Drivers of Reverse Logistics in the Plastic Industry: Producer’s Perspective

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Abstract

In the light of growing concerns over resource conservation, environmental protection and the development of recovery systems, reverse logistics (RLs) has become a key factor for many manufacturing companies. If properly implemented, RLs has the potential to contribute positively to environmental concerns and economic gains. As more and more plastics products are produced for once of use, it has become necessary for plastic manufacturing industries to develop RLs systems for their end-of-life products in order to reuse, recycle or remanufacture them. An examination of the drivers that influence the implementation of reverse logistics from the producer’s perspective was conducted in the plastic manufacturing industry. A survey of PET beverage companies in Zambia was conducted focusing on environmental concerns, economic gains and government legislations as drivers of analysis. A structured questionnaire was administered to managers of the selected companies and a decision matrix was used to averagely rank the companies’ drivers according to their preference. Analysis of the questionnaires indicated the following RL drivers as having the most influence towards RL implementation in the PET beverage companies: decreasing waste production, getting prepared for future legislations, environmental regulations and directives and national legislations.

Keywords

Drivers, Reverse Logistics, Plastic Industry, PET, Waste

1. Introduction

The estimated global production of plastics for 2013 was 299 million tons representing a 3.9% increase over the 2012 output (Gourmelon, 2015). Smithers Pira Organization (2012) indicates that, by 2017, 19.1 million tons of Polyethylene Terephthalate (PET) packaging is forecasted to be consumed globally. The increase in plastic production results in a proportional increase in the amount of end-of-life plastic products. Consequently, these end-of-life plastic products become solid waste and immediate actions are needed to manage them. Reverse Logistics (RL) is one of engineering management concepts used to sustainably recover end-of-life products. It involves planning, controlling and implementing of the backwards movements of packaging, finished goods, raw materials and/or in process inventory from use, manufacturing or distribution points to proper disposal or recovery points (De Brito and Dekker, 2004). It is a concept that is linked to waste management. The reverse logistics relationship with waste management in the reverse distribution channel involves activities such as proper disposal, recycling and reuse of waste (Kinobe et al, 2015).

With the current rate of plastic manufacturing and the anticipated plastic waste generation, it is necessary that plastic manufacturing companies design reverse logistics networks in order to recover their materials for recycling purposes...
and at the same time contributing to sustainable waste management. However, in developing economies, RL logistics is still at its infancy stage (Sarkis et al., 2011). A number of studies have focused on reverse logistics of PET bottles and others have looked at RL of municipal solid wastes. Coelho et al. (2010) examined the best alternatives in an integrated manner as a way of improving the system for recycling PET bottles using life cycle analysis in Brazil. Bing et al. (2014) conducted a study on the design of a decision support tool for logistics network for analyzing the effects of a number of separation, treatment and collection systems for household plastics. Shifting the opportunities from tipping to RL as a way of closing the balance was pursued by Fehr et al. (2014). Kinobe et al. (2015) examined in detail the reprocessing, redistribution, collection and final markets of products into a reversed supply chain network. Ferri et al. (2015) proposed a reverse logistics network involving municipal solid waste management (MSWM) to solve the challenge of managing these wastes in an economic way considering the new legal requirements and the inclusion of waste pickers. Most of these studies have focused on designing RL networks for plastic, PET or MSW. None of the studies have focused on the drivers of RL from the producer’s perspective. The emphasis of these studies has been on model development or network development. Few studies have focused on drivers of RL. Akdoğan and Coşkun (2012) used analytical hierarchy process, multi criteria decision making method to analyze the drivers of RL from the producers’ perspective for household appliance industry in Turkey. Chiou et al. (2012) explored the consideration factors of reverse logistics implementation based on survey questionnaires for Taiwan’s electronics industry and analyzed the research data using fuzzy analytical hierarchy process, a multi criteria decision making method. Further, both studies focused their research on the drivers influencing RL in the electronics industry of Asian economies.

The focus of this study is to assess the drivers influencing RLs of PET bottles from the producers’ perspectives in the plastic manufacturing industry in Zambia in Africa. A different perspective of data analysis will be used to show how the drivers under study influence RL implementation from the producers’ perspective. Further, a study of this nature has never been conducted before in Zambia and in so doing, it will contribute positively to the plastic manufacturing industry in terms of value addition to their decision making and the end-of-life plastic products.

2. Literature Review

Reverse logistics always starts with the movement of products from the user to the producer. In the case of PET bottles, a number of players are involved in the supply chain and therefore, it is important to understand, what drives users and producers to return the end-of-life or end-of-use PET bottle. However, the scope of the study focuses on understanding the RL drivers from the producers’ perspective.

