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# Current Situation and Future Prospects for Plastic Waste in Maysan Governorate: Effects and Treatment during the COVID-19 Pandemic

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**Abstract**

Perils of plastic waste (PW) from polymers (ex: Polyethylene Terephthalate (PET), high-density polyethylene (HDPE), low-density polyethylene (LDPE), polyvinyl chloride (PVC), nylon, polystyrene (PS), etc.) , the mechanism of its spread in general and all of these types that are included in our daily life system as a product expelled continuously and/or frequently are 21st century crisis as reported from United Nations in 2019, and especially after the outbreak of the COVID-19 pandemic. PW is a very serious issue that has negative and harmful effects on the ecosystem, beside; health and the economy through direct proportionality with the rate of increase in the state population, moreover, weak environmental awareness and Energy International Administration (EIA) towards this dangerous issue. The aim of the current survey study is to shed light on the importance of plastics in our daily life needs for food packaging, single-use personal protective equipment's, laboratory tests, etc... PW problems by knowing the chemical composition, components, uses, and harms, as well as knowing the possibility of benefiting from these wastes within the solid waste management system (MSW / Municipal). By providing some suggestions that helps reduce the harm of this waste either recycling or disposal. This study will also include approximate theoretical equations to calculate the percentage of PW in particular at Maysan governorate, Iraq; because we haven't any physical mechanism at the operational level that deals with waste sorting, especially PW; as these statistics generally depend on the official information published by the competent authority about the total amount of waste presented at the governorate level.

**Keywords:** Plastic Waste (PW), COVID-19 pandemic, Recycling and Statistics.

## 1. Introduction

Plastic is an enormous burden to the environment due to its rebellious nature makes it resistant to biodegradation**.** Discarded plastic remains in the same condition for a longer duration pose a great threat to the environment, Plant life and wildlife as well as for humans. Elastomers are a group of organic polymers that include synthetic, semi-synthetic, or natural materials that can be folded and formed into rigid objects [1-2]. Polymers are large molecular weight synthetic materials made of long chains consisting of carbon and other elements such as hydrogen, chlorine, and nitrogen, each unit in the chain is called a (monomer), and it is a chemical substance that is produced from crude oil and gases. The demand for plastic has increased in the global market as an alternative to natural rubber, glass, wood and other raw materials and metals which may be attributed to their properties that plastics / polymers have, and as a result of these properties, these materials have many uses in many areas of our daily life needs and as raw materials for different industries. Commercial and economic applications of plastics are a very unique "mixture" in terms of low cost, low

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toxicity, and easy of processing, excellent thermal stability, balance of physical properties [3-7]. Ever since the first industrial-scale production of synthetic polymers (plastic), many of the current follow those outlined by Yarsley and Couzens took place in the 1940's. their account of the benefits [47]. The age of plastics has been known for the age of great optimism. It is a world completely free of both moths and rust, full of color. A world largely built of synthetic materials prepared from the widest spread materials [8-10]. Virgin plastic polymers are rarely used alone, and the polymer resins are often mixed with various cheap additives to improve the properties of the polymer and extend its half-life. Although useful for the functionality of polymer products, these cheapness additives may contaminate soil, air, water and food by leaching harmful elements [9, 11-12].

However, the emergence of the COVID-19 pandemic [41] has reinforced the complexities of managing plastic waste (PW) [13]. Alarming cases of infection have exerted personal protective equipment (PPE) (containing a substantial proportion of plastic) because it is the most trustable and inexpensive defense against the spread of infection and transmission of the virus [14-15]. The increased demand for single-use PPE by doctors and other health care workers and enforce the use of masks to the public (to contain the spread of disease) has transformed the dynamics of plastic waste generation. The knowledge of the healthy superiority of one-use plastics PPE over other alternatives has changed the consumer choice in favor of plastic packaging and single-use plastic bags [13,16]. Additionally, local closures and home quarantine instructions have increased depending on the online food delivery and other needs groceries which increase in plastic packaging waste generation [17-19]. Inspire of this new life style has explains the public value of plastic, it has also clearly highlighted our vulnerabilities to pollution. Maysan Governorate (located in southern Iraq) is considered one of the sites of great importance for its richness in natural resources. It is a middle-income city, where the quantities of waste and its production vary according to the population density in it as shown in the map in **Figure 1**.

