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Designing a Closed Loop System for PET Bottles Recovery in Nigeria

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Abstract

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The project is to design a closed loop system for PET bottle recovery. The purpose is to tackle the issue of indiscriminate dumping of PET bottles and to build a sustainable long term design to enable manufacturing companies reclaim used PET bottles, recycle and reuse the bottles in their manufacturing operations

The thesis consist of the theoretical and the empirical sections which helped the author to divide the project into two different design options to fit the Nigerian context. In order to identify the most important issues to drive initial process to spur the returns of PET bottles, the writer interviewed people who are stakeholders in the industry notably Palpa in Finland, scavengers, and a PET bottle manufacturing company in Nigeria.

Based on the response from the above stakeholders, it was easy but challenging for the writer to note the most important issues to be taken into considertion for the successful implementation of the closed loop system in a country like Nigeria. The project implementation design validate the interview conducted which if implemented will yield the desired result.

Keywords
Reverse Logistics, Closed Loop System, Green Logistics, Recycle, Re-use

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1 Introduction

The project is designing a return system of PET (Polyethylene terephthalate) bottles in Nigeria. Introducing the closed loop system is a vital component in the designation of this system. There are various means of bottle recollection system worldwide based on the existing infrastructure, knowledge and information and or orientation of consumers. These systems help the recollection process easy and less cumbersome.

Designing a system of return of PET bottles in Nigeria will be peculiar given the different infrastructure and challenges in that part of the world. There's a growing need for such system considering the menace indiscriminate disposal of these bottles cause. Proper disposal and re-use/recycling will be beneficial both to the company and will drive the sustainability index of any organisation to the top of its operations.

Indiscriminate disposal can be seen by the dumping of bottles in landfill which can cause environmental impacts and interfere with the ecosystem. Dumping of bottles indiscriminately also affects humans to a large degree and this gave rise to the concept of proper management.

Proper disposal of PET bottles involve the concept of recycling or reuse. The designing of a recollection system in Nigeria will focus on the case company partnering stakeholders in obtaining information which will aid the best approach and ultimately resulting in ensuring the success of such returns. The ever increasing population in most urban cities in Africa has necessitated the need for proper management of solid waste, PET bottles inclusive (Bjerkkli 2005, 1).

The growth of many urban settlements cannot be overlooked. It has given rise for institutions to look into the rising environmental hazards associated with the population explosion. Population in urban settlements in the world is considered to reach an all time high of five billion people in the next 35 years, and an expected 90 percent growth in developing countries (Medina 2002, 1). To this end, many beverage manufacturing companies has resorted to the use of PET bottles to meet the demand of their products. Attention should be drawn to the environmental issues caused by PET bottles. The issue of effective PET bottle disposal management cannot be overemphasised, PET bottles has caused environmental and health issues and it should be effectively tackled.

1.1 Background Information

According to Eyong (2006, 135) concern about sustainable practices and awareness in the developed world is on an ever ascending but not same in most undeveloped parts of the world. With a growth in awareness of depletion of environment also on an ever ascending scale, sustainable practices are the only way companies can maintain robust positions in our competitive world.

Companies all over the world are beginning to act responsibly by taking a look at their operations and end products to ensure they do less damage to the environment. Firms have no choice than giving a critical look at the effect of their activities on the environment. Responsible firms would do their best to reduce any negative environmental impact their operations would have on the environment. Nigeria as a developing country is facing huge challenges in waste management and improper plastic waste disposal has become a menace to the country as a result, firms must begin to take actions to help curb this harm to the environment.

1.2 Project Objective and Task

The overall objective of this project is to design a close loop system for the recollection of PET bottles, building an eco-efficient and environmentally friendly operations as it relates to how companies manage PET bottles.

Project Tasks

- Designing a recollection system for PET bottle return
- Propose a development plan to manage the process on the long term
- Encourage an environmentally eco-friendly attitude among stakeholders

1.3 Project Significance

The significance of the project is to improve knowledge in the area of environmental sustainability. Most importantly to tackle the menace of indiscriminate dumping of PET bottles and steer companies to be environmentally responsible in this era of conserving scarce resources.

More so, the project is concerned with tackling environmental sustainability issues. The issue of indiscriminate dumping of PET bottles is a huge problem that calls for urgent attention and this project will be able to tackle that. The project represents one of the issues in my sustainability courses and my thesis is a direct application of the knowledge garnered during the course work.

1.4 Key (Terms)

Reverse Logistics: Reverse logistics is the processes that come into play when materials flow back from consumers to the manufacturing operation for re-use (Hawks 2006, 1).

Close Loop System: This refers to the reversible movement of material in supply chain activities to effect cost reduction, promote profitability and most importantly support sustainable environment (Ferguson and Souza 2010, 2).

Sustainable Supply Chain Management: This is the effective control of various activities involved in product and services for the ultimate goal of satisfying customers. (Cetinkaya 2011, 3)

Green Logistics: It is the management of the flow of goods and services to achieve customer satisfaction, societal and environmental goals with less harm on the environment (Zheng & Zhang 2010, 116).

Recycling: This is a method employed with th aim of protecting the environment and significantly reusing waste materials (Spilka, Kania & Nowosielski 2008, 97).

Reuse: Putting materials that would have could have been defines as waste into new use and thereby reducing the accumulation of waste materials.

1.5 Scope

The scope of this project is strictly limited to PET bottle. It will involve the design of a system that supports recollection of PET bottles. The project would not involve the recycling of PET bottles but only a design of recollection system that fits the Nigerian context. The project would only limit itself on recollection due to the fact that the researcher has no knowledge of plastic manufacturing. It is believe that after the recollection, a manufacturer can take advantage of the recollected bottles.

1.6 Description of Case Company

Joenate Limited is a private owned consultancy company, It was registered by the Corporate Affairs Commission (CAC) in April, 2013. The company's operations cuts across initiating and monitoring environmental projects. They work with other environmental professionals that provide technical expertise in driving the green revolution which has forced many companies the world over to re-evaluate their operations. The company has a reputation to commit and deliver excellent services to its clients that cuts across multinational and private companies as well as NGO's.

As an environmental consultancy firm, the company is constantly considering ways in which it can influence corporate organizations to manage the environment in which they operate. They advise their clients on how the environment should be conserved and ultimately contribute to making the world a better place for humans. Manufacturing companies operations creates a great deal of environmental impact and also the indiscriminate disposal of wastes gave rise to the firm's consideration in raising awareness of the dangers it poses.

Reduction of carbon footprints by proper wastes management and recycling of materials are the directions the company considers that many third world countries should explore. Recycling/reuse of materials is important to many firms in Nigeria due to the volume of waste generated and the environmental degradation it causes should not be overlooked.

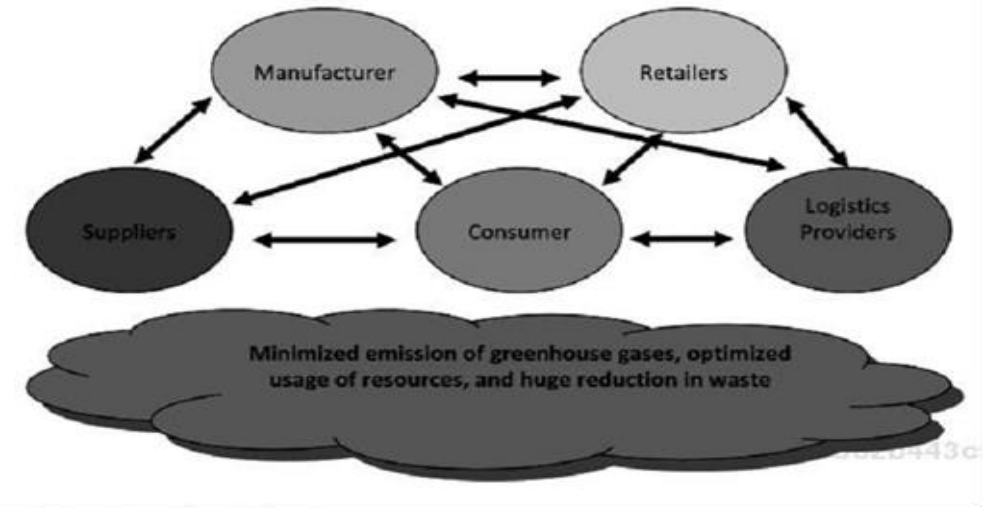
2 Conceptual framework

Green logistics is a new concept in developing country like Nigeria. However, in industrialized societies it has been in operation for many years and it is been integrated into the production and distribution of goods and services. It is a concept that all stakeholders should be involved in to prevent damaging the eco-system. Environmental issues such as pollution, erosion and landfills are social issues that government constantly legislate against. Though, it could add to the production cost of companies, it is of huge benefit to the society and humanity. The consumer also should be environmentally friendly just as the activities of the society at large should be eco-friendly. It is a concept adopted in the twenty-first century especially the developed countries (Vahabzadeh & Yusuff 2012, 35).

