

RESEARCH PAPER

Current practices and futuristic options in plastic waste management in Pakistan

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Highlights

- Waste Management (WM) is collecting, transportation to landfill, energy recovery, or recycling into useful products.
- Economic growth, changing consumption and production patterns, result in an increase in the generation of waste plastics in the world.
- Solutions include waste management, material reduction, design for recyclability, increase recycling capacity, waste reduction strategies, etc.

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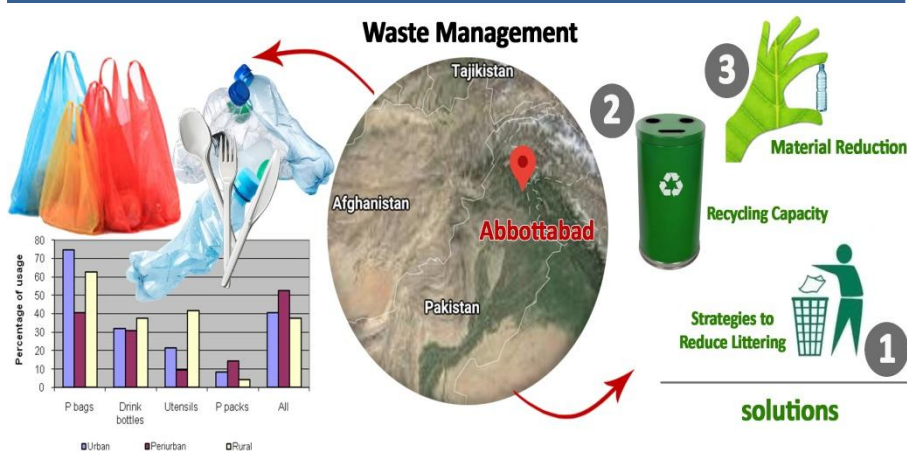
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Graphical Abstract



Abstract

This research determined the current understanding and concerns about plastic waste management and trends surrounding plastics use and looked into future priorities, challenges, and plastic waste management opportunities. The data were collected from observations made during visits to selected areas, structured interviews with relevant professionals, and a questionnaire filled by the stakeholders. Reliable national data on waste generation and composition that will inform effective planning on waste management in Abbottabad were absent. Data was collected about a waste generation on a regional basis, the physical composition of waste, sorting, and separation efficiency was done besides per capita of waste generation in selected households in each region. Plastic Waste (PW) quantification by weight was done on selected waste dump points in District Abbottabad. PW generation in peri-urban areas was 0.000102 t/person/day while in the urban area, it was 0.0704 t/year PW was generated. On the whole, the projected value of 59920.506t/year PW was produced by 1.5 million persons in Abbottabad annually. There is a need to redirect a large proportion of all solid waste (SW), especially PW, towards more environment-friendly recycling and recovery options. There are solutions, including material reduction, design for end-of-life recyclability, increased recycling capacity, strategies to reduce littering. Such measures will be the most effective through the public, industry, scientists, and policymakers' combined actions.

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1. Introduction

Waste Management (WM) is collecting, transportation to landfill, energy recovery, or recycling into useful products. The primary purposes of solid waste management (SWM) strategies are to address the health, environmental, aesthetic, land-use, resource, and economic concerns associated with the improper disposal of waste (Henry et al., 2006, Nemerow, 2009; Wilson, 2007). These issues are an ongoing concern for nations, municipalities, corporations, and individuals worldwide (Nemerow, 2009), and the global community (Wilson, 2007). Plastics are synthetic organic materials produced by polymerization and do not absorb water than paper and wood. Approximately 50% of plastics are used for single-use disposable applications, such as packaging, agricultural films, and disposable consumer items (PlasticsEurope 2008). Economic growth and changing consumption and production patterns result in a rapid increase in the generation of waste plastics in the world. The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes; thus, 20 times more plastic is produced today than 50 years ago.

