Asian Region by WHO In (Asnani, 1991)

TABLE 2.3 Composition of Waste in Different Countries

Description	Percentage by weight				
	Thailand	Nepal	Myanmar	Sri Lanka	India
Vegetable/leaves / grass	54.21	56.9	75	61	40.15
Paper	15.48	5.4	3	5.4	3.80
Plastic	12.02	2.0	1	2.8	0.81
Leather/rubber	0.67	0.4	–	0.1	0.62
Textile	3.25	2.0	–	0.5	–
Wood/carton	2.14	1.3	–	–	–
Glass/ceramic	3.31	0.6	–	2.2	0.44
Metal	2.86	0.4	–	1.4	0.64
Steone-bone-dead animals	1.46	0.3	1	–	–
Stones, ashes, dust	–	28.9	1	–	41.81
Cane, bamboo, baskets	–	–	3	–	–
Miscellaneous	4.10	0.8	16	27	11.73

Source : Asnani, 1991

TABLE 2.4 Comparison of Physio–Chemical Characteristics of Waste

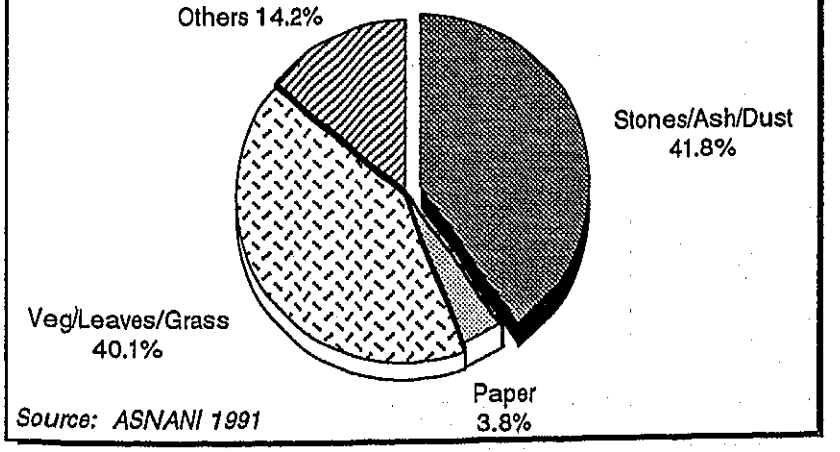
Characteristics	India*	Developed countries (Figures in Percentage)
Paper**	3 – 7	20 – 50
Plastics**	0.5 – 0.9	1 – 3
Metals**	0.4 – 1.0	4 – 14
Glass**	0.3 – 0.8	3 – 10
Ash and fine earth**	30 – 50	3 – 10
Total compostable matter**	30 – 50	10 – 20
Moisture content**	20 – 30	15 – 30
Organic Matter***	20 – 30	15 – 30

* – *Mean value of data from 33 Indian cities*
** – *On wet weight basis*
*** – *On dry weight basis*
Source: Bhide and Sundaresan, 1984

Although across different areas within an urban centre, such as residential, commercial, market and industrial, the waste composition is likely to vary significantly, it is estimated that overall, of the municipal waste generated in urban centres, anywhere between 45 to 75 percent constitutes organic matter (see Table 2.5). It is also important to note that waste composition varies significantly across areas of different economic levels of residents. The specific needs of a set of people, as pointed out by Ali (1993), play an important role in determining waste generation patterns. He points out how, unlike high income areas, low income areas, in addition to domestic waste, also generate waste resulting from a variety of informal sector activities persued from home or surrounding areas.

Intra-city variations however could be extreme; in Bangalore city for instance, a study carried out in different residential, commercial, market and industrial areas, found that the organic content ranged from 13.7 percent to 76.9 percent (Rao, 1990). For the country as a whole, over 40 percent of the waste is estimated to be organic matter (see Figure 2.1). Residential areas have a larger component of organic matter and ash/fine earth in their waste. Commercial areas have a high content of recyclable material such as paper, glass etc. and market areas have the highest degree of organic matter (see Table 2.6).

Figure 2.1
Composition of Waste in India



Source: ASNANI 1991

TABLE 2.5 Average Physical Analysis of Indian City Refuse (Percentage by Weight)

Name of City	Paper and card	Metals	Glass	Textiles	Plastic Leather and Rubber	Wooden matter Hay and Straw	Bones etc.	Stones etc.	Fine Earth and Ash etc.	Fermentable	Density Refuse (kg/cum.)
Lucknow	1.66	0.2	0.66	2.91	4.2	3.02	0.18	5.27	21.59	60.31	407.6
Kanpur	1.35	0.18	0.38	1.57	0.66	1.00	0.21	18.38	22.93	53.34	500.0
Madras	5.9	0.7	-	7.07	-	-	-	13.74	16.35	56.24	-
Delhi	5.88	0.59	0.31	3.56	1.46	0.42	1.14	5.98	22.95	57.71	-
Calcutta	0.14	0.66	0.24	0.28	1.54	-	0.42	16.56*	33.58	46.58	600.00
Bangalore	1.5	0.1	0.2	3.1	0.9	0.2	0.1	6.9	12.0	75.0	578.00
Ahmedabad	5.15	0.80	0.93	4.08	0.69	1.50	0.12	8.77	29.01	48.95	-
Bombay	3.20	0.13	0.52	3.26	-	17.57	0.5	-	15.45	59.37	-

