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Estimating the quantity of consumed plastic products and their economic returns in the city of Benghazi

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Highlights

- **Plastic products have different consumptions based on their applications.**
- **The products produced from other plastic materials such as thermoset and epoxy are not studied.**
- **The product type and area for the study are the limitations of this work.**
- **PET products have the highest percentage of the consumed products.**

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ABSTRACT

Plastics recycling has gained significance and popularity over the last few decades due to environmental and economic reasons. Huge quantities of plastic products can be found in Benghazi city in places such as hospitals, restaurants, schools, factories, etc. Rather than accumulating these plastics products in the landfill areas, they can be recycled. Such an action preserves the environment and leads to great financial savings. This study aims to gather data on post-consumer plastic products from different locations and facilities in Benghazi. The plastics products have been classified into five types namely, PET, HDPE, LDPE, PP, and PS. The results revealed that many of the consumed products were PET. The study also reported the potential economic return of these products to some public institutions such as schools, the orphanage, and the homes of the disabled. Also, the study may-serve as a starting point to the municipality of Benghazi and other local authorities towards improving the utilization of plastics waste and realizing the significance of their economic return.

1. Introduction

The production of plastics has increased significantly in the last few decades motivated by the invention of several new techniques for producing polymers from petrochemical sources (Hopewell, Dvorak, & Kosior, 2009). This considerable expansion of the plastics industry is attributed to the fact that plastics are inexpensive, lightweight, and very durable (Andrady & Neal, 2009). Also, plastics can easily be shaped into various products and have a wide range of applications. However, plastics do not corrode, and they decompose very slowly (Shen & Worrell, 2014). These characteristics of plastics have caused many problems in the environment. One way to reduce these environmental problems is to recycle plastics. Recycling can be described as the process of reuse, recovery, or reclamation of waste material to extract value in the form of energy or new material (Elsheikhi, 2017).

1.1 The need for recycling

One of the main factors is the quality of the recycled product. The quality of the recycled product depends on the molding machine,

- *The quality of the tools used in the recycling process,*
- *The proper settings of the molding machine and its axillaries.*
- *The virgin material.*

There is a variety of processed materials that are available for recycling. Many of these materials originated from post-consumer products, landfill material; material reclaimed from yards or mixed material. Non used products and defective products can also be used in the recycling process. Little is known about the effects of the processing of recycled materials. Regardless, recycling has been very attractive due to economic and environmental factors. In this regard, understanding the material properties significantly influence the quality of the recycled product.

1.2 Plastic Recycling Steps

The recycling process comprised of many sub-processes such as sorting, filtering, cleaning, drying...etc (Fig. 1). These processes may lead to increased manufacturing costs (LA Mantia, 2002). The following are the steps of plastics recycling:

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Fig. 1. Steps of plastic recycling

Step 1: Collection

This is the first step in the plastic recycling process, and it includes the collection of plastic waste from many locations such as houses, stores, hotels, restaurants, scrap yards, etc.

Step 2: Sorting

Sorting plastics is a very important step. Although the type of plastics has similar characteristics, adding a small percentage of incompatible plastics may spoil the batch. Such action may lead to deterioration of the product's properties. There are various techniques in which the sorting process can be performed namely, manual sorting, X-ray detector, IR detector, laser detector, air sorting, melting/softening point, sink-float tanks, and selective dissolution.

Step 3: Washing and drying

After sorting, plastics must be washed and dried to remove any dirt or residues adhered to plastics from waste. The washing process has many advantages such as enhancing the purity of plastics and increasing the efficiency of the sorting process. After washing, plastics must then be dried with hot air to dry the plastic flakes.

Step 4: Granulating, and molding

To make the regrind materials resemble the raw materials in terms of size and shape, plastics need to be granulated. This granulating process improving the efficiency of the molding process and enhance the quality of the produced product.

2. Limitations

2.1 Product type:

The majority of the recycling works focused on post-consumer materials, landfill material; material reclaimed from yards or mixed material. In this study, post-consumer products were used; due to ease of recognize them and hence, no need to sorting and filtration operations. Besides; the most used products were selected.