2.1 Green Logistics

Green logistics is the management of the flow of goods and services to achieve customer satisfaction, societal and environmental goals with less harm to the environment (Zheng and Zhang 2010, 116). Murphy & Poist (2003, 121) also describe green logistics as the strategy, manufacturing and allocation of goods and services with less damage to the environment. From these definitions green logistics can thus be described as a management strategy that aims at producing and distributing goods and services with less environmental damages. In this scientific and technologically advancing world, conserving the environment is one of the major challenges facing logistics and the supply chain management activities. Green logistics co-ordinates with the environment, consumers, production companies and government agencies, also it is an environmentally friendly and effective logistics system (Tang, Chen,Chen,Wang & Lin 2013, 1335).

From the figure below, it is clear that all stakeholders in the chain have a role to play in the achievement of a cleaner and safer environment for humans. Reduction of pollution by all the stakeholders can have a maximum impact in the achievement of a green supply chain.



(Source Emmett and Sood, 2010, 10)

Figure 1. A pictorial view of the concept of green logistics

According to Mckinnon (2013, 5) the history of green logistics can be traced to research done over forty years by different researchers, which focused on topics like reduction free transport externalities, city logistics, reverse logistics, corporate environmental strategies towards logistics, and green supply chain management, (Nietz, n.d.) also points out that the first concept of green logistics started in the 1990's due to the witting of consumers on environmental issues. According to Murphy and Poist (2003, 123) at the turn of the twenty-first century, environmentalism became the issue of discussion in government cycles, businesses and the society. With advancement in information available cheap to consumers, they are becoming more and more informed about whatever they consume and they way and processes that produce what they purchase, the idea of green logistics has come to stay and would be expected to dominate global logistics and supply chain issues for a long time to come.

Closed loop supply chain has become popular in the industrial sector as an effective and efficient method to deal with issues that affect end of life product disposal and amalgamating economic and environmental impacts of activities in the manufacturing sector is becoming the accepted norm on a worldwide scale (Hu et al. 2007, 1665). More and more firms have shifted their activities towards close loop systems and manufacturing companies have an opportunity to act in a very responsible way by retrieving back wastes from their customers after their end of life.

Clary (2013), strongly argues that because resources are becoming expensive recycling and re-use will develop to become the only option for optimization and cost efficiency. Manufacturing firms would be retrieving part of their products back to reuse in their pro-

duction cycle. Our natural resource availability are becoming limited due to rising consumption rates, population increase and etc., therefore there is the need for ensuring that resources are used efficiently.

Driving forces of green logistics

Green logistics ideology has the tendency to impact and affect the management practices of organisations, some of the ideas that drive green logistics are grouped into classes such as legislation, environmental concerns, economic and consumers as pointed out by different authors.

Legislation: According to Mann et al., (2010, 52) the main driver of all driving forces of all green logistics adoption by firms is legislation by governments, and other regulatory agencies. In some countries legislations would exist to set standards that firms would have to comply with at all cost. To exist in such an environment, one has no option but to comply because doing the otherwise would mean going out of business. As known widely about the developed world, legislations exist to monitor and ensure firms organize their activities in manners that pose the less threat to the environment (Sood 2010, 124) environmental regulations are continuously been set by regulators in most countries non-compliance on these laws brings sanctions and fines that can affect both the image and profitability of organizations. Even in the developing countries a time would come when there would be such legislations to limit degradation of the environment by organisations.

Environmental concerns: Walker, Di Sisto & McBain (2008, 69) points out that there has never been a time that people have become concerned with environmental and climate change issues as this generation. Organisations are beginning to have data on the effect of their activities on the environment and are becoming more responsible and finding ways to reduce the damage and harm they cause to the environment. Firms are beginning to look at life cycle management of their activities and to also find ways that can reduce unsustainable processes and activities in their operations.

Economic drivers: Mann et al., (2010, 52) makes a claim that improved financial performance may arise from the recapturing of value from products recovered, cost reduction, newer markets, higher revenue and etc. Bringing back products that can be re-used or recycled into new use can also reduce operational cost; the cost of buying virgin materials would be higher than a used material that can be recycled. As said by Jensen, Munksgaard & Arlbjørn (2013), the pressure on limited natural resources globally, there

has been an increasing pressure to find other alternatives inputs that can ease the pressure. Businesses operate to make some amount of profit margins, so if a cheaper source of input can be obtained firms would obviously use that alternative. So to achieve financial gains firms are strategically finding ways to make profit by adapting sustainable approaches to management.

Consumers: Consumers have become more aware of environmental issue due to the deterioration of the environment (Walker, Di Sisto & McBain 2008, 53). Consumers are the ones that bear the consequences of degradation on the environment and they are beginning to align themselves to products and firms that have less harm to the environment. Firms would have no choice than to present a good image that they care about the environment.

2.2 Close loop system

The closed loop system is a sustainable process that recovers materials for recycling, reproduction and remanufacture. It is an integrated system that involves the life cycle of a product which also involves customer participation for its effectiveness. Close loop system is sustainable due to its economic, social and environmental benefits (Amano 2014, 1). Daniel, Harrison & Van Wassenhove (2003, 3) also described close loop as systems that involve activities such as acquisition of products from end users. In simple terms close loop systems are strategies that ensure zero waste by reusing of products for the same or other uses.

As said earlier, pressure on global resources that are depleting are pushing firms to squeeze out the very best value of all resources putted into the production of goods and services. Global oil reserves are declining and this would have an effect on the amount of resins produces for plastic material production.

2.3 Types of Close Loop System

Wells & Seitz, (2005, 249) describes four different kinds of closed loop systems which are;

Internal closed loop systems: This occurs within the manufacturing process and it involves the re use of collected waste from production. For example waste water can be recycled and reused for production.

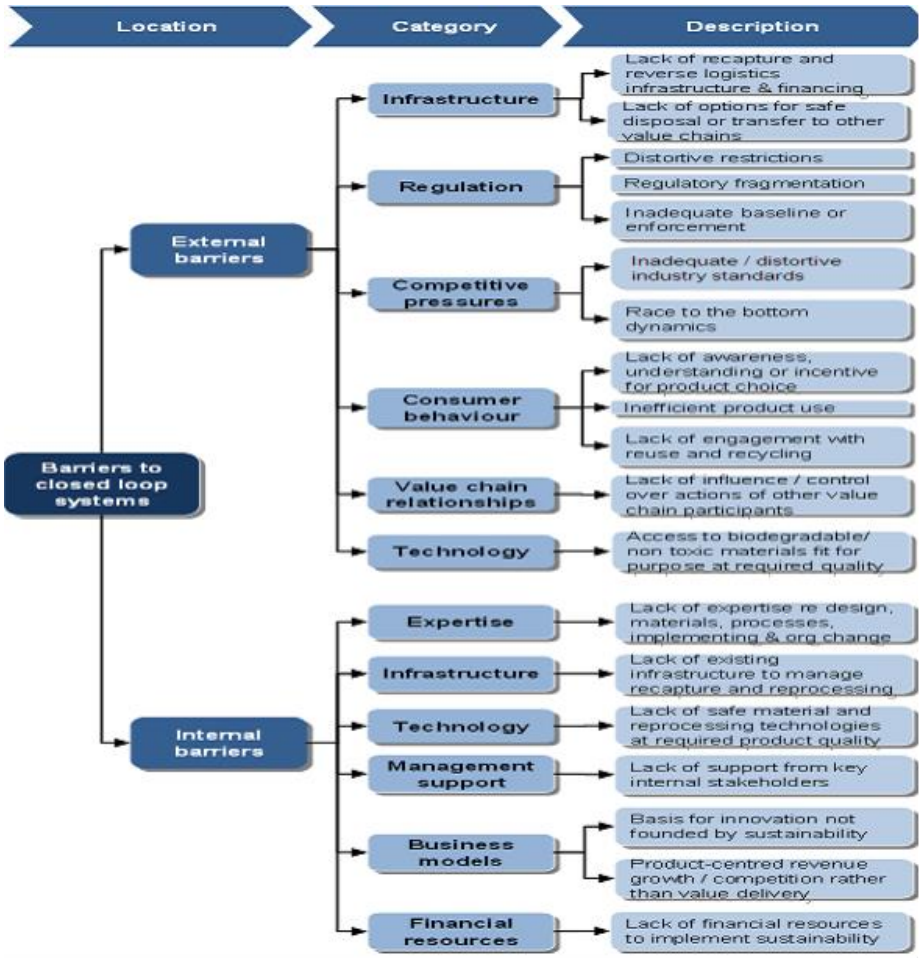
Post business loops: In this type of close loop system materials may be collected and returned between different business entities for value extraction: this type requires the participation of a third party to take delivery of the recycled material. Metal chippings or waste wood can be reproduced into new products after they have been transferred to another third party.