This implies that on the one hand, more resources are being used to meet the increased demand for plastic, and on the other hand, more plastic waste is being generated (Feil et al., 2017). To regain plastic, there are two ways: first, to collect plastic before entering the Municipal Waste Stream (MWS), and second is collection after they enter MWS (Rebeiz and Craft, 1995). Their visibility and near indestructibility have been perceived as problems and made plastics a target in solid waste management (Sadeef et al., 2016). The plastic component of municipal solid waste is slightly more than 7% by weight and, according to recent figures from research firm Franklin Associates, Prairie Village, Kan., about 18% by volume. By the turn of the century, this is generally expected to increase roughly 10% by weight (Thayer, 1990).

Integrated solid waste management refers to the control of generation, storage, collection, processing, and ultimate disposal of solid waste that agrees with the best environmental stewardship principles. Therefore, the practices cover various aspects of public health, environmental science, education, engineering, economics, finance, and many more (He, 2012; Schneider et al., 2017).

The South Asian region, as a whole, is experiencing rapid urban growth. Increasing population, urbanization, industrialization, and changing consumption patterns result in increasing amounts of solid waste and diversification of the type of solid waste generated (Visvanathan and Glawe, 2006). Factors that affect waste generation in the country were size and type of community and their income level. Trends in recycling show that waste plastic from packaging streams such as PET bottles and PE containers is one of the primary sources driving the waste plastic recycling industry.

Plastic shopping bags were especially identified as the primary component, accounting for 45.72% of total plastic waste in Taiwan. Relevant factors such as household income and household size correlate to plastic waste generation in detailed composition (Sharuddin et al., 2016). The household habits and behaviors of plastic waste discharge and environmental impacts and resource consumption for plastic waste disposal alternatives were also evaluated (Mapar et al., 2017). Concerning a strong link between poverty and environmental issues, one of the Millennium Development Goals, MDG 7, seeks to integrate sustainable development principles into country policies and Programme and reverse the loss of environmental resources. Environmental Fiscal Reform (EFR) can play an essential role in helping countries raise revenues while creating incentives that generate environmental benefits and support poverty reduction efforts. This includes taxes on natural resource exploitation or pollution. EFR can directly address environmental problems that threaten the livelihoods and health of the poor. EFR can also free up economic resources or generate revenues to finance the poor's finance access to water, sanitation, and electricity services.

2. Materials and Methods

The study area was Abbottabad, which is a district in the Khyber Pakhtoon Khawa Province of Pakistan. The district covers an area of 1,969 km, surrounded by refreshing green hills of Sarban, which is one of the best-known hill resorts of Pakistan .

The three areas were selected in Abbottabad to know the difference between interventions, attitudes, and concerns regarding locality as the difference is basically in facility provision. Jinnah Abad represented the urban setup, the Salhad as a moderate setup in terms of necessary facilities provision, and Lodhraan was a very remote area presented shallow setup regarding the provision of necessary facilities.

2.1. Data collection

The following two kinds of approaches were used to get insight into the PW generation and the people's perceptions regarding PW management.

2.2. Qualitative data collection and quantitative data collection

Primary and secondary data were collected to capture the evolving process concerning laws, institutions, financial mechanisms, technologies, and stakeholder participation. To know PW's generation and management status, both primary and secondary surveys, was involved. The critical inputs are existing market products, existing recycling, and reuse processes. The study mainly focuses on more generated waste, which is according to observation and interviews, are plastic bags and pet bottles and packaging waste. The secondary data included a literature review of existing reports and studies—data sources for estimating the quantum of waste generated, including government statistics, from published articles on the internet. The secondary literature review proved to be an essential asset in the absence of access to information available with the Municipal Corporations. The random sampling technique from different district Abbottabad areas was used for questionnaire distribution (Drop and collect method). A total of 110 interview schedules were arranged for the frequent and detailed responses of people. In selected study areas, respondents were included both literate and illiterate, so the interview schedule method was considered a better way.

