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ON THE THEME OF

"ENDING PLASTIC POLLUTION"

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PROFILE OF PRESIDENT
Engr. Ch. Muhammad Arif

Engr. Ch. Muhammad Arif, President Pakistan Engineering Congress is a distinguished civil engineer with an illustrious career spanning over five decades. After completing his early education at Govt. Central Model High School and Govt. College Lahore, he pursued a B.Sc in Civil Engineering from the University of Engineering and Technology (U.E.T.) Lahore. Throughout his career, he has excelled in planning and executing complex infrastructure projects, particularly in the construction of highways, major river bridges, and other prestigious developments both within Pakistan and abroad. His expertise in executive and management control has earned him a reputation for handling challenging projects with remarkable efficiency.

He retired as Chief Engineer from the Communication & Works Department, Punjab, after years of exemplary service. His extensive knowledge in contract law, administration, and arbitration has made him a respected figure in dispute resolution, acting as an arbitrator for major inland and international contracts of the National Highway Authority (NHA), Water and Power Development Authority (WAPDA), and the Communication & Works Department Punjab. His contributions to academia include serving as an external examiner for U.E.T. and as a visiting faculty member at the Punjab Engineering Academy, where he has imparted his expertise on contract administration and arbitration.

Beyond his professional endeavors, Ch. Muhammad Arif has actively participated in various engineering associations. He has held prestigious positions such as President of the Punjab Highways and Building Engineers Welfare Association, Member of the Board of Governors of the Govt. Engineering Academy Punjab, and Executive Council Member and Vice President of the Pakistan Engineering Congress. His contributions to the field have been widely recognized, receiving appreciation from the Chief Minister of Punjab, the Minister for Communication & Works Punjab, and the Secretary of the C&W Department for his meritorious services on several occasions.

Currently, he serves as the Chief Executive of a renowned consulting engineering firm, where he has been leading the design and supervision of major infrastructure projects, including highways, buildings, water supply, and sewerage schemes, for the past sixteen years. His expertise, leadership, and dedication continues to shape the engineering landscape in Pakistan.



Engr. Ch. Muhammad Arif
President,
Pakistan Engineering Congress
(78th Session)

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Welcome Adress
By
Engr. Ch. Muhammad Arif

President
Pakistan Engineering Congress

Welcome Address
Engr. Ch. Muhammad Arif,
President Pakistan Engineering Congress
at the eve of
World Environment Day, 2025
On the theme of
"Ending Plastic Pollution"

Honorable Chief Guest,
Distinguished Delegates,
Executive Council Members,
Fellow Engineers, Ladies & Gentlemen,

Assalam-o-Alaikum !

Ladies & Gentlemen!

Today, as we gather to mark World Environment Day 2025, we are united by a shared purpose—a commitment to protect and nurture our planet for future generations. This year, the theme that calls us to action is *Ending Plastic Pollution*. It is a theme that resonates deeply, for plastic pollution is a crisis that touches every corner of the Earth, every living creature, and every human being. It is time for us to face this challenge head-on, armed with determination, innovation, and compassion.

Let us first reflect on the magnitude of the problem. Plastic, once hailed as a miraculous invention for its versatility and convenience, has become an emblem of environmental destruction. Every year, over 400 million metric tons of plastic are produced, and a significant portion of it is single-use—destined to be discarded within minutes of its use, yet haunting our ecosystems for centuries to come. Our oceans are choking under the weight of nearly 12 million tons of plastic waste annually. Marine life is entangled in a web of microplastics and debris, and human health is at risk as plastics infiltrate our food chain.

Ladies & Gentlemen!

The staggering scale of plastic pollution may seem insurmountable, but despair is not an option. Today is a reminder of the power of collective action—of what we can achieve when we come together with a shared

vision. Ending plastic pollution is not merely an environmental imperative; it is a moral duty, a social responsibility, and an opportunity to transform our world for the better.

It begins with awareness. We must confront the reality of our choices and understand the true cost of convenience. Each item we discard—a plastic straw, a food wrapper, or a water bottle—has a story, and that story doesn't end in the trash bin. Instead, it continues in landfills, rivers, and oceans, creating a legacy of harm. By educating ourselves and others, we can ignite a spark of change that grows into a flame of transformation.