** Includes coconut shells*

Source : Nath, 1984

TABLE 2.6 Physical Analysis of Bangalore City Refuse (Percentage by net weight)

Sl. No.	Type of Locality	Paper	Plastics	Rags	Metals	Glass	Rubber & Leather	Wooden matter	Croc kery	Bones	Stones and Bricks	Ash & fine Earth	Vegetable matter
1.	Residential (Rajajinagar)	2.70	0.49	2.95	0.74	0.49	1.23	0.37	1.47	0.25	3.20	41.54	44.40
2.	Residential (Jayanagar)	3.29	0.98	3.05	1.10	0.49	0.73	0.37	1.34	-	4.02	41.95	42.08
3.	Residential (Malleswaram)	3.29	0.80	2.50	-	0.68	1.02	-	0.57	0.46	3.75	40.00	46.93
4.	Commercial (Brigade Road)	10.16	5.08	1.02	3.04	5.08	1.02	-	4.10	-	0.38	37.60	32.52
5.	Commercial (Commercial Street)	11.42	5.65	11.29	2.28	9.14	3.36	10.22	5.65	-	-	27.28	13.71
6.	Market (KR Market)	0.26	0.26	4.61	-	-	0.52	1.02	-	-	-	16.14	76.92
7.	Market (Russel Market)	0.54	0.68	4.34	-	0.41	-	0.68	-	4.34	1.08	26.05	61.87
8.	Industrial (Rajajinagar)	4.13	14.47	9.25	5.12	7.28	12.40	-	-	-	38.09	9.25	-
9.	Industrial (Peenya)	3.83	4.47	8.51	4.25	-	5.74	3.51	7.13	-	27.23	18.94	16.38
10.	Industrial (Mysore Road)	3.91	7.91	4.72	2.46	6.37	9.75	0.92	-	-	21.97	18.48	23.51
11.	City as a Whole	4.35	4.08	5.22	1.90	2.99	3.58	1.71	2.03	0.51	9.97	27.75	35.90

Source : Rao, 1990

WASTE MANAGEMENT PRACTICES

A look at any of the Indian urban centres brings into sharp focus the state of neglect of solid wastes, raising issues not only of environmental degradation, but also of economic and institutional concerns in urban development. This is the situation despite the existence of extensive infrastructure and large investments in managing this waste, in most cities in the country. This, then, clearly merits the need to critically look at the systems of solid waste management in existence.

Waste management in India is generally the responsibility of the municipal corporations, within which it is either looked after by the corporation's health officer or the municipal engineer. The former leads to a focus on health aspects rather than on efficient and optimal waste disposal or resource recovery.

Within the Municipal Corporation there usually exists an extensive team engaged in the planning and implementation of solid waste management (SWM). In Delhi for example, the overall responsibility of SWM within the Municipal Corporation of Delhi (MCD) area lies with the Director, Conservancy and Sanitation Engineering (CSE). Other administrative heads, including three joint directors, one for each of the four zonal areas, constitutes part of the CSE department at headquarters. Each of the zonal areas are looked after by an executive engineer who is assisted by an extensive staff of zonal engineer, assistant engineers, sanitory inspectors and several thousand 'safai karamcharis'. The entire system of waste management is thus dominated by engineers and technocrats.

Storage and collection systems

Collection of waste is done in community bins and it is only in some specific areas of a few metropolitan cities that house to house collection is carried out. The community bins, provided at specified locations on the streets, are of concrete or metal, at some places large enough to be the size of a room.

Storage in these bins is generally found to be unsatisfactory as people are often reluctant to walk to the communal bins and hence dump the waste on sidewalks, streets or open drains; even when they do find their way to the communal bin, they tend to throw the waste from a distance, in the process missing the bin altogether and scattering the waste all around the bins. Not

only does this create unhygienic conditions in the area, but also difficulties for the municipal staff in collecting the waste for transportation, as they do not have brooms or shovels to gather the waste. In the case of masonry waste collection structures, waste from the corner of the walls remains uncollected, starts decomposing and creates a foul smell.

It has often been found that these garbage bins have been situated at unsuitable locations. Location being an important determinant of acceptance or rejection of a facility, it is not surprising that in such cases people prefer throwing the garbage at any other convenient place.

Street sweepers, generally women, are employed by the municipality to manually sweep the roads and empty out the sweepings in the bins. The MCD for example, currently employs about 36,000 street sweepers or 'safai karamcharis' as they are called.

