Economic and Environmental Advantage Evaluation of the Reverse Logistic Implementation in the Supermarket Retail

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Abstract. In this article it is presented a market study case that allowed a recycling specialized organization with physical space to implement the reverse logistic of the following packing residues: cardboard, Styrofoam, plastic and aluminum into correct residue destination. This study's objective consists in developing a methodology to evaluate economic and environmental advantage of the reverse logistic implementation in the supermarket. The utilized method consists in observing and semi-structure interviewing, allowing it to develop a case study. To analyze the environmental improvement, the Mass Intensity Total was measured, to determine the environmental impact reduction. The research results indicate economic and environmental advantage very representative, which may improve the decision making and access to the reverse logistic, favoring the sustainability in the supermarket retail.

Keywords: Reverse Logistic, Supermarket Retail, Economic and Environmental Advantage

1 Introduction

The Solid Residue National Plan of Brazil is driving many segments to implement the reverse logistic, to promote the solid residue management by developing procedures to improve the gathering and restitution of solid residues to their producers, so that they are treated and repurposed in new products, by input means, in its cycle or in other productive cycles, seeking the non-producing of tailings [1].

With that, the reverse logistic can reduce costs related to the raw material, storage, finished products and information from the selling point to the origin point with the objective of adding value or the correct use of resources [2] to give the correct direction to material goods [3], ensuring the environmental and economic advantage in the operation by recuperating, reusing and remanufacturing of goods [4].

The reverse logistic use is extending to the retail sector, including supermarkets [3]. The supermarket retail is characterized by the auto-service system with a variety of products, being the edible and non-edible products with, a minimum of, 2 *check-outs* and valid selling space between $300m^2$ and $5000m^2$ and, still, offers the consumer, shopping carts and baskets to be used while shopping, without a selling-man presence [5].

Supermarkets could implement the reverse logistic because the commercialized products are the main producers of solid residues of packing, considering edible products and appliances [6, 7].

The reverse logistic implementation could be a differentiation strategy [8], which promotes sustainable marketing [9], as by an example, in the Wal-Mart, that demands the feeders, devolution of damaged products and packing [7], utilizing the same truck that delivers the order to take the residue from the clients, cutting costs with transport [10], generating financial gain [11].

Other researches support the development of a return plan in the solid residue supermarkets and product devolution guaranteed. Especially Wal-Mart, that implemented the reverse logistic to repairing, replacing parts and consumer return, inspection and reuse [12, 13], resulting in a cost reduction and improvement of product recuperation [14, 15], and in Spanish Carrefour that has a specialized recycling infrastructure to manage solid residues [16, 17].

It was noted the need to improve the governmental support to implement the reverse logistic. In Brazil, it is still considered embryonic, due to lack of governmental support, actions by the producing organizations, lack of gathering spaces and environmental conscience from the society [18]. In China, the situation is not different, despite establishing legislation, which pressures the producers [19]. This discovery drives the supermarkets and the recycling organization in the propagation of gathering points and motivating their clients [16], mainly because the majority of the clients don't deposit their solid residues, due to lack of economic support [6].

In the existing researches analysis about the reverse logistic implementation in the supermarket sector it was noted that despite some articles mention in a positive way about the economic and environmental gain they did not evaluate theses gains. With that, the article's objective consists in developing a methodology to evaluate if it has occurred economic and environmental advantage from the reverse logistic implementation in the supermarkets.

2 Methodology

In the research's first phase, it was realized a bibliometric analysis to quantify and select the scientific production [20].

The Databases Proquest, Ebsco, Science Direct, Emerald, Capes and academic Google by using the following keywords: (i) "reverse logistics" AND "supermarket"; (ii) "reverse logistics" AND "grocery"; (iii) "reverse logistics" AND "retail" AND "market"; (iv) "reverse logistics" AND "retail"; (v) "reverse logistics" AND "retailing" (vi) "reverse logistics" AND "retailing" AND "market" in summaries, keywords and scientific publication titles with the objective of analyzing the existence of researches that helps understanding the environmental and/or economic results in reverse logistic implementation process in the supermarkets retail.

In the analysis it was noted 15 articles about the reverse logistic in the supermarket retail, allowing the categorizing of research results about environmental and economic gain [21]. In the analysis it was identified a lack of researches that produced quantity evaluations in economic and environmental terms.

To attend this lack of research, it was realized an exploratory research of qualitative and quantitative nature through the unique-case method, which allowed developing a methodology to evaluate if it has occurred economic and environmental advantage from the reverse logistic implementation in the supermarket.