2.2 Key areas:

Due to military operations in some areas of Benghazi (during the period of this study) such as city center and Alsabry; free and safe areas were selected.

3. Procedure

3.1 Study Duration:

The year 2016/2017 was selected to execute the study. This in part is due to the availability of data at that period. Such data is considered, after close examination, sufficient and clear data that meet study requirements.

3.2 Selected Areas for this study:

This study was carried out in most areas within the city of Benghazi (referred to in green as shown in Fig. 2), except for areas within the limits of military operations such as Sabri, City center, Qanfouda, Qawarshah and Qaryounis (red areas as shown in Fig. 2).

Fig. 2. Locations of selected areas

3.3 The Consumed Products Selected in This Study:

Based on the information available from the markets and shops as well as from the daily observations, the most common and more consuming products were selected. These products can be classified based upon the material type as shown in Table 1. Table 1 and Fig. 3, show all products selected which classified under five types of materials: Polyethylene terephthalate (PET), High-Density Polyethylene (HDPE), Polypropylene (PP), Low-Density Polyethylene (LDPE), and Polystyrene (PS).

Table 1

Classification of selected products based on material type

	Type of material				
	PET	HDPE	PP	LDPE	PS
Product name	Water bottle (0.5 L)	Nesquik bottle	Water cup	Spoons	Nail polish re-mover bottle
	Drinking water pack (18 L)	Liquid soap dish bottle	Drinking cup	Forks	Mustard pack
	Case of bottled water (0.5 L)	Liquid soap hand bottle	Yogurt cup	Dishes	
	Case of bottled water (1.5 L)	A laundry soap package	Pack of butter		
	Pack of soft drink	Fabric fragrance bottle	A tray of milk		
	Pack of cooking oil	Antiseptic flooring bottle	Chocolate box		
	Natural juice box	Clothes softener bottle	Sweetness pack		
	Pack of ketchup	Ceramic cleaner pack	Body lotion bottle		
	Mayonnaise pack	Bleach bottle	Pack of hair balm		
	A bottle of vinegar	Hair shampoo pack	Hair cream bottle		
	Pack of flower water	Body cream bottle	Hair oil bottle		
	Pack of peanut butter	Baby powder pack	Hands cream bottle		
	A bottle of vanilla liquid	Toothpaste tube	Children cream bottle		
	Diapers food box	Shaving cream tube			
	Polished glass pack				
	Pack of hair gel				
	Pack of baby shampoo				
	Carpet Freshener bottle				

Fig. 3. Classification of products based on material type

3.4 Data Sources

The teamwork of this study prepared a specific form to collect different information about the used products as shown in Fig.4. This form is translated into the Arabic language to fill it easily.

Data Collection Form

Source Name:....., Region name: ....., Date:.....

General classification	Type	Size	weight	Quantity	Number	Depreciation period		
						Day	Month	Year
Drinks and Food								
Health& Beauty + Household								

Fig. 4. Data collection form

Many visits have been carried out to many places in Benghazi such as houses, schools, companies, hospitals, factories, restaurants, cafes…etc. Three selected schools were selected in each targeted area in Benghazi as shown in Table. 2. The name of other selected places for the data source such as hospitals, restaurants, banks, banquet halls, and companies are shown in Table 3.

3.5 Calculation of economic return:

Initially, the mass should be determined in order to calculate the economic return. In this study, the product mass was obtained by weighing it using a digital weighing scale. The economic return can be calculated in this way:

*Sell price (LD/Kg) * Material amount (Kg)*

It has been found that the sale price per kilogram for any type of product is 0.7 LD/Kg (Database of LUJAIN plastic factory).

