https://dx.doi.org/10.22161/ijaers.6.6.40 ISSN: 2349-6495(P) | 2456-1908(O)

Recycling Analysis in Northern city in the State of Rio de Janeiro: A Study of Reverse Logistics

Cintia Rios Tavares[1], Priscila Moreira Faria da Silva[2], Denise Cristina de Oliveira Nascimento[3], Ailton da Silva Ferreira[4], Tulio Cremonini Entringer[5], Paulo Maurício Tavares Siqueira[6], Antonio de Souza Boechat[7], Isabel Balloussier Cerchiaro[8], Saulo Bichara Mendonça[9], Rodrigo Resende Ramos[10]

[1,2,3,4,6,7,8,9,10]Federal Fluminense University, Macaé, Rio de Janeiro, Brazil
[2]Federal Fluminense University, Macaé, Rio de Janeiro, Brazil
[3]Federal Fluminense University, Macaé, Rio de Janeiro, Brazil
[4]Federal Fluminense University, Macaé, Rio de Janeiro, Brazil
[5]State University of Northern of Rio de Janeiro, Campos dos Goytacazes, Rio de Janeiro, Brazil

Abstract *— This work analyzes the recycling process of the PET bottle in a company located in Campos dos Goytacazes, - a northern city in the state of Rio de Janeiro, from the concept of reverse logistics. It was sought, through qualitative research with the company to know the process of recycling the PET bottle and its understanding as a contribution to the environmental issue. Visits were made to the company for a period of one month, alternating times during work hours, observing since the arrival of the material collected in the streets until the end of the recycling process, together with the visits carried out was applied a questionnaire with the company's employees in order to measure their understanding of the recycling process. It was developed the process flowchart and the mapping, aiming to allow not only to know the sequence of the process developed, but also to analyze it in terms of strengths and weaknesses. After data collection, it was verified that, with regard to the production process, the employees performed their tasks empirically, knowing only the stage of the process by which they were responsible, and they and the company had no formal procedure to demonstrate the sequential steps involved in the recycling process.*

Keywords *—* ***Reverse Logistics, Recycling, Environmental, PET Bottles.***

I. INTRODUCTION

Industrialization techniques developed in recent years, together with the increase in population and consumption, factors that have caused the rise of global demand, with consequent increase in the amount of post-consumption disposal, hampering its final destination. In this context, recycling arises not only as an ecological flag, but also as a real option for industry and society, combining ecological awareness with economic and technological Development (BALLOU, 1993; ANDERSON & NARUS, 1990).

The logistics of return flows or reverse logistics is aimed at the efficient execution of product recovery. Reverse logistics has as its purpose the reduction, disposition and management of toxic and non-toxic waste. Although it is easy to think of logistics such as managing the product flow from the acquisition points to the customers, for many companies there is a reverse logistic channel that must be managed as well. The life of a product, from a logistic standpoint, does not end with its delivery to the client (BALLOU, 2006; ARBACHE, 2004).

The needs of reverse logistics also stem from the growing number of laws prohibiting indiscriminate disposal and encourage the recycling of beverage containers and packaging materials, which also emphasize that the most significant aspect of logistics reverse is the need for maximum control when there is a possible responsibility for damage to health. In this sense, a market withdrawal program is similar to a maximum customer service strategy, which must be executed independently of the cost (Bowersox & CLOSS, 2001).

Together with the recycling process, studies have been carried out on the Life Cycle Analysis of the PET bottle (ethylene Polyterephthalate), from the extraction of the raw material to the final destination, in order to better know the product and its influence on The Environment (ABEPET, 2009; OLIVEIRA, CANDIDO, 2009).

https://dx.doi.org/10.22161/ijaers.6.6.40 ISSN: 2349-6495(P) | 2456-1908(O)

This work aims to evaluate the Productive Chair of the reverse logistics of PET (ethylene Polyterephthalate), verifying the stages of the recycling process, being necessary for this a bibliographical survey and a case study in the organization searched. The objective is also to form a specific knowledge base on the subject, absorbing the theoretical knowledge and adapting the practice.