The case study is a research strategy focused in comprehending the researched scene dynamic, which combine data gathering methods, as data, interviews, questionnaires and observations, resulting in qualitative and/or quantitative evidence [22]. With that, it is possible to create the adequate conditions to comprehend the researched study object [23].

In the case study, it was adopted the observation and interviews as the logistic base, which allowed to gather quantitative data about the recycled goods and the economic results of implementing the reverse logistic. The observation was realized in files and efficiency indicators with recycling data provided by the supermarket, being an adequate technique for case study [24, 25], with support of the semi-structured interview to ask questions and align the comprehension of the observation [26].

With the environmental and economic results obtained it was developed a methodology to evaluate if it has occurred environmental and economic advantage from the reverse logistic implementation in the supermarket.

With the economic results obtained, it was possible to evaluate the economic advantage of reverse logistic implementation by calculating the return of investment (ROI) based on equations 1 and 2 presented [27]:

%ROI = semiannual liquid profit/ reverse logistic investment Eq. 1

ROI Period= reverse logistic investment / semiannual liquid profit Eq. 2

After that, with the recycled goods results it was possible to evaluate the environmental gain through the Mass Intensity Factors method (MIF) identified in the file provided by the Wuppertal Institute supported on the abiotic, biotic, water and air compartments.

The ecosystem is composed of biotic and abiotic compartments with interaction between them, the biotic compartment consists of the set of all live organisms as plants and decomposers, while the abiotic compartment is the set of all non-alive factors of an ecosystem, but influences the biotic compartment, consists of temperature, pressure, rain falling in the landscape, among others [28].

With that, the total goods quantity of each compartment that was processed to supply a material data is called Mass Intensity. To determine the Mass Intensity Factors (MIF) in equation 3, the Mass entry flux (M) - express in the corresponding units is multiplied by the Intensity Factors (IF), that corresponds to the quantity of necessary goods to produce an entry flux unity [29]. The IF values used in this research are presented on Table 1.

$$MIF = (M \times IF) \qquad \text{Eq. 3}$$

Table 1. Goods Intensity Factors used in the Research

	Mass Intensity Factor			
	Abiotic Goods	Biotic Goods	Water	Air
Plastic (g/g) [a]	6.45		294.2	3.723
Cardboard (g/g)[b]	1.86	0.75	93.6	0.325
Styrofoam (g/g)[c]	5.70		146	1650
Aluminum (g/g)[d]	37		1047.7	108.870

Source [a e c] Germany Data
[b e d] Europe Data

After calculating the IF by recycled residue in relation to compartments, it becomes possible to calculate the Mass Intensity per Compartment (MIC), that measures the environmental impact reduction by abiotic compartment (w), biotic (x), water (y), and air (z), following the Equation 4. And at last, it is realized the calculation of the Mass Intensity Total (MIT) summarizing the total environmental reduction, when applied to MIC's, following the Equation 5.

*MIC = (IF residue A of compartment w + IF residue B of compartment w + IF residue C of compartment w + IF residue n of compartment w) Eq. 4

*MIC example to the w compartment, equal to the others.

MIT = (MICw + MICx + MICy + MICz) Eq. 5

To finish it is compared the economic gain with the environmental gain and vice versa to verify the economic gain index (IGE) and environmental gain index (IGA). To evaluate the IGE, it is considered the Total Saved Goods (MTE) in relation to the GE and to calculate the IGA, is it divided the Mass Intensity Total (MIT) by the GE. The equations are presented:

IGE = (MTE/GE) Eq. 6

IGA = (MIT/GE) Eq. 7

3 Results and Discussion

Economic Advantage

The economic advantage results of the Reverse Logistic implementation were summarized in Table 3. The gathered residues resulted in a semiannual gain of $9.236.77.

In the main project the initial investment was of $20.000.00 for employees training about solid residue management and implementing residue gatherers in the supermarkets so that the clients could deposit its residues and, implemented in the receiving sector the solid residue retention resulting of the delivery process and store assortment. This result shows an practical example of the reverse logistic implementation in the supermarket retail [30], in relation to the adequate destination of the residue to reuse and remanufacture [6, 13, 1] by an specialized organization [16, 17].

To the recycling operation implementation the organization decided outsourcing to a specialized organization. With that, the recycling organization provided infra-structure, as which: press, involved people, load accommodation and transport to the residues destination in a correct way and began to pay the supermarket by Kg of collected residue (Cardboard - $0.17; Plastic - $0.37; Styrofoam - $0.10; Aluminum - $2.30).

