An Investigation into the Advancement of *Polyethylene Terephthalate* (PET) Beverage Bottle Recycling in Georgetown, Guyana

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Abstract

Improper disposal of waste has resulted in a number of risks to human health and the environment. This is compounded by the fact that PET beverage bottles are considered stock pollutants. This study was conducted in Georgetown, Guyana. A structured survey of 203 households, and interviews with local PET recyclers, beverage companies, and key informants in waste management were carried out. The study revealed that there is both a need to recycle PET beverage bottles and room for PET recycling to advance, under the right conditions.

Keywords: PET Beverage Bottle, waste disposal, recycling

Introduction

Polyethylene Terephthalate (PET) has gained acceptance worldwide since its introduction in the 1970s. PET is economical to produce, lightweight for transport, and flexible while still shatterproof. It is unique and enables marketing strategies for companies and convenience for consumers (Vest, 2003, pp. 1, 3; CWC, 1997, p. 1; Kenplas Industry Ltd, 2011). The number of plastic water bottles sold in the USA grew from 4 billion in 1997 to an estimated 26 billion in 2005, while disposal amounts increased from 3.4 to 22 billion for those respective years (Green Raising, n.d.). The average worldwide production of plastic products is 35 kilograms per year per person and is estimated to increase by 3% per year (Time For Change, 2009).

Locally, the city of Georgetown's per capita solid waste generation is ranked the second largest in Guyana (PAHO/WHO, 2004, p. 46), and according to the 2009 waste characterisation study, there are approximately 83,000 tonnes of solid waste generated annually in Georgetown. This is comprised of 50% of organic waste, while the other 50% mainly consists of plastic, cardboard, and aluminium. Plastic comprises approximately 21% of the overall waste generated; i.e. 17,430 tonnes of plastic waste¹ with the generation of 2,490 tonnes of plastic bottles (Urlin, 2010, p. 4) (HYDROPLAN CEMCO INC, 2010, p. 8). The Mayor and City Council (M&CC), Georgetown spends approximately US\$1.5 million annually (US\$ 750,000 and US\$ 540,000 on collection and

¹Calculation: 83,000*21%= 17,430

disposal respectively) to deal with solid waste management, which is 16.7% of the M&CC annual budget (Urlin, 2010, p. 5).

During the last 10 years, local beverage companies have opted for the use of plastic bottles to meet increasing market demand for beverage products sold, and this serves as a cost saving factor in the areas of breakage, handling, storage and production (Monize, 2010; Stabroek News, 2003). Currently, the services provided by the M&CC, in terms of solid waste management (SWM), entail overlooking and organising the collection and disposal of the city's solid waste, but do not provide a service for recycling or segregation (PAHO/WHO, 2004, p. 18). Further, recycling has not been addressed in the solid waste management policy of Guyana (PAHO/WHO, 2004, p. 29). Nevertheless, the opportunities for recycling in Guyana are evident with the separation of recyclable materials such as scrap metal and cardboard by small businesses. The separation process, although not organised by the M&CC, has served to benefit the municipality via a reduction in the quantity of waste handled daily, with savings of 2% (US \$29,000) in expenditure on waste management and income generation for members of the public (Urlin, 2010; Gonzales, 2009, p. 8).

Improper solid waste management poses a number of risks to human health and the environment (United States Environmental Protection Agency, 2002), such as, pollution of waterways and associated blockage of drains and canals, resulting in flooding during the rainy season and high tide. This also serves as a breeding ground for mosquitoes, allowing the spread of vector borne diseases (Monize, 2010). In addition, land pollution by PET is of greater concern since it affects the aesthetics of the environment, attracts insects and rodents (Monize, 2010) and occupies arable lands for landfill site. Finally, PET beverage bottles are a stock pollutant which accumulates over time in the environment. The environment has little or no absorptive capacity for stock pollutants. Therefore the damage becomes greater as more plastics enter the environment (Tietenberg, 2000, p. 335).

The purpose of this study is to highlight the need to address the problem of PET beverage bottle waste disposal. The research objectives are to justify the need to recycle PET beverage bottles in Georgetown, and to determine opportunities that exist for PET beverage bottle recycling. This paper examines alternative approaches to managing PET beverage bottle disposal through recycling processes. Advancement of the current PET recycling activities is necessary for Georgetown as it will lead to efficient resource management and ensure recyclable materials re-enter the system, creating a cycle that would produce less environmental burdens (Shanghai Manual, pp. 10, 12). In addition, this research will justify the advancement of PET beverage bottle recycling in Georgetown, emphasise that PET beverage bottle is a resource, and encourage further research in the planning and implementation of a comprehensive integrated solid waste management programme.

