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ECONOMIC ASSESSMENT OF A DEPOSIT-REFUND SYSTEM (DRS) FOR JAMAICA

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ACRONYMS

CAPRI	Caribbean Policy Research Institute
DRS	Deposit refund system
JIS	Jamaica Information Service
JMD	Jamaican dollars
NSWMA	National Solid Waste Management Agency
OECD	Organisation for Economic Cooperation and Development
PET	Polyethylene terephthalate
RPJL	Recycling Partners of Jamaica Ltd.
RVM	Reverse vending machine
USD	United States dollars

1. BACKGROUND

Inexpensive, light, durable and versatile, plastic bottles have become a part of everyday life. They have also come to be one of the biggest sources of pollution of our time: one million plastic bottles are bought around the world every minute,[1] the majority of which are used just once and thrown away, ending up in landfill or in the ocean.

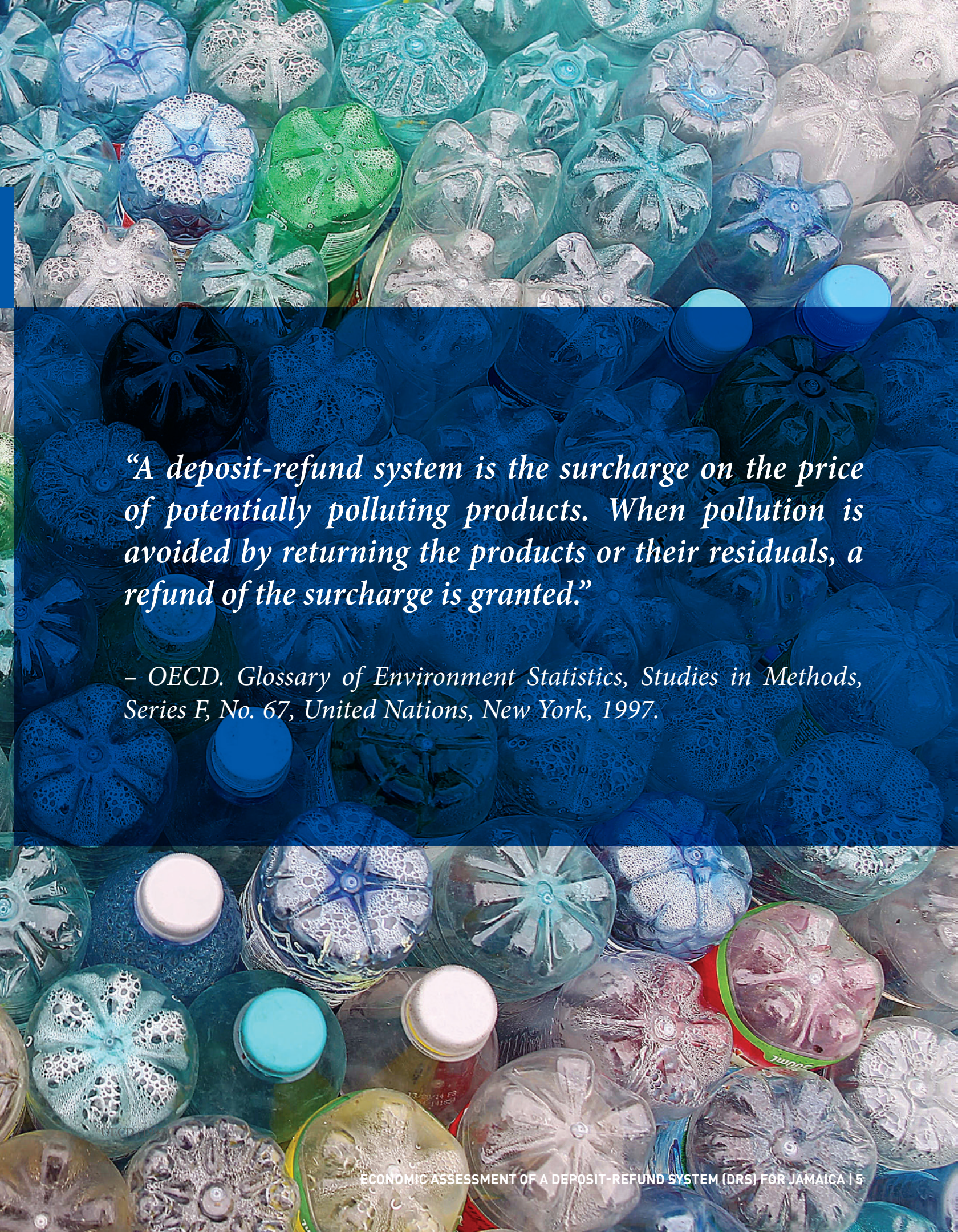
Most plastic bottles used for water or soft drinks are made from polyethylene terephthalate (PET), a highly recyclable material. Why then is PET recycling not more widespread? In the United States, one of the world's largest consumers of plastic bottles, recycling of PET bottles is only around thirty percent.[2] The main distinguishing factors for countries such as Germany and South Korea,[3] which do achieve relatively high recycling rates, is that they have waste separation systems which facilitate recuperation of the PET and other materials for recycling. They also use economic measures – incentives or dis-incentives – to achieve high material recuperation; in the case of South Korea fee systems, and in the case of Germany deposit-refund systems.[4]

In Jamaica, recuperation of PET bottles from the waste stream for processing and export to be recycled is currently estimated to be five to ten percent.[5] A recent study by the Caribbean Policy Research Institute (CAPRI),[6] which assessed various measures for PET waste management, recommended that a deposit-refund system (DRS) be considered to increase recuperation, and improve management, of PET waste in Jamaica.

DRS have two key benefits. They increase the rate of recuperation, and thus recycling, of containers covered by the deposit scheme, as the deposit provides an incentive to the consumer to return the material to obtain their refund. Second, they reduce litter of the targeted material, since in the case that the consumer does decide to litter, someone else more desirous of getting the refund may pick it up. Both benefits hinge on the level of deposit/refund applied.

However, as CAPRI's report[8] indicated, the cost of implementation of a DRS can be considerable, indicating the need for an assessment of the potential costs and benefits of a DRS in the decision-making process regarding the implementation of this type of system for PET waste management.

[1] "A million bottles a minute: world's plastic binge 'as dangerous as climate change'," The Guardian, June 28, 2017. (www.theguardian.com/environment/2017/jun/28/a-million-a-minute-worlds-plastic-bottle-binge-as-dangerous-as-climate-change)
[2] Rick Leblanc, "Plastic Recycling Facts and Figures," The Balance Small Business, June 1, 2017. (www.thebalancesmb.com/plastic-recycling-facts-and-figures-2877886)
[3] OECD (2015).
[4] CAPRI (2018).
[5] Personal communications with Recycling Partners of Jamaica Ltd. and Jamaica Recycles Ltd. 2017
[6] CAPRI (2018).
[8] CAPRI (2018).



"A deposit-refund system is the surcharge on the price of potentially polluting products. When pollution is avoided by returning the products or their residuals, a refund of the surcharge is granted."

– OECD. Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, United Nations, New York, 1997.

2. PURPOSE

The purpose of this study is to build on CAPRI's previous report, which recommended an assessment of the economic costs and benefits of a DRS for PET bottles in Jamaica, to inform decision-making regarding its implementation. This study seeks to:

- **Quantify the costs of establishing and operating a DRS to manage PET waste in Jamaica, considering different configurations for implementation;**
- **Assess the benefits associated with the implementation of a DRS, and thus the economic attractiveness of a DRS for PET waste management;**
- **Advise on the financing for a DRS; and**
- **Recommend a structure for DRS.**

3. A COST-BENEFIT APPROACH IS USED AS THE BASIS FOR ADVISING ON A DRS FOR JAMAICA

The assessment of a DRS for Jamaica is based on cost-benefit analysis.

Two types of cost-benefit analysis are conducted:

1. **Cost analysis to compare alternative configurations for implementing a DRS, and**
2. **Cost-benefit analysis to assess the value of a DRS for Jamaica compared to the cost of implementing it.**

The cost-benefit analyses are conducted with respect to the economy as a whole, not from the point of view of any specific actor within the DRS system.

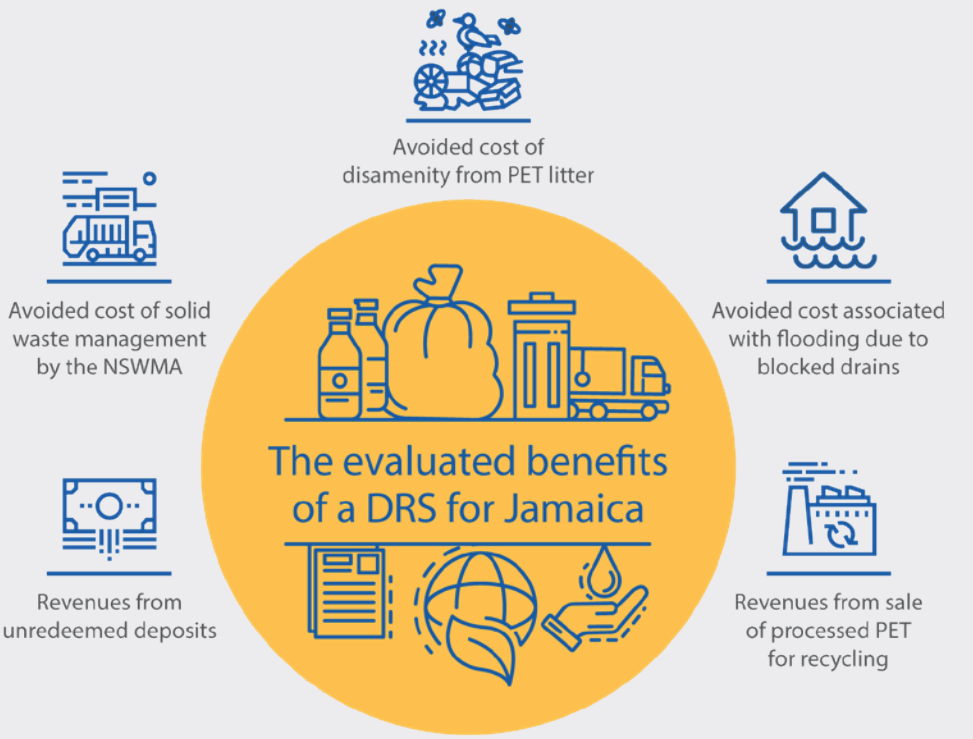
Costs analysed with respect to the DRS include:

- **Operating costs associated with the transportation of the PET bottles from consumers to intermediate- and end- collection points,**
- **Fixed and operating costs associated with collection, handling and processing of PET bottles, and**
- **Fixed and operating costs for the administration of the DRS.**

The benefits evaluated include:

- **Avoided cost of solid waste management (SWM) by the National Solid Waste Management Agency (NSWMA)**
- **Avoided cost of disamenity[9] from PET litter**
- **Avoided cost associated with flooding caused from drains blocked by PET litter**
- **Revenues from sale of processed PET for recycling**
- **Revenues from unredeemed deposits**

Other costs and benefits of a DRS, such as the environmental costs of greenhouse gas emissions from transportation of PET bottles, and avoided costs of having to clean PET litter, are not assessed in this study.