The character of waste determines how critical the frequency of collections is. Where organic matter constitutes a high percentage of waste and climates are warm, decomposition of waste is likely to take place more quickly than compared to areas with different waste composition. Uncollected waste, in such cases, would only increase bad odours and risks to health in the surrounding areas. In a country like India, where not only is the organic content of waste high but temeratures are very high and living spaces are usually small, the frequency of waste collection becomes a critical factor in SWM.

Although on paper waste collection is carried out daily, in actual practise it takes place less frequently. Whenever waste generation in a given area is less that one truckload with a capacity of about four tonnes, waste collection is carried out once in two days. Street sweepings are also irregular and could be as infrequent as twice in a week. In general, the lower the socio-economic level of the residents of an area, the lower is likely to be the collection frequency of its garbage.

Transportation of waste

In most cases the transfer of waste from the bins to the transport vehicle is carried out manually, with an average of two to three trips made by a vehicle in a day. Only in a few cases, such as in large waste sites, front end loaders are used. Manual loading of waste is not only time consuming but also injurious to the health of the workers.

Open trucks are normally used for the transportation and only in some cases is the waste inside covered. Tractor trailors are commonly used in smaller towns, which also at times see the use of animal drawn carts, when the transport distance is small and traffic is low. Such animal drawn carts are usually engaged to collect waste from narrow lanes and transport it to a transfer station from where it is carried by a larger vehicle.

Waste disposal

Disposal of waste is carried out through various different processes, viz. uncontrolled dumping or controlled tipping at landfill sites, manual or mechanical composting and incineration. The most common of these is dumping at landfill sites located around the city and it is estimated that more than 90 percent of the waste collected in Indian cities and towns is disposed by landfilling (Rosario & Von Der Weid, 1990). Depending on the manner of dumping, landfilling can be categorised into (Nath, 1984) :

- sanitary landfilling
- controlled tipping in low lying areas adjacent to the sea for land reclamation
- uncontrolled tipping on municipal land
- uncontrolled tipping on private land
- uncontrolled tipping into water.

Most sites in India are uncontrolled dumps and not sanitary landfills. Domestic, commercial, hospital and industrial waste are dumped together. No daily cover is applied to the waste nor is the waste compacted. Dumping is also sometime carried out illegally on the private property of farmers.

Very rarely do local bodies carry out an environmental impact analysis in selecting a disposal site. Any site with depressions which can hold waste is usually used for disposal.

Disposal of waste in this manner then leads to ground water pollution through leachate as well as other problems associated with flies, rats, rodents and odours. Additionally, because of the loose or non existent control measures for incoming waste, industrial waste is sometime disposed of at such disposal sites. Similarly, hospital waste often reaches these sites, which, because of its hazardous nature, poses health problems for anyone handling the waste.

Although the landfill method is the most easily adopted and the least expensive of the various disposal methods (not taking into consideration the value of the land used for dumping), it does entail earmarking precious land sites near urban centres, which in view of the decreasing availability of land, as well as the environmental aspects, makes it less attractive. Naturally, distance of landfill sites from the collection areas is increasing; Delhi at present uses six dumping sites and the average distance of the sites from the collection areas varies between 15 kilometres to 20 kilometres.

The other systems of disposal are simultaneously systems of resource recovery.

Resource recovery

With the acceptance of waste being a misplaced resource, there are various forms of resource recovery that take place from waste. Recovery of recyclable items, composting and energy recovery are some of these.

Recovery of recyclable items takes place at various levels, viz. at the source of waste generation where paper and glass bottles etc are sold to itinerant waste vendors, from the community dust bins by waste pickers and the local sweepers, from the transportation vehicles by the municipality staff and from the disposal sites by waste pickers. It is difficult to establish accurately the quantum of waste recovery taking place in this manner. There have been few studies and the estimates vary considerably. Whereas Bhide (1990) estimates that about six to seven percent of the total waste generated is recovered in this manner, a study carried out in Bangalore (De Souza, 1991) found this figure to be 15 percent.

However, the conditions under which much of such resource recovery is carried out are abysmal and no efforts are made at maximising such recovery by attempting to change waste handling habits such as waste segregation at source.

Composting is another mechanism of resource recovery, where the organic manure so produced can be used as a soil conditioner by the municipal authorities in public parks etc, sold to farmers or used by farmers for their own purposes, where they are preparing the compost themselves. Manual composting has been adopted in several urban centres, producing fertilizer at a cost relatively lower than chemical fertilizer. Mechanical composting, tried in some cities in India, has met with little success, primarily because of the high capital and operating costs which increased the sale price of the

compost (the transportation cost also increased since the plants were located at a considerable distance from the point of use), making it less attractive to the purchasers.

Despite compost being an excellent substitute to chemical fertilisers for increasing soil fertility, which not only replenishes micro nutrients to the soil but reduces the country's import needs for petroleum products used in chemical fertiliser manufacture, it is nevertheless not favoured by municipal bodies as a form of waste disposal because of the costs involved. Whereas composting costs Rs 250 per tonne, disposal through landfill costs the Municipal Corporation Rs 10 per tonne (Jain, 1990). An additional problem with composting remains the need to separate out non compostable material from the waste to be composted. Often farmers experience cuts from pieces of glass which remain in the compost. The demand for compost moreover, has often been found to be affected by its price which becomes disproportionately high on account of excessive transportation costs.