Literature Review

As plastics are non-biodegradable, they occupy considerable space in landfills. A landfill that reaches its carrying capacity requires the development of another landfill, eventually diminishing available land space. Recycling would facilitate an efficient way to conserve material resources and energy, thus reducing the cost of production and extraction of the natural resources, minimise disposal in landfills, improve public sanitation and reduce air, water, soil and land

pollution (Smith, Harrison, & Simmons, 1999, p. 32; Coelho, Castro, & Gobbo Jr., 2010, pp. 291, 295). Additionally, PET plastic recycling offers the opportunity to engage stakeholders from the private and government sectors to work on extending PET life cycle (Coelho, Castro, & Gobbo Jr., 2010, p. 291). PET recycling also offers many economic benefits such as a reduction in the volume of plastics generated as waste, cost savings in transport and collection for municipal waste management, and job creation (Coelho, Castro, & Gobbo Jr., 2010, pp. 292, 296).

The results obtained from studies undertaken by Al-Maaded and Thanh found that recycling was the best and most favoured solution to deal with plastic waste management compared to thermal treatment and landfill disposal, because recycling has a low environmental impact (Al-Maaded, Madi, Kahraman, Hodzic, & Ozerkan, 2012; Thanh, Matsui, & Fujiwara, 2011). This position was supported by a seminar conducted by the Guyana Training Agency, which concluded that recycling was the best option to manage discarded plastics. One of the major difficulties affecting PET beverage bottle recycling in Georgetown is sufficient finances to manage the recycling operations (PAHO/WHO, 2004, p. 103). Presently, the environmental levy collected by the Government of Guyana is not used for environmental management in terms of SWM in Guyana (PAHO/WHO, 2004, pp. 101, 102).

Recycling is the most preferred option to effectively manage PET beverage bottles disposed of in the waste stream. Based on the literature reviewed, however, the successful implementation of PET beverage bottle recycling is dependent on a number of external factors that relate to governing legislations and support, local market share, buying market and global trade prices, efficient planning, and good management. The literature generally lacks a number of specific studies addressing PET beverage bottle recycling, focusing generally on solid waste management. Therefore, this study will address *Polyethylene Terephthalate* (PET) beverage bottle recycling in terms of justifying the need to recycle PET beverage bottles and determine opportunities for recycling within Georgetown.

Methodology

Both quantitative and qualitative methods were undertaken in this research. Primary data on PET beverage recycling was gathered using questionnaires and interviews, whilst secondary data sources included books, journals, and documents provided from relevant authorities. The researcher distributed letters to local beverage companies requesting the quantity of PET bottles manufactured and imported between the years 2006 to 2011 and PET beverage bottle products distributed in Georgetown. This was done in an effort to quantify data received and estimate the quantity of PET bottles entering the waste stream and the importation growth trend. A census was taken to obtain the names of all known local PET bottle recyclers and beverage companies, some of whom were interviewed. This was done to enable a broad understanding of the PET issue and the ways in which PET recycling can be promoted in Guyana.

Twenty questionnaires were pre-tested along the East Bank of Demerara outside of Georgetown. Questionnaires were then distributed at households in Georgetown. Probability sampling was used, where Georgetown was first sub-divided into four Cluster blocks (Figure 1), in an effort to ensure the capture of all wards in close proximity and wards located on the boundary of the city. Subsequently, the sample size was calculated using a 7% margin of error to obtain a sample size of 203 households.

$$n = \frac{N}{1 + N(e)^2}$$

where: n = Sample size
N = Population Size
e = Margin of error (Israel, 2009)

The sample proportion for each cluster was then calculated to ensure the required sample needed for each cluster would be proportionate to the overall sample. The stratum size represents the total households found within each cluster.

$$\text{Sample Proportion} = \frac{\text{Stratum Size}}{\text{Total Population}} \times \text{Sample Size}$$

Figure I: Sub-division of Georgetown (Clusters)
Source: Mr. Colvern Venture, City Engineer (M&CC)

Geographical distribution was undertaken to ensure a wide spread of the sample among the household population within each ward in each cluster. The sample proportion for each cluster was divided by the total wards found in that cluster. Sample interval (k) was then calculated by dividing the total population (N) of the clusters by the calculated sample proportion for each cluster. The mean interval 12 was applied in each ward within cluster blocks to select participating households. Field enumerators administered the questionnaire using the birthday rule to select respondents from households; that is, the individual with the next upcoming birthday who was present at the time of the survey was selected to participate. In the event of non-response at the

originally selected household, the house immediately following was the first alternate and the house preceding the original house, the second alternate. After completion of the questionnaire at the alternate house, the sampling interval was continued from the original house.

