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LIMITATIONS IN PLASTIC RECYCLING, A REVIEW

ABSTRACT

Recycling of plastic wastes has improved significantly lately, although there are still lots of challenges. A literature survey has been carried out to investigate the limitation in the plastic recycling sector. It was found that limiting factors were the ineffective collection of recyclables, poorly trained employees, diversity of multi-layered packaging, variety of additives, other contaminations and degradation.

LITERATURE REVIEW

Plastics are crucial for our lives in the 21st century. The word “plastic” is derived from the Greek word "plastikos", meaning fit for moulding. This refers to the material’s elasticity during manufacture, which allows it to be pressed into a variety of shapes - such as films, fibres, plates, tubes, bottles, boxes, and much more (Ahlhaus, 1997).

Nowadays, we use the term “plastic” for a spacious range of different materials such as PETE, HDPE, PVC, LDPE, PP, PS, and others. They are used in vast fields of our lives, for instance packaging of goods, clothes, construction, insulation, toys, electronic devices, medical equipment, automotive, machinery, agriculture, etc. Plastics used in packaging tend to have shorter lifetime than other sectors such as electronics, construction, and automotive.

In 2018, the production of plastics reached 360 million tonnes globally and 62 million tonnes only in Europe. 29.1 million tonnes of plastic waste out of 62 million tonnes of produced plastics were collected in the EU in order to be treated (PlasticsEurope, 2019). Top plastics demand by resin types were PE and PP, which is used mostly in the production of food packaging, sweet and snack wrappers, hinged caps, microwave containers, pipes, automotive parts, bank notes, reusable bags, trays and containers, agricultural film, food packaging film, etc. Plastic packaging provides prevention of the goods from contamination and extends its shelf life. In addition to these, transportability and storage capability are also primary functions of packaging. Since the demand is growing, the complexity of packaging is increasing as well (PlasticsEurope, 2012). In order to reduce plastic waste generation, source reduction, reuse, and landfilling have been utilized. However, increasing usage of plastics and its waste existence in the environment have led to continuous discussions of better management of plastic wastes. These plastic wastes are accumulated directly or indirectly to the environment. Therefore, finding more effective ways to increase the recycling proportion is necessary. Recycling plastic wastes will prevent contamination of the environment (Awoyera, Adesina, 2020).

It can be seen in Fig. 1 that since 2006, the amount of plastic waste sent to recycling has doubled and energy recovery has increased by 77% in EU. However, 25% of plastic post-consumer waste was still sent to landfilling in 2018 (PlasticsEurope, 2019). It can be observed from Fig. 2 that Hungary landfills most of its plastic post-consumer wastes.