Energy recovery from waste takes place in the form of biogas, through anaerobic decomposition of the organic component of waste deposited in landfills, as well as power generation from incineration of domestic and trade waste. However, given the high organic content as also high content of dust/earth in Indian waste, burning of waste has been possible only with the use of extra fuel, making the entire process of incineration too expensive. The unsuitability of incinerating waste for energy recovery is reflected by the 300 tonnes incineration plant set up in Delhi at a cost of Rs 20 crores. The plant was a complete failure because whereas the highest calorific value of the garbage which the plant could take was 1465 kilo calories per kilogram, the generated garbage gave only 750-800 kilo calories per kilogram (Seth, 1990). There were thus very high capital and operating costs in running the plant, which was closed down not very long after it was made operational.

The actual recovery of energy for cooking and/or power,through anaerobic decomposition, is not carried out on any significant scale in the country as yet.

ENVIRONMENTAL ASPECTS OF WASTE STORAGE/DISPOSAL

Indiscriminate dumping of waste around waste bins, on the streets and in water bodies give rise to air and water pollution. Unlifted waste from storage points causes health risks. In the case of waste dumped at landfill sites, improper selection of the site causes ground water pollution through leachate.

During periods of heavy rains, runoff could also cause surface water pollution.

Air pollution could also result from spontaneous combustion of waste at disposal sites. Based on an estimate of two cubic metres of methane gas generation from one tonne of garbage, Mr R C Jain (in Shunglu, 1993) calculates the total methane released into the air every day at 7000 cubic metres. Methane, as is well known, is harmful and contributes substantially to the greenhouse effect.

Health impact on workers and the general population

Workers handling waste come in constant direct contact with waste and remain exposed to the impact of wastes. Studies have shown that such workers suffer from skin diseases due to contact with waste; from respiratory and opthalmic diseases due to inhalation or contact with infected dust; and from ulcers and infected wounds (Giroult, not dated). Studies carried out by the National Environmental Engineering Research Institute on waste workers found them to suffer from skin and eye infections, respiratory diseases, jaundice etc. (Bhide, 1990). A study in Ahmedabad found that more than 15 percent of sweepers suffered from tuberculosis (TB) and that the prevalence of TB among sweepers was three times higher than the national average.

Operators at the screening stage of composting plants are exposed to wounds and blood infections and those at manual composting plants are exposed to insect carrier of germs (Giroult, not dated). Workers at landfill sites similarly are exposed to methane gas explosions.

Clearly, waste handling is a hazardous occupation. Despite this however the workers are seldom protected by occupational health and safety measures and work without any protective equipment.

The general population on the other hand, is affected both by uncollected wastes as well as waste treatment and disposal activities. The former causes wounds, diseases transmitted by vectors breeding on wastes and a wide range of infections. Uncontrolled fermentation of wastes also creates conditions favourable to the breeding and growth of rodents and insects acting as vectors of diseases (ibid). Uncollected wastes also pollute the soil and waters.

The most significant impact of waste treatment and disposal activities on the general population consists of underground water pollution by leachates

from landfill sites, since regular water treatment does not remove such micropollutants.

INVESTMENTS IN SOLID WASTE MANAGEMENT

The extent of waste generated and the range of activities involved in dealing with this waste in an efficient and optimal manner, merits a large infrastructure in terms of manpower, machines and therefore finances. It is not usually possible to determine the exact percentage of the municipal budget that is spent on solid waste management, since other functions such as drain cleaning etc. are often carried out by the same staff. It is however estimated that anywhere between 10 to 40 percent of the municipal budget is utilised for SWM (Bhide, 1990). Per capita expenditure on SWM for India (see table 2.7) in 1990 was estimated between $2.38 - $4.15 (WHO, 1990). For Delhi the total cleaning and waste management budget for 1993-94 is approximately Rs 70 crores (see table 2.8), which constitutes 20 percent of the total MCD budget.

TABLE 2.7 Per Capital Expenditure on Solid Waste Management in Different Countries

Country	$/capital/year
Bangladesh	0.36 in Dhaka and range 0.07 – 0.30 in other towns
India	2.38 – 4.15
Indonesia	0.84 – 1.9
Myanmar	0.75 – 8.4
Nepal	2.03 in Kathmandu and range 0.25 – 0.84
Sri Lanka	1.79 in Colombo, 0.9 – 1.1 in medium and 0.15 – 0.25 in small towns
Thailand	1.6 – 5.35

Source : Asnani, 1991

TABLE 2.8 Municipal Corporation of Delhi Expenditure on Solid Waste Management

(in lakh Rs.)

Expense head	1989–90	90–91	91–92	92–93	93–94 (Budget)
Supervisory Salary					486
Sreet Cleaning					5600
Waste Collection and Transportation (including wages, repair and maintenance diesel etc.)					743
Disposal					80
Total	**5305**	**6162**	**6391**	**6906**	**6909**

Source : Municipal Corporation of Delhi

Solid waste activites in India employ a large number of workers. The average manpower provision for the country is estimated between two to three per thousand population (table 2.9); in metros it could be between four to six whereas in small towns it is typically around one (Asnani, 1990).