Post-consumer loops: this type is the standard closed loop known but difficult to operate. It involves the cyclical flow form production points to the consumer and back into the production as it left it. The idea here is to recover back used goods back into the supply chain for dismantling and reuse in the supply chain.

Post society loops: are the most extensive loops and involve materials recycling rather than reproduction. Among all these types of loops, the post-consumer loop best fits the idea of this project. It would involve the design of a system to reclaim the used parts of the product back into the system for reuse.

2.4 Challenges and Risks of managing close loop systems

Like every management practice close loop supply chains has its own challenges that creates a friction on the road to a creating a successful system. The World Economic Forum (2009) gave a vivid description and forms of barriers and challenges that can affect close supply chains.



Source World economic forum (2009)

Figure 2. Challenges of closed loop system

Infrastructure: Inadequate infrastructure in certain societies makes it difficult for close loop supply chain to operate smoothly.

Regulation: There are less adequate regulations to force both consumers and manufacturing firms to ensure sustainable approaches are adopted in the management of the end of life of products.

Competitive pressures: Though the recapturing of products that are either at the end of their life or are defective can bring benefits to firms, it requires substantial financial and other resources to achieve sustainable gains. Due to fear of loss of competitive positions through the use of funds in for example expansion of business ideas and rather using it on sustainable projects can make it difficult for those who even want to join the train of the green revolution.

Consumer Behavior: consumers can also create a challenge for a possible closed loop supply chain. If the consumers are not aware of the importance of bringing back products for reuse the system would not be efficient.

Partnerships: Lack of partners that can hold the different parts of the system, control of the activities must be done in coordination with other stakeholders so when there is no co-ordination everything becomes distorted.

Technology: It would enable for sustainable are not existent in certain societies, biode-gradable resources are also not available leaving producers with no option that to use bio-degradable resources.

2.5 Internal

Expertise: Dearth of adequate people with innovative ideas that can be used in the de-sign of green products and processes. If the organization does not have the people with the necessary knowledge and skill to manage the systems, there will all be complications that would not be successful as there will be chaos.
Infrastructure Lack of infrastructure to aid the management of the inflow of materials re-covered and processing can also be an obstacle that can prevent the possibility of having a well-functioning close loop system. A firm that does not have the necessary infrastruc-ture, for instance cars for the recollection from receiving agents and etc. can face difficul-ties.

Technology Lack of the necessary technology for the making of safe and sustainable products before forwarding to consumers can also be an obstacle to implanting close loop systems.

Stakeholder Support Stakeholders in the value chain must be willing to commit to the idea of adopting the close loop system right from the material sourcing to the product re-covery. Lack of stakeholder participation or involvement can also limit the chance of im-plementing a successful close loop system.

Business model Every business has its own business model and agenda, if the business does not have a vision of imbibing sustainable approaches in their management ap-proaches but just focus on profitability issues when facing intense competition, it would certainly be difficult to consider fully participating in a close loop supply chain.

Financial Resources Commitment of financial resources towards sustainability can also be a big challenge for firms.

2.6 Reverse logistics systems

The term reverse logistics has been described by Hawks (2006, 1) as procedure of moving products from their original state to their final destination (customers) with the intended purpose of capturing value from it or better disposal. Sarder, Rahman, Yenduri & Ijumbaet (2009) also describes the term as a supply chain process that strategizes, installs and controls the reverse flow and storage of retuned products. According to Abdullah, Yaakub & Hilman (2011, 513) it involves activities like processing returned goods due to faults, re-stocking, recalls, packaging and the reclamation of materials from customers.

Though the importance of the idea cannot be disputed. Mollenkopf & Closs (2005, 34) points out that, many firms see the idea of reverse logistics but do not give much respect in their planning activities. Murphy, (2007) also makes a point that though the concept of reverse logistics may not get the necessary resources and focus given to traditional product distribution, but it is getting attention in current supply chain management practices. As global awareness on the importance of sustainability keeps growing and growing, firms can no longer turn a blind eye to the reverse logistics, in especially areas where products can be returned back from the source for safe disposal or reuse in another form, this point is made clear by Partridge, (2014) that the idea of achieving cost-efficient and sustainable reverse supply chains has become a priority for many firms.

2.7 Benefits of reverse logistics

There can be no compromises between sustainable logistics and sustainable profitability; there are no logical arguments not to do it. Firms have immense benefits they obtain from reverse logistics and a few are as follows:

Ecological Objective

Our global environment is under threat due to the introduction of toxic and hazardous into materials by manufacturing firms that produce for consumption. Partridge (2011) makes acclaim that through an effective reverse logistics. Inefficient return processes that results in unnecessary transportation moves can be reduced and improve air quality as carbon emission would be reduced.

Products that have hazardous material components must have proper waste disposal to curb their impact on the environment. Reverse logistics would enable these toxic materials to be reclaimed back for the end consumer and either disposed of properly or used for other beneficial purposes. Through this waste disposed in our land fields and burnt in the open air would be reduced drastically, thereby reducing the impact they would have had on the environment.

Protection of Assets

Firms that have high intellectual property secrets that they do not want to reveal to other customers can use the idea of reverse logistics to reclaim their products and protect their intellectual properties.

Corporate social Responsibility

Customers would like to align themselves with firms that are responsible, and companies that have the advantage of applying sustainable approaches to their activities are using this as an advantage against those who do not have that privilege. Applying sustainable and practices can be a strategic weapon that can be used by firms to differentiate themselves from firms that do not use sustainable activities. It can also enhance the image of the firm since consumers are becoming more critical of firms now.

Economic Rewards

Firms that adopt sustainable approaches in the supply chains get value from recovered materials through either the recycling or used in other forms, governments and local authorities that also give tax benefits and other forms of incentives to firms that act responsible by taking care of the waste they generate in the environment. It can also at the end affect the bottom line and increase profitability. (Partridge, 2011) points out that applying sustainable methodologies in the management of activities enables the reduction of inefficiencies and costs. Oil prices influences the prices of virgin plastics from which PET bottles are derived and due to the fluctuating prices of oil prices, having a cheaper alternative can be a game changer.

2.8 Reasons for returns

Wells and Seitz (2005, 249) points out that though the idea of reverse logistics is to bring back product to the original manufacturing point, there are several other reasons why it happens, Bonev (2012, 12) describes some reasons for products returns which are;

When consumers do not get the intended features or quality they expect from products they have purchased, they return them to the place of purchase. A typical example of this is the purchase and return of shoes online and returning it back because the size does not fit the user.
Another reason is service return which is the return of defective product to make or servicer for repairs. An example is a rented photocopy machine, when this stop function the owner comes to replace it with a new one.
End of use returns occurs when a customer can return a product at a certain stage in its life time; usually such products can be reused because they come in a usable condition. The products are then sent on to other buyers who would need them for use.

End of life returns, here the products usefulness has come to an end and the user has the possibility of returning it to the original maker for safe disposal or recycling into other forms.

2.9 Current Trends in Bottle Returns

PET bottle returns has assumed a global dimension, due to the fact that various government of the world have recognised the need to produce products that are eco-friendly, so as to protect the environment and discourage landfills. PET bottle returns the world over, is converging to almost the same system which is the deposit system.

The deposit- refund system is a system whereby, bottles for drinks bought haven been paid for and a refund is given at the various designated return centres. This system is operational in most developed countries of Europe, North America and some parts of Asia, whereas in developing countries of Africa and Asia, the scavenging system is operational.

In Finland, the current trend of PET bottle return is the deposit-refund based system where there is a company (Palpa) that administers and develops the deposit based system of bottle returns. It is a broad based recycling system in which almost all bottles such as soft drinks, beer, sport drink and long drink bottles and cans have a deposit which can be recognised by an inscription on each bottle/can (Palpa.fi, 2014).

In Sweden, a law was introduced in 2006 requiring all package drinks in aluminium cans and plastic bottles to be recycled, it also set recycling target for beverage producers and was implemented in 2007. This system required beverage cans to be covered by a recycling/return system which is not run by the government but by manufacturing companies and its partners (Bottlebill.org, 2015).

The two systems are similar in that it is both backed by a law. The design of a recycling/return system will not be successful in its implementation without government law backing it. Finland and Sweden represents two examples of this theory.

2.9.1 Product Recovery Process

There are two means of product recovery process, the pickup and drop off options (Bajpai 2014, 47). The option adopted is dependent on the available infrastructure. In some countries, both options are employed for effective recovery of products from consumers. The recovery process should be driven by different stakeholders depending on the design adopted and structure put in place to aid the process.