II. LOGISTICS IN BRAZIL

Logistics is the area of administration that takes care of the transportation and storage of goods. It is the set of: planning, operation and control of the efficient and effective flow of materials, services and information of the company, integrating and rationalizing the systemic functions, from production to delivery, ensuring competitive advantages in the chain of Distribution and, consequently, clients satisfaction (CHING, 1999).

The word logistics comes from the French "Logistic", which derives from "Loger" (place, lodge, inhabit). This term originally meant transportation, supply and troop accommodation. It is related to the word "lodge" (which is an older word in english, but has the same latin origin). "Logistics" appeared in the english language for the first time in the 17th century. It is noteworthy that logistics is not related to the logistic mathematical function (BALLOU, 2006; LUMUS, 1999).

The new requirements for logistics activity in Brazil and in the world go through greater control and identification of opportunities to reduce costs, reduce delivery times and increase quality in compliance with the deadline, constant availability of products, scheduling of deliveries, ease in order management and manufacturing easing, long-term analysis with increments in technological innovation, new costing methodologies, new tools for redefinition of processes and adequacy of business (CHRISTOPHER, 1997; FIGUEIREDO & ARKADER, 1998).

III. REVERSE LOGISTIC

In the 80 years, the concept of reverse logistics was still limited to a movement contrary to the direct flow of products in the supply chain. It was in the decade of 90 that new approaches were introduced and the concept evolved driven by increased concern about environmental preservation issues. This pressure, induced by consumers, implied legal actions of the supervisory organs. In addition, from this period, the processing and distribution companies began to see reverse logistics as an important source of loss reduction. In this way, the reverse logistics activities began to be used in greater intensity in the United States and Europe, countries where the concepts and classical tools of logistics were already more widespread (BARRATT, 2004; FLEYRY, 1999).

Therefore, reverse logistics as the area of business logistics that plans, operates and controls the flow and the corresponding logistical information, the return of after sales goods and post-consumption to the business cycle or production cycle, through the channels of reverses distribution, adding value of several natures: economic, ecological, legal, logistic, corporate image, among others (LUMUS, 1999; GRIMAS, 2010).

The analysis of products and materials has the function of defining its state and determining the process to which it should submit. Figure 1 shows, in a simplified way, the operation of the reverse logistic process (LACERDA, 2009; TERPENE, 2008).