3.1 THE STRUCTURE OF THE DRS HAS IMPLICATIONS FOR ASSOCIATED COSTS

3.1.1 SOME ELEMENTS OF A DRS INFRASTRUCTURE ALREADY EXIST IN JAMAICA, BUT THE SYSTEM WOULD NEED TO BE AUGMENTED FOR A FULL DRS

The Recycling Partners of Jamaica Ltd. (RPJL) already conducts collection, transportation and processing of a portion of the plastic bottles in Jamaica for processing, and has established recycling programmes in a number of communities and schools. RPJL also has established relationships with brokers to whom they sell the processed material, for export for recycling. RPJL therefore has a network of trucks, collection depots and processing equipment that can be integrated into a DRS.

The current infrastructure would however need to be expanded to accommodate a Jamaica-wide DRS collection and processing system. The structure and logistics of collection, transportation and processing may also need to be re-visited, to achieve greater efficiency for an island-wise DRS.

[9] Disamenity is the unpleasant character or quality of something
[10] A central system is an entity that manages and administers the deposit refund scheme and is therefore the focal point for the flow of information regarding bottle sales, collection and finance for the entire system.

3.1.2 A NUMBER OF POSSIBLE CONFIGURATIONS EXIST FOR A DRS, EACH WITH ITS OWN COST IMPLICATIONS

In its simplest form, a DRS functions as described below and in the accompanying Figure 1.

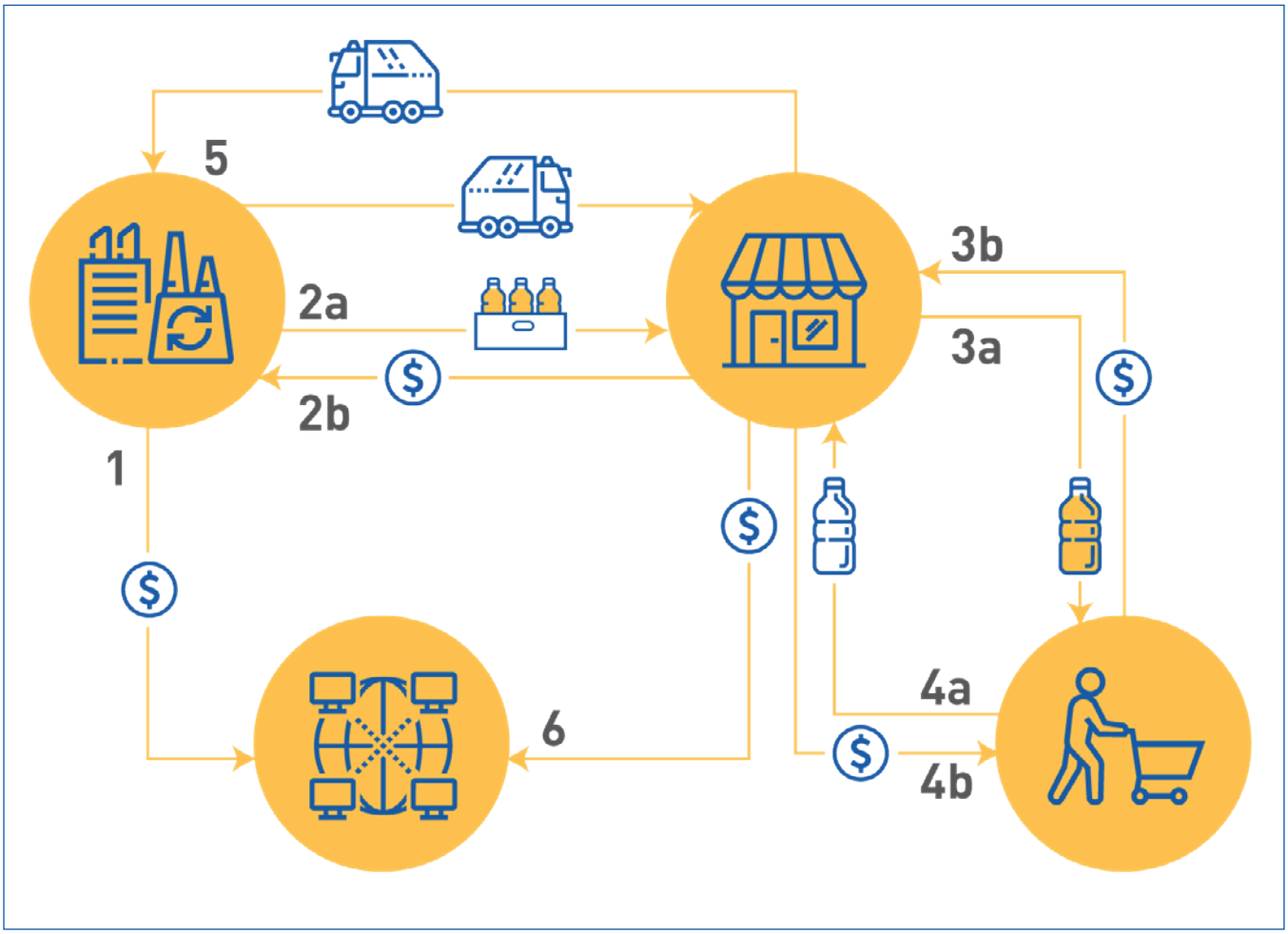
1. The manufacturer or importer of the beverage pays the central system, which administers and facilitates the running of the DRS, a fee for the beverages delivered for sale.
2. a) The manufacturer or importer delivers the beverages for sale to the retailer (shops, supermarkets for example).

   b) The retailer then pays the deposit to the manufacturer or importer of the beverage in the price of the product.
3. a) The consumer buys the beverage from the retailer.

   b) The consumer pays the deposit when purchasing the beverage, included in the cost of the beverage.
4. a) After consumption, the consumer returns the empty container to the retailer.

   b) The consumer has the deposit refunded to them on return of the empty container.
5. The manufacturer, commercial recycler, or central administrator collects the empty beverage containers stored at the retailer and transports them to the processing plant (where they are processed and recycled, or exported for material revenue)
6. Both the retailer and processing plant report the number of returned containers to the central system.
7. The central system then repays the deposits to the retailer in accordance with the number of reported returned containers.

Figure 1: Basic structure of a DRS



Several possible variations in the DRS configuration exist as outlined in Table 1 below. CAPRI has chosen to analyse the most relevant of these variations with respect to the Jamaican case, as indicated in the last column of the table.

As the table shows, no quantitative analysis is done with respect to the **managing entity of the DRS.** As this study conducts an economic analysis, only the cost of managing the DRS is analysed, not who manages it. The choice of managing entity may have implications for the efficiency and effectiveness of the DRS, however, and this is analysed qualitatively in the recommendations.

In terms of **return points,** we analysed the economic impact of having a DRS based on a few large redemption sites/depots, compared to several smaller collection and intermediary processing points. The former model is similar to the model currently used for the handling and processing of PET bottles in Jamaica by RPJL, whereas the latter is similar to the model used in most countries which have adopted successful DRS. The situation of a combination of both is not analysed as it is not common, but we could expect that a combined system would lie somewhere in between the two models analysed. Within the retailer model, we also analyse two different possibilities: manual collection and accounting, and automated collection and accounting through the use of reverse vending machines (RVM) (section 3.1.3 explores the RVM model in greater detail).

MANUAL RETURNS SYSTEM:

Customers return empty containers to the retailer (who may have designated employees responsible for the task,) who count the bottles, refund the deposit (either via cash or store credit,) and take the containers to the processing area for storage, with or without prior compaction, until pick-up, typically done on a pre-determined schedule (according to expected volumes) in agreement with the collection agents. The containers are transported to a central depot to be weighed, to reconcile the count, and retailers are accordingly reimbursed for the deposits they have refunded.

AUTOMATED RETURN SYSTEM USING A REVERSE VENDING MACHINE (RVM):

Customers deposit used (empty) drink packaging into the RVM, which returns either money or a voucher for store credit voucher to the user. Containers returned in the RVM are scanned, identified (matched to a database) and determined to be a participating container; once confirmed as an eligible container it is counted (and a refund provided) and compacted to reduce size and storage space requirements. RVMs may be digitally connected so that collection data can be transmitted to the body responsible for the administration of the DRS. Such information facilitates the scheduling and optimisation of collections and allows faster accounting within the system for reconciling payments to retailers.

We analyse, based on the costs of the DRS, how the DRS infrastructure (return and collection points, transportation etc.), could be **financed.** Here, we examine whether and for how long the unredeemed deposits and revenues from PET material sales would be sufficient to cover set-up and operation costs, and the amount of additional financing that may be required from other sources, for instance via manufacturers, through the payment of joining and/or handling fees. The case of a partial rebate is not analysed, as it is not commonly used in DRS around the world and introduces additional complexity which we do not recommend at the outset of DRS implementation.

Table 1: Possible variations in the structure of a DRS

Key Elements	Variations		Analysed
Management of Central System	**Managing Entity**		
	NGOs		Qualitative analysis only
	Industry bodies – manufacturers, importers, retailers		
	Public and private sector partnerships		
	Combination of various stakeholders		
Return Points	**Number**	**Types**	
	A few large points	Large redemption sites/depots	✓
	Several points of smaller size	Retailers (large and/or small)	✓
	Combination	Combination of different types	
Financing	**Possible Sources**	**How**	
	Bottlers/Manufacturers	Through payment of handling fees to retailers and recyclers to offset their operational costs	✓
		Through joining and annual fees paid to the central system to cover expenses of the DRS	✓
	Consumers	"Unredeemed deposits" – the value of deposits not claimed by consumers	✓
		Partial rebate – a portion of the deposit value which is not returned to the consumer but kept for financing the DRS	
	Material Purchasers	Revenue from sale of PET material to material purchasers for further processing and/or export for recycling	✓

Source: Based on CAPRI, 2018

As this study conducts an economic analysis, only the cost of managing the DRS is analysed, not who manages it. The choice of managing entity may have implications for the efficiency and effectiveness of the DRS, however, and this is analysed qualitatively in the recommendations.