**Figure 2** show how the mismanagement of PW and PPE kits has become a new a nuisance source to what is already there at Maysan governorate. Poor management of PW caused by the COVID-19 pandemic and poor awareness may cause the virus to spread widely, and the genetic mutation of the virus becomes more lethal to humans. Science, media and safety signs have the main task to beat this epidemic. Contrasted with the general perception of a plastic wastes, it is mismanagement and underutilization of resources that harm the environment [20]. However, due to its greater flexibility, high durability, water/gas resistance, affordability and native plasticity, it fuels scientific and technological innovations in every possible industrial sector [21-23]. Their benefit is clear in protecting human health and the safety of health workers on the front lines of the epidemic and the public, it clear that plastic products are one of the important components of most medical equipment and protective kits in use. Hence, mixed plastics products such as that of one-use masks/kits with one layers of plastics merged with other materials also pose a huge threat to our environment due to their low recyclability knowledge till date. Shortcomings and inconsistencies in the list PW management systems such as staff shortage, capacity limitations of processing facilities, and disturbances in mechanical recycling mechanism facilities because the epidemic, can lead to improper disposal of PW and polluted the environment [24-25]. Moreover, several are contagious PW such as all masks, gloves, and face protectors can also cause further damage of COVID-19 transmission without proper sterilization. As the world begins to move forward in the face of this century pandemic, we are may realize that our increasing needs dependence on plastic is at an expense our surround environment has created a new epidemic of plastic waste we were struggling to get live with. The polymeric structure of most plastic gives them such mechanical properties as height tensile strength and resistance to varied climatic change conditions as well with regard to biological activity, hence enhancing their half life time for use and storage. Conversely, these are the high profitable qualities of plastics for possible application purposes a most drawback is in their solid disposal. Various effective treatments are used to treat these recalcitrant PW from the last three decades taking into consideration all key factors. The current survey is an attempt to highlight on gaps, the current and future prospective situation in the sector of simple and/or complex polymer biodegradation.

So, to overlap with the current crisis this survey research paper provides a futuristic view on the disruption caused by COVID-19 in plastic waste management across Maysan governorate Iraq. The goal of this study is shining a light on the harmful effects of COVID-19 on the coming generation of plastic waste. In addition to that, the challenges the pandemic has created on the existing waste management systems and the potential technology strategies for a post-pandemic World.