But awareness alone is not enough. We need action—bold, decisive, and sustained action at every level of society. Governments must enact and enforce policies that curtail the production and use of single-use plastics, while encouraging innovation in biodegradable alternatives. Businesses must take responsibility for their environmental footprint, adopting practices that prioritize sustainability over profit. Communities must come together to clean up plastic waste and demand change from the authorities and corporations. And as individuals, we must embrace the principles of reduction, reuse, and recycling, making conscious choices that reflect our commitment to the planet.

Ladies & Gentlemen!

Innovation will be a key ally in our fight against plastic pollution. The bright minds of today are designing solutions that inspire hope—from creating edible packaging and advanced recycling technologies to developing methods to extract microplastics from water bodies. We must support and invest in these innovations, fostering a culture where sustainability is the driving force behind progress.

As we look ahead, let us also honor the resilience and beauty of nature. Despite the scars of pollution, our planet continues to sustain us, offering breathtaking landscapes, vibrant biodiversity, and resources that fuel our lives. We owe it to Earth to be stewards of its care—to tread lightly and live mindfully.

Ladies & Gentlemen!

In the end, I urge each of you to reflect on your role in this journey. The challenge of ending plastic pollution is immense, but so too is our collective power to overcome it. Together, we can rewrite the story of

plastic—not as a tale of waste and destruction, but as a conquest of human ingenuity and responsibility.

Let this World Environment Day be a turning point—a moment where we pledge to act with courage and urgency. For the sake of our oceans, our wildlife, our health, and our future, let us rise to the challenge. Let us end plastic pollution and let us do so with unwavering resolve.

Thank you.

Pakistan Paindabad

Address
By
Engr. Riaz Nazir Tarar

Chief Guest
World Environment Day 2025

Address by the Chief Guest Engr. Riaz Nazir Tarar at the eve of World Environment Day, 2025 On the theme of "Ending Plastic Pollution"

Distinguished Delegates,
Executive Council Members,
Fellow Engineers, Ladies & Gentlemen,

Assalam-o-Alaikum !

Ladies & Gentlemen!

It is with great humility and an unwavering sense of purpose that I address you today as both a policymaker and your chief guest on this World Environment Day 2025. Today, we stand united under a singular and pressing theme: *Ending Plastic Pollution*. This theme is not just a call for change; it is a resounding demand for decisive and immediate action. The responsibility is ours to shoulder, the challenge ours to overcome, and the legacy ours to create.

Ladies & Gentlemen!

Let us reflect for a moment on the magnitude of the crisis we face. Plastic pollution has become one of the most formidable threats to our planet. It is an invisible intruder in our food, air, and water, and a glaring scar on our landscapes, rivers, and oceans. Over the past century, what began as a revolutionary invention has spiraled into an environmental catastrophe.

As mentioned by Mr. President in his address, Each year, we produce over 400 million metric tons of plastic, and a significant proportion of this finds its way into our environment. Marine ecosystems are choking with 12 million tons of plastic waste annually, and microplastics are now present in the bodies of fish we consume and even in the rain that falls from the sky.

These statistics are staggering, but behind them lies an even greater tragedy. Plastic pollution knows no boundaries. It affects every community, every country, and every ecosystem on Earth. It threatens marine life, suffocates wildlife, and undermines the health of humans across the globe. This is a challenge that cannot be ignored, a battle we cannot afford to lose.

Ladies & Gentlemen!

We stand at a crossroads. The decisions we make today will shape the future of our environment and define our legacy. Ending plastic pollution requires bold leadership, courageous action, and unwavering commitment. We cannot continue with business as usual. We must rethink, redesign, and reform.

Our first responsibility is to enact robust policies that address the root causes of plastic pollution. This means introducing and enforcing bans on single-use plastics, incentivizing the development and adoption of sustainable alternatives, and setting ambitious reduction targets across all sectors. It also means holding corporations accountable through extended producer responsibility, requiring them to manage the life cycle of the plastic they produce.

Second, we must invest in innovative solutions and infrastructure. Recycling systems in many parts of the world are inefficient and underdeveloped. We must modernize these systems, making them more accessible and effective. Moreover, we must support the research and development of groundbreaking alternatives to conventional plastics, such as biodegradable materials and advanced recycling technologies. These solutions have the potential to revolutionize the way we consume and manage resources.

Third, international collaboration is essential. Plastic pollution is a global crisis that transcends borders. To tackle it effectively, we need collective action and global cooperation. This includes establishing international agreements to reduce plastic waste, sharing knowledge and resources, and committing to a shared vision for a sustainable future.