For Delhi, the MCD employs about 36,000 sweepers or safai karamcharis, of which about 2000 are involved in loading of waste into trucks and the remaining are essentially street sweepers. Their deployment within the city is such that the slum areas and resettlement colonies account for about 8000 sweepers whereas the rest of the areas account for the remaining 24,000sweepers. It is estimated that every year about 1000 sweepers are added to the labour force. In addition to sweepers there are 1000 assistant sanitory inspectors, 150 sanitory inspectors, 600 drivers and 200 employees at the landfill sites.

Table 2.9 Manpower Provision Per 1000 Population for Solid Waste Management

Country	No. of persons/1000 persons served
Bangladesh	0.5 – 2.2 (av.) commonly less than 1
India	2 – 3 (av.) 4 – 6 in Metros and less than 1 in smaller towns
Indonesia	2.2 – 6.6 in metros and 0.4 to 1.4 in other towns
Myanmar	1.3 in Yangon – Range 0.3 – 3.1
Nepal	1.8 – 2.6 in big cities. 0.6 – 1.8 in other towns
Sri lanka	4.7 in Colombo, 1.5 – 1.9 in medium and 0.2 – 0.5 in smaller towns
Thailand	1.3 – 3.0

Source : Asnani, 1991

EXTENT AND COVERAGE OF SOLID WASTE MANAGEMENT SERVICES AND EMERGING ISSUES

Despite the extensive resources invested in SWM practices in the country, the eventual service provided is largely inefficient, with substantial amounts of refuse left uncollected in many cities. For the country as a whole it is estimated that waste collection by dustbin is 60 to 86 percent (Rosario & Von Der Veid, 1990). A survey carried out by the National Institute of Urban Affairs (NIUA, 1989) found that waste collection in different cities in India ranges from 66 percent to 82 percent of waste generated (see table 2.10).

Table 2.10 Refuse Disposal Level as Proportion of Refuse Generation by Size Class of Cities, 1986-87

Size Class	No. of responding urban centres	Average per capita refuse (grams/day)		% Disposal (as proportion to generation)
		Generation	Disposal	
I	98	302.8	217.6	71.9
II	27	479.9	319.0	66.5
III	13	375.9	288.9	76.9
IV	6	483.8	354.4	73.3
V	7	413.7	341.4	82.5
VI	2	294.4	203.4	69.1
VII	–	–	–	–
All/Av.	153	377.8	273.8	72.5

Source : NIUA, 1989.

Quite apart from the overall shortfalls in collection, a look at the spatial coverage of SWM services reveals that in most urban areas only about 70 percent of the population is served (Fritz, 1990). In the Calcutta Metropolitan district, 60 percent of the total annual expenditure on solid waste management is enjoyed by 30 percent of the population living in the city corporation area (Nath, 1984). Significantly, it is the poorer communities, the slum settlements or other areas of recent rural migrants, who have little political influence in demanding any service, which are left out. That slum settlements are poorly served is illustrated by a survey carried out in a little less than 600 slums across the country (NIUA, 1991b), which found that only 41 percent of the sampled slums had any municipal waste collection depots. As in most cases of infrastructure and public services, it is the poorer areas that are most easily marginalised. The result is clogged sewers, waste littered everywhere and disease caused by the unhygienic conditions created by uncollected waste.

In the case of slums the problem is compounded by the fact that because they are unauthorised, they already suffer from inadequate services of water supply, sanitation/toilet facilities, waste water disposal etc. The absence of SWM services, in such conditions, gives rise to piling of waste contaminated

with human and animal excreta, creating extremely serious health problems for the slum population.

Limited equipment and staff, rapid growth of "unofficial areas" and streets inaccessible to the equipment used are reasons most commonly cited for this. That choice of technology also has a role to play in the spatial coverage of services is illustrated by Cointreau (1982). She points out how accessability of poorer habitats affects their access to service; local governments usually provide systems of waste collection which involve vehicles that can service only paved roads. In such habitats where paved roads are not present, it is common to find waste being dumped in drains, between houses and on any available land, where it accumulates and degrades. In Onitsha, Nigeria, she found that because of such technology adoption, the service levels in the low income areas was only 10 percent as compared to 80 percent in high income areas. She further observes, "there tends to be a discriminatory attitude on the parties in power against the people living in these low income areas, an assumption that their neighborhoods are dirty because the people are dirty and too lazy to carry their refuse to a paved route where service is provided. There is a general lack of recognition of the disincentives that the absence of walkways, clean drains, and other basic infrastructure create to residents making this level of effort" (ibid).

Part of the overall inadequacies in waste management are attributed to shortfalls in staff. In the Delhi MCD area for example, the staff norm for vehicle maintenance is 0.7 persons per vehicle whereas in actual practise there are only 0.3 to 0.4 persons per vehicle. Even the staff that does exist is not motivated and often take attendance but do no work. Lack of supervision also contributes to the inadequacies in these services.