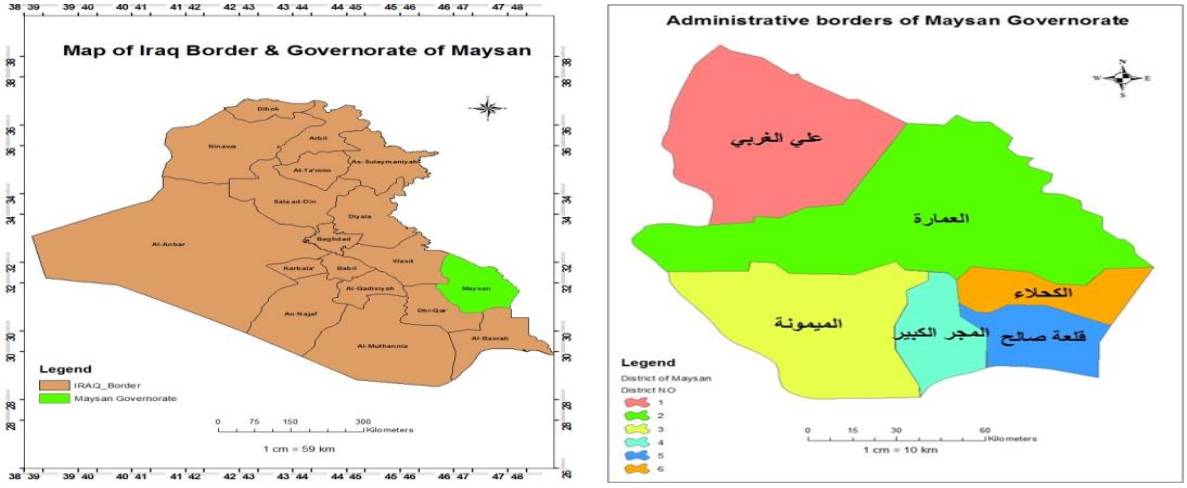


**Figure 1: Maps of Maysan governorate.**

**Figure 2: PWs and PPE kits spread at Maysan governorate.**

## 2. Classification of plastics / polymers

Classification of plastics / polymers aims to define and arrange those families that summarize the physical similarity between he grades of polymers are relevant to the engineering designer by judgment Chemical similarity. Our intention in creating this initial rating is structure design to represent engineering plastics who can extension and mutation while simultaneously leading to usefulness and practical combinations for database members, plastics categorize themselves, from the point of view of a researcher looking for material information [26-27]. However, investigation of the properties and principles of plastics behind the establishment of a classification of plastics reveals a conflict between these two conditions: basic field principles based on chemical similarity do not reflect engineering influences and thus fail to assemble like with like from an engineering point of view. So, formal High-level abstraction is required as the basis for any formal representation intended to convey global. These classifications will enable us to make the specie more specific and useful because it facilitates discussion of the characteristics, **Figure 3** scheme explains the classification of plastics / polymers while **Figure 4** gives brief examples of plastics / polymers.

## 3. Repercussions of COVID-19 on PW accumulations

It is very important to admit that we are living in a new-normal and unfamiliar life style. The reality after the outbreak of the COVID-19 epidemic with the temporary restaurant, malls and stadiums closures during lockdowns and government rule "stay-at-home" directives have changed our life process. Our living habits and daily consumption, which creates uncertainty in waste generation patterns [16, 28-29]. So, we installed on cleanliness faced with fear of contagion, our behaviors changed appropriately patterns such as the use of PPE, and the widespread demand for plastic packaging food and groceries, and the use of disposable utensils, for both comfort and reassurance. The temporary relaxation of banning single-use plastic bags in several regions in Iraq such as Baghdad, Mosul and Maysan is likely to have long-term consequences for consumer daily behavior. Backtracking on such policies that strongly restrict single-use plastics bags and PPE kits can increase PW generation, reinduce use and throwing culture away in all consumers, causing a transformation in their sustainable way of life. Although there is no conclusive evidence to reduce the risk of virus transmission from these single-use bags, such as the attitude taken by governments may incorporate people's deeply belief in plastic hygienic. The ability of the coronavirus to survive on plastic surfaces up to three days compared to paper (3 hours), cardboard (1 day) and fabric (2 days) also contradicts this concept [30-34]. Moreover, the paranoia caused by the coronavirus has resulted in irrationality stocking up on groceries and other household necessities, causing unwanted things to happen. The demand for packaged products with long life in many Arab countries. In particular, proactive mental and reactive health management are the two of the major consumer behavior thresholds linked to the great panic shopping pandemic. Despite the constant challenges**,** in the shadow of the epidemic, it has become online purchases and ecommerce defect reactionary solutions [35]. Despite the high operating costs, hiring new employees and additional extra costs on PPE safety measures, Amazon ecommerce services reported a 21% increase in the year sales in the final quarter of 2020 [36]. An increase in online food purchases and daily necessities has been reported by 84.3% and 46.2%, respectively, in Iraq, relative to the past due to the COVID-19 pandemic which leads to accretion of plastic waste, has thin films, foam and multilayer plastic with low recyclability and durability. In addition, the increased production of biomedical waste from studies and lab tests that also contain a lot of plastic contributes to the problem. Deficiencies in the current waste management system to handle this momentum flows of PW could be produced its utter mismanagement, according to a world health organization (WHO) report, "If only 1% of the masks were improperly disposed of/and littered in nature, that is It could contaminate up to 10 million masks a month Environment" [26,37]. Moreover, the use of medication by patients increased, self-medicating with over-the-counter (non-prescription drugs), the increasing demand for popular immune suppressive drugs can all increased generation of pharmaceutical packaging waste like packaging, bottles, etc. from hospitals and families. Medical waste should be collected, treated and disposed of as per biomedical waste management instructions, and it must not be a part of the municipal solid waste recycling process as the opportunities of the virus transmission to the people of concern will be very high [38]. The loss of our faith in all products without good packaging might risk the return back of the throw-away behavior and effect the resurgence of usage of single-use plastics. Hence, high portion from the PW generated through increased usage of PPE kits, the increment in need for plastic packaged products plus pharmaceuticals, online/call delivery services of fast food**,** and groceries