Fourth, let us empower communities and individuals. Education and awareness are the cornerstones of change. By informing citizens about the impacts of plastic pollution and equipping them with practical

solutions, we can inspire a groundswell of action. From reducing personal plastic use to participating in cleanup campaigns, every small action contributes to the larger mission.

But let us also remember that this fight for our planet must be grounded in equity and justice. Vulnerable communities often bear the brunt of plastic pollution, from living near landfills to facing polluted waterways. Our policies must prioritize these communities, ensuring that environmental justice is at the heart of our efforts.

Ladies & Gentlemen!

As your chief guest today, I am moved by the passion and commitment I see in this room and beyond. There are countless stories of hope and resilience—students mobilizing plastic cleanup drives, entrepreneurs pioneering eco-friendly innovations, and activists pushing for stronger laws. Together, these efforts remind us that change is not only possible but inevitable when we work together.

Ladies & Gentlemen!

The theme of this year's World Environment Day—*Ending Plastic Pollution*—is both a challenge and an opportunity. It is an opportunity to reimagine our relationship with plastic and redefine what progress means in a sustainable world. It is an opportunity to leave behind a legacy of stewardship and responsibility for our children and grandchildren.

So let us take this moment, this gathering, this World Environment Day 2025, as a pivotal point. Let us reaffirm our commitment to ending plastic pollution—not tomorrow, not someday, but starting now. Let us lead with purpose, act with determination, and inspire with vision.

Together, we can and will create a future where our rivers run clean, our oceans thrive, and our Earth flourishes. Let us rise to the challenge, united in our mission and guided by hope.

Thank you.

Paper No.153

MANAGING PLASTIC WASTE

Ahsan Iqbal Bela
Frans Follings

MANAGING PLASTIC WASTE

By

Ahsan Iqbal Bela[1] and Frans Follings[2]

Abstract

Plastic has become a major commodity in our daily lives due to its unique properties and advantages, while plastic waste is one of the most problematic components of Municipal Solid Waste (MSW) for safe disposal. Plastic waste comes from various sources, mainly from food packaging, shopping bags, bottles and other packaging waste. Type and percentage of plastic waste in MSW vary from area to area depending on geographical location, community behavior, economic conditions, government policies and technological advancement. Plastic polymers are very stable, which makes it difficult to treat using conventional solid waste bio-treatment techniques i.e. biodigester and bioremediation. Therefore, plastic pollution has become a global problem. An estimated current annual production of plastic worldwide is just above 400 million tons. An estimated 33 billion pounds of plastic enter the ocean every year. Plastic pollution clogs landfills, leaches into water bodies, and releases toxic smoke when burned, making it one of the gravest environmental threats. A bespoke waste management plan is required for managing plastic waste in an environmentally acceptable way.

The Waste Management Hierarchy was developed in the Netherlands in 1979 and later adopted worldwide for effective waste management practices. A sequence of waste management hierarchy is:

reduce → reuse → recycle → recover → disposal

It is important to follow the waste management hierarchy and preference should be given to minimize the production/usage of plastic on reusing, recycling or disposal, respectively.

A typical range of plastic waste in the MSW of urban area of Punjab, Pakistan is 10% – 15%. In Pakistan, municipal solid waste management is mainly comprised of collection, transportation and dumping of waste in the outskirts of urban areas. However, the waste disposal practice is poor and deteriorates the environment of the area. Waste collection and

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[2] BSc MSc, Solid Waste Management Expert, 2Ensure Consultant; Member Supervisory Board Waste Management Company HVC and Expert Board Verpact (EPR of packaging waste in the Netherlands)

transportation activities have been improved to some extent under the recently launched “Suthra Punjab Program”. But there is a significant room for improvement in the waste management system of the province, particularly under 3Rs concepts of waste management hierarchy.

Introduction

The plastic industry is recognized as one of the fastest emerging industries. Plastic products are used in various industries, such as packaging, construction and manufacturing. Unique properties of plastic make it a common commodity in our daily lives. It is light, non-reactive, durable and is a poor conductor of heat and electricity. However, the distinctive nature of plastic makes it difficult to manage plastic waste in safe and environmentally acceptable ways. Primary sources of plastic waste include packaging waste, bags, bottles, straws, crisp packets etc. Globally, we produce about 400 million tons of plastic waste every year [1]. An estimated 33 billion pounds of plastic enter the ocean every year [2]. It’s choking our oceans, melting out of Arctic sea ice, sitting at the deepest point of the seafloor, and raining onto our national parks. Plastic is greatly contributing to the climate crisis and disproportionately polluting communities in low-income communities.