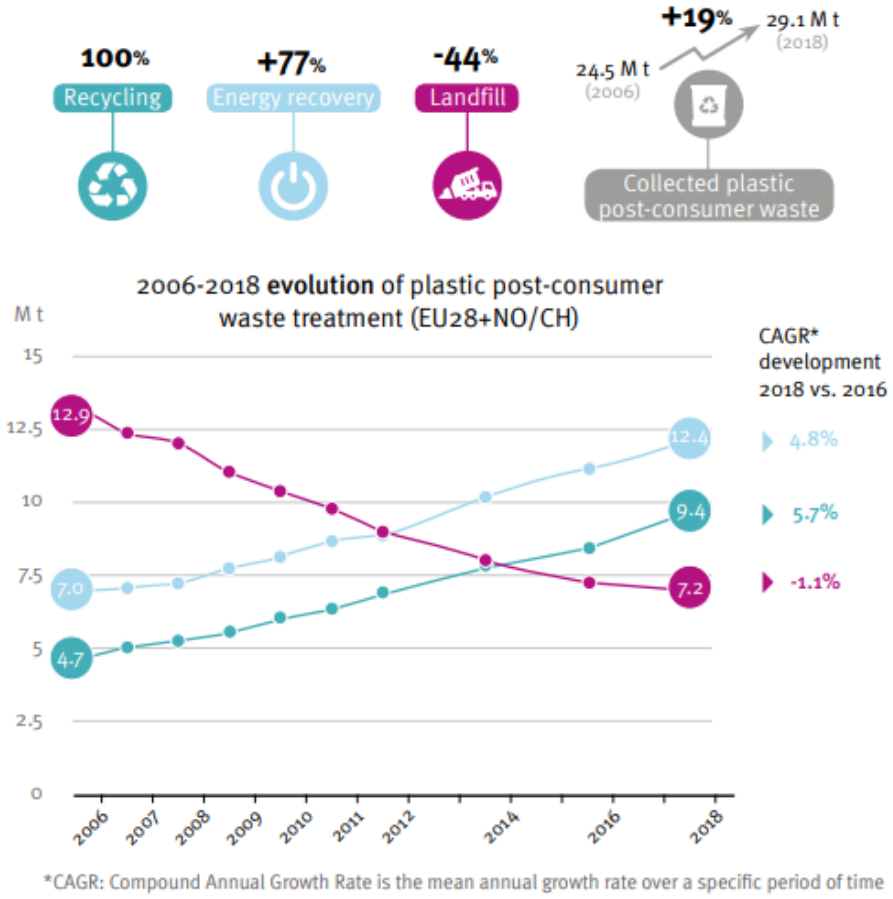

Figure 1. 2006-2018 evolution of plastic post-consumer waste treatment (PlasticsEurope, 2019).

Plastic wastes can be recycled either mechanically, chemically, or thermally. Mechanical sorting can be done in 2 different ways including manual sorting and automatic sorting. The manual sorting method is considered inefficient as a result of the complex nature of plastics. Although it is still the most used technique in the plastic recycling industry as it is more affordable to pay for employees than to buy an automatic sorting machine. Chemical recycling of plastic wastes is very promising for the production of secondary raw materials and fuel. Thermal recycling of plastic wastes involves heating plastic waste at high temperatures to melt them followed by pouring into a mould to form new products (Awoyera, Adesina, 2020).

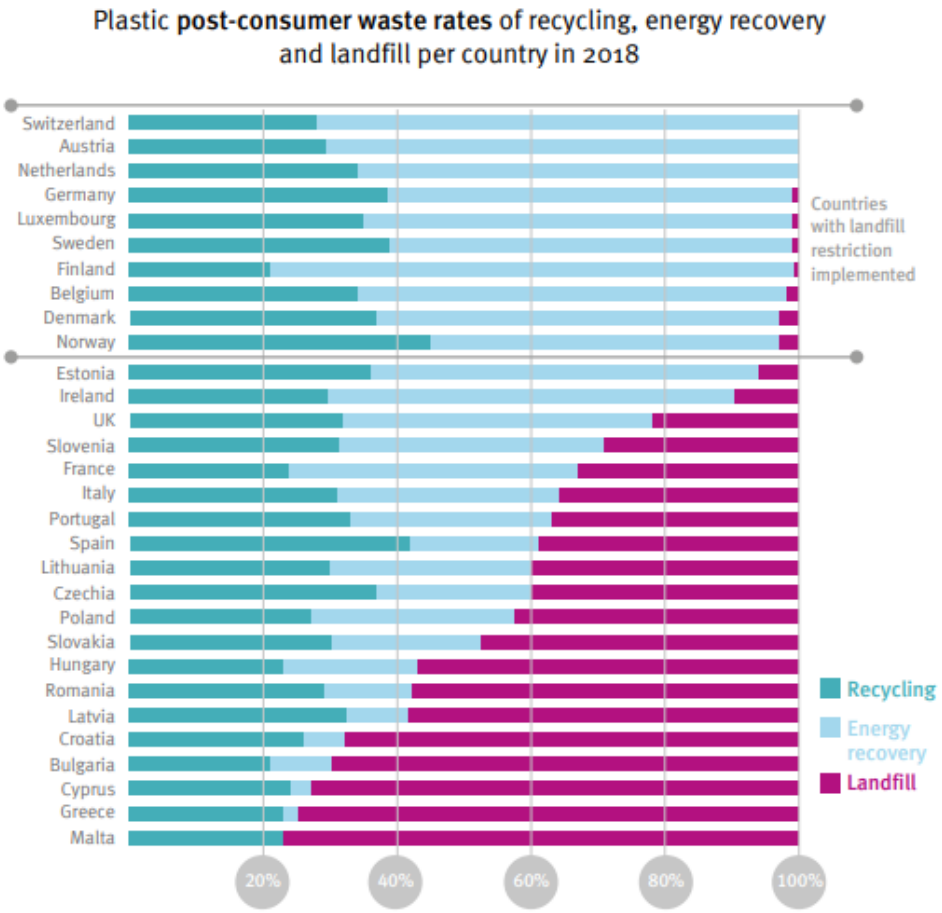

Figure 2. Plastic post-consumer waste rates of recycling (PlasticsEurope, 2019).