A number of authors have identified the drivers of RL. Carter and Ellram (1998) identified customers, stakeholder commitment, regulations, top management support, quality of inputs and policy entrepreneurs, incentive systems, vertical coordination and uncertainty as the drivers needed in RL activities. Srivastava (2008) indicated that RL has three drivers; government legislations, economic value of returned recovered products and environmental concerns. Fuller and Allen (1995) explain the factors that lead to the application of RL as economic, legislation, corporate social responsibility, technology and logistics. Though most of the recovery of PET is conducted for the purposes of economic gain, it is also important to examine other drivers that influence producers to participate in RL of PET bottles from the Zambian perspective. In this study, the drivers of concern are economic, legislation and environmental concerns (Srivastava, 2008).

2.1 Economic Gains

Economic gains contribute significantly to the recovery of products. Lambert (2011) alludes that the second motivation for implementing RL are economic factors. For this reason, it is important to indicate that most product flows in today’s supply chain do not end once it has reached the consumer (Fleischmann et al., 2004). This means, a product is capable of leading a second, third or even fourth life after accomplishing its initial purpose. In the case of a company, this results in direct and indirect benefits. Akdogan and Coskun (2012) states that, direct and indirect gains in all recovery actions are related economic benefits. Recovery of waste products can result in a company decreasing the use of raw materials, which is a direct benefit. As a result of the relationship between waste management and reverse logistics, indirect benefits of decreased waste materials are achieved by a company. Akdogan and Coskun (2012) indicate that, environmental problems have made strong pressures to be imposed by customers on companies therefore making companies take environmental aspects into account. Thus companies take environmental matters seriously resulting into decreased disposal costs and waste materials. This is a reflection of indirect benefits on the producers’ side.
In developing economies, most reverse logistics is conducted by the informal sector. However, these informal sectors consist of six groups and together; they form a waste recycling hierarchy (Wilson et al., 2006). The waste recovery hierarchy finally sells its recovered waste to companies and this result in economic gains to a company as the price at which they purchase recovered waste is cheaper than the virgin raw material. Understanding these economic gains in the plastic industry is important as it is one of the industries consuming a large amount of resources in the production of its products.

2.2 Legislations

Legislation refers to any jurisdiction indicating that a company should recover its products or accept a take back (Peters, 2009). In many developed economies, the concept of legislation works as the government compels companies to address the issue of proper disposal and recovering value in end-of-life products (Kinobe et al, 2015, Xevgenos et al, 2015). Japan, has the highest recycling rates of PET bottles in developed economies as a result of the Extended Producer Responsibility (EPR) established in 1993 (Zhang and Wena, 2014). This law clearly defines the role of each participant in the recovery and collection system of PET bottles. The EPR system in Japan has resulted in quality and quantity guarantee of recycled PET bottles (Zhang and Wena, 2014). Xevgenos et al (2015) points out that, Germany has a producer responsibility system in which packaging and manufacturing are responsible for the waste produced. A number of countries in developing economies such as Norway, Australia, Italy, United States etc have implemented the EPR in their packaging and manufacturing industries. Further, Colling et al (2016) indicates that, legislations on solid waste management in Brazil will result in integrated management improvement for all waste types and decrease landfill usage.

Legislations’ influence regarding RL of products has been seen in the electronic industry. Lambert (2011) explains the directive of the European Union (EU) on WEEE waste. However, legislations have begun to compel producers to set up systems for product recovery and safe disposal in a number of industries and it is also important to determine how legislations have influenced PET bottles recovery from the Zambian perspective.

2.3 Environmental Concerns

According to Wong (2010), CO₂ emissions due to the production of virgin polymer are 6 kg per polymer, while it is 3.5 kg for recycled plastics. For companies that uphold environmental concerns, the use of recycled plastics is an advantage as it contributes to less environmental pollution. Saphire (1994) affirms that, processes utilizing the least energy and materials are considered effective environmental strategies. In this era of sustainability, environmental concerns have become a marketing strategy for companies and therefore it’s been used to gain consumer confidence. According to Coelho (2010), recycling prevents product termination at the final consumer point and adds value after its use therefore its considered to be a post-consumer or reverse logistics concept. In Brazil, technological advancements and recycling booms for PET bottles has reduced environment impacts through plastic waste removal from landfills.