The Government of Pakistan recognizes difficulties/challenges of dealing with plastic waste and produces several policies, legislation and regulations for sustainable management of plastic waste including the *Plastic Management Strategy, Punjab 2023*; *Plastic Action Roadmap 2024; Single Use Plastic Prohibition Regulation 2023* and *Plastic Regulation 2023*.

The handling of plastic waste in Pakistan is not up to the mark and needs to be organized and modernized. Approximately 49.6 million tons of Municipal Solid Waste are being produced annually in Pakistan (including rural and urban areas) [3]. Out of this amount, about 3.3 million tons of waste is plastic waste [4]. Only 26% of the total amount of waste being produced in Pakistan, is collected by waste management companies operating in the major cities [5]. Out of the 26% of collected waste, only 4% of plastic waste is recycled [5]. About 74% of plastic waste is not collected at all, leading to severe environmental pollution. Mismanaged waste often contaminates water bodies and land. The informal sector of recycling of valuable components of waste, including PET bottles, plays an important role in processing this limited quantity of recycling.

Types of Plastic and Their Properties

There are more than seven main types of plastics i.e. Polyethylene Terephthalate (PET), High Density Polyethylene (HDPE), Low Density

Polyethylene (LDPE), Polyvinyl Chloride (PVC), Polypropylene (PP), Polystyrene (PS) and others (fabricated plastic using different additives). LDPE bags and PET bottles are the highest demand plastic products in the province of Punjab, Pakistan.

PET is mostly used for food and drink packaging purposes due to its strong ability to prevent oxygen from getting in and spoiling the product inside. PET bottles are the most widely recycled plastic in the world.

HDPE is an incredibly resistant resin used for grocery bags, milk jugs, recycling bins, (agricultural) pipes and also playground equipment. It is much stronger and thicker than PET. It is one of the easiest plastics to recycle.

PVC comes in two forms: rigid and flexible. In its rigid form, PVC is widely used in the building and construction industry to produce doors, windows and pipes. It can be made softer and more flexible by mixing with other substances and applied to plumbing, wiring and electrical cable insulation and flooring.

LDPE is characterized by low-density molecules, giving this a thinner and more flexible design. It is used in plastic bags, various containers, dispensing bottles and plastic cling films. It is not often recycled in low-income countries as it is easy and cheap to produce. However in several countries in Europe, including the Netherlands, LDPE is recycled.

PP is hard and sturdy, it can withstand higher temperatures and is found in Tupperware, car parts, thermal vests etc.

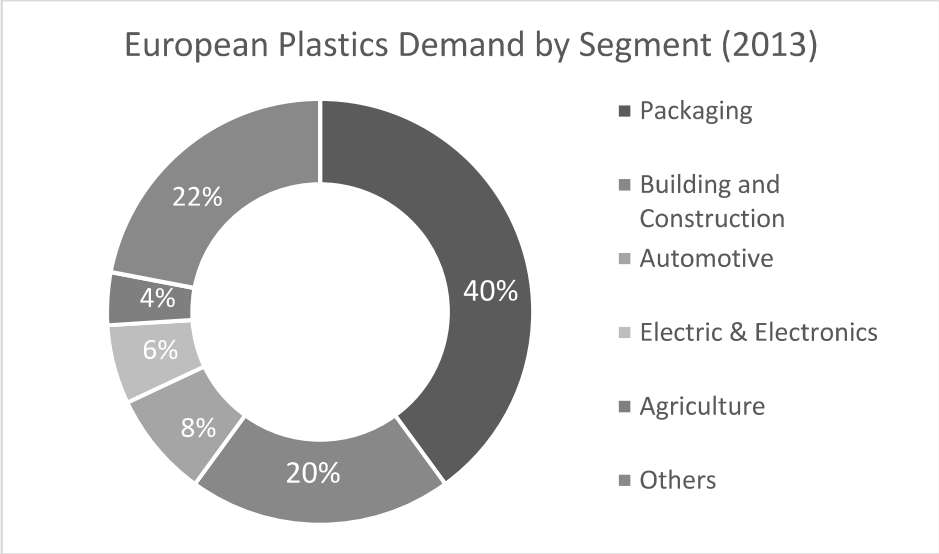
PS is a very inexpensive resin per unit weight and easy to create, for these reasons, it can be found everywhere from beverage cups, insulation, packing material to egg cartons and disposable dinnerware. PS foams blow in the wind and float on water. It is regarded as not biodegradable and hard to recycle. It is therefore losing market in packing waste.