3.1.3 THE NEED FOR FRAUD PREVENTION MECHANISMS, AND THE LEVEL OF AUTOMATION AND TECHNOLOGY EMPLOYED, ALSO HAS COST IMPLICATIONS

A DRS system is vulnerable to fraud, as persons may attempt to return the same bottle several times to recuperate multiple refunds. Fraud can be reduced by:

- **Ensuring the returned bottles, once accounted for, are stored in a secured (locked) location with restricted access; and**
- **Destroying returned bottles, once accounted for, for instance by crushing or shredding.**

We conduct the analysis for two possible means of minimizing fraud in the retailer model: 1) use of compactors/crushing machines at the point of collection, for the case of manual returns; and 2) use of reverse vending machines (RVMs) with a compacting function, for the case of automated returns. In the manual returns system, only intact (uncrushed) bottles would be accepted for returns. At the point of return (the retailer) compacting machines crush the bottles prior to storage so that they cannot be redeemed a second time. In the automated returns system, containers are compacted by the RVM itself preventing redemption more than once. In addition, RVMs have been shown to achieve sixteen percent cost savings per container compared to manual redemption;[11] this savings is factored into the cost-benefit analysis of section 4.

In the depot model, the main means for preventing fraud would be to store bottles in a secure area on-site until they are placed for processing. This is currently the method practiced by RPJL.

In the early stages of the DRS, consideration must also be given to prevent bottles which were in the market prior to the introduction of the DRS, from being redeemed for refunds under the DRS. The use of labelling or barcode information, to indicate the eligibility of bottles for refund under the DRS would take care of this problem.

A DRS system is vulnerable to fraud, as persons may attempt to return the same bottle several times to recuperate multiple refunds.

3.2 RECOVERY RATES IMPACT DRS COSTS; A DRS FOR JAMAICA ASSUMES 60% RECOVERY WITHIN TEN YEARS OF IMPLEMENTATION

As recovery rates increase, the greater the infrastructure costs due to the need for more collection points, transportation services and processing equipment. However, with greater recovery rates, fixed costs of a DRS are spread over a larger number of bottles, lowering the recovery cost on a per bottle basis. At the same time, the higher the recovery rates, the greater the overall benefits to be realized in terms of avoided costs of solid waste management, litter and flooding. Recovery rates therefore influence both costs and benefits of the DRS; they depend primarily on the deposit/refund amount and the convenience of bottle return.

CAPRI conducted a survey to obtain public feedback on required features of a DRS for Jamaica to encourage public participation. Responses provided insight on the required deposit/refund amount and level of convenience that would be required to incentivise persons to return bottles to collection points.[12]

In terms of the level of convenience, CAPRI's survey results indicate that – for those members of the population that would not voluntarily return their plastic bottles – roughly 90% of the population would require that the points of return be within five minutes' drive or walk for them to be incentivized to return their bottles. A significant proportion of respondents indicated the desire to have collection points located at places that they would be likely to go anyway as a matter of course, or not far off from their regular daily commute. Table 2 gives an overview of the survey results in relation to the required level of accessibility of collection points required to incentivise consumers to return their bottles.

The collection point most often cited as convenient was large

[11] S. Edwards (2018)
[12] The survey received 223 responses at the time of publication

Table 2: Willingness to return bottles based on accessibility of collection points

TIME TO COLLECTION POINTS (MINUTES)	% OF RESPONDENTS WILLING TO RETURN BOTTLES
0	100%
5	93%
10	77%
15	35%
20	13%

supermarkets (91% of respondents). Depots were significantly less desirable as collection points (41% of respondents). Given these results, we expect that recovery rates achieved using depots as collection points – where there may be only one or a few per parish – would be lower than that achieved using major retailers such as supermarkets as collection points.

The survey indicated that, for those members of the population that would not voluntarily return their plastic bottles (i.e. those that would require a monetary incentive to return their bottles,) 25% of respondents would require a minimum deposit amount of J$2 to return rather than throw away their plastic bottles, and approximately 80% of persons would require a deposit amount of J$5 to return rather than throw away their bottles. In other words, a deposit amount of J$2 would be required to achieve an additional 25% in the recovery rate (from the current level based on voluntary returns,) whereas a deposit amount of J$5 would be required to achieve an additional 82 % in the recovery rate.

Table 3 shows the expected recuperation rates based on the results of the survey conducted by CAPRI, compared to the calculated recuperation rates from applying equation 1 above.

These results are consistent with recovery rates seen around the world. As seen in Table 3, recovery rates of 60-80% are observed for deposit amounts of approximately J$5. Higher

Table 3: Expected recovery rates based on deposit amount

DEPOSIT (REFUND) AMOUNT	% RECUPERATION INCENTIVIZED WITH DRS IN NON-VOLUNTARY POPULATION
J$	CAPRI survey
1	11%
2	26%
3	27%
5	83%
15	97%
20	99%
50	100%

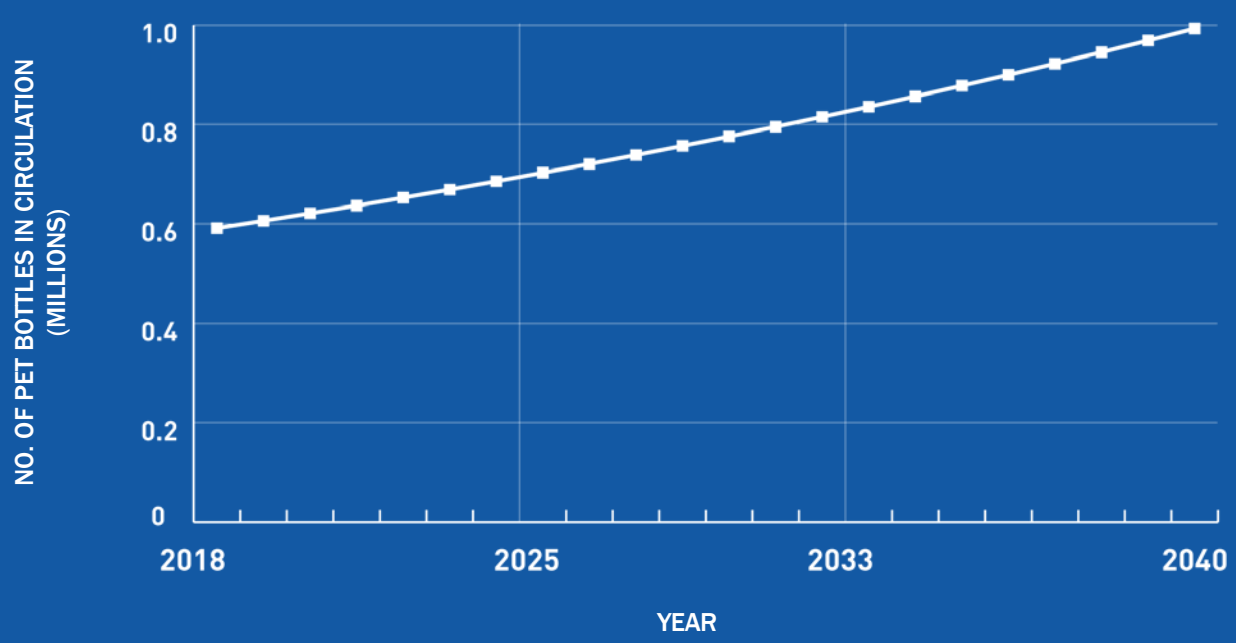
recovery rates, above 85%, require significantly higher deposit amounts ranging from approximately J$6 in Alberta, Canada (recovery rate of 86%) to a high of almost J$14 in Denmark (recovery rate 89%).

Based on data provided from manufacturers and distributors of PET bottled drinks in Jamaica, there are currently a total of 650 million PET bottles in circulation. The expected trajectory for consumption of PET-bottled drinks, based on

Table 4: Recovery rates in a sample of DRS countries according to deposit amount

COUNTRY	CURRENCY	DEPOSIT AMOUNT	PPP-ADJUSTED J$ DEPOSIT AMOUNT	RECOVERY RATE
Australia – South Australia	AUS Pound	0.1	4.83	79%
Canada – Alberta	CAN$	0.1	5.71	86%
Denmark	DKK	1.5	13.70	89%
Finland	EUR	0.1	7.45	92%
Norway	NOK	1	8.07	95%
USA – Michigan	USD	0.1	6.89	97%
Israel	Shekel	0.3	5.08	56%

Figure 2: PET-bottled drink consumption in Jamaica up to 2040



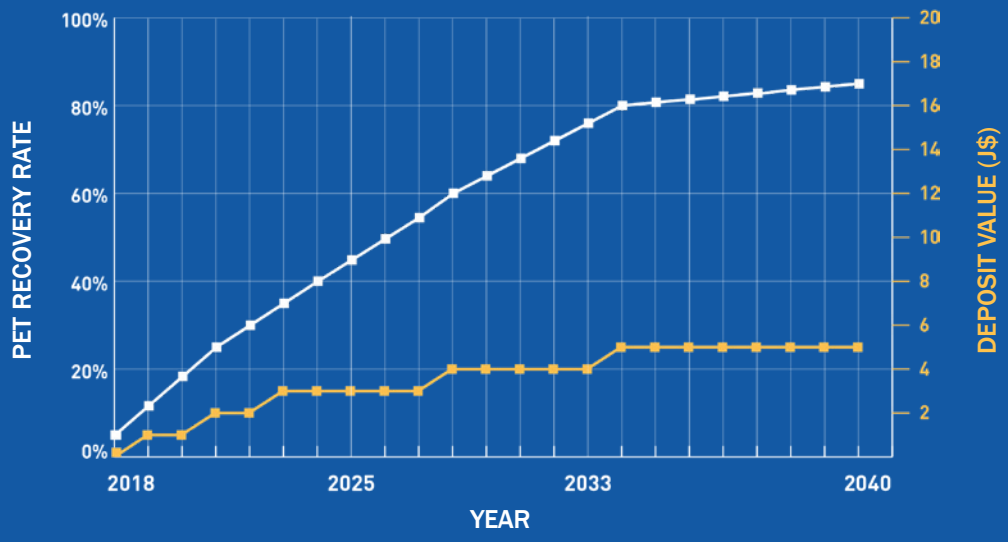
past growth trends, is shown in Figure 2 below.