may be considered as huge sources of PW during the COVID-19 pandemic. **Figure 5** shows the drawbacks of pandemic on PW accumulation / management in brief.


**Figure 3: Classification scheme of plastics / polymers**

| | |
|---|---|
| **Natural Polymers** | • Organic source as: cellulose, starch, gum Arabic or acacia gum, cotton, natural rubber, silk, proteins, wool, hair, skin and others.<br>• Inorganic sources as: asbestos, graphite, glass. |
| **Synthetic Polymers** | • Organic source as: polyester, polyamide, polyethylene, polyacrylic, polycarbonate, polypropylene, etc.<br>• Inorganic sources as: polysilicon polymers. |
| **Modified Natural Polymers** | • They are recycled polymers from natural polymers and include some natural polymers that undergo some modifications, either by changing their chemical composition, such as introducing new groups into the polymer, or changing the composition of some active polymers, or by grafting a natural polymer on the contrary. Such as: cellulose acetate, nitrocellulose, precipitated cellulose (viscose) cellophane, synthetic wool, acrylic fiber etc..... |
| **Thermoplastic** | • It is a solid polymeric material (Hard) at normal temperatures, but it softens by heat and turns into something like a paste, and melts with increasing temperatures, this type of plastic is called (Thermoplastic polymers). Examples of this type are: commercial polymers that fall into this category: polyethylene, polystyrene, polycarbonates, polyvinyl chloride, polypropylene, etc.. |
| **Elastomers** | • they are hard, rubber-like polymers that have elastic properties. These properties are acquired through weak intermolecular forces, which help in holding the polymer chains together. These weak bonding forces allow the polymer to expand, by inserting a small number of (bonds). Interlocking) between the chains, which helps the polymer to retract to its original position after the influence of the forces on it has disappeared |
| **Thermosetting** | • These are polymers that are not heat-melted, but that heating aids them in stabilizing their final shape. It is used in many electrical industries because it is used as an insulating material for heat and electricity. This is due to the chemical changes that result when heated, as the polymeric chains are intertwined, becoming incapable of melting and poor conductivity of heat and electricity. For example: phenol-formaldehyde resins, urea-formaldehyde resins, epoxy, some cross-linked polyesters, etc. |
| **Fibers** | • The filaments that form solid materials have high strength and tensile modulus; These properties can be attributed to strong molecular forces such as hydrogen bonding; As these forces cause the chains to close tightly and thus convey the crystalline nature used in the textile industries. Example: polyamides (nylon 66), polyester (terylene), etc. |

**Figure 4: Brief examples of plastics / polymers.**


**Figure 5: Drawbacks of pandemic on PW accumulation / management.**

## 4. Root cause analysis (RCA) on PW accumulations

Despite the recognition of the problem of plastic waste and even if it run over, the absolute existence, and abundance of plastic, takes decades to self-decompose, like many other solid wastes, which pose great human and environmental damage to ecosystems, and despite this, the use of plastic is increasing dramatically [35]. RCA of PW accumulations effects on the environment and humans is summarized at **Figure 6** [36,38], quantitative "Fish-Bone" analysis, these wastes cause many problems such as distortion of the urban landscape, soil pollution, depletion of its wealth, pollution and destruction of the aquatic environment, and the spread of disease transmission factors resulting from water pollution, in addition to that these wastes are flood aid factors because they reduce the penetration of water into the soil.