4 Results and Discussion

4.1 Estimation and comparison of percentages of consumption

The consumption of products for any material can be expressed in quantities in the form of a percentage of their total weight. The mass of each product was weighted then the total weight for each consumed product can be determined. The weight (%) of each consumed product can be calculated as: the total mass of this product divided into the total mass of all products for the same material, and then multiply the fraction obtained by 100. Fig. 5 shows an example of the weight (%) for accumulated PET products according to the data gathered from different selected places in Benghazi.

Table 2

The selected schools and houses

Region	School name			No. of houses
Hay Al-sallam	Shohadaa Al watan	AL Siada Hajer	Shabab AL thawra	**24**
Alfu-wayhat	AL Theqa	Yousef Boker	Zohor Al pialasan	**25**
Almajori	Shohadaa Al Zentan	Khalied Ben Al	AL Noor	**23**
Tabaleno	Madad Al maarif	Jeser AL Maarifa	Ebn Khal-don	**25**
Bohdema	Tapouk	AL Aqsa	Mousaab Ben	**25**
Alhawari	AL Mo-staqbal	AL Dawlia	Noor AL Maarif	**23**
Balaon	AL Owla	Om Habeba	AL Tay-seer AL	**24**
Alberrca	Sadeq Balla	Tariq Ben Zeyad	Meshaal AL Wahda	**22**
Allaithi	AL Sedeqa	AL Aid ALfedi	AL Mawred 1	**24**
Gardens	Hadeq	Marcaz AL Mot-	Dyar Al Alem	**25**
Shibna	Noor Almaarifa	Zohoor Bengazi	AL Fadeel Bo Omar	**23**
Eastern Salmani	Hateen	Fatat Al-thawra	AL Oroba	**24**
Western Alsalmani	Bellal Ben Rabah	Oby Ben Kaab	AL Najem AL Sataa	**24**
Sedi Hus-sen	AL Motaf-waqeen	2 Mares	Shohdaa Yanayer	**25**
Alwaheshi	AL Gahera	Om AL Qora	Shodaa AL Hani	**22**
Alnaher Street	perintchy	24 Decem-ber	Rainbow	**23**
Elkeesh	AL Amal AL Kabeer	Jabal Nafosa	AL Qay-rawan	**25**
Boutni	Aser AL ho-ria	AL Amal	AL Olla	**23**
20 Street	AL Somod	AL Watheqa	AL Mawred 2	**21**
Alkaiwefia	Bashear AL Naser	AL AId Alfedi 2	Josoor AL Maarifa	**24**

Table 3

The names of the places of data sources

Hospitals	EL Safwa Hospital	EL Galaa Hospital	Libyan-German Hospital
	Mother Hospital	Center of Communicable Diseases	International University
	Benghazi Medical Center	Pectoral Hospital	Kidney Center
	College Of Dentistry	Alhawary General Hos-	Children Hospital
Restaurants and cafes	Pizza Soliman	AL Deyafa	Be Al Beak
	AL Omda	AL Robyen	Vabiano
	Paris	Kudo	Toscana
	Iuna	Pordo	AL Moad
	AL Nahla	AL Hemry	Linza
	Bo Hjer	AL Khayrat	Randa
Banks	AL Aman Banke	Jumhouria Bank	AL Wahda Bank Cen-
Banquet halls	AL Jamela	AL Bahja	Venecia
	AL Hadeel		
Companies	Libyana	Arabian Gulf Oil company	Noor AL Bayad
	Abar Libya	General works company	HP Group
	Benghazi	AL Amal	AL Tawfiq
	AL Madar	Social Solidarity Fund	ALNasma
	Nabaa AL Hayat	Dreams	White Birds
	Municipality of Ben-	AL Nahda	AL Ryada Group
	National Oil Com-		