3. Methodology

3.1 Qualitative Data Collection

Research data was collected from primary and secondary sources. Qualitative research design was used. It was used to study the problem comprehensively by using a structured questionnaire. The structured questionnaire was administered to the production managers in the selected plastic manufacturing industries. The purpose of the questionnaire was for the managers to complete the questionnaire by ranking the drivers of RL under study. The questions were designed after an extensive review of literature on reverse logistics drivers. The tentative research questions focused on the environmental concerns, government legislations and economic drivers of reverse logistics according to Srivastava (2008). Further economic drivers were categorized into direct gains and indirect gains. Direct gains consisted of; decreasing the use of raw materials, decreasing waste production and obtaining valuable spare parts. Indirect gains consisted of; green image, good relation with clients and suppliers, and getting prepared for future legislations. Environmental concerns focused on environmental regulations & directives, consumers’ environmental awareness, pressures with stakeholders, and reverse logistics management information system. Legislations focused on national and international legislations.
3.2 Sample Size

A purposive sampling approach was used to select the companies for the study. Four major companies in Kitwe city were selected for the study. The criteria for selecting was based on the size of the company in terms of being on the Lusaka stock exchange and the fact that, these companies are beverage manufacturing companies using PET as a packaging material.

3.3 Data Analysis

Microsoft Excel computer software was used to analyze the raw data to show the ranking of the drivers and their attributes. Graphs were used to depict these rankings. Later a decision matrix was used to rank the manager’s preference of the drivers. The decision matrix was used to give an average representation of the rankings from the four companies.

3.4 Coding of the RL Drivers’ Attributes

Table 1 below shows the coding of the attributes that were used in the research.

<table>
<thead>
<tr>
<th>Economic Drivers</th>
<th>Environmental Concerns</th>
<th>Government Legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Attribute</td>
<td>Coded Attribute</td>
<td>Initial Attribute</td>
</tr>
<tr>
<td>Direct Gains</td>
<td>DG-1</td>
<td>Environmental regulation and directives</td>
</tr>
<tr>
<td>Decreasing use of raw material</td>
<td>DG-2</td>
<td>Consumers’ environmental awareness</td>
</tr>
<tr>
<td>Obtaining valuable spare parts</td>
<td>DG-3</td>
<td>Pressure from stakeholders</td>
</tr>
<tr>
<td>Indirect Gains</td>
<td>IG-1</td>
<td>Reverse logistics management information systems</td>
</tr>
</tbody>
</table>

3.5 The Decision Matrix

A decision matrix is used to compare design solutions against one another, using specific criteria that are often based on project requirements. The list of criteria must be developed from the customer needs and engineering specifications, however, for this research, the producers’ perspective was considered and their needs or criteria in terms of implementing reverse logistics were considered. For this research, a numeric scale for the decision matrix was developed and ranking for each criteria category were assigned. The most preferred score was assigned 4 while the least preferred score was assigned 1.

4. Results and Discussion

This section discusses the results obtained from four companies that participated in the research.

4.1 Economic Gains
Figure 1 and 2 depict the results obtained from the companies concerning economic gain drivers. According to figure 1, direct economic gains depiction indicates that, companies were driven to participate in reverse logistics because of DG-2 (decreasing waste production). Decreasing waste production had the highest frequency followed by DG-3 (Obtaining valuable spare parts) and finally DG-1 (Decreasing use of raw material).

As a result of participating in reverse logistics of PET bottles, companies have been able to reduce the amount of waste production to the environment since most of the PET bottles are recovered. A study by Kinobe et al (2015) indicated that, application of reverse logistics actually reduces the amount of waste at landfills. Applications of reverse logistics helps companies acquire new spares and machinery in order to recycle or remanufacture their recovered PET bottles. Even though decreasing the use of raw materials had the lowest frequency, many studies have indicated that, recovery of wastes contributes to reduced utilization of virgin materials (Wilson et al, 2006, Coelho, 2010). However in developing economies where industries have limited technology to fully utilize their recovered waste, this could have be the reason DG-1 had the least frequency.

Whichever way the results have been depicted; the application of reverse logistics systems in plastic manufacturing companies is cardinal as it contributes to sustainable manufacturing as well as waste management. In developing economies where application of reverse logistics is considered non-profitable, Kinobe et al (2015) points out that, encouraging waste segregation to ease sorting and grading can lead to sustainable economic and environmental gains.

Fig 2 indicates that, getting prepared for future legislation had the highest frequency while green image and good relation with clients and suppliers were the second preferred drivers. Despite the fact that most developing economies legislations and regulations are not strictly implemented as a result of many challenges faced by those in the regulatory offices. The advocate for sustainability is slowly changing the perceptions most companies have regarding complacency to legislations. It is not surprising to find companies preparing for future legislations on waste recovery and management. Green image and good relations with clients and suppliers is also one of the drivers for implementing reverse logistics systems. Along the supply-chain, companies that are concerned with issues of sustainability desire to trade with companies that do the same. For example some suppliers’ and clients would prefer to work with companies that are concerned with the environment.
4.2 Environmental Concerns