Discussions with Jamaican manufacturers/distributors of PET-bottled drinks – some with experience implementing DRS in other countries in which they were present – concluded that the following recovery rates were highly ambitious but feasible:

- **25% within three years of implementation of the DRS (by the end of 2021, if the DRS were to be implemented in Jan. 2019)**
- **35% within five years of implementation of the DRS (by the end of 2023)**
- **60% within ten years of implementation of the DRS (by the end of 2028)**

Figure 3 shows, based on the data collected in the survey, the estimated deposit amounts that would be required to achieve the above-mentioned recovery rates.

Figure 3: PET recovery rates according to deposit amount under DRS in Jamaica



Note that the recovery rates of Figure 3 assume that returning bottles is convenient to the consumers. The convenience of return will depend on the DRS model adopted. A depot-based model is likely to be less convenient than models in which a larger number of easily accessible collection points exist. We would therefore expect recovery rates for a depot model DRS to be somewhat lower than indicated in Figure 3. However, for ease of comparison in choosing the most cost-effective model to employ for a DRS in Jamaica, we analyse both retailer and depot models assuming the same recovery rate for both types of models.

3.3 A UNIFORM DEPOSIT AMOUNT IS ASSUMED FOR ALL PET BOTTLES IRRESPECTIVE OF SIZE

The cost-benefit analysis assumes a uniform deposit (return) amount for all PET bottles irrespective of size. A few DRS internationally employ different levels of deposits according to the size, and in some cases the colour of the bottle, however, we suggest that a single uniform return amount be employed so as not to introduce additional complexity to the system. Minimizing the complexity at this level will give the DRS a greater chance of functioning smoothly, at the very least in the early stages when the system is still being learnt. Differences in sizes and colours can be introduced at the level of handling fees, if applied.

4. RESULTS OF THE ANALYSIS

Two types of cost-benefit analysis are conducted:

1. **Cost analysis to compare alternative configurations for implementing the DRS;**
2. **Cost-benefit analysis to assess the value of a DRS for Jamaica compared to the cost of implementing it.**

The cost-benefit analyses are conducted with respect to the economy as a whole, not from the point of view of any specific actor within the DRS system.

4.1 ASSESSMENT OF ALTERNATIVE DRS CONFIGURATIONS

In comparing alternative configurations for the DRS, we analyse the following, as mentioned in section 3.1.2:

1. **Retailer model with manual return system**
2. **Retailer model with automated return system**
3. **Depot model**[13]

Costs are assessed up to the point of achieving processed (crushed) bottles stored at the depot for collection by material purchasers. The costs analysed with respect to each configuration include:

- **Operating costs associated with the transportation of the PET bottles from consumers to intermediate- and end- collection points;**
- **Investment and operating costs associated with collection, handling and processing of PET bottles; and**
- **Recurring costs for the administration of the DRS.**

Other costs, such as the environmental costs of greenhouse gas emissions associated with transportation of PET bottles, with and without DRS, are not assessed in this study.

Table 5 shows the various configurations considered in the cost-benefit comparison, and Table 6 the main cost items for each configuration. As can be seen from Table 5, in the retailer model, we consider two possible options for transportation of the crushed containers from retailers to depots: using trucks which are externally contracted by the central administration body; and using trucks which are purchased and operated by the central administration body. Further details on the data assumptions used in the cost-benefit analyses are provided in Appendix 6.1.2.

The costs analysed with respect to each configuration for the DRS include:

Operating costs associated with transportation of PET bottles.

Costs associated with handling and processing of PET bottles.

Recurring costs for the administration of the DRS.

[13] A manual returns system is assumed for the depot model.

Table 5: Components of the DRS configurations analysed

Abbreviation	Description	Point of collection and processing	Means of handling	Transportation means
Ret-Man-Out	» Consumers bring bottles on their regular trips to retailers e.g. supermarkets » Bottles are manually handled and crushed by balers located on-site » Transportation companies are hired by the central administrator to transport bottles to large central depots to be accounted for prior to collection by material purchasers	Retailers	Manual	Contracted by DRS managing entity
Ret-Man-Int	» As above, except that the transportation of bottles to central depots is done by trucks owned and operated by the central administrator	Retailers	Manual	Trucks owned by DRS managing entity
Ret-RVM-Out	» Consumers bring bottles on their regular trips to retailers e.g. supermarkets » Bottles are fed into a RVM where they are counted and crushed on-site » Transportation companies are hired by the central administrator to transport bottles to large central depots to be accounted for prior to collection by material purchasers	Retailers	RVM	Contracted by DRS managing entity
Ret-RVM-Int	» As above, except that the transportation of bottles to central depots is done by trucks owned and operated by the central administrator	Retailers	RVM	Trucks owned by DRS managing entity
Depot	» Consumers make dedicated trips to the depots to return bottles » Bottles are manually handled and crushed by balers located on-site » The central administration does not undertake transportation	Depot	Manual	Consumer

Table 6: Main cost items included for each configuration

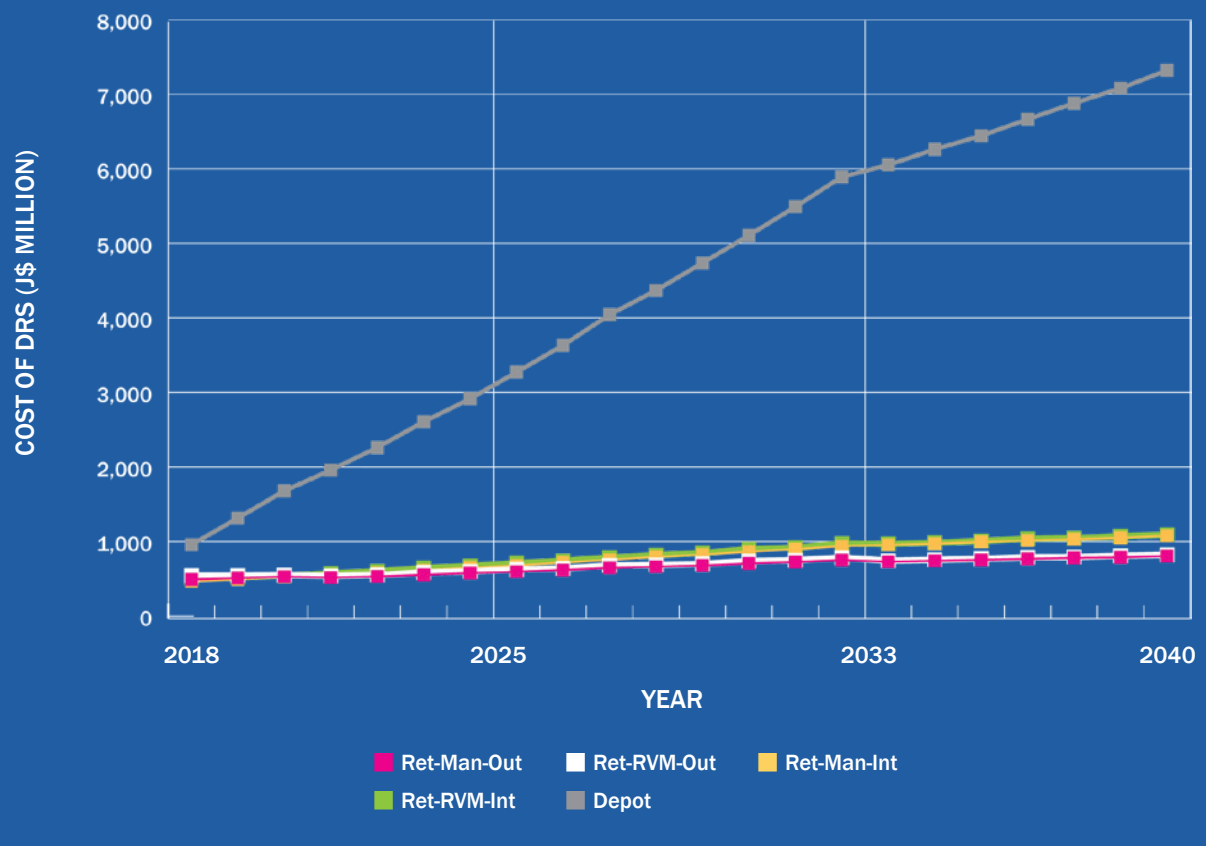
DRS Configuration	Investment Cost		Recurring Costs	
Ret-Man-Out	I1	Mini-Balers	R1	Labour
	I2	Bottles/Refunds accounting software	R2	Non-labour (utilities, e.g.) storage space
			R3	Regrouping depot – land lease
			R4	Regrouping depot – operating cost
			R5	Transportation cost (externally contracted)
			R6	Central administration (includes central system accounting, monitoring, customer service, education and public relations)
Ret-Man-Int		I1, I2 as above		R1 to R5 as above
	I3	Trucks	R7	Fuel + Labour for operation of trucks
Ret-RVM-Out		RVM		R1 to R6 as above
Ret-RVM-Int		I3 as above		R7 as above
Depot	I4	Processing depot – capital cost	R8	Processing depot – land lease
			R9	Processing depot – operating cost
			R10	Fuel costs for consumers

4.2 THE RETAILER-BASED MODEL, WITH AUTOMATED RETURNS SYSTEM, IS THE LEAST-COST DRS CONFIGURATION

The analysis shows that the retailer model, with automated (RVM) returns and outsourced transportation is the least-cost configuration for a DRS in Jamaica, costing the economy approximately $J500 million by 2040.

Figure 4 shows the economic costs of various DRS configurations. In all cases, the retailer model incurs significantly lower economic cost than the depot model. The very high costs of the depot model are due primarily to recurring costs, as shown in Figure 5, which are due to the cost in fuel to the consumer of transporting bottles to depots (refer to Figure 6), which represent approximately 80% of the economic cost of the depot configuration. In the case of the retailer model, the cost in fuel to the consumer is considered negligible since s/he would be going to the retailer to conduct other business anyway, and would simply return the empty bottles during the same trip. In the depot model, consumers would have to make a specific trip to the depot to return the bottles, and would not be travelling to the depot for any other reason. In terms of fixed costs (refer to Figure 5), the investment outlay of systems employing manual returns is lower than systems using automated returns where RVMs must be purchased, producing lower fixed costs. Also, as expected, the investment cost is higher for the configuration where transportation is undertaken through purchasing and operating trucks internally versus outsourcing transportation to an external company, resulting in higher fixed costs. On the other hand, the higher outsourcing of transportation incurs higher recurring costs.