2.3. Quantitative data collection

Jinnah Abad is a well-planned area and is divided into streets, so from every street, two houses were selected, from every street 2 houses are enough to show the current practices. Regarding Salhad as houses are scattered, some near roads and shops, and some houses are located far from the commercial area. Salhad is divided into Upper Salhad and Lower Salhad. A sample size of 85 was taken as a total of 1432 houses are there. Lodhraan village as there are scattered houses and density per area was considered, so seven houses were selected. Direct waste analysis and material flow approach are the two standard methods to quantify the aggregated waste streams and analyze waste composition. The most commonly used method is a direct measurement to analyze the composition of waste, known as direct waste analysis (DWA); owing to the high cost involved, this approach is often used to measure samples rather than a large amount of waste from the whole population, i.e., measuring the throughput of significant waste management facilities.

The researcher uses DWA. Quantitative methods, Questionnaire, Direct waste analysis, Visual estimation, and Hand sorting. To get representative data, the timing of sample collection could be a vital factor. Waste disposal patterns, concerning types of materials, often vary according to the time of day or week. Therefore, based on the economic viability, the study should include plans either (1) to collect data that covers the *entire* period of disposal, or (2) to collect data that may be assembled later in a way that represents the entire period. The researcher used the latter approach in the sampling of the data in study areas. Both designated and informal collection points were identified in key residential and commercial areas for the baseline survey. Primary surveys were also carried out at landfill sites for a fair idea of the different types of waste being generated in each city and the composition of the waste (with particular reference to the contribution of plastics). It also allowed a comparison between the waste compositions at collection and disposal sites.

3. Results and Discussion

3.1. Types of plastic items used at the household level

People mostly prefer plastic items due to low strength, low cost, attractive, flexible, insulator of heat, waterproof, and economic affordability (Fig. 1). When usage pattern was assessed most frequently in use plastic

items are plastic shopping bags, in three areas in comparison to other daily in use plastic items which are disposable.

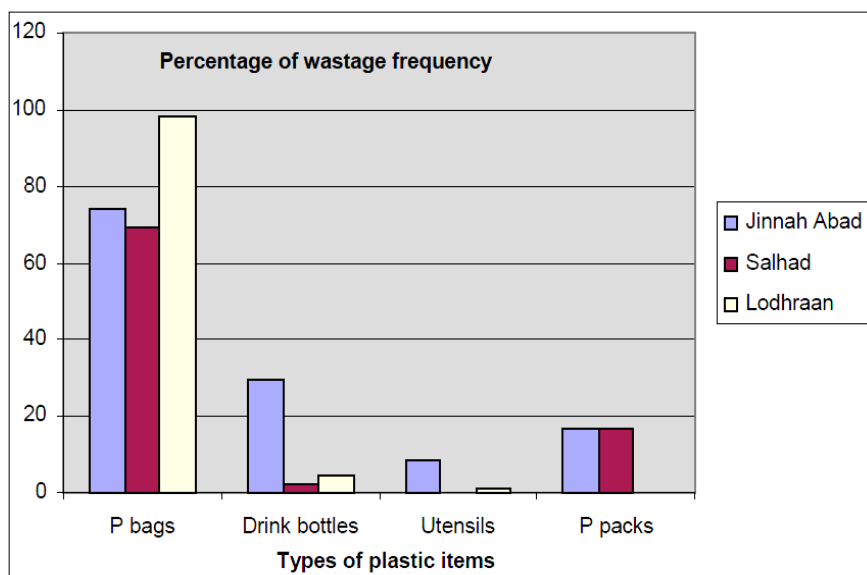


Fig. 1. Wastage frequency of plastic items in three areas.