Clearly the gaps in services relate not merely to availability of infrastructure and investments, but also to inappropriate management of the service. In Delhi for example, the number of trucks and waste transporters,for waste collection and transportation,approximate 400. Taken at a capacity of about 5 tonnes per vehicle (it could range between 4 tonnes to 6 tonnes), 400 vehicles would be able to carry 2000 tonnes of waste. Clearly just two trips per truck per day would be adequate to clear the entire waste generated in a day. Even if some trucks were to be under maintenance, the truck availability would be adequate since in areas of low waste generation waste is collected only once in two days. In addition to this, some trucks could make three trips in the day as the number of trips currently made range

from two to three. Yet the local authorities are unable to clear the entire waste generated.

Another possible case of mismanagement is illustrated by a study carried out by the National Institute of Urban Affairs on Environmental Sanitation and Waste disposal, which found that even though the norms for deployment of sanitary workers for each city depended on the population of the city, the population density, the physical characteristics, quantum of waste generated etc., none of these norms were used in actual deployment of staff, resulting in suboptimal effectiveness of the systems.

In summary, waste management services suffer from many constraints: beginning in some cases with inappropriate technology (as in storage, collection and transportation systems) to inadequate and disinterested staff as well as an absence of efficient management and planning. There are also, as Furedy (1987) observes, attitudinal factors which inhibit genuine interest in waste management and accord this service little prestige. All these factors combine to result in large quantities of uncollected waste, health risks to workers and waste pickers and a waste or sub-optimal use of the resource that garbage constitutes.

The overall emphasis of waste management systems lies in technology as opposed to efficient labour management. With due focus on the labour needs of the system, not only could staff inefficiencies and inadequacies be addressed but, where it is more appropriate, labour could replace technology, for instance in the collection of waste from low accessability areas.

Moreover, the current systems of disposal point to the need for greater resource recovery through recycling of dry waste, composting and energy generation. Not only do these gain relevance in the context of dwindling national resources and the economic status of the country, but also in terms of land availability for dumping and its environmental implications.

Hence, the predominantly technology oriented nature of waste management systems, without due social and ecological considerations, has been responsible in large part for many of the constraints and inefficiencies experienced in waste management. Clearly, the concepts of waste management have not, to any significant extent, included considerations of resource conservation, pollution reduction and employment generation.

Although the resource poor status and low consumption levels of most developing countries would, prima facie, point to a very low level of recycling activity, specially as compared to the richer nations, in actual practise the very nature of such economies, the poverty and to some extent the cultural ethos, ensures that very little is actually wasted. The recycling industries, in fact, provide enormous opportunities for the economies of such countries. Not only are recycling activities extensive, spanning a wide range of products and providing jobs to vast numbers in the population but simultaneously save valuable raw material in the production of different commodities. The dwindling supplies of raw materials, whether it be wood pulp for paper or petroleum for plastics, only reinforces the need to recover from the existing resources. The shortage of land, additionally, for locating waste disposal sites adds another dimension to the importance of recycling.

That waste provides invaluable resources that can be recycled is reflected somewhat by the fact that in many cities of developing countries, municipal waste is privately collected at no cost to the city (Holmes, 1984). In Mexico City, private entrepreneurs are reported to pay a fee to municipal refuse workers for the privilege of picking up waste from residential buildings in high income areas (ibid). Similarly, in Cairo, families in the Zabbaleen settlements pay a fee to middlemen who have purchased from the original builders the rights to waste in high income areas (ibid). In Bangkok, studies of waste collection crews have indicated that 40 percent of their loading time while on the collection route is spent retrieving recyclable material, through which they are able to double their regular wages. Closer to home, a survey in Delhi (Galloway, 1993) found that people have left well paying, secure jobs to become waste dealers. Clearly then, through recycling there exists an enormous value to these waste products.

NATURE OF RECYCLING ACTIVITIES

Taking a close look at the different processes of waste recycling unfolds the wide range of products that different kinds of waste are transformed into. Waste paper, apart from producing paper (typically duplex boards and kraft paper) is also used for toilet paper, tissues, hand towels and wrappings. Similarly, steel scrap is used for making drums, buckets and jerry cans. It had been estimated that the United States imported some 500 tonnes

(1984 data) of newly rolled steel from India, on account of the considerably lower production price in India, which was made possible only because the steel was re-rolled from scrap (Vogler, 1984).

Glass products such as glass tumblers, bottles, jars and chimneys for oil lamps are made with glass pieces - breakages from bottling plants as well as other pieces collected from houses, streets etc. In fact, in some countries production of wall and floor tiles can also be seen to take place using coloured pieces of broken glass (Vogler, 1984).