Figure 4: Economic cost of various DRS configurations



[11] S. Edwards (2018)
[12] The survey received 223 responses at the time of publication

Figure 5: Comparison of fixed and recurring costs for various DRS configurations (2019 snapshot)

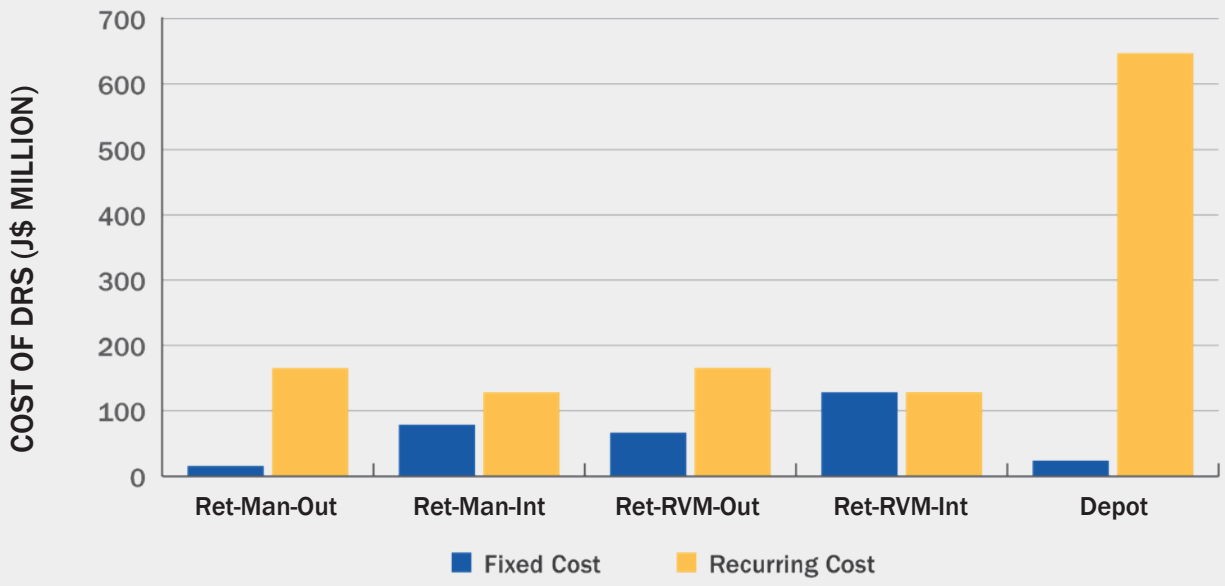
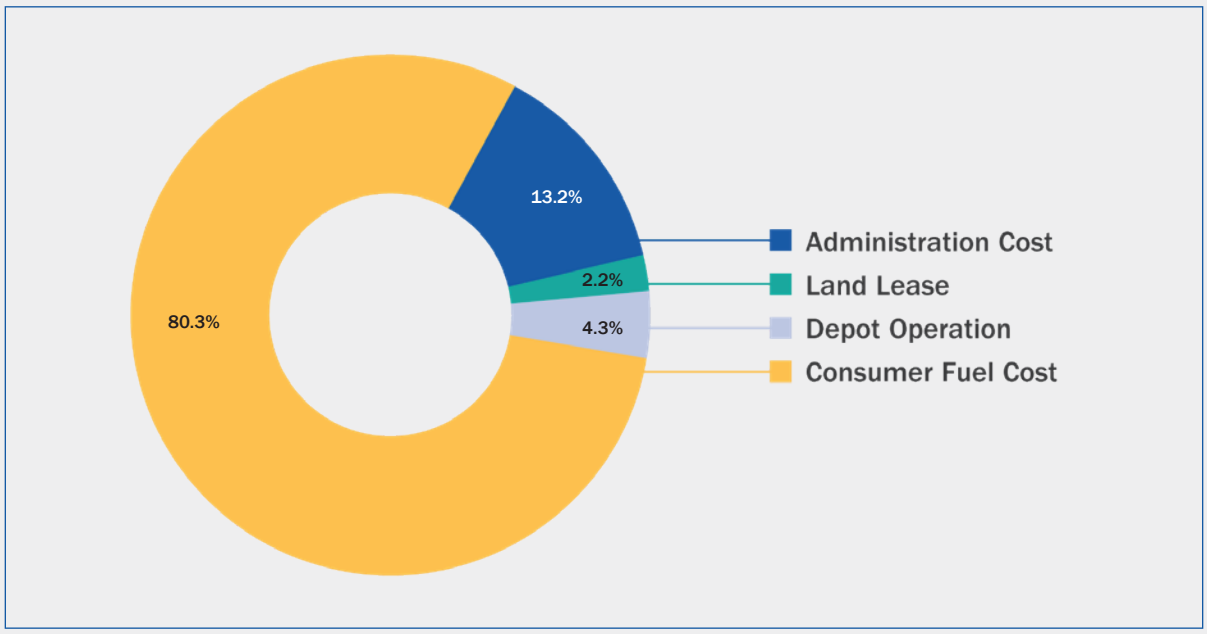
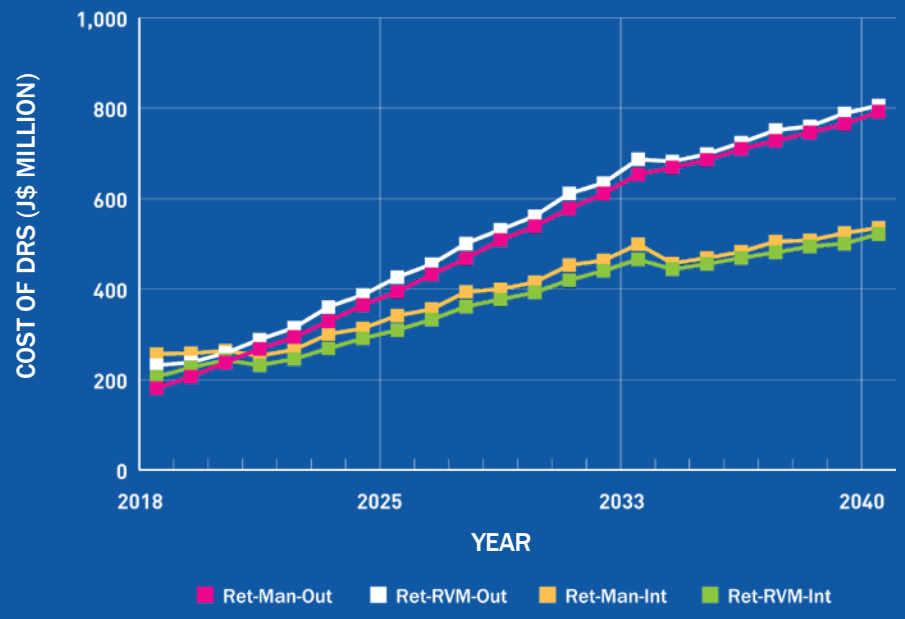


Figure 6: Breakdown of recurring costs for depot-based DRS configuration (2019 snapshot)



A closer look at the retailer-based DRS configurations (Figure 7) shows the automated returns systems to be lower cost than the manual returns systems. It also shows that overall, when both investment and recurring costs are taken into account, systems with outsourced transportation are lower cost than those where transportation is executed with purchased trucks.

Figure 7: Economic cost of retailer-based DRS configurations



4.3 THE ECONOMIC BENEFITS OF A DRS IN JAMAICA FAR OUTWEIGH THE ECONOMIC COSTS

The second cost-benefit analysis looks at the cost of implementing a DRS, compared to the benefits of a DRS to the Jamaican economy.

The benefits assessed with respect to DRS implementation include:

- **Avoided cost of solid waste management (SWM) by NSWMA**
- **Avoided cost disamenity from PET litter**
- **Avoided cost associated with flooding caused from drains blocked by PET litter**
- **Revenues from sale of processed PET for recycling**
- **Revenues from unredeemed deposits**

The avoided cost of SWM of PET recuperated in the DRS is the cost that would otherwise be incurred to transport and landfill PET. This is estimated to be approximately J$10.5 per kilogram, based on the current costs of transporting PET, and factoring in an additional twenty percent provision each for landfilling and overhead. The avoided cost of SWM is thus the per kilogram cost multiplied by the quantity, in kilograms, of PET removed from the waste management stream as a result of implementation of a DRS.

The avoided cost of disamenity from PET litter is estimated based on studies carried out in England and Australia on citizens' willingness to pay to reduce litter.[14] These studies found that citizens were willing to pay £40 to £50 per year in 2014 money (on average £45/year) to reduce litter. Based on relative purchasing power parity, the equivalent willingness to pay by Jamaican citizens is determined to be £0.50/year or roughly J$96/year per citizen. On this basis, the equivalent annual willingness to pay of the Jamaican population of 2.7 million persons is roughly J$260 million per year to reduce improperly disposed of waste. The benefit attributable to the DRS is therefore the proportion of this expense that would be avoided based on the increased quantity of PET waste removed from improperly disposed of waste, as a result of the

[14] Eunomia Research and Consulting (2014), based on Cambridge Economic Associates (2010) and based on PricewaterhouseCoopers (2010)

DRS.

The costs from flooding are estimated as the value of time lost by employed Jamaicans, on their daily commute, as a result of flooded roads from blocked drains due to improperly disposed waste, part of which results from PET in the waste. It is well known that even light rainfall in Jamaica causes significant traffic disruptions and longer commutes, particularly in urban centres. It is estimated that on average commuters lose thirty minutes of productive time as a result of flooding after each moderate rainfall event, and that there are five such events annually. Based on average weekly salaries of all employees in Jamaica, the value of time is estimated at J$1062/hour per employee, or J$531 per moderate rainfall incident. On an annual basis, this is equivalent to roughly J$3 billion per year in productive time lost due to rainfall. This lost value is attributed to the total amount of waste which is improperly disposed of each year. According to the Ministry of Local Government, approximately twenty-five percent of waste is improperly disposed of.[15] Attributing the cost of lost time to the amount of waste improperly disposed of results in a loss of J$11.3 per kg of improperly disposed of waste. With a DRS fewer PET bottles are improperly disposed of, reducing the amount of improperly disposed of waste and thus flood-related costs. This is because the DRS ascribes a value to PET bottles increasing the likelihood of recuperation, in line with the trend shown in Figure 3. The reduced flood-related costs resulting from a DRS can therefore be considered a benefit to be attributed to the DRS.