Fig 3 depicts results from environmental concerns drivers’ analysis. Existing environmental regulations and directives had the highest frequency. Companies were driven to implement reverse logistics PET bottles as a result of current existing regulations and directives. Consumers’ environmental awareness had the second highest frequency followed by reverse logistics management information systems and lastly pressure from stakeholders. Environmental regulations and directives have contributed to companies implementing reverse logistics systems. In developed economies, a number of regulations and directives are in place and these have influenced waste recovery (Xevgenos et al. 2015). Most companies compel to regulations and directives because they do not want to go against the law and also they want to impress their consumers. Consumers’ environmental awareness is not only an environmental driver for reverse logistics but it is also used as a waste management strategy. Some consumers would prefer to consume products from companies that are concerned with the environment and this has driven most companies to recover their end-of-life products (Carter and Ellram, 1998; Akdogan and Coskun, 2012).

Reverse logistics information systems are cardinal in implementing reverse logistics systems. However, in this study, it had the third highest frequency. It seems implementing reverse logistics was not entirely driven by technology. Pressures from stakeholders had the least influence on the companies. However, according to Carter and Ellram (1998), stakeholders have a hand in driving companies to implement reverse logistics systems.
4.3 Government Legislations

Figure 4 depicts government legislations results. These indicate that, most companies have implemented reverse logistics because of the national government regulations. It means sense that companies compel with existing country legislations before compelling with the international legislations. Legislations are fundamental in influencing countries and companies to implement recovery programs and reverse logistics systems. Xevgenos et al (2015) affirms that countries such as Germany had existing legislations on the recovery of packaging waste before the establishment of the packaging and packaging waste (PPW) directive in the European countries. Therefore companies in Kitwe have indicated that, existing legislations have influenced their recovery programs.

![Government Legislations](image)

Figure 4: Government Legislations

4.4 Decision Matrix Results

A decision matrix was used to verify the results from the questionnaire. Economic gains attributes, environmental concerns and government legislations attributes were tabulated and each criterion was given a score. The most influential criteria were assigned a score of 4 while the least preferred was assigned a 1. Table 2 depicts an average analysis of the results from the four companies that participated in the study. Analysis of the results from the decision matrix indicates, environmental concerns drivers with the attribute of Environmental regulation and directives had the highest ranking of 4 while international legislations, pressure from stakeholders and decreasing the use of raw materials had the lowest ranking.

<table>
<thead>
<tr>
<th>Economic Gains</th>
<th>DG-1</th>
<th>DG-2</th>
<th>DG-3</th>
<th>IG-1</th>
<th>IG-2</th>
<th>IG-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Gains</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect Gains</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Environmental Concerns</td>
<td></td>
<td></td>
<td>EC-1</td>
<td>EC-2</td>
<td>EC-3</td>
<td>EC-4</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
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<tr>
<td>Legislations</td>
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<td></td>
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<td></td>
<td>GL-1</td>
<td>GL-2</td>
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<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2: Average Representation of the Results Using a Decision Matrix

5. Conclusion

The rise in the amount of end-of-life PET bottle waste production continues and without establishment of strategies to recover this waste, environmental degradation will continue as well as losing valuable resources. In developed economies a number of strategies have been put in place to manage PET bottles and manufacturers’ of this end-of-life plastic bottle are mandated to develop systems for recovering this waste type. Reverse logistics is an engineering
management concept that has been implemented in a number of industries in developed economies. However, the implementation of RLs systems is influenced by a number of drivers. This study has identified economic gains, environmental concerns and government legislations drivers that have influenced PET beverage companies to implement RLs systems in Zambia. The identified drivers will prove useful decision making information for a number of companies in developing economies that need to develop RLs systems. The fact that most of waste recovery is performed by the informal sector, the result from this study will enable small to medium enterprises consider establishing RLs systems. The decision matrix has strategically ranked the attributes of RL drivers according to the preference of the companies and this information provides a useful platform for companies in the plastic industry as well as other industries.

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**References**


Biography

Bupe Getrude Mwanza is a part-time PhD student with the School of Engineering Management at the University of Johannesburg, South Africa. She is a holder of a BSc in Production Management from The Copperbelt University and MEng in Manufacturing Systems and Operations Management from the National University of Science and Technology. She has research interests in solid waste management, manufacturing technologies, maintenance management, cleaner production and operations management. She has taught Maintenance and Reliability Systems, Production and Operations Management, Integrated Production Systems and Manufacturing Technology. She has published and presented works on Maintenance Management and Solid Waste Management. Bupe has served as a Process Associate for Konkola Copper Mines in Zambia. She also served as a Lecturer at Harare Institute of Technology in Zimbabwe and at The Copperbelt University in Zambia. She is a member of the Engineering Institute of Zambia (EIZ) and The Southern Africa Institute for Industrial Engineers (SAIIE).

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