2.10 Evolution of PET bottles in Nigeria

Nigeria as a country that witnessed oil boom in the early 1970's through the late 1980's did not witness the PET bottle menace. As a result of globalization and increase in population, manufacturing companies conceived the idea of producing beverages, water and alcoholic drinks using PET bottles. The manufacturing companies did not envisage the menace PET bottle will constitute at the early stage and as such, there was no proper laid down management of the bottles.

However, as PET began to constitute environmental hazard, state government made legislation for example, the Lagos State Waste Management Authority (LAWMA) to protect the environment and society from pollution. In Nigeria, the closed loop system is at its evolutionary stage. The design of this system is to look at the future benefits to the Nigerian society. It is therefore imperative to see how it is evolving, managed and sustained.

Presently, Lagos state waste management authority (LAWMA) is responsible for the collection of PET bottles engaging the services of the unemployed youths as well as women who scavenge the streets to pick up these bottles and returned by LAWMA to recycling centers. The close loop system will socially benefit Nigerians because the socially disadvantaged who engage in the returns of PET bottles are economically empowered to provide support for themselves and their families. These activities impact environmentally on the society thereby, meeting the target of the environmental regulatory agency who legislates on environmental matters in Lagos state through the Edict number 55, 1991 (LAWMA).

2.10.1 **Menace of PET bottles/Cans in Nigeria**

Water bottle is chemically composes of polyethylene terephthalate (PET). The bottling of water and the preparation of foods in cans has made life much easier for human. However, large quantity of PET and plastic bags are produced and consumed the world over. According to (Okrand 2008, 1) about five hundred billion to one trillion plastic materials that are produced around the world yearly, billions end up as litter or in landfills.

Nigeria as a nation has begun to experience the menace of PET bottles since it has become a plague to the human environment. These bottles end up in the open drains in the country trapping mosquitoes and other harmful insects that can cause diseases like malaria and cholera.

The problem of PET bottles also constitutes a serious danger to the coastal marine environment by affecting the aesthetic and recreational values (Schriever, 2013). PET bottles also causes huge economic lose when they fill the waterways. It is known to create waste management problems because they do not degrade easily. It threatens human safety by accumulating in landfills and natural habitats. They cause trans-boundary pollution because of their high buoyant nature thereby, affecting the global environment (Vennila, Jayasiri & Pandey 2014, 24).

(Hutchinson, 2008)
Figure 3 Environmental impact of PET bottles

The PET bottles affect the ecosystem in many ways such as the destruction of the natural habitat, which is evident in the sizeable portion of a large amount of plastic garbage patch currently floating in the Pacific Ocean (Ellsbury, 2012) and the introduction of unknown species. This is caused by the floating plastic debris and PET bottles which are usually

colonized by marine organisms thereby facilitating the transport of the unknown species. The PET bottles and plastic debris also serve as carriers of toxic organic and inorganic chemicals that are dangerous to human safety and health and also causes damage to vessels (Derraik 2002, 845).

Another menace of the PET bottles in Nigeria is that, it blocks drains, gutters, and canals thereby preventing the free flow of water and emitting foul stench. This has been regular feature in Lagos and other major cities in Nigeria. Unfortunately, Nigerians has adapted to this as a normal way of life (Adegboye, 2014). Before now, wastes are disposed indiscriminately in public places and landfills in Nigeria, thereby creating social chaos.

2.10.2 **Benefits of closed loop systems in Nigeria**

As a sustainable system, Nigeria stands to benefit socially, economically and environmentally.
Economically, the companies benefit by reduced cost of production through the re-use of materials and products rather than wasting them. This practice reduces landfill and the use of new resources. Through the reuse of products economic value is extracted from what would have ended up as waste (Wells & Seitz 2005, 250). Adopting the reverse logistics system by firms in Nigeria will boost the image of such firms and improves the firm's competitive advantage. Individuals' benefits from the proceeds earned returning the bottles. As it stands, it serves as employment to many in the society given the number of unemployed youths in the country. Scavenging for PET bottles is an informal industry with the potential to becoming a formal one in the near future.

Socially, the society becomes technologically inclined to meeting the standards practiced all over the world. The system also provides means of livelihood for some of the unemployed, as poverty is very common in less developed nations like Nigeria. Sustainable practices like these can affect the lives of people by providing a means of making some earnings for a living.

Environmentally, it discourages landfills, reduces solid waste to a manageable proportion and also prevents flooding. It also promote green environment and encourages better air circulation by reducing pollution. It reduces the rate of climate change by reducing carbon dioxide emission.

For a closed-loop supply chain to be successful requires total coordination of the forward supply chains and firms that have been able to practice proper implementation and coordination of reverse chains has produced excellent results (Guide Jr & Van Wassenhove 2003, 6).

The project is to design a recollection system for PET bottles in Nigeria. This process has been going on in the advanced economies of the world over the years in countries like Finland, Sweden, Denmark (Astrup & Hedh 2011, 1) . PET bottles are the most abundantly recycled plastic products in these countries for example in the US (US Environmental Protection Agency, 2010). PET bottles are used to produce secondary Pet polymer (R-PET)

R-PET is widely used in textiles and rigid packaging applications, including new PET bottles (Kuczenski & Geyer 2010, 2). Therefore, this design will be of benefit to the Nigerian economy.

3 Methodology

Methodology is the process of gathering data for analysis in a research work or gathering information to help design a process or a system. This work employed semi structured and unstructured interviews as a means of gathering information to design the closed loop recycling system for PET bottles. Interviews were held with stakeholders in the industry both in Finland and in Nigeria that led to the project design.

3.1 Qualitative research

Qualitative research is the theoretical background of this work. It is a kind of scientific research that explores respondent's in-depth perspective about an idea, it is flexible. Personnel to be interviewed include the company's administrative/communications manager (Palpa, Finland), logistics manager (PET bottle producer company, Nigeria), consumers in Nigeria. Interview is one of the tools for qualitative research, this is a research method that is designed to help researchers to understand people and what they say and do (Myers 2008, 5). According to Myers (2008, 5), one of the benefits of qualitative research is that the researcher understand the context within which decisions and actions take place. Also, qualitative research is about finding out what people think and why they think so, a face-face interview can provide valuable insights into a product or customers feelings.

Qualitative research can also be seen as a form of enquiry that analyses information contained in a language, it helps to identify customers' needs and what is important to them (Berkwits & Inui 1998, 195). Consequently, interview was utilized as a qualitative research tool for this project design because it helps to gather a reliable data, ensures good return of information (Cohen, Manion & Morrison 2011, 410), it offered opportunity for appropriate response from key actors in the recycling industry. The semi-structured and unstructured types of interview were used, since both are exploratory tools to study how the closed loop system will be designed in Nigeria, both research tools are non-standardized.

The semi-structured interview was used as a research tool because the researcher can alter the order of questions, have a list of themes, questions to be covered and can probe answers given by respondents (Saunders, Lewis, & Thornhill 2012, 320-325). It was used to gather expert's opinion about the closed loop system.
More so, the unstructured interview also known as in-depth interview or informal interview was also used to generate data for the design of the system. It was used because it explore in-depth area which the researcher is interested in, in order to meet the objective of

the study, it has no predetermined list of questions, interviewee is given the opportunity to talk freely so as to explain or build on his/her responses, it is a face to face interview (Saunders, Lewis, & Thornhill 2012, 320-325).

Expert viewpoint was gathered through face-to-face interview with Tommi Vihavainen- Admin/communications manager Palpa Finland (10 April, 2015). He possess vast knowledge in the design of beverage bottle return systems and gave valuable insights into designing one. I also interviewed Mr. Richard Aderogbo who is the Logistics manager of a PET bottle manufacturing company, Deno Plast Nigeria Ltd on 30th March, 2015. About 20 consumers was also interviewed and many dcided to stay anonymous.
The question asked Mr. Vihavainen: “How can a sustainable return system be established”?
His answers helped designed the results in building the recollection of PET bottle design in the project.