PET material recovered through the DRS can be exported and sold to PET recyclers. Currently RPJL sells its PET material to an intermediary to be exported for recycling; a similar practice is envisaged under a DRS. Revenues from the sale of PET material recuperated through the DRS are calculated using the current PET selling price received by RPJL of roughly for J$5.5/lb or J$12.1/kg.

As shown in Figure 1, when the consumer purchases a PET-packaged drink s/he pays a deposit price which goes to the central administration system. If the empty bottle is not redeemed for a refund the value of the deposit remains with the central administration. Unredeemed bottle deposits are therefore a source of revenue within a DRS, as no DRS is likely to achieve a one hundred percent recovery rate. The benefit from unredeemed deposits is simply the deposit amount multiplied by the number of unredeemed bottles, which is the total number of bottles in circulation, less those recuperated in accordance with the trend shown in Figure 3.

Table 7 shows the results of evaluating the benefits of a DRS. As can be expected the benefits are greater in 2040, where recovery rates approach eighty-five percent compared to the start of the system where recovery rates are around ten percent. Savings in the costs of solid waste management are J$122 million in 2040, and J$48 million of productive time is saved under a DRS. In addition, the avoided disamenity from PET litter is J$4.1 million in 2040. The largest benefits, however, come from the revenues generated by the DRS itself, with PET sales generating approximately J200 million/year in revenue by 2040 and unredeemed deposits accounting for over J$ 1 billion. Note that although a greater percentage (85%) of bottles is recovered in 2040 compared to 2019 (10%), the deposit value to attain that level of recovery is very high at J$10 per bottle, hence the high level of revenues generated from unredeemed deposits.

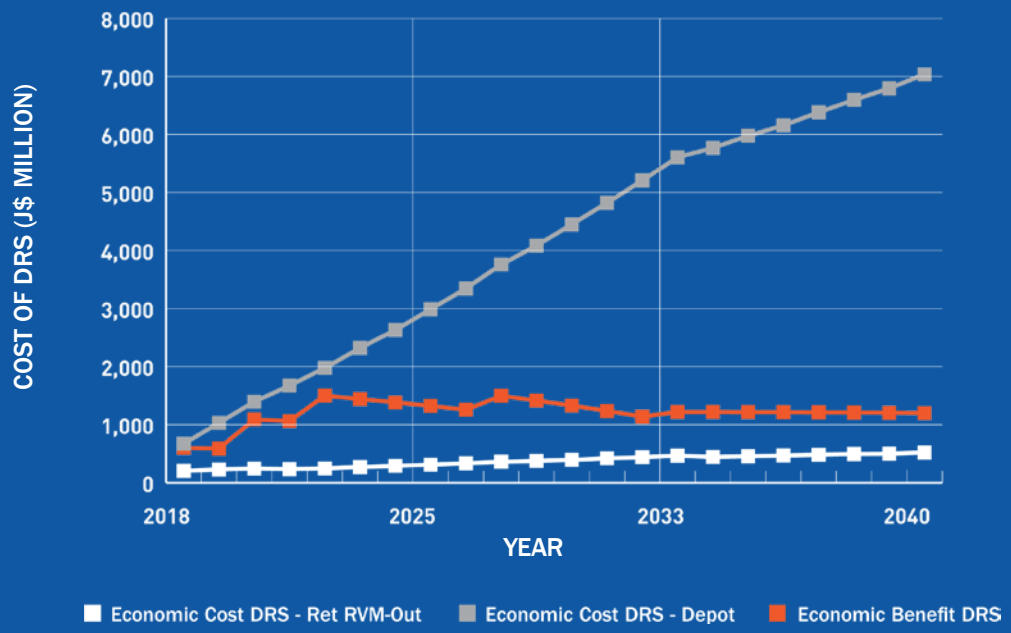
Table 7: Evaluated benefits of a DRS

Source of Benefit	Value of Benefit (mill JMD/yr)	
	2019	2040
SWM Cost Savings	4.7	123
Avoided dis-amenity from litter	0.34	4.2
Avoided flood-related costs	3.9	47.6
PET Sales	16.7	204
Unredeemed Deposits	575	819
TOTAL	**600**	**1,198**

[15] JIS (2016).

In terms of how the benefits measure up to the costs of a DRS, we compare the benefits to the costs of both the highest and the least-cost DRS configurations. As Figure 8 shows, the benefits of a DRS largely outweigh the costs for the least-cost choice of DRS, which is the retailer-based model with automated returns and outsourced transportation; benefits do not cover the costs of the highest-cost DRS which is the depot-based configuration. The choice of DRS configuration is therefore decisive in whether the implementation of a DRS is of net benefit to the economy or not.

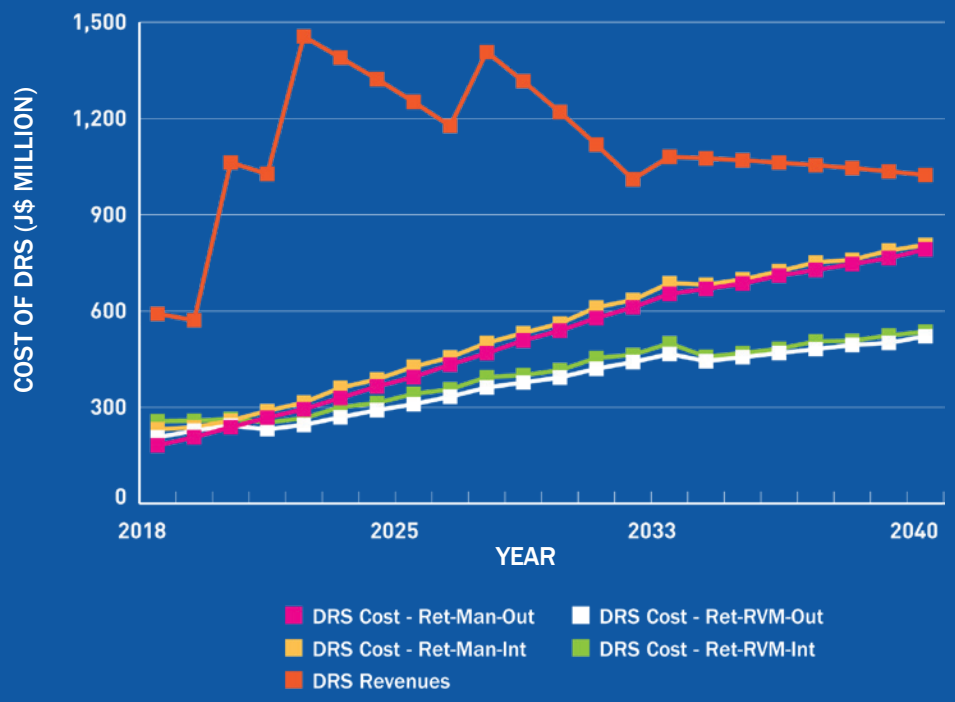
Figure 8: Costs and benefits of DRS in Jamaica



4.4 A DRS IN JAMAICA IS SELF-FINANCING

The cost-benefit analysis includes all economic costs and benefits of a DRS, including non-financial benefits such as avoided costs of disamenity from PET litter. It, however, does not tell us if the revenues from the DRS cover its costs, and thus if it can be self-financed or requires funding from other sources, for instance through joining and/or handling fees (paid by manufacturers and distributors) as is done in some countries. Revenues from the DRS include the value of PET sales and unredeemed deposits.

Figure 9: Revenues from the DRS compared to its costs



As seen in the figure, in the earlier years of the DRS, the system generates significantly more revenues than are required to finance the system, and is therefore self-financing. This is due to the relatively low redemption rates in the early years of DRS implementation. However, from 2032 onwards, where recovery rates are eighty percent and higher, the revenues raised from PET sales and unredeemed deposits and the costs of financing the DRS start to converge.

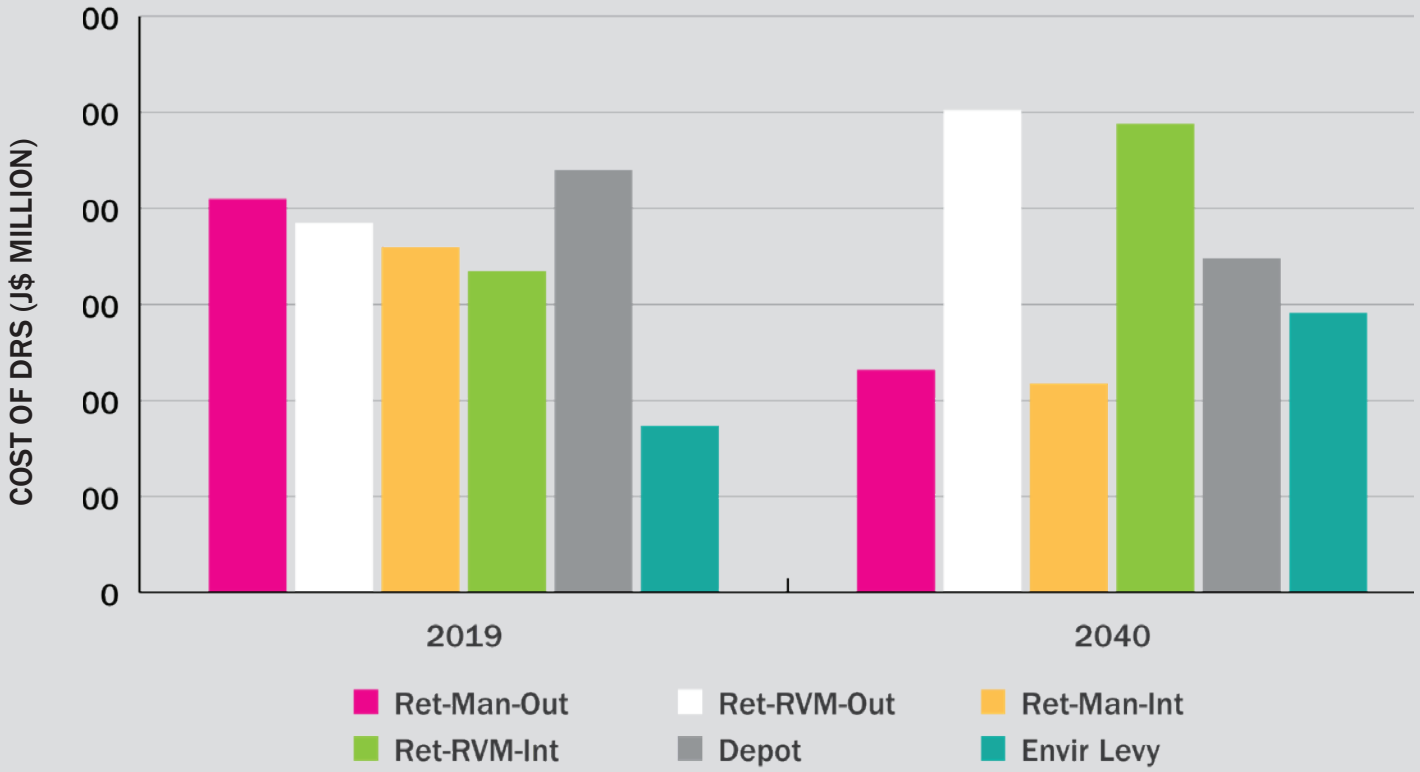
Excess revenues should be used to cover the costs of recovery from large PET-packaged drink consumption points, such as schools and hotels (refer also to section 5.7). Unlike the general consumer, who would effect her/his returns at a retailer where s/he would be doing business anyway, these large consumption centres would require their own collection and transportation services to be able to get their PET-packaged products to the redemption points. The costs of collection at these locations e.g. collection bins, transportation to processing centres and actual processing have not been included in the previous cost-benefit analyses, which have centred around recovery from the general consumer, and should be covered by the DRS.