Further, India produces several thousand tonnes of reclaimed rubber every year, used, depending on the basic grade of reclaim, for cycle tubes and beadings, motor tyres and moulded items, cycle tyres, shoe soles, coloured footwear, battery boxes and trolley wheels to name a few. Tyres, additionally, are used for producing footwear and repairing shoes, after which the nylon thread is used for binding. Strips of tyres are used by upholsterers to form the spring base of beds or the gently yielding seats for stools and chairs (Vogler, 1984).

There similarly exists an extensive industry producing low grade products from plastic scrap. In some cases waste plastic is melted to produce new plastic items. Buckets, water hose, containers, bottles, jerry cans are just some of the items that are produced through such recycling. Other types of plastic are ground into a fine powder and used as fillers to provide insulation in products such as quilted jackets.

Quite apart from the recycling of dry waste, the organic content of waste too offers tremendous opportunities for recycling, most of which are exploited only to a very small extent in India currently. Organic waste can be converted into compost which when used as manure in place of chemical fertiliser supplies nutrients to the soil and improves its fertility. Similarly, decomposed refuse produces methane which can be tapped to provide energy - for cooking as well as for electricity. In fact, the amount of biogas (a mixture comprising methane and carbon di- oxide) that can be recovered from waste (in sanitary landfills) is estimated to range between 85-115 cubic metres per tonne of waste disposed (Bhide, 1990b). Even though Indian waste is most often not disposed in sanitary landfills, given the high organic content of the waste and the higher ambient temperatures at which it decomposes fast, biogas recovery has been found to be feasible in Indian cities (ibid).

EXTENT OF CURRENT RECYCLING AND FUTURE POTENTIAL

Given the nature of the recycling industry, which can range from some large organised set ups to several thousands of small scale operations, it is not really possible to estimate, to any satisfactory degree of accuracy, the number of recycling units or the number of people involved in such activities. The industry essentially comprises of several small units scattered across the country. In this situation, the scattered data that is available can at best be used as representative of the magnitude of operations. To illustrate this, consider the case of the thin coloured polybags which are used by all vegetable, fruit and other vendors when such items are purchased. It is estimated that Delhi alone produces 200 tonnes of such recycled bags daily (personal communication with a plastic recycler).

Clearly, given the current trends in consumption and lifestyle habits, the use of plastics is likely to increase manifold. This is reflected in estimates of future demand for different types of plastics (see table 3.1). Given the foreign exchange situation and the scarcity of petroleum products, this only reinforces the need to focus increasingly on recycled plastic.

Table 3.1 Demand for Plastic in India

(Demand in MT)

Type	Use	1991	2000
Low Density Polyethylene	Packaging, films and bags, wires and cables, extrusion	1,75,000	7,00,000
High Density Polyethylene	Monofilaments, pipes, films, injection and blow moulding	50,000	–
Polypropylene	Films, strapping, injection moulding, fibres, crates, doors, windows	75,000	4,20,000
PVC	Pipes, fittings, wires and cables, footwear, bubble wrap	2,40,000	748,00,000
Polystyrene	Refrigerators, air conditioners, tape recorders, housewares, cassettes	35,000	1,20,000

Source : Galloway, 1993

Taking the case of paper, it is found (ICICI, not dated) that waste paper is one of the principal raw material used by small paper mills (with a capacity of upto 5 or 10 tonnes per day). Larger mills of 30 to 75 tonnes per day capacity use waste paper in a combination with agricultural residue. Not only is waste paper used by waste paper based paper mills, but also by wood based mills, which use waste paper upto five to ten percent of their furnish. Waste paper based mills are estimated to constitute about 27 percent (see table 3.2) of the effective installed capacity for manufacture of paper and paper boards (ibid). With a production of 4.20 lack tonnes (during 1990-91) the capacity utilisation of the waste paper mills works out to 63 percent (ibid).

Table 3.2 Effective Installed Capacity and Production for Paper and Paper Boards (as on March 31, 1991) (Lakh Tonnes)

Category	Total Installed Capacity	Closed Capacity	Effective Capacity	Percent Share	Production (1990-91)	Capacity Utilisation (1990-91)
Wood Based	14.44	4.00	10.44	41	9.90	95
Agro Residue Based	9.42	1.29	8.13	32	6.50	80
Waste Paper Based	9.18	2.56	6.62	27	4.20	63
Total	33.04	7.85	25.19	100	20.60	82

Source : ICICI, not dated

The closed capacity as also the relatively low capacity utilisation for waste paper based mills is a function of many factors, one of which constitutes the availability of waste paper as raw material. It is estimated that only **15 to 20 percent of the total paper production in India is currently recycled** whereas the rest is used for packaging (ibid). Of course some of the material used for packaging may also eventually find its way into the waste stream, from where it might be collected for recycling; the process of such collection however, may result in the loss of substantial quantities of the material.

A projection of the demand and supply of paper and paper board by 2000-01 (see table 3.3) reveals that there is likely to be a deficit of 10.20 lack tonnes (ibid). If newsprint is added to this, the total deficit is projected at 13.6 lack tonnes (ibid).