3.2 Reliability and Validity

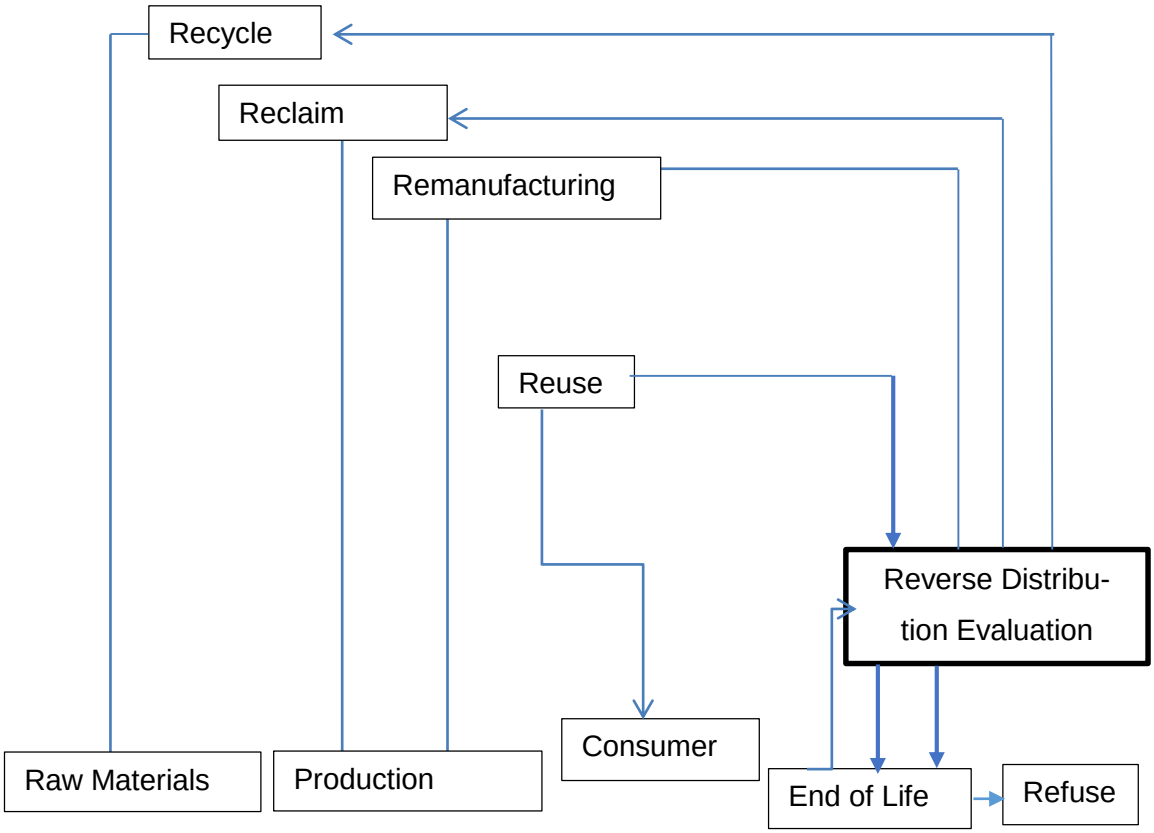
The reliability of the study was checked by adopting the semi-structured and unstructured interviews because it helps to eliminate response bias since the interviewer will seek explanations from the responses of the interviewee. Also the validity was checked by conducting the interview carefully such that, questions were clarified, the meanings to responses probed and topics were discussed from many angles (Saunders, Lewis, & Thornhill 2012, 327). Reliability from using non standardized research tools is assured because the research methods are not intended to be repeatable as they reflect the reality of the data at the time they were collected.

4 Results

The results of the interviews gave rise to the project design. It is noteworthy to mention that Mr. Vihavainen made an hour long presentation while answering the questions thrown at him.

The other interviews were also valuable in drawing up the design. The results of the interviews, theories from the theoretical framework formed the basis of the project design.

4.1 Network design for returns



Source: (Integrated recycling technology, 2008)

Figure 4 Network Design

The profitable and long term means of preserving the environment is avoiding waste but because it is impossible to do so because of human activities, the principle of the 3R's is adopted (Spilka, Kania & Nowosielski 2008, 98). The three R stands for reduce, reuse and recycle.

Reduce: According to Spilka, Kania & Nowosielski (2008) is the means of reducing waste in every possible means in the production and consumption.

Reuse: Spilka, Kania & Nowosielski (2008) opines that this is taking into consideration, the ploughing back of materials after consumption into remanufacture of new products. It is a means of reducing environmental impact and pollution due to waste accumulation.
Recycle: It is a known fact that products can be repeatedly used after virgin production and it hold true for a lot of materials that are disposed. Stakeholders (customers, manufacturers etc.) participation is vital for the network to be successful.

5 Project Implementation

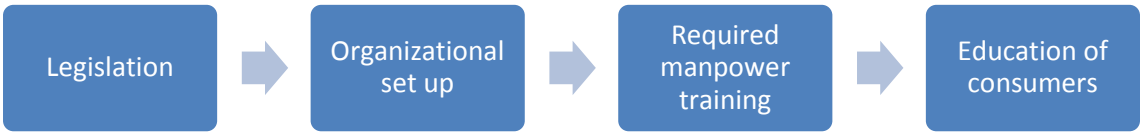


Figure 5 Steps for implementation of PET bottle returns

5.1 Steps

Figure 5 are the steps required to implement the design a closed loop system for PET bottle return. From the theoretical framework, legislations has being mentioned repeatedly as a very important tool needed for the design. Legislation makes the other steps easy to carry out and it is considered to be the most important step in the design. Organization of an administrative body is made possible and backed by law as in the case of Finland and Sweden (refer to chapter 2.10).

5.1.1 Legislation

Legislation is a very vital process in the implementation of the project, according to Burdett (2009, 4 & 5), it will kick-start the implementation process without which no success can be recorded in the implementation process. Legislation is needed in the following areas:

- ✓ Mandating and Enforcing Recycling
- ✓ Enforcing PET bottle Landfill Ban
- ✓ Recycled Content Legislation
- ✓ Product Take-back Mandate
- ✓ Legal Framework to Facilitate Sustainability

Mandating and Enforcing Recycling: Nigeria as an emerging economy, with a very large population generates tons of PET bottle waste (Balogun, 2012), without proper enforcement of recycling legislation mandate will not be effective. More so, there is a need for government legislation to ban the disposal of recyclable PET, since indiscriminate disposal of PET constitute environmental and health hazards. There is also the need for government legislation prohibiting the mixing of solid waste with recyclable PET because of the high cost involved in the separation of solid waste and PET.

Government should therefore impose fines against any organisation or bodies that infringe on this law. Furthermore, government should state the responsibility of the local state and federal on recycling of recyclable materials (Burdett 2014, 4).

Enforcing PET bottle Landfill Ban: Various arms of government should legislate in the enforcement of ban on PET bottle landfills. This is important because in Nigeria, PET bottle landfill has become a normal practice irrespective of the adverse effect of this act on the environment. To implement this project to the latter, it is recommended that the three tiers of government in Nigeria should legislate and enforce total ban on PET bottle landfill. It is also recommended that the law should be explicit on which arms of government should provide waste bin for the proper disposal of PET bottles in Nigeria (Burdett 2014, 4).

Recycled Content Legislation:

To implement this project satisfactorily, there should be a recycled content legislation whereby the state will play a leadership role in recycling by passing a law that gives preference to government agencies buying products with recycled content. The legislation should increase collection and supply of post-consumer recycled PET bottles in order to increase and sustain recycled content policy. The recycled content legislation will help to create a large market for PET bottle recyclers by increasing domestic demand, jobs, and investment (Burdett 2014, 5). The law should make provision for the state to take additional steps in the regulation of packaging by requiring a minimum recycled content in PET.

Product Take-back:

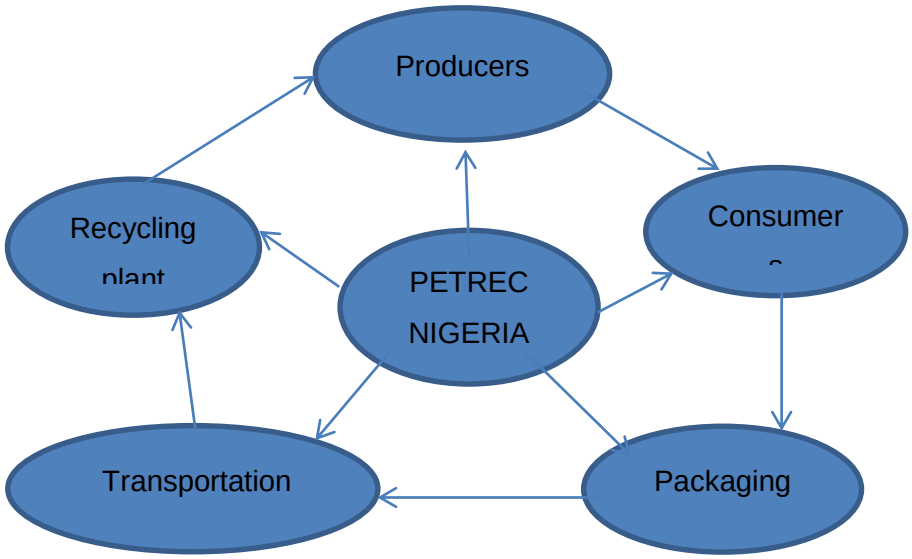
The law will make manufacturers to be more responsible by mandating them to establish a take-back system or become a member of the association that administers the refund-deposit system. The law should make manufacturers and retailers to play active role in the designing, manufacturing and selling of products so as to reduce the amount of waste generated (Burdett 2014, 5).