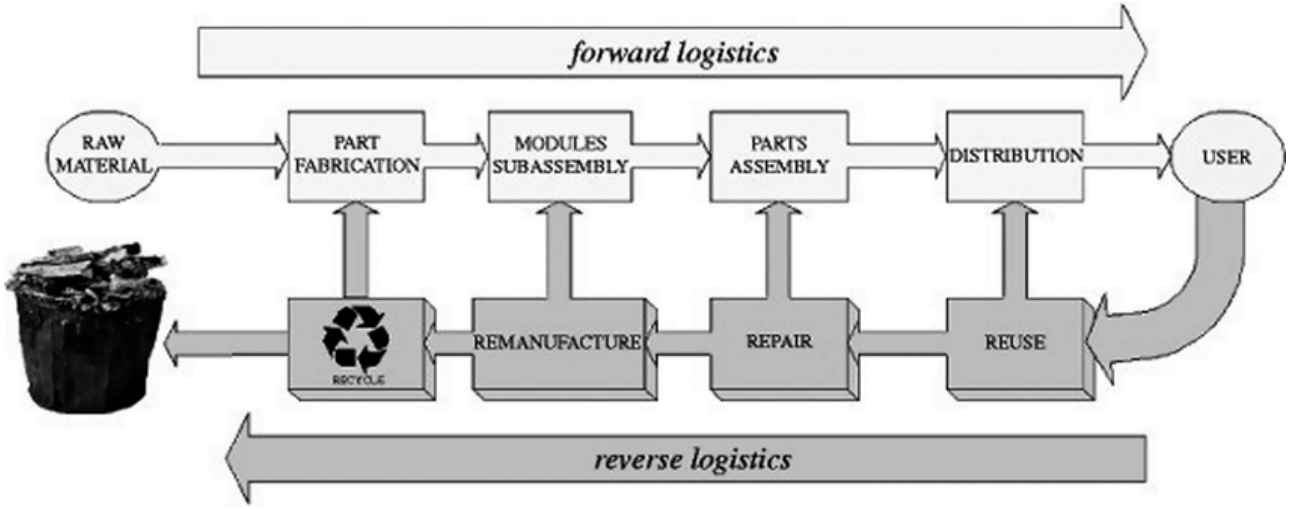


Fig. 1: Schematic illustration of logistics and reverse logistics.

https://dx.doi.org/10.22161/ijaers.6.6.40 *ISSN: 2349-6495(P) | 2456-1908(O)*

Source: Adapted from Lacerda, 2003.

Figure 2 emphasizes how the reverse channel can add value to the logistic system. It is observed that the reverse logistics of after sales, in conjunction with the post-consumption, provides benefits to the corporate image, competitiveness and cost reduction of the company (LEITE, 2003; LAMBERT, 2009).

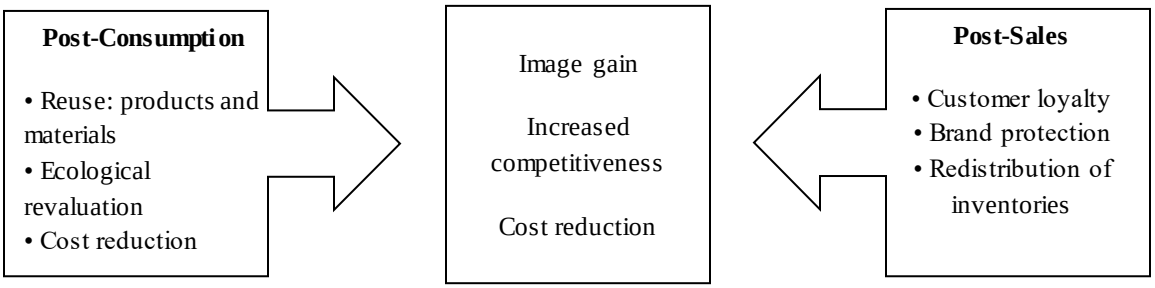
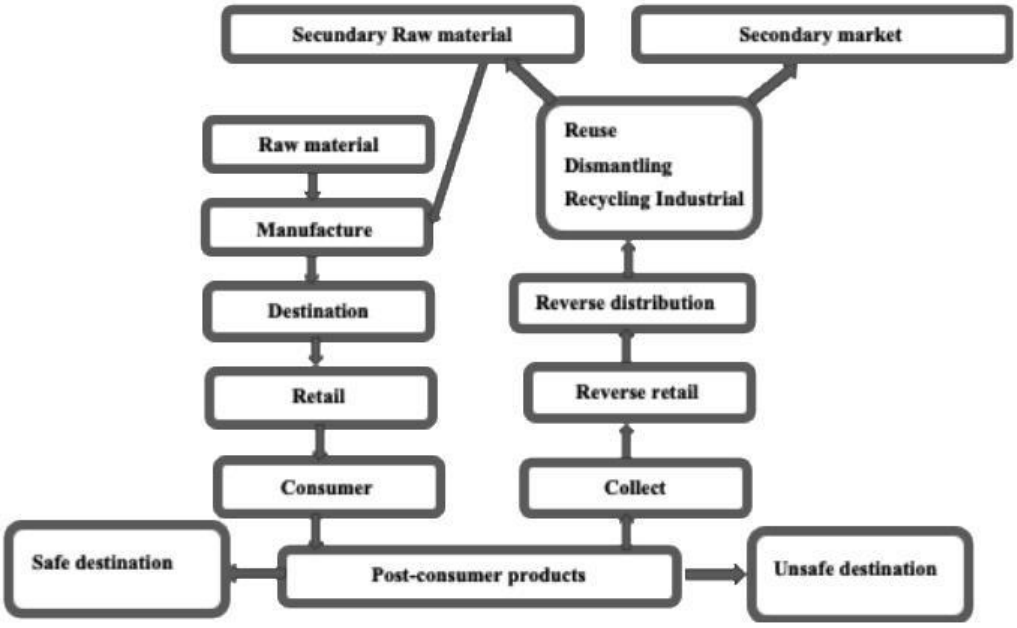


Fig. 2: Reverses Streams: adding value.
Source: Adapted from Leite, 2003.