Anonymity was assured when gathering data from the respondents. Steps were also taken to ensure that names of recyclers were not identified in the discussion, in order to protect their identity. Additionally, contact information was not requested from respondents participating in the survey. Data collected was analysed using SPSS to carry out descriptive and cross-tabulation analysis, while Microsoft Excel was used to generate graphs and computations of numerical data.

Limitations encountered while conducting the research included:

1. Lack of sufficient financing resulted in a change in margin of error from 5% to 7%. The subsequent change was due to the cost of making copies of the questionnaires, which delayed the timely commencement of the survey, as the researcher sought financial assistance. A five percent (5%) margin of error required 395 respondents to be surveyed but due to the limited time left to carry out the survey and the slow access to finances, the researcher used a margin of error calculator to determine the margin of error for a sample size of 203 from the household population of 34,962. This was practical based on the available finances of the researcher.
2. Difficulty accessing data, due to a lack of willingness by beverage companies to divulge data, limited the scope of quantification of PET bottles in Georgetown. Therefore, import data on bottles of plastics from the Bureau of Statistics was utilised which did not specify PET imports alone or distribution to Georgetown. Additionally, a bottle weighing exercise was conducted to make estimations and quantify PET bottles in waste stream.
3. Some beverage companies declined to participate in the interviews.
4. Recyclers were unwilling to divulge financial data concerning their business, with respect to the acquisition of machinery, recovery of PET beverage bottles, operational and processing costs. This resulted in the researcher not being able to do quantifiable analysis between recyclers to effectively determine feasibility of PET recycling among the local recyclers.

Analysis and Discussion

The need to recycle PET Beverage bottles

The volume of PET bottles legitimately recognised and tariffed as plastic is approximately 1.9 billion bottles. An additional 1.1 billion bottles imported are not tariffed as plastic because Customs only recognises the contents and not the container. An estimated 6 million bottles illegitimately enters Guyana (Fordyce, 2003, p. 8). The data showed fluctuations of PET bottle imports between 2006 to 2010, with the years 2007 and 2009 showing an increase by 26.53% and 56.07% respectively, while in 2008 and 2010, importation decreased by 24.64% and 9.45% respectively (Figure 2).

Figure 1: Historical Imports of Plastic Bottles in Guyana and Projection to 2015
Source: Bureau of Statistics, 2011

Despite fluctuations, the trend line is upward moving until 2015, indicating a potential increase in the importation of plastic bottles by Guyana. This trend is supported by responses from beverage companies that indicated their intention to expand the use of PET for bottling beverages geared towards making a variety of beverage bottle sizes available to consumers, packaging other products with PET such as rum, and increasing the market share of products.

Based on the bottle weighing analysis: 1 tonne of plastics = 26,279 bottles (average from various sizes of bottles), plastic waste generation for 2009 was 2,490 tonnes; therefore, 65,435,133 million plastic bottles was generated as waste for 2009 in Georgetown. On a monthly basis, 5,452,927 million bottles (207 tonnes) would have been disposed. Weekly, 1,363,231 million bottles (51.87 tonnes) were disposed and 194,747 thousand plastic bottles (7.4 tonnes) disposed daily in 2009. With regard to finance, one recycler indicated that his operation would require 30 to 40 tonnes weekly for viability but the weekly targets are not met consistently. Nevertheless, the recycler has approximately 769.6% monthly profits, which is approximately 7 times his monthly expenditure (shipping, maintenance, labour, packaging, electricity, transport, tax/duties, and administrative costs).

Several factors highlight that recycling would be a useful approach for the effective management of non-biodegradable PET bottles: the quantity of PET bottles entering the waste stream, along with the projected increase of PET bottles import by 2015; the reality of illegitimate entry of PET bottle products into the local markets; the expansion of PET use by local beverage companies in Guyana; some PET bottle imports not being tariffed, and the prospects of recycling profitability. It would also be better to engage in PET beverage bottle recycling because there is a trade market for recovered PET that would reduce volumes of this substance entering the waste stream.

Opportunities for PET Beverage Bottle Collection

Approximately 88% of Georgetown residents dispose of their garbage via regular garbage collection service. Plastic waste (32%) was the material most frequently disposed, and of the 32% of respondents, the majority (31.3%) dispose of plastic beverage bottles. Forty-three percent of the 31.3% that dispose beverage bottles discard approximately 1-5 bottles per week followed by

26% who disposed 6-10 bottles weekly (Figure 3). This data clearly shows that beverage bottles are a major component of plastic waste discarded by households. Weekly household collection of PET would not be cost efficient for local recyclers, as approximately only 1-5 bottles are disposed of weekly.