Best known plastic from other groups of plastic is polycarbonates used to build strong, tough products e.g. lenses for sunglasses, sports and safety goggles.

Plastic Demand

In general, plastic demand is higher in developed countries than in developing countries. Developed countries, with their higher income and living patterns, require greater demand for plastic in different sectors including food packaging, consumer goods, construction etc. Most of the

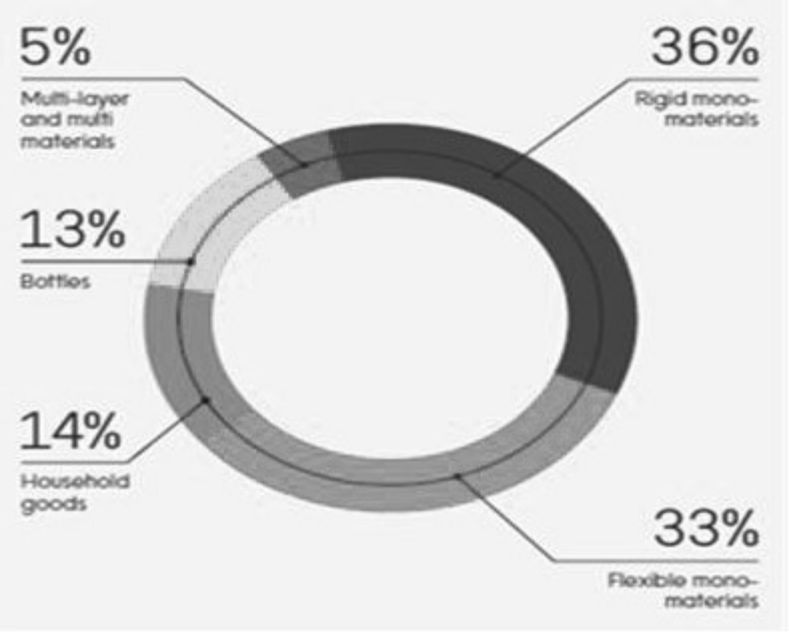
plastic waste produced in developed countries is recyclable or degradable and therefore it is possible to manage the waste more sustainably.



Source: Plastic Europe (PENG)/Consultic /RECEBO, EU-27 Norway and Switzerland

On the other hand, low-income countries are surging in plastic demand driven by urbanization and economic growth. The percentage of single-use plastic (flexible mono-material) in plastic waste is high in underdeveloped countries. The flexible light plastic is cheap to produce but difficult to recycle and therefore it is often disposed of at a landfill (waste dumping site) or burned in an incinerator or disposed of by uncontrolled burning. The multi-layer packaging waste is considered to be more difficult to recycle than mono-layer plastic waste due to the extra work required for separating different layers of materials. Multi-layer packaging waste often ends up at a waste dumping site or in an incinerator, which is a less sustainable solution than recycling waste.

The composition of plastic waste in Pakistan is presented in the charts below:



Source: Pakistan National Action Roadmap to Reduce Plastic Pollution

Characteristics of Plastic Waste

About 40% of total plastic products are made for single-use plastic [6], which results in extensive waste generation and also entails massive socioeconomic cost of collection and disposal. Generally, plastic waste decomposes very slowly in the natural environment, depending on the type of plastic and the environmental conditions of the area. Plastic waste decomposes through enzymatic processes and requires a long period, possibly centuries. The plastic litter chokes the urban sewerage infrastructure, increasing the risk of urban flooding and the operation and maintenance costs of the drainage manifold.

Plastic-rich waste has a relatively high calorific value, usually ranging from 5.5 to 11.5 MCal/kg [7] and making it a good candidate for energy recovery through processes like pyrolysis or gasification. It is estimated that one ton of plastic-rich municipal waste can produce energy equivalent to 0.5 ton of coal. However, a waste-to-energy (WtE) plant is an expensive investment and is therefore only found in high-income countries. Cleaning the exhaust air of a waste-to-energy plant and achieving stringent targets of the emissions requires significant investments and covers a major chunk of the cost of the plant. It is the dominant form of waste disposal in these countries because of the robustness of the technology. WtE plants must be able to

handle a very complex and constantly varying fuel (waste). They produce electricity and heat, partly covering the capital and operational costs of the plant. The weight of the waste is reduced by 75% and the volume of the waste by 95%.