The non availability of forest resources, specially bamboo and hardwood, as raw material for the wood based mills and also for newsprint is most likely to affect their production. It is estimated that about 34 lack tonnes of wood would be required by 2000-01 for the wood based mills, newsprint units and agro based large mills; as aginst this, availability of raw material is estimated at 32.1 lack tonnes as per the report of the Raw Material Committee of the Development Council for Paper, Pulp and Allied Industries (ibid). With increasing rates of deforestation however, the actual deficit may be much greater.

Table 3.3 Projected Demand/Supply Balance for Paper, Paper Boards and News Print Year 2000-01 (In lakh Tonnes)

	Estimated Demand	Production	Deficit
Paper and Paper Board	37.90	27.70	10.20
News Print	10.80	7.40	3.40
Total			13.60

Source : ICICI, not dated.

To augment production, the large mills as also newsprint industries are likely to focus their attention on waste paper as raw material. As mentioned earlier, already the large mills use waste paper in a small proportion. This would compound the existing shortage of waste paper as raw material and affect the waste paper based paper mills. This shortage, combined with the low estimates for the total quantum of paper recycled currently, point to the need to evolve mechanisms to optimise on waste paper availability for recycling.

ECONOMIC AND ECOLOGICAL IMPLICATIONS OF RECYCLING

As mentioned earlier, precious raw material, most of which is dwindling at a rapid rate, is used in the production of various commodities. To examine the extent to which this can be arrested by reusing or recovering from waste, let us take the case of paper production. It is estimated that approximately 17 trees are cut in order to manufacture one tonne of paper. Deinking waste paper and using it for paper production, with or without virgin wood pulp, reduces the need to cut trees and therefore the process of deforestation.

Additionally, recycling of waste paper contributes to a reduction in environmental pollution and energy consumption. In terms of the three types of pollution caused by paper production viz. air pollution by particulate matter and toxic gases, water pollution by discharge of process water containing toxics and chemicals and land pollution through solid wastes, the pollution from waste paper based paper products, as compared to the wood and agro based paper products, is comparatively small.

The paper industry is energy intensive and energy costs can amount to 25 percent of the total production costs (ICICI, not dated). Whereas the wood based paper industries consume about 1600 kwh per tonne, agro and waste paper based mills consume 1000 kwh per tonne. Similarly steam is also used for various activities of paper production; for wood based paper mills the average steam consumption per tonne of paper is about 8.3 tonnes which translates into 1.7 tonnes of coal, for agro based mills it is 1.0 to 1.2 tonnes of coal and for waste paper mills it is about 0.6 tonnes of coal.

Clearly waste paper based paper production not only addresses issues of dwindling forest resources but saves energy and contributes less to environmental pollution.

Looking at metal similarly, it is found that recycling one tonne of scrap metal conserves about 1.5 tonnes of ore and one tonne of coal, minimising the need for mining operations. Plastic recycling conserves petroleum products and in the process precious foreign exchange for the country.

THE PROCESSES OF RESOURCE RECOVERY FOR RECYCLING

Not only is the recycling trade extensive, but involves a wide range of people at several different levels, involved directly or indirectly, with recycling activites. In order to understand the many levels of operations in recycling, it is imperative to identify the various participants.

The collection of waste is carried out at several different levels: from homes and shops it is sold to itinerant waste collectors periodically; larger commercial establishments and industries sell their waste to contractors in bulk; and from what is discarded by households, commercial establishments and industries, as municipal waste, items are retrieved by a section of the population called waste pickers.

The material sold at the household level is in visibly reusable form, such as newspapers and magazines, whole glass bottles, tin boxes, items of rubber etc. Industrial/commercial waste would typically contain large amounts of paper, cloth, plastic or any other material depending on the nature of the industry/commercial establishment. Finally what finds its way into municipal waste is what is seemingly of no value. Those who live on the margins of society however, recognise the value of resource even in this, and retrieve it from various different sources: dustbins, communal waste collection points, streets and municipal disposal sites.

The next level of participants include petty traders, who are typically located in slums or other low income settlements, and who buy waste material from waste pickers and sell it further to wholesalers. These petty traders are usually found to be serviced only by waste pickers, as waste contractors and itinerant collectors sell their material to wholesalers or the recycling units directly. The wholesalers, who typically specialise in a specific item, have large godowns where extensive sorting of material is carried out. Since the petty trader buys material in a mixed form and has neither the manpower nor the space required to carry out any extensive sorting, different qualities or grades of each material are sorted by the wholesalers. The rate of returns from the recycling units are a function of the extent to which the material has been sorted, hence making such investments for the wholesaler worthwhile.

Clearly, the waste pickers constitute the lowest rung of the collection hierarchy and petty waste traders similarly, of the dealer hierarchy. The waste pickers, the most invisible participants in the entire set of recycling operations, are also the most powerless and inextricably linked with the petty traders. Dependent on daily income for survival and devoid of space for storing large quantities of collections, they have no option but to sell their collections to petty traders as the others would only buy in bulk. The traders in turn, constrained by space, are unable to maximise their own profits through sales to recycling units and are forced to deal with wholesalers.