**Figure 6: RCA on PW accumulation.**

## 5. Challenges for the current waste management systems in Maysan

Maysan governorate (located in southern Iraq) is one of the sites of great importance because it is rich in natural resources and is one of the middle-income cities, where the quantities and production of waste are different according to the population density in its administrative units, which consists of six districts are: (Ali Al-Gharbi district, Al-Amara district (city center), Al-Maimounaa district, Al-Mejar Al-Kabir district, Qal'at Salah district, and Al-Kahlaa district). There are nine townships: (Ali Al-Sharqi, Kumit, Al-Mashrah, Sayed Ahmad Al-Rifaei, Al-Kahlaa, Al-Salam, Al-Adl, Al-Khaier and Al-azier). In general, the population ranges between 102116 to 117110 thousand people [39-40]. In recent years, the rate of consumption of various products has increased due to COVID-19 pandemic**,** changing patterns and necessities of life, this increase has led to the generation of large quantities of solid waste especially PW, as explained in **Table 1**, which has formed a heavy burden on the environment, where the fate of most of these wastes is in landfills without processing waste recycling with modern technology far from polluting the environment from the emitted gases [41].

It is evident from the previous data for the 2020 government survey of the approximate components of waste in Maysan governorate. Organic waste makes up the highest percentage of total soil waste at 58%, while other wastes are commercial, industrial and building demolition waste at 11%. The proportions for PW, glass, metal and paper waste are 14%, 4%, 10% and 3%) respectively. Therefore, the consumption of plastic products increases the volume of waste, as this waste poses a great danger in addition to; the issue of solid waste in the city. It's hard to get rid of, and needs a very long period of hundreds of years to completely decompose, for example: The plastic containers we use daily to save food and water bottles take 800 years to biodegrade. A large proportion of this waste ends up in landfills and causes a big problem as it leads to the reproduction of insects and rodents, as it causes the emission of some environmentally harmful gases such as $CO_2$ and flammable gases such as methane, in addition to the production of toxic leachate that pollutes groundwater and soil.

In the advanced case of the issue of plastic waste generated in the governorate through scheduling and calculating the amount of waste raised as the main problem arises through the lack of a suitable mechanism for special sorting of these wastes and determining their exact quantities in order to provide a special place equipped with vehicles, equipment and workers for this purpose before transporting the waste to the landfill. As all waste is mixed with all kinds of waste, including plastic, glass, metals, paper, wood and other materials, this makes the process of separating them impossible during the operations of the waste management system. Consequently, with regard to the issue of estimating the quantity and types of plastic waste in the governorate, we will try to conduct an approach based on the principle of the percentage and proportionality-process between what was previously mentioned in terms of an approximate percentage, its clarified in **Figure 7**, as an indication of the expected percentage regarding the amount of plastic waste which is it was up to 14% of the total amount of waste generated during a period of one year/tons, and depending on the principle of the mathematical process percentage and proportionality. Cities with high consumption of PW are represented in the blue column, while low consumption are represented in the green columns.

**Table 1**

The amount of waste tons/year for each city and town.

| City and Town Name | Population | | The amount of waste tons/year |
|---|---|---|---|
| | Villagers | Urbanites | |
| **Al-Amara** | 40667 | 573403 | 68800 |
| **Al-Mejar Al-Kabir** | 22663 | 102116 | 44727 |
| **Qal'at Salah** | 27786 | 41472 | 18145 |
| **Al-Kahlaa** | 19372 | 24340 | 10670 |
| **Al-Maimounaa** | 37786 | 21625 | 9500 |
| **Ali Al-Gharbi** | 16803 | 19105 | 8400 |
| **Ali Al-Sharqi** | 11049 | 12820 | 5615 |
| **Kumit** | 30626 | 11853 | 5200 |

| | | | |
|---|---|---|---|
| **Al-Adl** | 5584 | 18428 | 8075 |
| **Al-azier** | 32722 | 19899 | 8800 |
| **Al-Mashrah** | 20923 | 14055 | 6250 |
| **Al-Salam** | 21445 | 21054 | 9222 |
| **Al-Khaier** | 46217 | 9742 | 4400 |
| **Bani hashim** | 20624 | 1839 | 1100 |
| **Sayed Ahmad Al-Rifaei** | 14664 | 1710 | 7550 |