Revenues should be reinvested into the DRS infrastructure and operations, to constantly improve its efficiency and effectiveness.

Finally, the revenues could be used to provide a partial rebate on the costs of the environmental levy borne by manufacturers and distributors, to provide them with an incentive to make individual efforts, through their marketing and awareness-raising channels, to incentivise consumers of their brands to return their used PET bottles. Under an industry-owner led DRS (refer to section 5.4), it would also encourage manufacturers and distributors to join the DRS. Manufacturers and distributors would receive a contribution towards the costs of their environmental levy in proportion to the level of returns of their bottles within the DRS. The partial rebate would only be allowed if the DRS meets its recovery targets. Figure 9 compares the value of excess revenues under various DRS configurations to the cost of the environmental levy in 2019 and 2040.[16] Depending on the DRS configuration adopted, the cost of the environmental levy can be at least partially compensated, for manufacturers who join the DRS. Providing incentives to manufacturers for participating in a DRS is not uncommon, for instance, in Finland, manufacturers and distributors who participate in the return systems, are exempted from the beverage packaging tax.

[16] The amount of the environmental levy is estimated using the value of the finished product only. That is, the environmental levy is calculated at a rate of 0.5% on 75% of the selling price, excluding GCT. In reality, the tax applies as such for locally manufactured goods only. At least 25% of PET-packaged drinks in the country are imported, and would therefore have the environmental levy of 0.5% applied to the cost, insurance and freight value of the imported good. However, in absence of detailed information on the value of PET-packaged imports, an estimate based on assuming all drinks are locally manufactured is expected to provide a reasonable estimate (for details on how the environmental levy is applied, see: www.jamaicatradeandinvest.org/faqs/what-environmental-levy-and-how-it-applied)

Figure 10: Excess revenues under various DRS configurations compared to the cost of the environmental levy to manufacturers



5. CONCLUSIONS AND RECOMMENDATIONS

5.1 A DRS IS ECONOMICALLY AND FINANCIALLY VIABLE FOR MANAGING PET WASTE IN JAMAICA, BUT MUST HAVE HIGH ENOUGH DEPOSIT RATE TO BE EFFECTIVE

From the analysis it is evident that the economic benefits of a DRS largely outweigh the costs, and should therefore be implemented as a means to manage PET bottle waste. Different DRS configurations do, however, entail different costs and a cost-effective DRS configuration should be adopted for its implementation to be of net benefit to the economy. A retailer-based model, with collections done at major retailers across the country, is more cost effective than a depot model – indeed the depot model's costs outweigh its benefits. The most cost-effective DRS configuration is one using retailers as collection points, and one which is based on automated returns using reverse vending machines. Here, any fixed and operation costs that would be borne by retailers when participating in the DRS would be covered through revenues generated by the DRS, as the retailer is not expected to cover these costs itself.

For the medium term a DRS appears to be self-financing with the revenues from unredeemed deposits being sufficient to cover the costs of implementation. Excess revenues should be used to cover the costs of collection and processing of PET bottles of large centres such as hotels and schools, who would have to entail additional costs e.g. transportation to get their PET-packaged products to redemption centres, unlike consumers who would be making returns to retailers where they would be doing business anyway. Excess revenues from the DRS should also be used to provide a partial rebate to manufacturers and distributors on their environmental levy.

Successful implementation of a DRS requires that the deposit level be sufficient to incentivise returns. The deposit should be progressive, to allow consumers time to become aware of the system and accept it, and gradual ramping up of recovery rates.

Successful DRS implementation entails a number of additional considerations and recommendations are provided in the following sections.

Successful implementation of a DRS requires that the deposit level be sufficient to incentivise returns.

5.2 CONVENIENCE OF RETURNS IS KEY TO A SUCCESSFUL DRS

Under the current model of voluntary returns, collection points are located at RPJL depots and a handful of voluntary collection points, such as Jamaica Environment Trust (JET) premises. CAPRI's survey indicates that achieving larger recovery rates will require that redemption points, for returning containers and obtaining refunds, be easily accessible. It will also require that collections be facilitated regularly and at convenient times.[17] The current system of collection points in Jamaica is not compatible with a convenient and easily accessible returns system and would therefore need to be revisited. Likewise a DRS based on a depot-based configuration, in which consumers would need to go to dedicated depots/collection centres to make their returns and get a refund, would not be considered convenient to the majority, based on the results of CAPRI's survey. Consumers would have no cause to go to these locations otherwise and would thus have to make a dedicated trip to be able to drop off their bottles. In addition, many existing depots and collection points currently do not accommodate drop-offs on weekends, which is when most persons would have time to drop off their bottles. CAPRI proposes that a DRS be based on integrating major retailers e.g. supermarkets, where many consumers are likely to go to in the course of doing regular business as collection and redemption centres. The retailer-based model is supported by the cost-benefit analysis as the better model; indeed, the depot-based model is not attractive from an economic cost-benefit point of view. The retailer-based model could be approached in phases, starting for instance with large supermarkets and gradually including a larger number of smaller retailers.

5.3 A CENTRAL ADMINISTRATION BODY SHOULD MANAGE THE DRS

A central body should manage and administer the DRS to ensure its smooth operation. The central administration body would be responsible, at a minimum, for:

- designing the system
- developing, organising and overseeing the logistics of the DRS
- accounting for bottles returned under the system and monitoring recovery rates and compliance
- administering the deposits (refunds) and any handling fees to be paid to retailers for participation in the scheme
- acting as a focal point for the flow of information and finances within the system
- communications concerning DRS operations
- facilitating progress towards meeting recovery targets

A key role of the central administration body is to ensure compliance and prevent fraud; having a single entity to oversee these functions, increases the effectiveness of monitoring and fraud prevention. Aggregating all managerial functions and operational responsibilities under a single entity also allows greater economies of scale. A central administration entity should ensure that unredeemed deposits are ring-fenced to ensure funds are always available to pay refunds. Transparent management of funds will be required to ensure unredeemed deposits and revenues from PET material sales are used towards agreed uses e.g. collections from hotels and schools, reinvestment in DRS infrastructure and, as relevant, partial rebates on the environmental levy.

The administrative body may choose to undertake some parts of the logistics themselves, or simply act as a coordinating body (for instance, as in Finland), which assures that all the required services of the DRS – collection, transportation, processing – are contracted and performed according to stipulated requirements. Currently, the RPJL – the managing and administrative body of the centralised PET bottle recycling system in Jamaica – assumes its own collection and transportation, and operates the processing depots. However, as the analyses have shown, it is more cost-effective to outsource collection and transportation services. Given the RPJL's central role and experience to-date in managing the collection and recycling of PET, they are a likely candidate for the central administration entity. However, with the expanded operations that would be expected under a DRS, the RPJL should consider whether it should continue to assume operational responsibilities or focus solely on the management and administration of the system. We recommend, that if the RPJL were to assume the role of administrative body, that it focus primarily on organization, management and oversight of the DRS and minimize its involvement in operational activities. Operational activities, such as transportation and processing could be outsource to increase the efficiency of operations. Isolating management and oversight activities from operational activities would also enhance the transparency of the central administration. Having a separate management and administrative entity, which has no involvement in operational activities, is common practice in industry-led systems. In Finland for example, Palpa, the administrative body, does not own any operative sections of the DRS, such as transport equipment or recycling plants, they solely manage and develop the operations of the system. RPJL indicates that their experience with outsourcing transport has not been particularly positive, as contractors do not always fulfil their obligations as required, with material sometimes left to stockpile at collection centres e.g. schools, exceeding the collection/storage capacity of these centres and creating health risks. This problem could possibly be addressed by contracting the transportation services under a competitive bidding process, with minimum service conditions specified in the terms of reference and contract to the winning party; failure to meet those conditions would be met with a financial penalty.

5.4 THE DRS SHOULD BE INDUSTRY-LED AND OWNED

The majority of successful and cost-effective DRS around the world are brand owner-controlled systems, that is, manufacturers, distributors and DRS-participating entities, such as supermarkets, lead and control the DRS. In Norway, for instance, the central administration entity is wholly owned by industry, including the brewery and beverage association, and the grocery store association, with its board of directors including representatives from Norway's leading grocery chain, Coca Cola, and two of Norway's major breweries.[18] In Oregon, the beverage recycling cooperative is owned by one hundred and eight of Oregon's beverage distributors and grocery retailers.[19] The RPJL, which already has significant experience in the management and operation of Jamaica's current PET collection and recycling system, and whose board includes representatives from Jamaica's largest PET-packaged beverage suppliers, is a good candidate to assume the role of central administrator. The Board should, however, be diversified to include other major players in the DRS value chain, to include for instance representatives from the private recycling industry and major retailers such as large supermarket chains.