Table 2. Economic Gain with the Reverse Logistic Implementation

Period	**Cardboard**	**Plastic**	**Styrofoam**	**Aluminum**
June	$1.509.00	$552.30	$4.30	$18.98
July	$590.00	$221.00	$4.00	$14.49
August	$1.297.00	$410.40	$0.00	$24.15
September	$1.698.00	$228.40	$1.50	$34.50
October	$598.40	$202.30	$5.00	$26.45
November	$1.068.00	$696.00	$5.00	$27.60
Total	$6.760.40	$2.310.40	$19.80	$146.17

Applying equations 1 and 2 proposed [27], summarized:

%ROI = $9.236.77/ $20.000.00 = 46.18% per semester.
Period ROI = $20.000.00 / $9.236.77 = 1 year and 2 months.

The financial return invested in reverse logistic was of 46, 18% per semester in one year and two months, since this period the monthly liquid gain, considering the reverse logistic increased to $9.236.77, resulting in economic advantage to the market. This result exemplifies the proposition about the possibility of obtaining financial resources with reverse logistic [8].

Environmental Advantage

In the total sum of goods, it is considered all the products that were not disposed in the environment. The organization provided the Mass in goods (M) by Kg of residue that were submitted to the recycling process in the semester, which are: 40.196 kg of Cardboard, 6.327 kg of Plastic, 198 kg of Styrofoam e 63.55 kg of aluminum, con-substantiating 46785 Kg of Total Saved Mass (MTE).

Applying equation 3 it is determined the Mass Intensity Total (MIT) to evaluate the environmental gain, as for an example, 6,327 x 6.45 – abiotic goods, represents MIT of 40.809.15, as it is presented on table 3.

Table 3. Environmental gain with the reverse logistic implementation

	Abiotic Goods	**Biotic Goods**	**Water**	**Air**
Plastic (g/g) [a]	40809.15		1861403.4	23.555
Cardboard (g/g) [b]	74764.56	30147	3762345.6	13063.7
Styrofoam (g/g) [c]	1128.6		28908	326700
Aluminum (g/g) [d]	2351.35		66.581.335	691
Mass Intensity per Compartment (MIC)	119053.7	30147	5719238,3	350946
Mass Intensity Total (MIT)				6100331.5

The recycling total in mass was of 46785 Kg of residue per semester with Mass Intensity Total (MIT) of 6100331.5, representing the environmental impact reduction in compartment (w) abiotic of 119053.5 Kg, contributing with sustainability in global warming matters, the ozone layer waste, the atmospheric pressure, among others; (x) biotic – 30147 Kg, which reduced the vegetation pollution, the soil and the decomposers, (y) water – 5719238.3 Kg and the (z) air with 350946 Kg. The results show that it is possible to measure the environmental gain with the reverse logistic implementation, subject still considered incipient in literature.

Comparison between economic and environmental advantage

To finish it is compared the economic with the environmental gain and vice versa to verify the representation in percentage of the economic gain (GE) and environmental gain (GA).

GE = (46785 Kg of Residue/$9236.77) = 5.07 Eq. 6

GA = (6100331.5//$9236.77) = 660.44 Eq. 7

The results show that in relation to the IGE, that each Brazilian Real saved corresponds to 5.0 Kg of goods. When it is considered the Mass Intensity Total (MIT), by each Brazilian Real, there is a benefit of IGA – 675.42 Kg of goods that are not modified nor taken from the ecosystems. This discovery contributes with the possibility of conquering economic and environmental gain through reverse logistic actions [30, 2], subject that was not explored in quantitative methodology terms to analyze, mainly because it presents just qualitative results.

7 Conclusions

The present research shows that the reverse logistic implementation in the supermarket retail resulted in an economic and environmental gain, which was the research's objective. The action taken to achieve the result was of implementing residue gatherers in the supermarket so that clients could deposit their residues. Also, implemented in the receiving sector the retention of solid residues resulted from the deliver process and the store assortment.

The result in the semester showed the retention and correct destination of 46785Kg, considering just the gathered and weighted residue resulting in an economic gain of $9.236.77 each semester. When the Mass Intensity Factor was calculated, it was noted that it avoided the pollution of: (i) 119053.7 Kg in the abiotic level, considering as indispensable factors to survival, as temperature, pressure, rain falling in the landscape, among others; (ii) 30147 Kg in the biotic level, represented by the set of all live organisms such as plants and decomposers and (iii) 5719238.3 Kg in the water and 350946 Kg in the air. The results show that despite occurring economic advantage $9.236.77 to the businessmen the environmental advantage was the most representative when considered the Mass Intensity Total (6100331.5 Kg).

It is important to highlight that the presented and tested methodology may be used in cleaner production processes, environmental projects (DfE), among others. A limitation of the case study consists in the impossibility of generalizing the results, suggesting the realization of new researches to generate comparisons.

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