The ratio of plastic waste in the MSW of high-income countries is comparable to that of Pakistan. Although People use more packed and ready-made food in developed countries and produce more waste. In the Netherlands, the percentage of plastic waste in MSW (without 15% of recyclable waste segregated at door step) of households varies between 6 and 12% depending on the category of municipality [8]. The total weight of the plastic waste is limited, but because of the low average density of plastic waste, the volume can easily go up to 30 to 40% of the total waste.

Characterization of MSW of Punjab, Pakistan

During the recent past, several waste characterization studies have been conducted by different organizations to assess components of municipal solid waste in the urban area of Punjab, Pakistan. Punjab Municipal Development Fund Company (PMDFC) conducted a "Waste Generation and Characterization Study" for Muridka City of Punjab during 2024 under the World Bank-funded Punjab City Program [9]. The study was designed and executed following the recommended international standard i.e. *ASTM Designation: D5231-92 (Reapproved 2016)*. A Forensic Waste Logging Laboratory was established inside the Muredka City for the study. The whole city was divided into three zones considering possible variations in waste characterization of the city. The three zones include Residential Zone of High-Income area (houses with gardens); Residential Zone of Low-Income area (small houses without front or back garden); and Commercial Zone. Door-to-door waste samples were collected and analyzed in the purpose-built laboratory by the trained staff of MC under the supervision of PMDFC. The major outcomes of the study related to plastic waste are as follows:

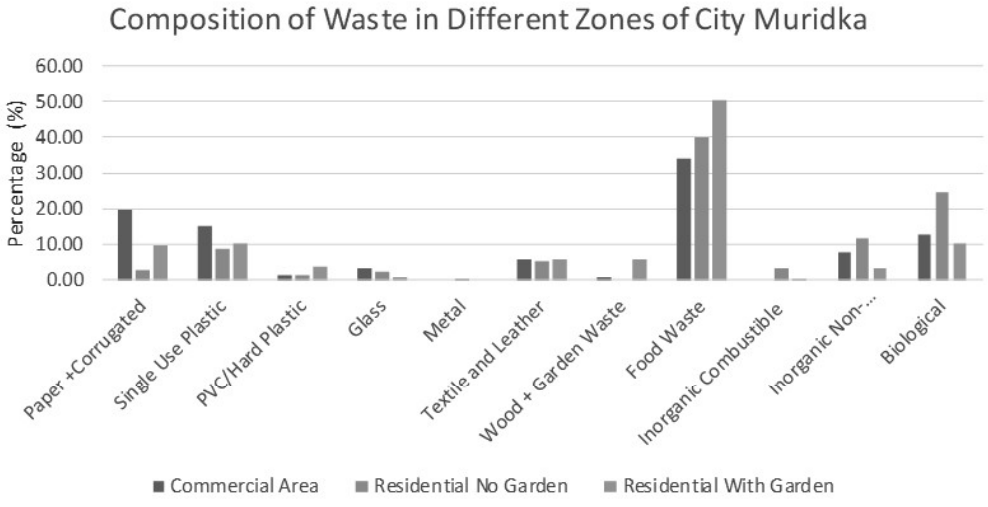
- The average waste production of residents of Muridka city is 0.388kg/day/capita
- The average percentage of all types of plastic in the MSW of the city is 13.33%

- Major plastic waste items include shopping bags, crisp packets, plastic bottles, disposable cutlery, empty oil pouches, pieces of hard plastic (broken toys, stationery), and pieces of plastic pipes.