Recognition of the informal sector (Job creation)

Legislation should recognise this informal sector in the implementation of this project considering the huge population of Nigeria and low rate of employment. This informal sector

is the first step in the recollection of the value chain. Since it will serve as a source of employment, the law should explicitly state an improved working condition for these scavengers. The law will benefit Nigeria as a developing country because in the future, the scavengers can form associations that could venture into recycling. The recognition of scavengers by law will benefit the industries as well as the scavengers since intermediaries would be side-tracked from the system. The informal sector is one very important stakeholder in the recollection of plastic waste and in South Africa with a population of 52 million people, it is estimated that 85,000 inhabitants eke out a living from collecting wastes from dumpsites (Berg 2014, 5)

5.1.2 **Organizational Set-up:**



Source: Adopted from presentation by Mr. Tommi Vihavainen.
Figure 6 Proposed network of stakeholders for PET bottle returns

The implementation process involves the management of the recollection system which is made of two bodies: the Network of stakeholders and the Co-ordinating body. The researcher named the co-ordinating organization PET Recycling, Nigeria (PETREC) for the sake of the project. The co-ordinating body will initiate the deposit refund system for PET bottles and this will spur customers to return PET bottles. The stakeholders in the recollection process system will ensure the steady supply of PET bottles to the recycling plant (refer to figure above). The activities of the stakeholders are designed in such a way that there is understanding and co-operation amongst them so as to sustain the entire system. The co-ordinating body will manage the activities of the stakeholders and will be established by law. This co-ordinating body will be expanded in the future with greater responsibilities like **PALPA** in Finland (palpa.fi) **and PETCO** in South Africa ((petco.co.za)

Deposit refund system: The deposit refund system is a system that merges a tax on products with a rebate when returned for recycling, reuse or appropriate disposal. The system discourages “midnight dumping” which constitute environmental hazards (Walls 2011, 1). The deposit refund system avoids the problem of illegal dumping or burning of materials, it circumvents the taxes levied by authorities when materials are retruned.

In practice, it is backed by law in various countries for producers of beverage drinks to place a bottle bill on beverage container bottles. According to Walls (2011) in the US state of Michigan, deposit return ranges from 5 cents to 10 cents depending on the size of the beverage bottle. Consumers return bottles to reclamation centres run by the co-ordinating body in different strategic locations in cities.

According to Vihavainen (2015), the administering of a the refund deposit system in Finland is made possible by the partnership it enjoys with manufacturers of beverage drinks, hotel and catering services, waste disposal companies and recycling companies. The manufacturing companies charge bottle bills on each beverage drink distributed to wholesalers who in turn sell to retailers and the charge is returned when consumers but the beverage drinks from stores. Most interesting is, the charge revolves around the cycle of partners till the bottle is recycled and a recycling fee is charged by Palpa. It is a cycle of of funds going through all the stakeholders and Palpa keeps a record of the number of recycles bottles which makes the system transparent and easy to run. This system is adopted in the researcher’s design in figure 8.

Source: (Anthill Online, 2010)

Figure 7 Reverse vending machine

5.1.3 **Required Manpower and Training:**

This phase of the project is to employ, train and educate staffs needed to sustain the recycling system. It requires unskilled workers such as the scavengers/small scale waste pickers, semi-skilled workers like the wholesalers and the agents and skilled workers such as the private waste management operators and information technology (IT) experts. The IT experts are highly technical manpower resource needed in the future to design and co-ordinate the PET recycling process using software which are highly a technical part of the process. They are needed for the sustainability of the recovery of PET bottle at the introduction of the reverse vending machine (RVM) and also the coding of PET bottles using radio frequency identification (RFID) codes system to enable reverse vending machines read them.

5.1.4 **Education of Consumers**

The next phase of the implementation process (figure flow chart) of this project is the education of consumers. Man as a social animal is resistant to change even when the change process is a positive one, therefore to sustain the entire design there is the need to embark on massive education and campaign of the consumers so as to create awareness for public participation, which will increase the amount of PETs collected, as a result lowering the cost per tonne of collection. The education process will involve various sources of the mass media such as radio, television, public transportation system.
According to (Omran et al. 2008, 275), "*long term education and awareness campaign will change public attitudes"*. This attitudinal change towards waste disposal in public places is what Nigerians need to help build a sustainable recycling system.

Since Nigeria is organised into community groups, there will be need for regular with neighbourhood groups using the chiefs or town heads or village heads for educating the consumers on how, when and where to recycle. Education should make consumers to be aware of the importance of purchasing products made from recycled post-consumer materials as a vital element to ensuring a long term demand and economic infrastructure for the recovery of post-consumer plastic bottles (Burdett, 2009, 3). One of the benefits of adequate consumer education is that the major sources of potential contaminants can be eliminated from the PET recycling; this reduces the cost linked to sorting, removal and disposal of contaminants at the recycling facilities that process PET bottles. Another benefit of consumer education is to create awareness to economic development which will lead to job generation.

Furthermore, consumer education should lead to awareness of resource conservation and environmental protection. This kind of education will make consumers to be aware of the significant usefulness of PET bottles recycling to them as consumers, the environment and the society at large.

Education of PET bottle recycling should spread to local government, state government, federal ministries and parastatals and all stakeholders, since this is a new concept in the country. Particularly, The Ministries of Education and Environment should be seriously involved in the education campaign. The officials of the Ministry of Education should be made to appreciate the importance of making the government to include environmental education in the school curriculum because people's attitudes and lifestyles are acquired at an early age, therefore the education of young Nigerians at this early age will inculcate in them the need for environmental sustainability awareness and importance of recycling PET bottles.

6 Discussion and Conclusion

The main objective of this thesis is to design a closed loop system for PET bottle returns and it is meant to introduce a system to improve the collection and recycling of PET bottles in Nigeria, with the intention of enhancing the economic infrastructure of the country as well as environmental sustainability. The implementation of this project design will help to boost recycling activities, not only in the plastic industry but as well as the automobile industry where little or no recycling activities are taking place in the country at present. The successful implementation of this project will therefore create an economic boom in the recycling industry in general.

It is hoped that using the framework provided by the author of this design, the company will be able to successfully implement the system. The final product has been presented and accepted by the company, this chapter therefore will discuss the key outcomes and challenges, suggestion for future research, the feedback and the analysis of learning.

6.1 Key outcomes

The major outcomes of this project design are

- Economic benefits
- Conservation of natural resources
- Green manufacturing
- Encouraging environmental awareness

6.1.1 Economic benefits

According to (Mohanty 2015, 12) the recycling of plastics in Bangladesh for example has helped to boost the GDP and export status of the country and as a result it is now a major foreign exchange earner sector of the country. With this result, recycling of Pet bottles in Nigeria will also help to increase the per capita income and export of the nation, since Nigeria has a bigger economy and a larger population. Another economic benefit of plastic recycling is that it will reduce the cost of using virgin raw materials in the production of plastics since these raw materials are the derivatives of petroleum products, whose price is controlled by world market demand. The price petroleum products have increased significantly that the use of virgin petroleum products will influence the production of plastics (Hopewell, Dvorak & Kosior 2009, 2123).

Plastic recycling is now a major source of job creation to countries that have successfully implemented the recollection and remanufacture of used plastics (Becker et al 2014, 1; Ebenezer, Osumanu & Yahaya 2013, 207). Mohanty (2015, 12) reported that plastic recycling in Bangladesh created half a million jobs. Furthermore, the rate of creation of jobs in the recycling sector makes a profitable venture for nations to engage in so as to reduce the rate of unemployment especially in developing countries like Nigeria.

6.1.2 **Conservation of natural resources:**

Recycling reduces the use of crude oil (Hopewell, Dvorak & Kosior 2009, 2123), which is the source of raw material for the production of PET bottles. It is evident that the reduction in the use of oil will help in the conservation of this natural resource. There is no doubt that the manufacturing of new plastics from virgin materials depletes the natural resources available (Becker et al 2014, 1) through constant exploration of these resources which will be reduced when post-consumer plastics are recycled. Government should therefore see that there is a strict adherence to the implementation of PET recycling so as to conserve the natural resources for the sake of the unborn generations.

Plastic recycling helps build a sustainable environment for the future (Becker et al 2014, 1) by removing plastic dumps in landfills and other natural environment. In report by (Mudgal & Lyons 2011, 101) he reported that the dumping of PET bottles and plastics into landfills take up major portions of the land and also this generate bio-aerosols, odour, and distort the natural beauty of the land.

The dumping of PET bottles and plastics leads to the release of dangerous chemicals into the atmosphere. (Mudgal & Lyons 2011, 101) also reported that the organic break down of biodegradable waste in landfill causes the release of greenhouse gases. Therefore, the collection and recycling of PET bottles and plastics instead of dumping into landfills help to recover land, eliminate odour and the health risk associated with it and also prevent the release of greenhouse gases. Recycling of Pet bottles will also reduce the emission of carbon dioxide into the atmosphere (Hopewell, Dvorak & Kosior 2009, 2122) and this will in turn help to eliminate acid rain.