Figure 2: Amount of Beverage Bottles Disposed Per Week

Using the median value of three bottles, we can estimate that each individual household disposes approximately 12 bottles per month, which may not reach one pound (lb.) based on the size of bottles disposed as persons would consume a variety of beverage bottles with sizes ranging from 12oz to 2 litres. Therefore, house to house collection of plastic beverage bottles would likely be unprofitable after factoring in transportation and fuel costs, and consumer propensity to litter. Once plastic beverage bottles are consumed they are not necessarily taken home; instead the bottles may either become litter or disposed of in the nearest receptacle available. Hence, it may be a more practical option for recyclers to engage in collection of PET beverage bottles from companies, institutions, supermarkets, dealers, schools and mini-marts (community shops), and provisions made to allow individuals to carry bottles directly to the recycler for a redemption price incentive (buy back/deposit-redemption). This would help provide incentives for the general public to separate the bottles and reduce the transportation cost of collecting the bottles by the recyclers.

Pricing

Based on the bottle weighing assessment, the smaller bottle sizes are lighter in weight. Therefore, larger amounts of bottles would be required per unit weight measurement (lbs, kg, and tonnes) according to estimates. Therefore, Recycler 'C' who is charging \$1 per bottle is actually paying more than Recycler 'B' who charges \$12 per kg. Thus, if Recycler 'C' purchased 1 kg of 2 litre bottles, \$17 would be paid to the consumer returning the bottles, compared to \$12 paid by Recycler 'B' for the same amount of bottles. In the long term, Recycler 'C' would spend more to acquire the bottles and therefore reduce his profits. Recycler 'C' should therefore purchase bottles based on weight instead of per bottle.

Additionally, it would not be advisable for an external body to set a standard price structure for the reclamation of PET beverage bottles because the price per weight will depend on factors such as overhead costs, trade prices, transportation costs, shipping cost, and product shipping. For

production shipping (bales/flakes), it is more economical to shred instead of bale, as shredding allows more weight to be packed into the same volume of container.

Public Awareness

Presently, none of the recyclers interviewed engage in public awareness campaigns for the collection of plastic bottles by their operations. Recyclers instead rely heavily on word-of-mouth communication. Based on data from the field survey, only 14% of respondents were aware of plastic recycling businesses. Additionally, 57% of the 14% indicated that their initial awareness of the businesses was through friends, family, or associates, while 27% were made aware through observation of the businesses in operations (Figure 4).

Figure 3: Initial Awareness of Local Recycling Business

It is interesting to note that 54% of those who were aware of plastic recycling knew that Banks DIH recycled, but did not know the local recycler providing that service to Banks DIH. This highlights the limited awareness about local PET recyclers among the general population, signaling that more should be done to sensitise the public in Georgetown of their operations to increase source market.

Commercial Operations

Recycler 'A' exports 11 tonnes of shredded PET flakes per month, while Recycler 'B' exports approximately 44 tonnes per month (shredded estimate) and Recycler 'C' is currently stockpiling and has not exported PET bales in recent months (Figure 5).

Recycler 'A' Batch of Mixed PET flakes

Recycler 'C' Bales of PET bottle

Figure 4: PET Flakes and Bales

Approximately 55 tonnes of PET flakes are exported per month, 44 tonnes are recovered post-consumer PET, while 11 tonnes are from post-industrial PET reject bottles. Therefore, with reference to 2009 plastic waste generation, the recyclers would have only exported 21.2% of the total tonnes of plastic bottles generated as post-consumer waste for 2009, leaving approximately 78.8% of post-consumer plastic waste unrecovered. Both post-consumer and post-industrial combined exports for 2009 would have been 26.5%. This figure demonstrates that there are potential opportunities to expand collection.

Some recyclers have encountered various issues in their operations. These include competition from other businesses, the high cost of import duties, financial planning issues, lack of technical requirements, the high shipping and logistical costs, operational costs (maintenance, packaging, electricity, and labour), machinery replacement costs, limited PET bottle supply in Berbice, no access to environmental tax, the impact of foreign policy on the PET trade, and deception in trade. According to Recycler 'F', this has put a hold on the advancement of his business. Despite the challenges faced, most recyclers indicated they are satisfied with what they are receiving from their ventures, even though in most cases they break even. Regardless, some recyclers strongly believe that PET recycling can be profitable once the opportunities are offered to the recyclers, along with Government support, to expand their enterprises and ensure clean environments.