This assessment was done to know frequently in use plastic items compared to other plastic items as options were given of those plastic items that are disposable, cheap, and more available. This is founded by observation and estimation because plastic bags being cheap and available and disposable, are disposed of without hesitation. Regarding drink bottles, due to their availability, they are more in use. Plastic as an integral part of our lives due to its low density, low cost, strength, are drivers for such growth. Plastic shopping bags were especially identified as the primary component, accounting for 45.72% of total plastic waste. Plastic items as more frequently become waste are again plastic bags (Fig. 1). Due to the increase in generation, waste plastics are becoming a primary stream in solid waste. After food waste and paper waste, plastic waste is the third major constitute of municipal and industrial waste in cities. Without proper collection, technology, and markets, cadre plastic recycling would not be successful economically and cost-effectively reprocessing waste and reusing recycled products (Rebeiz and Craft, 1995).

PW concentration was compared to two areas, and it was hypothesized that there is no significant difference in PW Concentration in two areas. The P-value showed a significant difference between PW concentration areas because $P=0.029 < 0.05$, as its P-value for the one-tailed test, was less than 0.05, so it is significant. Table 1 shows the statistical significance of various plastic items in two study sites (urban and peri-urban). The quantity of plastic waste was significantly different in both types of study sites (Turku et al., 2017).

Table 1. Statistical significance of various plastic items in different study sites.

Categories	Plastic waste Conc.		Plastic bags number		Plastic packs	
	Urban area	Periurban	Urban	Periurban	Urban	Periurban
Mean	2.352	3.28	21.1	42.07	0.346	0.108
Standard error	0.383	0.279	3.21	6.22	0.075	0.028
Confidence interval	0.172	0.568	6.45	12.64	0.151	0.058
P value (2-tailed)	0.059		0.007		0.0066	
P value(1-tailed)	0.029		0.0035		0.0033	
P value critical			=0.05/5%			

The reason behind was assessed by personnel and participant is that other plastic items which are more in use are being managed by own or by other informal (non-affiliated to organization/ Govt.) sectors like Kabarisi, Scavengers, and community. Plastic bags after one or two uses are disposed off, and drink bottles are used for

water storage or another purpose. If dumped, as usually is the practice in urban areas, Drink bottles are picked by rag pickers, or they sell these bottles to Scavengers who come their home to buy papers and plastic waste either free or 15-20 Rs per month. The response of people regarding the preference of plastic use was shown in Fig. 2. When the preference level was assessed, less preference comes from the village people, but they are using it. Analyzing the figure below shows more percentage of people less preferred plastic items, but they used them due to many reasons.

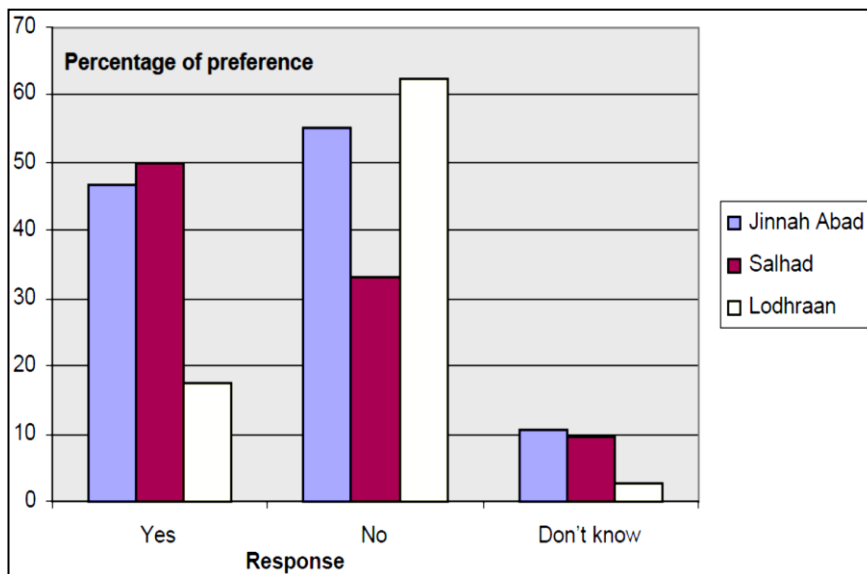


Fig. 2. Preference level for plastic items usage.

Trends in recycling show that waste plastic from packaging streams such as PET bottles and PE containers is one of the primary sources driving the waste plastic recycling industry.