Furthermore, plastics waste constitute a major source of land and water pollution of which PET bottles constitute a great amount. In developing countries like Nigeria, land and water environment are consistently being polluted by plastic litters and it is worthy to note that a very large percentage of waste ends up as litters in land and water environment (Lithner

2011, 3). Therefore, recycling of plastics especially PET bottles will help to reduce the pollution of land, water and air.

6.1.3 Green manufacturing

The term green manufacturing is not easy to pin down to a single definition as there are different schools of thought concerning the concept. However, (Liu et al 2005, 627) said the concept is an advanced manufacturing method and it is the application of sustainable science to the manufacturing industry. This concept seeks to use low raw material cost that is, recycling waste rather than virgin production, production efficiency gain by utilising less energy and water. Green manufacturing seeks to improve corporate image that, creating an environmentally friendly company. In a nutshell, it involves the production processes which use inputs with relatively low environmental impact which are highly efficient and which generate little or no waste or pollution.

6.1.4 Environmental awareness

Legislature by the government will enforce stakeholders to be environmentally aware of the impact their activities have on the environment. Education of customers is a vital component of the design which will discourage indiscriminate dumping of post-consumer PET bottles which clogged drainages in many parts of the cities in Nigeria. The combination of both legislature and education will ultimately serve the good of the environment thereby leading to environmental awareness.

6.2 Challenges

There is no design system without its challenges, I therefore envisage that this recollection system will be faced with some major challenges among which are fraud. Fraud can be in the area of consumers coding fake PET bottles to beat the reverse vending machine (RVM).

Secondly, mixing of coloured plastics which will translate into higher cost of separation and may not be conveniently and effectively recycled ((Hopewell, Dvorak and Kosior, 2009, 2126).

Thirdly, on the technical aspect of the design where "*Most post-consumer collection schemes are for rigid packaging as flexible packaging tends to be problematic during the*

collection and sorting stages. Most current material recovery facilities have difficulty handling flexible plastic packaging because of the different handling characteristics of rigid packaging" (Hopewell, Dvorak & Kosior 2009, 2115).

Humans resistance to change will pose another challenge to the success of the design as they have to be re-orientated to understand the importance of recycling and environmental sustainability.

6.3 Company Feedback

The company is satisfied with the design of the closed loop system for PET bottle return. The introduction of return using wholesalers and agents was considered the best step as this will ease the introduction of the future plan that is being proposed. The company is planning to speak with stake holders in the industry to kick-start the initial return of PET bottles which they consider as an important step in realising the PET bottle return in this part of Africa.

The project was done through seamless communication between the author and the case company and it made the project a lot easier though tasking on the part of the author. Both parties were constantly in communication throughout the design of the project and as a result it was easier for the company to understand the motive behind the design proposed by the author. The company also gave valuable advice to help the author consider many options thereby having a wide range of ideas on the table.

The project design is meant to tackle issues bothering on indiscriminate disposal of PET bottle, environmental impacts caused, sustainability issues, as well as conserving resources. At this point (April 2015), one cannot evaluate the success of the project as it has not been implemented but the author is positive that the implementation of this design will mark a turnaround in the PET bottle industry and change consumers behaviour towards the environment.

6.4 Analysis of Learning

The project has made me improve on my research skills and broaden my professional knowledge in the subject of PET bottle returns and issues of environmental sustainability overall. I was excited and impressed with the interview I carried out with communications manager at Palpa. It was the turning point of my project design and helped me understand the challenges of the project.

I have also developed an enviable time management skill which without it, it would have been a herculean task in completing the project. I have also improved my interpersonal relationship skills as this was vital in dealing with different people in the course of trying to complete the project. The task which the project presented improved my information gathering skills, sieving the most important information while discarding that which is not required for the project.

Finally, the research has opened a new horizon for the author in the field of environmental sustainability and has made to author to begin to consider further interest for advanced in this interesting field which many corporate organizations are taking advantage of to stay ahead in the ever competitive global business landscape.

6.5 Suggestion for future research

PET bottle recycling in Nigeria is at its developmental stage and this research design focused on the recollection of PET bottles which is one aspect of the recycling process and this does not give a comprehensive view of recycling. There are a lot of work to be done in the Nigerian context considering that it is a new concept. Consequently, further research should be carried out in the following areas:

- ✓ Economic impact of PET recycling
- ✓ Rate of PET bottle returns in Nigeria
- ✓ Impact of PET recycling on environmental sustainability
- ✓ Comparative study of PET recycling in emerging economy and the advanced world.

List of Figures

Rereference List

Abdullah N, Yaakub S & Hilman, H. (2011). Reverse Logistics Adoption among Malaysian Manufacturers. In: International Conference on Management, Economics and Social Sciences. Bangkok.

Amano, M. 2014. PET Bottle System in Sweden and Japan: Masters. - Lund University.

Anon, (2015). URL: (http://www.petco.co.za/ag3nt/system/about_petco_01_glance.php) Accessed 21 Jan. 2015.

Anthill Online, 2010. Reverse Vending Machines (SMART 100) - URL: http://anthillonline.com/reverse-vending-machines-smart-100/ Accessed 27 Jan. 2015.

Astrup, N. & Hedh, A. 2011. European refunding scheme for drinks containers Brussels: European economic area joint parliamentary committee. URL: http://www.europarl.europa.eu/meetdocs/2009_2014/documents/deea/dv/2611_07_/2611_07_en.pdf Accessed 18 Mar. 2015.

Berg, S. 2014. Case studies about involvement of the informal sector in the collection of PET bottles. Gouda: WASTE. URL: http://waste.nl/sites/waste.nl/files/informal_sector_and_pet_bottles_final.pdf [Accessed 12 Feb. 2015].

Bjerkkli, C. 2005. The cycle of plastic waste: An analysis on the informal plastic recovery system in Addis Ababa, Ethiopia.

Blumberg, D. 2005. Introduction to management of reverse logistics and closed loop supply chain processes. Boca Raton: CRC Press.

Bottlebill.org, (2015). BottleBill.org - Beverage Container Legislation in Sweden. URL: http://www.bottlebill.org/legislation/world/sweden.htm Accessed 24 Feb. 2015.

Burdett, S. 2009. Improving Plastic Bottle Recycling in North Carolina. URL: http://www.mpa.unc.edu/sites/www.mpa.unc.edu/files/KatieBurdettsCapstone.pdf Accessed 4 Nov. 2014.

Cetinkaya, B. 2011. Sustainable supply chain management. 1st ed. Berlin: Springer

Emmett, S & Sood V 2010. Green Supply Chains. Hoboken: John Wiley & Sons.

Ferguson M & Souza G 2010. Closed-loop supply chains. Boca Raton: CRC Press

Hawks, K 2006. Reverse Logistics Magazine - What is Reverse Logistics? | RL Magazine | Reverse Logistics Association. [Online] Rlmagazine.com URL: http://www.rlmagazine.com/edition01p12.php Accessed 6 Dec. 2014

Hutchinson, A. (2008). Is Recycling Worth It? PM Investigates its Economic and Environmental Impact.URL: http://www.popularmechanics.com/science/environment/a3752/4291566/ Accessed 27 Jan 2015.

Hu G, Wang L, Bidanda B & Wang Y. 2007. A New Model for Closed-loop Product Lifecycle Systems. In: IIE Annual Conference.Proceedings. [online] IIE Annual Conference. Proceedings: Institute of Industrial Engineers-Publisher, pp.1660-1665. URL: http://ezproxy.haaga-helia.fi:2133/abicomplete/docview/192452143/DB1197B085294552PQ/1?accountid=27436 Accessed 1 Dec. 2014.

Kuczenski, B. & Geyer, R. 2012. PET bottle reverse logistics—environmental performance of California's CRV program. URL: http://www.container-recycling.org/images/stories/PDF/CA-CRV_PET_bottle_reverse_logistics.pdf Accessed 22 Jan. 2015.

Mann H, Kumar U, Kumar V & Mann, I. 2010. Drivers of Sustainable Supply Chain Management. IUP Journal of Operations Management. URL: http://ezproxy.haaga-helia.fi:2133/abicomplete/docview/817457635/9F229126C7FD44D1PQ/5?accountid=27436 Accessed 14 Nov. 2014.

McKinnon, A. 2013. 11 Benefits of Green Supply Chains. 9 Key Drivers for Green Logistics and Supply Chains. URL: http://onlinesuccesscentre.com/2013/01/green-supply-chains/ Accessed 10 Oct. 2014.

Mollenkopf, D. & Closs, D. 2005. The hidden value in reverse logistics. Supply Chain Management Review. URL: http://ezproxy.haaga-helia.fi:2118/abicomplete/docview/221132943/5554003257E742F3PQ/2?accountid=27436 Accessed 10 Oct. 2014.