Therefore, based on data obtained on PET recycling, there is room to further advance PET recycling activities in post-consumer recycling in Georgetown, Guyana. Promotion could include improving collection efficiency, increasing market share (locally), and processing to include the cleaning and drying phases in order to export clean PET flakes. The best opportunity for PET recycling in Georgetown would ultimately depend on various factors, such as, effective planning, financial investment, efficient management, market research, public awareness, collection efficiency, logistics and Government support.

Conclusion

All stakeholders (policy makers, recyclers, commercial enterprises, and the general public) need to alter their perception of garbage from one of it as waste to that of a resource, since the majority of waste generated consists of material that can be reused, recycled and used for energy recovery. There is a need to recycle PET bottles in Georgetown, as approximately 6.9 tonnes/6,900kg/15,180lbs (181,763) plastic bottles are generated daily. The need to recycle PET is justified by the reality of illegitimate entry of PET products into the local market, the expansion of PET in production and bottling of other products; coupled with projected increases of PET bottle imports. Only 21.2% of PET was removed from post-consumer waste, indicating that there are volumes of PET to be recovered from the waste stream. Also, several viable opportunities exist for promotion of current PET beverage bottle recycling: export of clean flakes, sensitisation, improved collection efficiency, and Government support.

Guyana needs to establish a public-private initiative to address recycling, with involvement of the State, private companies, and environmental organisations for success in PET recycling. Government involvement should be indirect, in terms of revising laws, providing incentives, empowering citizens' involvement and organising financing for the acquisition of equipment. In the final analysis, this would create an environment that supports the development of recycling and leads to the success of recycling ventures that benefit both the state and private enterprise.

Recommendations

For a more effective and successful PET beverage bottle recycling programme, the following is recommended:

1. There should be more emphasis on recording imports of plastic according to the type of packaging and the category of its content (beverage, food, cosmetics and so on).
2. Policymakers need to establish effective legislation and legal frameworks that speak to recycling and separation of recyclable materials from regular garbage.
3. A percentage of environmental taxes collected by the Government should be redirected to various recycling endeavours. Support can also result from the lowering of import/export duties, provision of tax exemptions and provision of incentives to lending agencies to promote low interest loans to recyclers.
4. Educational awareness campaigns through the media to educate the general public on the importance of recycling. Efforts should also be focused on schools and government institutions.
5. Recyclers should sensitise the public of drop-off points, deposit redemption locations and transfer stations for various materials. Resources that can be used for such awareness activities include brochures, flyers, direct mail, billboards, advertisements, seminars, village talks, and promotional campaigns/events.
6. Recyclers should set a standard price of reclaimed PET by unit weight and not per unit bottle. Additionally, shredding operations should be close to the source market to minimise transportation costs.
7. Processing of reclaimed PET should be advanced to cleaning (manual/mechanical), as the world market prices for cleaned flakes is higher.

8. There should be encouragement to foster the development of middlemen, who purchase bottles from residents to be resold to the recyclers. This would minimise costs associated with recyclers travelling to the areas and would also create jobs for a number of individuals.
9. Supermarkets, dealers of PET, beverage companies, and local community shops (mini-marts) should encourage consumers to return PET beverage bottles at the entities by issuing a cash voucher. This system provides incentives for consumers and encourages new purchases for the entities. This would be an economical way for local recyclers to form arrangements with these entities to purchase or collect the recovered bottles. This creates direct savings on transport and fuel costs.
10. Drop-off points should be encouraged at various institutions such as the University of Guyana, schools (private and public), non-governmental agencies, international organisations, Governmental agencies, Ministries, and places of worship. This would facilitate the collection of PET beverage bottles and serve as a practical way to instil the principles of garbage separation and the values of recycling.
11. Deposits-redemption (buy-back) transfer stations should be set up at various locations to facilitate the purchase of bottles by the recycler. This provides an economic incentive for the general public to separate the PET beverage bottles and minimise transportation costs for recyclers.
12. Efforts should also be made to collect PET beverage bottles after public events such as the Mashramani road march, fun days, sporting events, and other activities where large groups assemble. This approach will necessitate that the recyclers liaise with event organisers to allow recyclers to collect PET beverage bottles disposed by the crowd.
13. Once plastic recycling can efficiently expand in Georgetown, this will contribute to the establishment of an Integrated Solid Waste Management Programme, inclusive of other waste material. This effort should be expanded to include other areas in Guyana.

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