STATE-RUN SYSTEMS

State-owned systems tend to be less flexible to accommodating changes in the evolution of the DRS and do not reinvest sufficiently in DRS for ongoing operational efficiency. In Connecticut, for instance, the handling fee received by retailers, established at the inception of the system in 1983, has not changed and does not reflect actual costs (which are higher than the handling fee currently paid.)[20] State-run systems also undermine brand-owners' product stewardship,[21] which not only removes the sense of responsibility from brand-owners but disempowers them. By allowing brand-owners to lead the effort in PET management, there is greater engagement of industry, and redemption rates tend to be higher as there is flexibility to ensure the system functions and adapts according to evolving needs. As brand-owners are also the most knowledgeable source of costs and logistics related to their products' distribution and use, they are the best placed to lead the design of the DRS, to monitor its operation, and identify efficiency improvements. Indeed, systems in which the state acts as the central administration entity, such as in California, do not allow brand owners to effectively control their costs;

state-run systems as obtains in the case of California, also have higher administrative overhead costs than comparable producer-controlled systems.[22]

Government does play an important role as it should establish recovery targets in line with those mentioned in this study; as the targets increase over time, there is a goal towards continuous improvement in the system. Under an industry-led system, however, industry is responsible for determining how those targets should be met i.e. how the DRS should be structured and run to meet those targets. An efficiently-run DRS, with a high enough deposit, and in which returns are convenient, should enable targets to be attained. The level of the deposit should be regularly reviewed to ensure it incentivizes returns. For instance, in Oregon, where a brand-owner led DRS is in place, legislation allows for the level of the deposit to be revised if the recovery rate drops below eighty percent.[23] A failure to meet targets could be accompanied by penalties, to ensure that manufacturers and distributors have an incentive to work towards recuperating the targeted number of PET bottles. A penalty could be in the form of foregoing any rebate on the environmental levy. Failure to meet targets should also signal a need for increased investment in infrastructure to enhance the ease and efficiency of redemption, and possibly a need to reduce fraud.

State-owned systems tend to be less flexible to accommodating changes in the evolution of the DRS and do not reinvest sufficiently in DRS for ongoing operational efficiency.

[20] Ibid
[21] Ibid
[22] Ibid
[23] S. Edwards (2018).

5.5 INITIAL INVESTMENT AND YEAR ONE OPERATION COSTS CAN BE FUNDED THROUGH A GOVERNMENT LOAN

Some up-front capital will be required to finance the cost of equipment and infrastructure for the DRS, as well as to operate the DRS in the first year, while revenues are just starting to be generated. Upfront costs include the costs of the participating retailers/collection centres, for acquiring equipment e.g. RVM, as well as the costs of any additional depots that may be needed to handle increased operations. Additional year one costs include storage costs for retailers/collection points, costs of additional staff to oversee the returns system, and costs of transportation and processing. In order to cover upfront and year one costs, the government could provide a loan to the DRS administration body, to be repaid as the DRS system starts to generate its own revenues.

Some up-front capital will be required to finance the cost of equipment and infrastructure for the DRS, as well as to operate the DRS in the first year, while revenues are just starting to be generated.

5.6 INFORMATION AND ACCOUNTABILITY IN DRS

PET-packaged bottles should have a label which indicates to the consumer that the empty bottle qualifies for a refund and the amount of that refund. Adjusting the labelling for locally-manufactured PET-packaged drinks is relatively simple, as it can be controlled in the production process to ensure labels meet the requirements at source. However, for imported products, it is unlikely that importers purchase in volumes that would give them sufficient buyer power to be able to convince producers to manufacture a label specifically to accommodate the requirements of a Jamaican DRS. In such cases, bottles would have to be labelled upon entry into the country and prior to sale. This could be done for instance through the placement of a sticker on the original manufacturer label. Some manufacturers/distributors have suggested that imported bottles be subject to a tax at the port equivalent to the amount of the deposit which is in effect in the DRS. However, this is not recommended as this will incur additional transaction costs in terms of monitoring and managing funds collected at the port to be brought into the decentralised DRS fund. Moreover, operating a separate system would require implementing additional controls to ensure a level of monitoring and accountability that could effectively control fraud, which would also incur transaction costs.

The accountability mechanism should ensure that returns can be identified according to the manufacturer or distributor, since manufacturer/distributor-specific information on returns will be useful for aspects such as:

- **Determining the allocation of any incentives linked to manufacturer return rates e.g. partial rebate on the environmental levy;**
- **Determining the allocation of any additional costs. In the case where the DRS revenues cease to cover its costs, manufacturers could for instance be required to pay handling fees in proportion to the volume of their brand which is collected and processed in the DRS; and,**
- **Monitoring recovery rates for individual brands, to identify whether additional marketing efforts may be required by to enhance their recovery rates.**

The accountability mechanism should allow for recording and reporting by retailers/collection centres on the amounts of bottles collected/refunded, by manufacturer, and the total deposits paid. It should also allow for cross-checking and verification of reported amounts, by the administrative entity, who effects refunds to retailers based on verified amounts. The frequency of reporting should be such that the retailer, which upfronts the cost of refunding deposits to consumers, is not out of pocket for a long period of time or for an amount which will significantly burden its cash flow. The reporting frequency should therefore be determined through careful analysis and consultation with participating retailers/collection centres. It should be noted that RVMs include digital counting and online connection features, which allows for faster accounting for and reconciling of returns, enabling retailers to be paid more quickly. RVMS also provide central administrators and distributors with quicker access to more reliable data on redemption rates by beverage type.

5.7 ENGAGING COMMERCIAL ENTITIES WITH HIGH BEVERAGE CONTAINER USE

The cost-benefit analysis of DRS configurations is based on the consumer bringing the bottles to the collection point. In the case of large-scale consumers of PET-packaged drinks, such as hotels and schools, we recommend that the entity charged with managing the DRS assume the responsibility (whether through their direct operations or through sub-contracting a service provider) of collection and transportation from these centres. This will relieve the burden from the hotels and schools, who would be dealing in much larger volumes than the general public, and who, unlike the general public, may not have regular cause to go to retailers (redemption centres), such as supermarkets.

The DRS framework should therefore include an obligation to ensure collection of manufacturers' PET-packaged products that are sold and delivered to these institutions. The obligation may be placed on the administrative body, who would factor these collections into its costs to be covered through the DRS revenues, or directly on the manufacturers/distributors, who may effect collection through their own distribution systems or through a separate service contract. The beverage supplier could, for instance, pick up the transportation units in connection with a beverage delivery, and deliver the returns to the processing plant, with refunds made back to the hotel/school. In Finland, hotels, restaurants, offices, schools and different event organisers return deposit packages through beverage suppliers.

5.8 THE PHASING OUT OF ONE- AND FIVE- DOLLAR COINS HAS IMPLICATION FOR CASH RETURNS

Given that Jamaica has dispensed with tender less than J$10, and bottle deposits are likely to range from J$1 to J$5 for the medium term, cash-based returns and refunds would need to be effected on the basis of counts of ten bottles. Alternatively, other means of effecting refunds should be looked into, such as providing vouchers that could be used towards the purchase of goods at participating retailers, or by refunding money to credit cards.

5.9 THE DRS SHOULD ALLOW FOR INCLUSION OF OTHER MATERIALS IN THE FUTURE

As mentioned in CAPRI's earlier study,[24] a DRS for PET bottles could function as a pilot for a wider pool of recyclable beverage containers. Containers such as glass bottles and aluminium could be phased into the scheme. One major manufacturer/distributor of glass-bottled drinks in Jamaica has already expressed interest in having glass bottles integrated into the DRS system. Several DRS around the world, such as those in Europe, do treat several types of material; for instance the Finnish system includes PET, glass and aluminium cans. Any DRS framework or policy should therefore contain provisions to allow for, or at least not exclude, the inclusion of other beverage containers into the scheme.

[24] CAPRI (2018)

6. APPENDICES

6.1 DATA AND ASSUMPTIONS OF THE MODEL

6.1.1 GENERAL DATA AND ASSUMPTIONS

Parameter	Units	Value
Exchange rate	JMD/US	125
No. PET bottles in 1 lb	/lb	25
Annual economic growth rate	%/yr	2.5%
Employed population		1,129,840
Total population		2,730,894
Gross domestic product of Jamaica	JMD	
Fraction of household waste which goes to landfill	%	75%
Fraction of household waste improperly disposed of	%	25%
PET recovery from waste stream (2017)	%	5%

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6.1.2 DATA AND ASSUMPTIONS RELATED TO THE COST ANALYSIS OF VARIOUS DRS CONFIGURATIONS

Parameter	Units	Value
Exchange rate		
Reverse vending machine – small	JMD/US	125
(incl. shipping, customs duty, GCT)	USD	27,000
Reverse vending machine – medium	%/yr	2.5%
(incl. shipping, customs duty, GCT)	USD	40,000
Mini-baler (for medium and large supermarkets/retailers)	JMD	267,500
Mini-baler (for small supermarkets/retailers)	JMD	89,000
Truck	JMD	10,000,000
Processing depot – capital cost	JMD/yr	11,500,000
Bottle/refunds accounting software	JMD	12,500,000
Operation costs		
Labour time per bottle	seconds	8
Labour cost (minimum wage)	JMD/wk	6,200
Non-labour costs of collection points e.g. utilities, storage space		
Regrouping depot – land lease	JMD/yr	3,600,000
Regrouping depot – operating cost	JMD/yr	4,000,000
Regrouping depot – capacity	kg/yr	4,000,000
Processing depot – land lease	JMD/yr	3,600,000
Processing depot – operating cost	JMD/yr	6,900,000
Processing depot – capacity	lb/yr	1,000,000
Transportation cost (all-in, externally contracted)	JMD/truck-load	10,000
Transportation cost, fuel (own trucks)	JMD/litre	138
Transportation cost, mileage (own trucks)	miles per gallon diesel	5
Transportation cost, labour (own trucks)	JMD/day	5,000

Parameter	Units	Value
Operation costs		
Transportation cost, maintenance (own trucks)	JMD/year	62,500
Truck capacity, uncompacted PET	lb	4,500
Truck capacity, compacted PET	lb	6,364
Average truck capacity factor	%	70%
Round-trip distance of average collection route (for retailer model)	miles	60
Transportation cost – consumers – fuel cost	JMD/litre	138
Transportation cost – consumers – mileage	miles per gallon gasoline	23
Round-trip distance for consumer to depot (depot model)	miles	10
Administrative costs		
Central administration costs	JMD/yr	85,200,000
Reduction in administrative costs as a result of the use of reverse vending machines	%	16%

6.1.3 DATA AND ASSUMPTIONS RELATED TO THE ASSESSMENT OF ECONOMIC BENEFITS OF DRS

Parameter	Units	Value
Benefits		
NSWMA waste management cost	JMD/kg	10.5
Amenity cost of litter	JMD/person/yr	96
No. rainflood incidents per year		5
Average productive time lost per incident	minutes	30
Economic value of productive time in Jamaica (based on average weekly salary of Jamaican employee)	JMD/h	1,062
Sale price of PET	JMD/lb	5.5

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