Photographs collected during the execution of the study

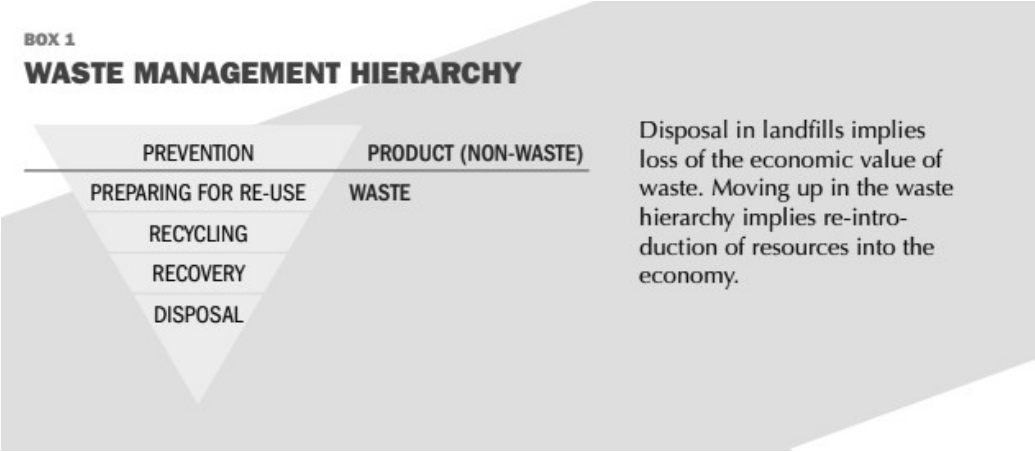
A graphical presentation of the waste characterization of each zone is presented below:



Waste Management Hierarchy

Historically, the focus of the waste management process was on the collection and disposal of waste to protect the health of city inhabitants and to improve the aesthetic appearance of territories. By the 20th century, waste was increasingly viewed as a resource to recover material and energy. Waste management gradually evolved from a focus on disposal to a focus on prevention, reusing, recycling and recovery.

The Parliament of the Netherlands passed the Resolution on Waste Management Hierarchy in 1979, which was later adopted by the world for sustainable Solid Waste Management Practices. Going forward EU intends to deepen its efforts and set up a target for recycling 65% of Municipal Solid Waste by 2030 [10].



Source: Municipal Solid Waste Management – A Roadmap for Reform for Policy Makers (World Bank Group)

Current Waste Management Practices in Pakistan and Their Impacts

In Pakistan, the collection of waste is sporadic and the disposal is poor. Recently launched program in the province of Punjab “Suthra Punjab Program” makes improvements in waste collection and transportation of waste away from the living area. However, hardly noticeable improvements are observed in waste disposal practices and mostly the collected waste is openly dumped in the outskirts of urban areas or along water bodies.

Plastic is the most problematic component of municipal solid waste, mainly because of its non-degradability/stable nature and low density. Considering the waste management hierarchy, the best solution for controlling plastic

waste is to minimize its production, followed by reusing, recycling, and recovery.

In Pakistan, plastic waste management is mainly divided into three headings i). Recycling; ii). Open Dumping; and iii). Burning plastic waste in the open environment. Recycling of plastic waste is considered to be a better option than the other two practices. However, not all types of plastic can be recycled and often single-use plastic ends up at a dumping site or is openly burned. Landfilling or dumping in open area of plastic waste is not considered to be a sustainable solution because of its slow degradation and staying there for a long time, possibly more than a century.

Burning of waste around landfills/waste dumping sites is universal, particularly in the developing world. Uncontrolled burning of plastic waste raises air pollution and causes respiratory diseases. Open burning of plastic releases various harmful substances and chemicals into the air, such as dioxins, furans, hazardous halogens, PCBs and mercury. Volatile Organic Compound (VOC) emission is considered higher in softer plastic polymers such as PS and PVC. Open burning of PVC contaminates the ambient air quality because of the chlorine content of PVC.

Animals also consume plastic waste from waste dumping, which could even cause of their death because of non-degradability of plastic and cause intestinal blockage.



Open Dumping of Waste along Water Body (River, Canal etc.)



Animal Grazing on Dumped Waste in the Outskirts of an Urban Area

The Government of Pakistan and Punjab Province have developed policies and strategies for dealing with plastic waste including the *Plastic Management Strategy Punjab 2023*, *Plastic Management Regulation 2023*,

and *National Action Roadmap to Reduce Plastic Pollution 2024*. The new legislations are designed to minimize the production of single-use plastic. However, compliance with these legislations is in process and has not been strictly followed by the community yet.