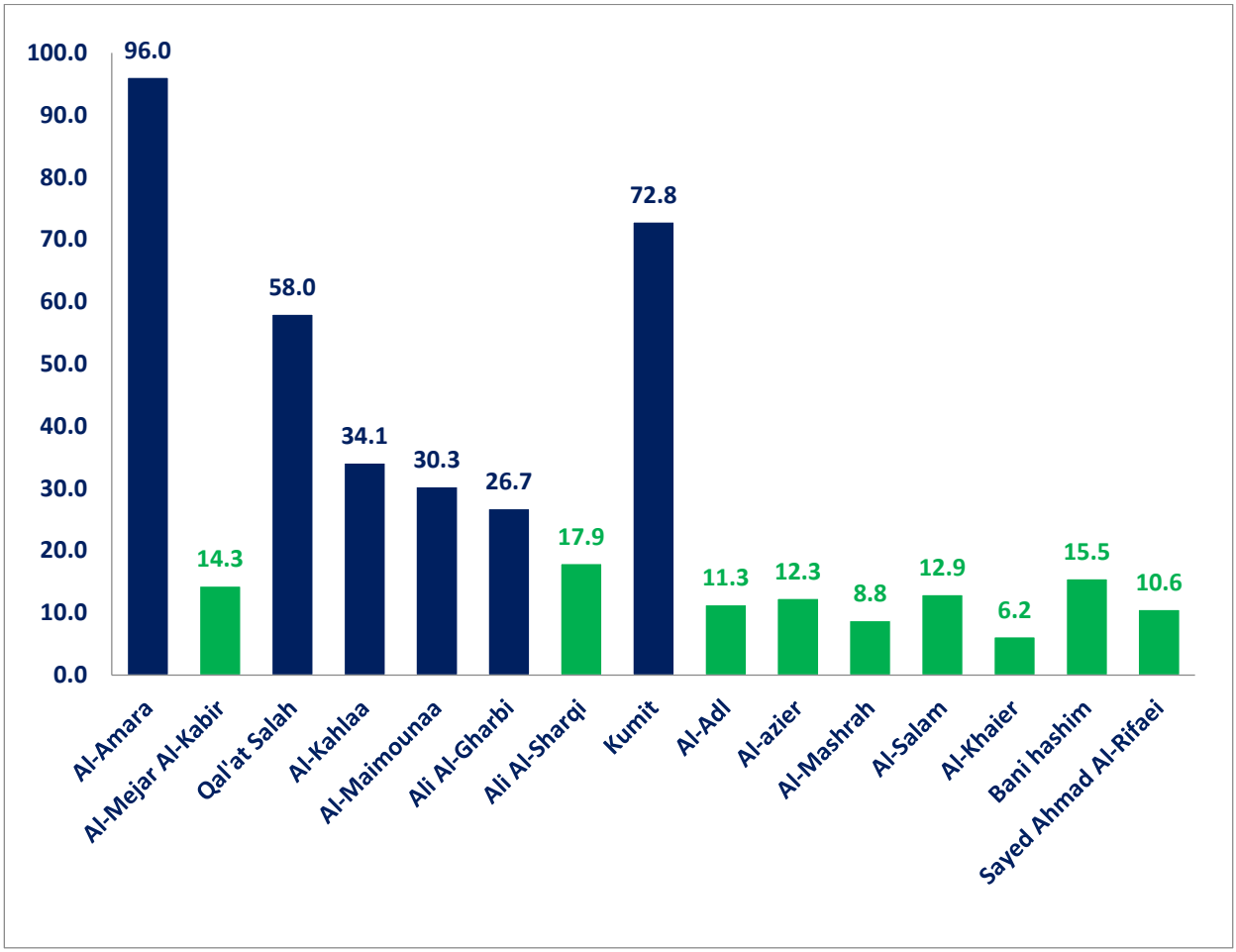


**Figure 7: Expected percentage of PW% for each city and town.**

## 6. Treatment systems

### *6.1. Current waste treatment systems*

Most Popular PW treatment techniques used mechanical recycling, incineration, and landfill operations take place all over the world. In comparison, the residual plastic waste either burned (25%), sanitary/unsanitary landfills (40%), or seeps into the environment due to poor management (19%) [42-43]. However, these technologies are far from perfect/suitable in containing the entire plastic problem remains. Not to mention the increased waste production during COVID- 19 pandemic, the problems became much worse. **Figure 8** explains the current waste treatment systems techniques.