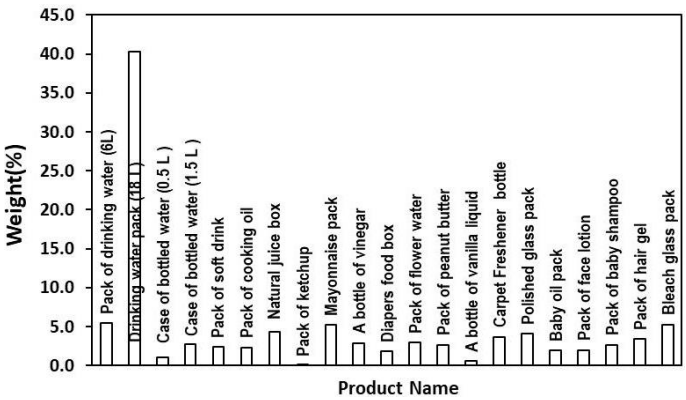

Fig. 5. The weight (%) of PET products

It can be noted from Fig. 4 that the pack (bottles wrapped together in nylon box) of drinking water (18L) has the highest weight percentage (67.38%). This is probably due to the large consumption of the pack of drinking water (18L), which can be observed in our daily life. On the other hand; the teamwork of this study classified the data according to the sources of data inside Benghazi; where it was found that the companies (service or production companies) have the highest consumption rate for the PET products which expressed as a percentage of the weight (42.4%) as shown in Fig. 6.

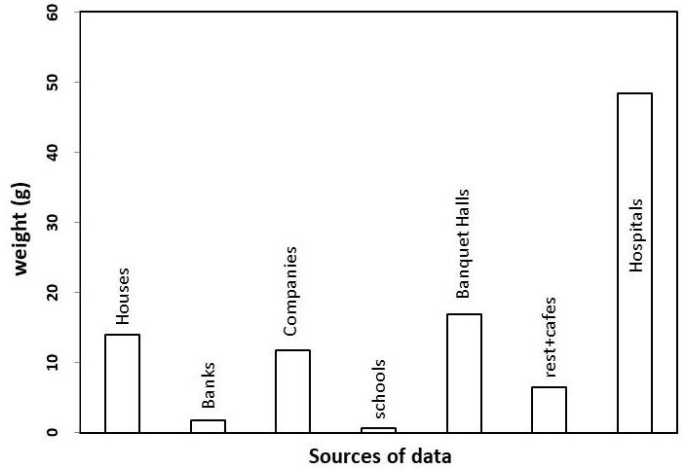

Fig. 6. The weight (%) vs PET data sources

According to the results obtained, it is clear that there are significant variations between plastic products consumed. This variation in products consumptions may be caused by the large use of some of these products. In this regard, it is useful to clarify these discrepancies, which have been classified according to the type of material as shown in Fig. 7.

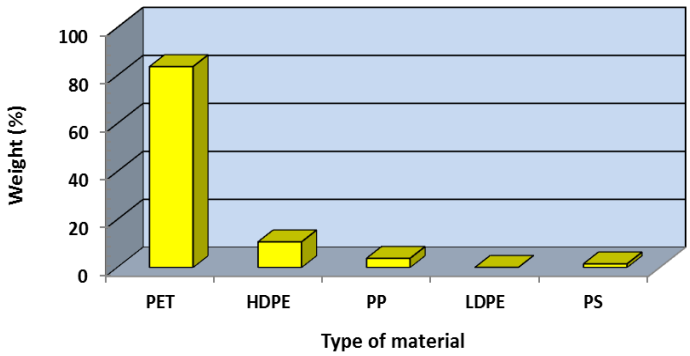

Fig. 7. Percentage of weight for all material

Fig. 7 shows the consumed products of PET, which have the highest percentage (83.76%) compared to other materials. This may be because the nature of products such as the pack of drinking water, and the pack of bleach glass are widely used in companies. The companies are one of the most popular places crowded with people, and hence the largest consumer of these products. On the other hand, the results of the study indicated that there are significant differences in the products consumed between different data sources. Fig. 8 shows a variation in the percentage of products consumed between data sources and the companies have the highest percentage (87%). The possible reason for this result is: the companies are one of the busiest places, especially during the study period due to the problem of cash shortage of the Libyan currency.