There is no formal waste recycling setup in Punjab. Over the past few years, a community of scavengers has developed in all major cities of Punjab and conducts segregation of recyclable waste from domestic waste. The main focus of the recycling industry is to recycle PET bottles. The scavengers' activities are unorganized and less efficient. Scavengers work in dismal working conditions without hygienic conditions, personal protective equipment and protection under labor laws. It is also observed that scavengers' activities often create a mess and generate more work for Waste Management Companies and Municipal Committees e.g. they empty waste collecting containers/bins on the ground and pick recyclable waste, in result of this, more work need to be conducted by the authorities to recollect waste from the ground. In addition, by collecting only the economically interesting waste they deprive municipalities of income from recyclables waste to cover part of the collection costs.



Scavengers Collecting Recyclable Waste in City Lahore

Plastic-rich waste usually has a high calorific value and can easily be burnt, especially when the moisture content is low. It is often observed, particularly during summer, in Punjab, the MSW is burned openly, including plastic waste, to reduce the volume of the dumped waste. This deteriorates the ambient air quality of the area and causes respiratory disease in the local community.



Plastic-rich Open Waste Dumping at town Luddon, District Vehari



Typical View of Open Waste Burning in Developing Countries

Plastic Waste Management in the Netherlands

In the Netherlands, the manufacturers and importers of plastics as well as the producers and distributors (retailers) of the packed products are made responsible by law for the plastic packaging waste. This is called: Extended Producer Responsibility (EPR). They have to finance the chain from collection, sorting, treatment to the selling of the recycled resource for 'new' plastics. This is not only the case for plastics in the Netherlands but also for other packaging waste like glass bottles and jars, carton boxes, metal cans etc. For this, they founded an organization (Verpact). They have to meet certain targets set by the government and in case of default, they have to pay a penalty. Most European countries have a certain form of EPR for packaging waste. So not the consumer is made responsible for the packaging waste, but the ones who produce and distribute the packaging. Several WtE plant are constructed and successfully operating under EPR mode. An aerial view of the Waste Power Plant located in the city of Alkmaar in the Netherlands is presented in figure below. The plant was constructed with a license of 675,000 tons of waste per year and an installed power of 70 Mwe.



Waste Management Facility Located in Alkmaar City, Netherlands

Recommendation for Improvement in Plastic Waste Management in Pakistan

In light of above research work following recommendations are made for the improvement in plastic waste management practices in Pakistan:

1. The government of Pakistan and the Punjab Province government have developed several legislations, policies and strategies focusing on reducing plastic waste pollution during last 10 years. However, the enforcement of new legislations and policies needs significant improvement and hardly noticeable differences appear on the ground. This is mainly because of the lack of institutional strengthening and capacity building of the enforcement/regulating bodies. Standard Operating Procedures should be developed to improve in enforcing new policies and strategies. Community involvement is important to achieve the desired results and enforcement bodies/authorities should run a coordinated public awareness campaign with all stakeholders.
2. As per the requirement of the universal Waste Management Hierarchy, emphasis should be given on reducing plastic waste production. This can be achieved through an integrated approach of all direct and indirect

stakeholders connected with the plastic industry. For example, one of the major plastic waste items that end up at waste dumping sites is single-use plastic bags/food packaging (plastic bags, chips packets etc.). There are countries where the use of plastic bags is no longer allowed. The users of chips packets should be encouraged to minimize their usage or purchase bigger portions of chips by giving them price incentives on buying one bigger packet instead of many small packets etc.

3. Convert the informal waste recycling industry to an organized and modern recycling approach. Several small and efficient material recovery facilities (MRFs) should be developed at suitable places near major cities. Consider producing Residual Derive Fuel (RDF) from plastic-rich MSW.
4. It is recommended to register scavengers and private waste collectors and make them a part of the formal waste management team. A communication channel should be developed between scavengers and waste management authorities (companies) for the improvement in waste recycling activities. Training and facilities should be delivered for their capacity building in order to improve their performance and efficiency.
5. Manufacturers and importers of plastics as well as the producers and distributors
   (retailers) of the packed products should be responsible by law for managing the plastic packing waste, similar to the concept of Extended Producer Responsibility (EPR) followed in Europe and other developed countries. They have to finance the chain from collection, sorting, treatment to the selling of the recycled resource for ‘new’ plastics etc.
6. The evolution of waste management systems in developing countries is sometimes frustrating and people are de-motivated due to delays in results and/or poor implementation e.g. minimizing use of single-use plastic, using three-bin system, doorstep segregation of waste etc. The Waste Consultation Body should be developed to maintain the pace in the development of the system and ensure continuous improvement,

raise awareness in the community and draft legislation that needs to be fully understood by the community.

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