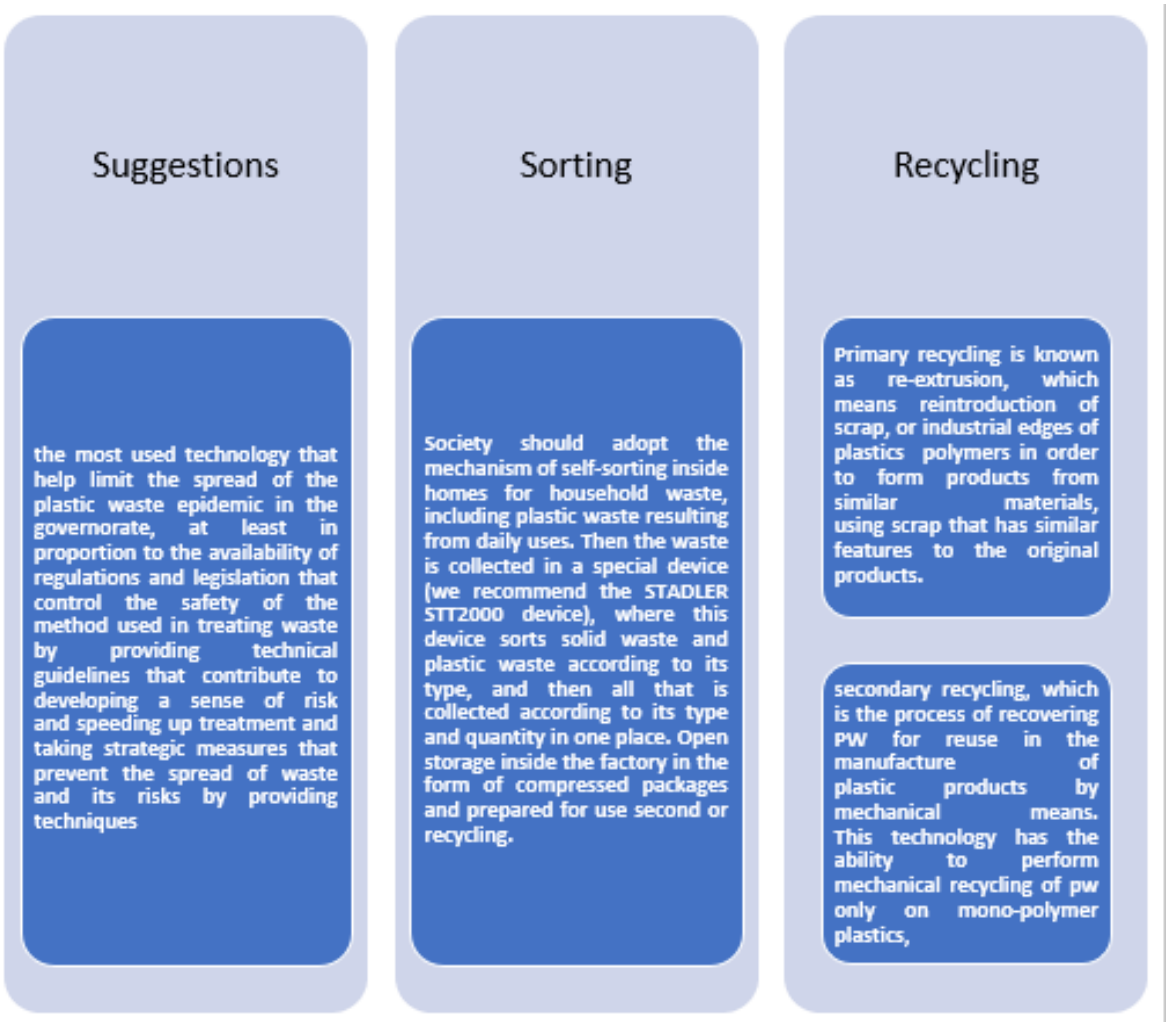


**Figure 8: Current waste treatment systems.**

*6.2. Alternative sources*

Alternative sources for conventional plastics made from raw materials based on fossil fuels are bioplastics, which are bioplastics, and biodegradable plastics, made wholly or partly from renewable materials derived from biomass [44-45]. Raw materials commonly used to produce these renewable feedstocks for the production of plastics include corn stalks, sugar cane stalks and cellulose, as well as increasingly diverse oils and fats from renewable sources Biodegradable plastics are plastics with innovative molecular structures that can be decomposed by bacteria at the end of their life under certain environmental conditions. If a plastic is biodegradable, this means that it can undergo decomposition under certain environmental conditions and upon contact with certain bacteria or microbes turning it into water or biomass and carbon dioxide or methane, depending on the aerobic or anaerobic conditions. Biodegradation is not indicative of bio-content; instead, it is related to the molecular structure of the plastic, although most biodegradable plastics are biomaterials, some biodegradable plastics are made from fossil oil-based raw materials. Not all bioplastics are biodegradable, while some plastics made from fossil fuels are biodegradable [46].

## 7. Recommendations

The reform of the plastic waste management sector we need to create personal behavioral and social institutional changes are necessary. Building adequate governmental framework along with policy-level guidance, it will help facilitate the desired change. What is required is a comprehensive and sustainable management of plastic waste that can be achieved when institutional and social behavioral changes occur

gradually at the same time. Recommendations based on the detailed study are given below for decision makers must make the necessary changes to combat the inevitable rise in usage and disposal of single-use plastics, and the post- current pandemic.

1. Designing policies that address psychological and behavioral obstacles, including distrust of the hygiene of reused and recycled products and create awareness among the public against visualize single-use plastic as protection, not a problem.