According to Leite (2003), the reverse after sale distribution channel characterizes the return of product that presented problems. For this same author, the strategic objective is to add value to a logistic product that is returned for commercial reasons, errors in the processing of orders, guarantee given by the manufacturer, defects or failures of operation, faults in transportation, among other things. This return flow will be established between the various links in the direct distribution chain, depending on the strategic objective or the reason for the return. The distribution channel of post-consumer reverse logistics is characterized by products discarded by society in general that return to the business cycle or to the productive cycle through the specific reverse distribution channels (WHIPDLE, FRANKEL, DAUGHERTY, 2002, VOSS, TSIKRIKTSIS, FROHLICH, 2002).

Reverse logistics operates in two large areas, differentiated by the stage or phase of the life cycle of the returned product (LEITE, 2004). This research highlights the concepts of reverse logistics of post-consumption (Figure 3), called as an area of logistics that equally equates and operationalizes the physical flow and information. Correspond to the post-consumer goods discarded by the society, which return to the business cycle or to the productive cycle by the specific reverses channels (MAYLETT & VITASEK, 2007, SANDBERG, 2007, SIMATUPANG, DHARAN, 2002).



https://dx.doi.org/10.22161/ijaers.6.6.40 ISSN: 2349-6495(P) | 2456-1908(O)

Fig. 3: Post-consumption Reverse Logistics Flowchart.
Source: Adapted from Leite, 2003..

In the conception of Leite (2009), these goods or materials are transformed into products called post-consumption and may be sent to traditional final destinations such as incineration or landfill, considered as safe means of storage and disposal, or return to the productive cycle through dismantling, recycling or reuse channels in an extension of its useful life. These alternatives to return to the productive cycle constitute the main concern of the study of reverse logistics and post-consumer reverse distribution channels.

IV. RECYCLING AS A STRATEGY FOR REVERSE LOGISTIC

The preoccupation with recycling emerged in the meaty of the decade of 80, when it was disclosed that non-renewable raw materials, such as oil and space for storage of garbage were running out (LEITE, 2004; ABIPET, 2009).

The word comes from the English recycle (re = repeat and cycle), where: Recycle and reuse assumes different meanings: reuse would transform the industrialized product into an equal product, and recycling is the act of reusing materials for a new Product (LEITE, 2004; OPENS, 2004).

Recycling is another area of the economy that suffers from the global crisis. Consumption decline production industries in large centers productive and demand reduction recycled materials worldwide economic effect. The situation demonstrates the increasing need to improve the recycling infrastructure in the country. Efficient collection materials greater value can obtain internal and external market. (LEITE, 2010; MORASH, CORNELHA, SHAWNEEE, 1999).

Polyethylene terephthalate, PET, was synthesized in 1941 by ICI (Imperial Chemical Industries), being very used in the manufacture of synthetic fibers for the textile industry. In Brazil, only in 1989 began the production of the PET bottle (Leite, 2003:196).

In Brazil as most recycling companies are small and manpower is cheap, the separation is done mainly in a manual way. The separation of polymers can be made by identifying the symbology contained in the finished product and/or the use of simple tests, such as the odor of burning vapors, flame appearance, melting temperature and solubility, which are based on their physical characteristics and thermal degradation, which are distinct (NOVAES, 2007). In addition, polymers are used to manufacture several finished products; However, some of them can only be produced from a specific type of polymer, such as carbonated beverage packages that are manufactured from PET, thus facilitating their identification and separation of polymeric residue (SPINACE, 2005; CEMPRE 2009), as shown in Figure 4.