Although quantitative targets are set on both regional and EU levels, they often do not take into account the quality of the recycled material. Recycled plastics are substituting products produced from virgin materials, and the quality of the recyclates affects the substitution ratio. The lower the quality of the recycled plastics is, the lower will be the substitution ratio, and the smaller will be the benefits from their recycling (Lazarevic et al., 2010). The main aspects influencing the quality of recycled plastics were identified to be the following four: polymer cross-contamination, additives, non-polymer impurities, and degradation. (Pivnenko et. al, 2015). Consumer plastics consist of a variety of different polymers (e.g. PP, PET, PS, etc.). Their recycling potential as well as the additives and degradation may vary significantly (Jakobsen, 2015). The addition of additives (kinds and amounts) will depend on the type of polymer and intended applications, while degradation will be different depending on the chemical structure of a polymer. (Pivnenko et. al, 2015).

Earlier, packaging was made of a single material. Recycling of single-layer films such as PE, PP, PVC, PS, or PET is technically solved and currently, there are many companies that are processing these films. Regranulates that are made of single-layer plastic wastes are used in the manufacturing of various products (Brandrup et al., 1996; Nikiel, 1996; Praca zbiorowa, 1997). However, single-layered packaging materials have a limitation ensuring the

quality of packed goods. By combining different materials, ideal packaging for most requirements can be met easily as a multilayer structure allows the package to perform a combination of functions that is not possible with a single layer (Ebnesajjad, 2013; Morris, 2016). In addition to this, costs can be reduced by adding a number of layers and thus decreasing the amount of material, in comparison to what would be needed to make a single layer perform the same function. As a consequence of its advantages, the usage of multilayer packaging increased significantly (Ahlhaus, 1997; Finlayson, 1989). The inner layer of multilayer packaging provides sealability for low-temperatures, and the outer layer provides resistance against abrasion, printability, or barrier. Because those sealants often lack stiffness, structural integrity, and abrasion resistance, an outer layer is used for additional functionality. This layer may provide a moisture barrier and is often used in the packaging of dry foods (Morris, 2016).

CONCLUSION

Plastics play a significant role in our society, and wastes generated at the end of the usage of these plastics are unavoidable. Therefore, in order to properly manage these plastic wastes while improving the sustainability of the environment, limitations should be well-studied. Based on this review, the following conclusions can be said;

Proper collection of recyclable plastics is crucial to an efficient recycling process. Therefore, citizens should be well trained starting from childhood to gain awareness. Not helping this system should have consequences such as penalty.

Most of the time manual sorting is applied to the waste materials. Proper identification of the material and its classification as a group depends only on the employees' experience (Soler, 1992; Hisazumi et al., 2003). Employees should be trained in order to understand the requirements of the recycled products. Thus, recycling operation and the recycling efficiency won't be affected since well-trained employees are aware of the contamination coming along with the recyclable waste. Even though, manual recycling is not sufficient enough due to plastics complex nature. These layers need special care to be separated from each other to be able to identify each material so it doesn't end up in another plastic resin storage which decreases its quality as recycled product. There is also a lack of identification system for these materials if automated sorting method is not being used.

Multilayer packaging causes problems in terms of waste management. Difference in the properties of each layer causes difficulties, thus detailed characteristics should be studied because of its effect on their recycling potential. Multilayer foils have similar visible characteristics compared to single-layer films, which may result in processing them with other films because of inappropriate segregation and false characterization of properties.

Most of the contamination of a polymer occurs in the manufacturing step (including the plastics product design and labelling. Chemicals in polymers can be the result of their direct addition (additives) or indirect addition through contamination (non-polymer

impurities) indicates an additional knowledge gap, as quite often the sources of potential contamination are not known and might be difficult to predict.

Recycling of plastics brings the losses of secondary materials along. Therefore, regulations applied to the quality of recycled plastics is necessary.

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