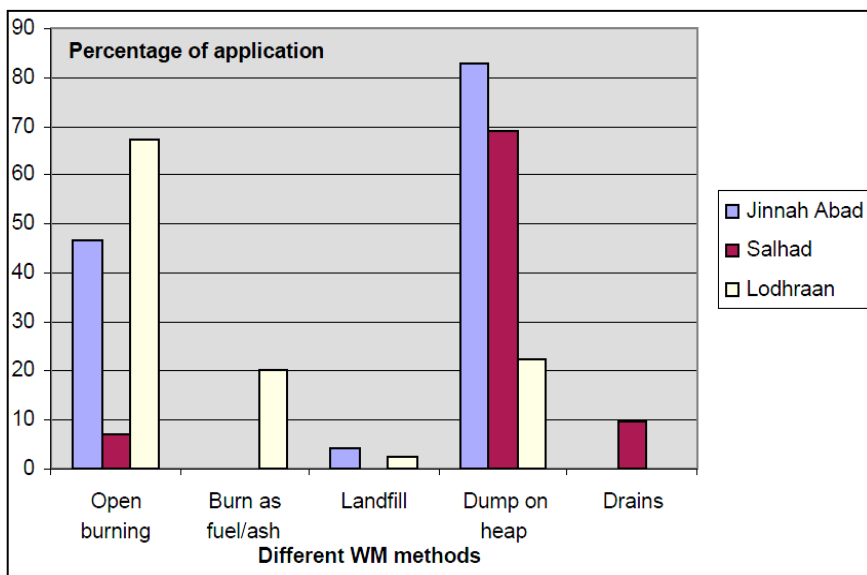


Fig. 3. Plastic waste management (WM) status.

Fig. 3 shows various options for the residents of the study area to dispose of plastic. The majority of Jinnah Abad people preferred recycling and source reduction, and fewer people preferred open burning, in Salhad and Lodhraan preferred open burning. People in urban and rural areas are willing to pay for waste management, as most people already pay and manage their waste privately (Fig. 4). In response, the majority of people want to manage all waste in a standard and proper way toward all people's health and environment, but in Salhad more

people want to pay to manage their waste that it must be getting away from their home, the other side they do not prefer. The informal sectors like Kabaris and scavengers contribute to waste management, but they must be involved in a properly planned way that they and the environmental sector must be benefited. Taxes and charges and legal enforcements must be implemented to waste management plans, and these scavengers can be involved in waste characterization, and quantification as waste quantification and characterization is a key to the proper waste management plan.

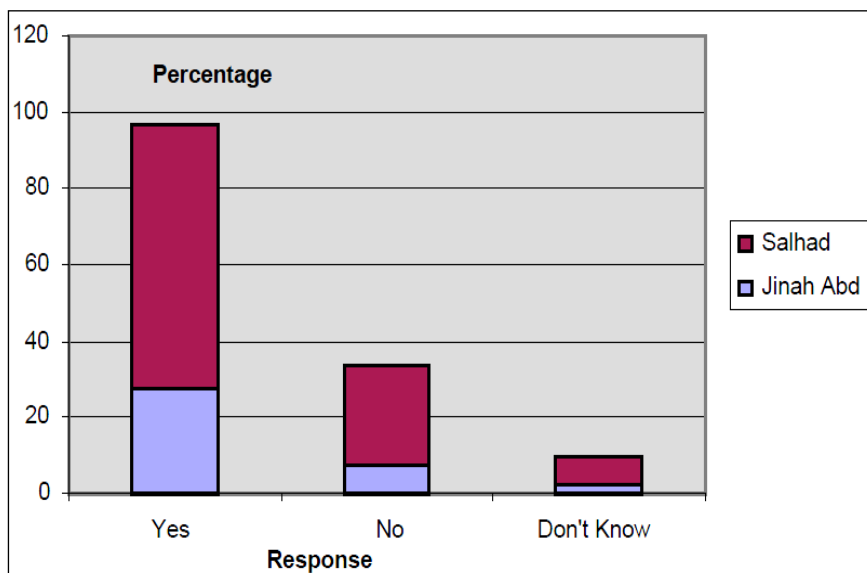


Fig. 4. Willingness to pay for waste management.