2. Specific colored bags may be provided by your local authority PPE kits (mask & gloves) should be disposed of in sealed bags, which makes it easy to separate and treat with it biomedical waste. Specific colored boxes must be provided in the community places to improve the collection of such waste.
3. Encouraging investment in the development of circular products designed for both hygiene and recycling, this can spark innovations in the current design of products that make them suitable for multiple uses after washing or disinfection.
4. Mine set for locals about life cycle sustainability assessment (LCSA), refers to the evaluation of all environmental, social and economic negative impacts and benefits in decision-making processes towards more sustainable products throughout their life cycle.
5. As a long-term strategy to combat plastic pollution and create socially and citizens concerned with the environment, the development of curriculum as part of environmental science education focusing on plastic pollution and its environmental consequences It's a necessity.
6. Establishment of modern treatment units that adopt modern technologies and in places far from residential and agricultural gatherings.

## 8. Conclusions

The increased trust in plastic during the current pandemic by 14% over the previous may permit or likely to change daily life habits towards a stable economy. PW management systems and infrastructure are prohibited by the government and/or decision-makers to deal with that waste generation, which will raise the needs for new treatment technologies and innovations to inspire economic and environment efficiency in addition, integration of creative sustainable waste management technologies into the currently implemented systems might envisage a new future in which all plastics are either reused again or possible recycled. Our major strategies and action as scientists might reflect our readiness for current and/or future crises so that we might not have to choose one certain crisis over another. Sustainability and innovations are the vision of all policies and regulations in order to safe environment. Further practical studies on PW management should be take place as corona virus still have transformation till date.

## 9. Conflicts of interest

"There are no conflicts to declare".

## 10. Formatting of funding sources

Maysan Environmental Directorate.

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