Murphy, J. 2007. Best Practices In Reverse Logistics Can Ease the Pain Of Product Returns. Supplychainbrain.com. URL: http://www.supplychainbrain.com/content/logisticstransportation/reverse-logistics/single-article-page/article/best-practices-in-reverse-logistics-can-ease-the-pain-of-product-returns/ Accessed 4 Oct. 2014.

Murphy, P. & Poist, R. 2003. Green perspectives and practices: a “comparative logistics” study. Supply Chain Management: An International Journal. URL: http://ezproxy.haaga-helia.fi:2118/abicomplete/docview/216864832/9D9F5916C1F241FDPQ/11?accountid=27436. Accessed 17 Nov. 2014.

Myers, M. 2009. Qualitative research in business and management. SAGE, Los Angeles

Nietz, M. (n.d.). Key elements for a well-functioning sustainable logistics system. Master. Brazilian School of Public and Business Administration - EBAPE.

Okrand, C. 2008. Cut Your Use of Plastic, Plastic, Plastic. URL: http://www.smithsonianmag.com/ecocenter/cut-your-use-of-plastic-plastic-plastic-36321324/?no-ist=&page=2 Accessed 22 Dec. 2014.

Palpa.fi, 2014. Company. URL: http://palpa.fi/company [Accessed 18 Nov. 2014].

Partridge, A. 2011. Full Circle: Reverse Logistics Keeps Products Green to the End -

Sarder, M. Rahman, M. Yenduri,, S. and Ijumba, E. 2009). Leaning reverse logistic operations. IIE Annual Conference. Proceedings. URL: http://ezproxy.haaga-helia.fi:2118/abicomplete/docview/192458498/5554003257E742F3PQ/3?accountid=27436 Accessed 11 Oct. 2014.

Saunders, M., Lewis, P. & Thornhill, A. (2012). Research methods for business students. 5th ed. Prentice Hall, New York

Schriever, N. 2013. Plastic Water Bottles Causing Flood of Harm to Our Environment. Huffington Post

Spilka, M., Kania, A. & Nowosielski, R. (2008). Integrated recycling technology. Journal of Achievements in Materials and Manufacturing Engineering. URL: http://www.journalamme.org/papers_vol31_1/31114.pdf [Accessed 19 Jan. 2015].

Tang, S., Chen, K., Chen, S., Wang, Y & Lin, Z. 2013.strategies for the development of green logistics in Taiwan. Varazdin Development and Entrepreneurship Agency (VADEA), Varazdin. URL: http://search.proquest.com.ezproxy.napier.ac.uk/abicomplete/docview/1542129041/454D6DF649234439PQ/1?accountid=16607 Accessed 25 November, 2014

V, Daniel., Guide, R Jr., Harrison, T.P. & Van Wassenhove, L.N. 2003. The Challenge of Closed-Loop Supply Chains. URL: http://www.mech.kuleuven.be/lce2006/key3.pdf

Vahabzadeh, A.H. & Yusuff, R.B.M. 2012, "GREENING your reverse logistics", Industrial Engineer, vol. 44, no. 12.

Vennila, A., Jayasiri, H. & Pandey, P. 2014. Plastic debris in the coastal and marine ecosystem: a. International Journal of Fisheries and Aquatic Studies. URL: http://fisheriesjournal.com/vol2issue1/Pdf/16.1.pdf Accessed 15 Nov. 2014.

Walker, H., Di Sisto, L. & McBain, D. 2008. Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors. Journal of Purchasing and Supply Management. URL: http://www.ipsera.com/assets/documents/Walker%202.pdf Accessed 10 Nov. 2014.

Walls, M. (2011). Deposit-Refund Systems in Practice and Theory. [online] Washington D.C: Resources for the future, URL: http://rff.org/RFF/Documents/RFF-DP-11-47.pdf Accessed 28 Apr. 2015.

Wells, P. and Seitz, M. (2005). Business models and closed-loop supply chains: a typology. Supply Chain Management: An International Journal. URL: http://ezproxy.haaga-helia.fi:2133/abicomplete/docview/216862429/CF5C5DE8DEB64952PQ/1?accountid=27436 Accessed 3 Dec. 2014

World Economic Forum. 2009. Driving Sustainable Consumption Closed Loop Systems. URL: http://www.weforum.org/pdf/sustainableconsumption/DSC%20Overview%20Briefing%20-%20Closed%20Loop%20Systems.pdf Accessed: 19 Nov 2014

Zheng, L. and Zhang, J. 2010. Research on Green Logistics System Based on Circular Economy.*ASS*, 6(11).

Appendices

Appendix 1:

Questionnaire (PALPA Finland) 10th April, 2014. 16:02What is your name?

Respondent**: Tommi Vihavainen**

1. What is your designation in PALPA?

Respondent**: Admin/Communications Manager**

2. How long have you being working at PALPA?

Respondent**: Over 2 years**

3. When was PALPA established?

Respondent: Palpa is an offshoot of another establishment, Suomen Palautuspakkaus Oy that was established in 1996. It is responsible for the administration of recycling of beverage can. The system of PET bottles started in 2008 and a new subsidiary was born in 2011 that is Palpa Lasi **Oy.**

4. What is PALPA's financial involvement?

Respondent: Palpa is a non-profit organization

5. How does Palpa generate funds to keep running its operations as it is a non-profit organization?

Respondent: Palpa is owned by the marriage between trade and beverage companies. The company generates its funds from the its partners for the running of its operations which includes recycling fees for PET and cans, registration of new beverage bottles etc.

6. For a developing country like Nigeria, what do you consider most important to stir recycling of PET bottles?

Respondent: Firstly, it must be incentive based. People are spurred to get involve in recycling when they are aware they can benefit even a token from it. The deposit based system is one system adopted in different parts of the world that is very successful.

7. How do you think PET bottle recycling should take off in a developing country?

Respondent: The government holds the key to the success of recycling in this regard. Government should establish laws that support recycling and discourage indiscriminate dumping of beverage bottles. The involvement of various stakeholders is very important and their participation will drive the initiative to be a success.

8. What are the possible challenges in setting up PET recycling in an emerging economy?

Respondent: There are many challenges that may evolve. One major one is making of fake identification codes on beverage bottles. Palpa has had such experiences before and that was one reason the codes are updated every two weeks to beat criminals who may want to dupe stakeholders.

9. What do you consider the benefits of PET recycling?

Respondent: Recycling of beverage bottles both PET and cans conserve natural resources. Besides conservation of nature's resources, it strives the sustainability index of many manufacturing companies, it lowers the environmental impact associated with dumping indiscriminately in the environment. I think the world is aware of the damage humans activities are causing to the environment and have decided to treat the environment better to have a better world now and for generations unborn.

Appendix 2

Interview and Response from PET Bottle Manufacturer

Name of Company: Denoplast Nigeria Ltd, Sango Otta Nigeria(30 March, 2015) 11:00

1) What is your name?

Respondent: Aderogba Richard

2) What is your position in the company?

Aderogba Richard: Logistics Manager

3) What are your source of raw materials?

Aderogba Richard: We source our raw materials from a company that that deals in synthetic fiber (polyethylene) production. This constitute the raw material for the production of PET.

4) Are you considering recycling as part of your manufacturing process?

Aderogba Richard: We have considered the option in the past but we didn't have a structure on ground to facilitatate the supply of used PET bottles.

5) Being a logistics professional, do you think the concept of closed loop system will aid the reclamation of PET bottle into your production process?

Aderogba Richard: The closed loop system would be a perfect fit for the reclamation of PET bottles not only in the plastic industry but other manufacturing sector. It will be a huge boost as regards the manufacture of products and will drive the econmy in my opinion.

6) How do you think this idea can be popularised?

Aderogba Richard: The idea of the closed loop system can be popularised if the umbrella body of manufacturers organise seminars and educate its members to integrate the system in their manufacturing operations.

7) Condidering the Nigerian context, what is your advise to aid successful implementation of this process?

Aderogba Richard: Most importantly, legislation, education, stakeholders involvement. These are most important for successful implementation

Appendix 3

Interview and summary ofrespondents from cross section of 20 consumers
30 January, 2015.
Consumers decided to remain anonymous

1. How do you dispose PET bottles after consumption of beverage

   Respndents: We dispose on the streets on the wate bin

2. Don't you think it is a wrong to dispose on the streets?

   Respndents: We do

3. So why do you dispose on the streets?

   Respndents: Officers of the waste disposal boards do pick it or scarvengers

4. Do you know that dumping of PET on the streets constitute health hazards?

   Respndents: Some agreed while others sid they are not sure

5. Will you return PET bottle to a recycling center if given an incentive?

   Respndents: The respondents agreed and will be willing to.