"Environmental fiscal reform" (EFR) refers to a range of taxation and pricing measures that can raise fiscal revenues while furthering environmental goals. EFR encompasses a wide range of taxation and pricing instruments, including taxes on the exploitation of natural resources, taxes and charges on water or air pollution, and the reform of water or energy subsidies. The suitability of individual instruments to specific countries will vary according to the country's level of development. In recognition of the strong linkages between poverty and environment issues, one of the Millennium Development Goals, MDG 7, seeks to integrate sustainable development principles into country policies and programs and reverse environmental resources loss (Van Schoubroeck et al., 2019). The poor's livelihoods and food security often depend directly on ecosystems and the diversity of goods and services they provide; Environmental Fiscal Reform (EFR) can play an essential role in helping countries raise revenues while creating incentives to generate environmental benefits and support poverty reduction efforts. EFR has the potential to free-up economic resources and generates revenues that can help finance poverty reduction measures, for example, infrastructure that improves access of the poor to water, sanitation, and energy services.

For cities in the developing world, the UNNDP, UNCHS, and World Bank represented a coordinated approach to strengthen their contribution towards economic growth, social development, and poverty alleviation (Thebe, 2017). Tax differentiation is used to promote the consumption of environmentally safe products. This instrument involves two surcharges added to other product charges: a positive charge levied on a polluting product and a negative charge on a cleaner alternative. It is used primarily in transport to discourage consumer purchases of polluting vehicles or fuels.

Waste management in selected areas has many problems. The high degree of uncollected waste is hazardous for the community. As landfill space is limited and incineration of the moist municipal waste is problematic, recovery presents a useful option for reducing the waste burden. The recovery sector in Pakistan, as revealed from the study and literature review, is rapidly changing. The informal sector is gradually taking over from the formal segment, which raises questions about maintaining the current formal system. In all cases, public awareness about recovery's economic and environmental merits plays an essential role in improving urban

solid waste management (Ukpong and Udofia, 2011). Separation at the source will increase the value of the waste and thereby reduce the pressure on landfills.

4. Conclusion

a) People are using plastic items because of availability and being cheap, but regarding plastic waste and solid waste management, there is a marked difference in study areas about education, facilities, and concern (Marshall and Farahbakhsh, 2013). Waste management is practiced more in rural areas, as is the case in Lohdraan. 99% of people managed their waste in one or the other way and satisfied on their own. 100% of people do not manage their waste even there is the provision of necessary facilities and waste management facilities. Regarding their concern for waste management, people in the village all 100% do not want to pay for waste management because they are managing independently even though there is no government intervention regarding waste management, even no necessary facilities.

b) In the present study, overall, the amount of P.W. generated was 0.1021kg/person/day 0.000102t/person/day in peri-urban areas, while in urban areas =70.4 kg/person/year - 0.0704t/year. Overall, total solid waste of 59920506 kg/year or 59920.506t/year is PW in Abbottabad. Quantification results showed that an estimated 59920.5 t PW is produced by 1.5 million persons in Abbottabad annually.

c) Urban literate people are willing to pay for PWM, but they demand waste collection from their dwellings only in response. Regarding the preference level for plastic items, there is a difference in three areas: 17.5%, 50%, and 55% % prefer to use plastic items in the village, periurban, and urban areas. The difference lies not in preference but as village people, despite less preference, use more plastic items more precisely because of affordability. Both formal and informal practices manage all solid waste. 60-70% of plastic bottles and containers that are more in use are recycled and managed by the informal sector and are not on dumpsites.

d) The PWM is currently facing a profound transformation, requiring a large proportion of this waste stream towards more environmentally friendly recycling and recovery options.

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