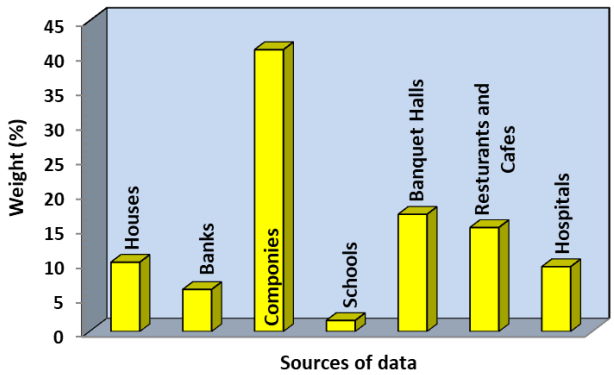

Fig. 8. Percentage of weights for all data sources

4.2 Estimating potential economic returns

Based on the data of the total weight of all products and their sale prices; the economic return can be calculated simply by multiplying the total weight to the selling price as mentioned before. For example, the economic return of all consumer PET products can be calculated as: 30029.281(kg) * 0.7 (LD/kg)=21020.4967 (LD).

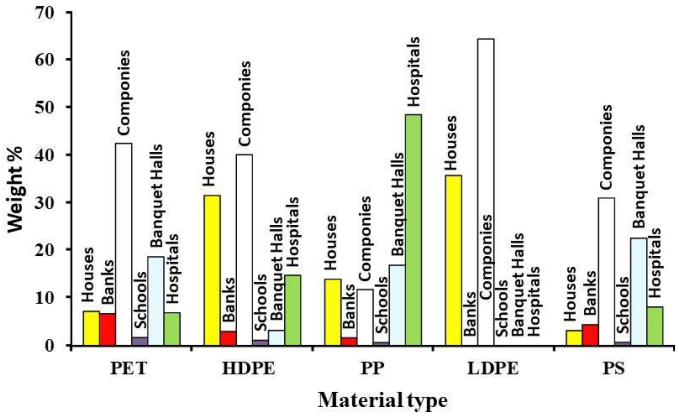

Fig. 9. Percentage of weights for all data sources for all materials

It can be observed from Fig. 9, that the companies have the highest percentages of weight for most types of materials. That is due to many service companies in Benghazi, as well as production and cleaning companies that used a large number of employees whom they use these products. Hospitals also have the highest weight (48%) of PP products because of the nature of this material and its product uses.

5. Conclusion

This study provides useful information about the products consumed in the city of Benghazi. The following points can be concluded:

- Based on the collected data, the most consumed products in Benghazi according to the type of material are PET, HDPE, PP, LDPE, and PS.
- PET products have the highest percentage of the consumed products (83.76%).
- HDPE consumed products have 10.72%.
- PP consumed products have 3.86%.
- LDPE consumed products have 0.09%.
- PS consumed products have 1.57%.
- It has been found that the total monthly economic returns are LD 25096.
- PET products have the highest economic return (LD 21020).
- HDPE products have an economic return (LD 2689.54).
- PP products have an economic return (LD 969.06).
- LDPE products have an economic return (LD 22.41).
- PS products have an economic return (LD 394.47).
- The companies as a source of data have the highest percentage of the weights of consumed products (41%) and thus they have the highest economic return (LD 10245).

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References

Andrady, A. L., & Neal, M. A. (2009) 'Applications and societal benefits of plastics', *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526), pp. 1977-1984.

Database of LUJAIN plastic factory (2017)

Elsheikhi, S. A., Eljaarani, M. A. (2017) 'Material reprocessing through blow molding in Misurata–Libya', *International Journal of Engineering and Information Technology*, 3, pp. 141-146.

Hopewell, J., Dvorak, R., & Kosior, E. (2009) 'Plastics recycling: challenges and opportunities', *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526), pp. 2115-2126.

LA Mantia, F. P. (2002) Hand Book of Plastics Recycling. Rapra Technology Ltd. London. ISBN:1859573258.

Shen, L., & Worrell, E. (2014) Plastic recycling. In Handbook of Recycling (pp. 179-190). Elsevier.