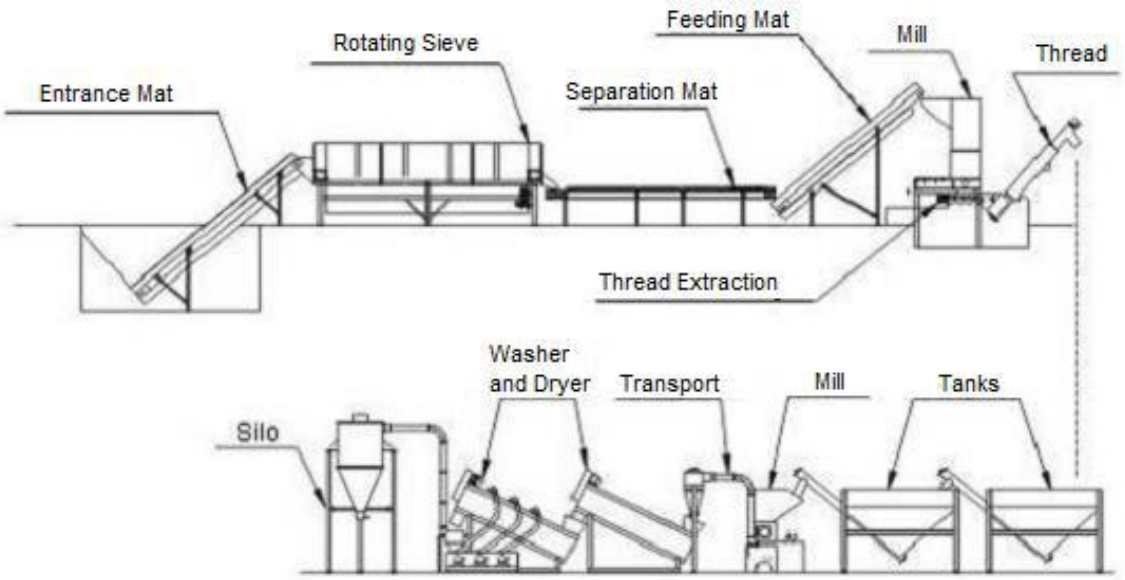


Fig. 4: Recycle Cycle.
Source: Spinace, 2005.

It is also possible to formulate post-consumer polymers by adding small amounts of virgin material in

https://dx.doi.org/10.22161/ijaers.6.6.40 ISSN: 2349-6495(P) | 2456-1908(O)

order to improve the properties of recycled polymers. After formulation, the polymer can be reprocessed and finally obtained a new artifact (SPINACE, 2005).

Through the quality tool, which are techniques used for the purpose of defining, measuring, analyzing and proposing solutions to the problems that interfere in the good performance of the work processes was chosen the flowchart.

The Company under study RGC Recycling – ME, which operates in the recycling area of the Pet Bottle in the city of Campos dos Goytacazes, is located at street F, number 15 in Parque Codin. Founded by Robson Gomes Barbosa 1982, working market present day.

Fig. 5: Photo of the company RCG-RECICLAGEM-ME
Source: Own.

In these years of business, the owner has been investing in the lacks the establishment, providing improvements in working conditions, equipment, the recycling sector and the decantation. With this, providing satisfaction to employees and customers.

As can be seen the company is growing increasingly, because it is always searching new ways to innovate and increase its revenues. It is also noted that the company has a high sales potential, but these factors are not sufficient to ensure success, because the company has a number of problems that need to be solved for the welfare of all. In Figure 5 shows the front of the company under study, RGC-RECYCLING ME.

V. ANALYSIS OF REVERSE LOGISTIC IN THE RECYCLING SECTOR

According to Villela (2000), the process mapping is an analytical and communication management tool essential for leaders and innovative organizations that intend to promote improvements or implement a structure geared to new processes. The process mapping becomes important for companies because it allows understand how processes work, their components, besides facilitating the analysis of their effectiveness and locating their deficiencies. Figure 6 shows the Process Mapping developed for the RGC Company.

https://dx.doi.org/10.22161/ijaers.6.6.40 ISSN: 2349-6495(P) | 2456-1908(O)

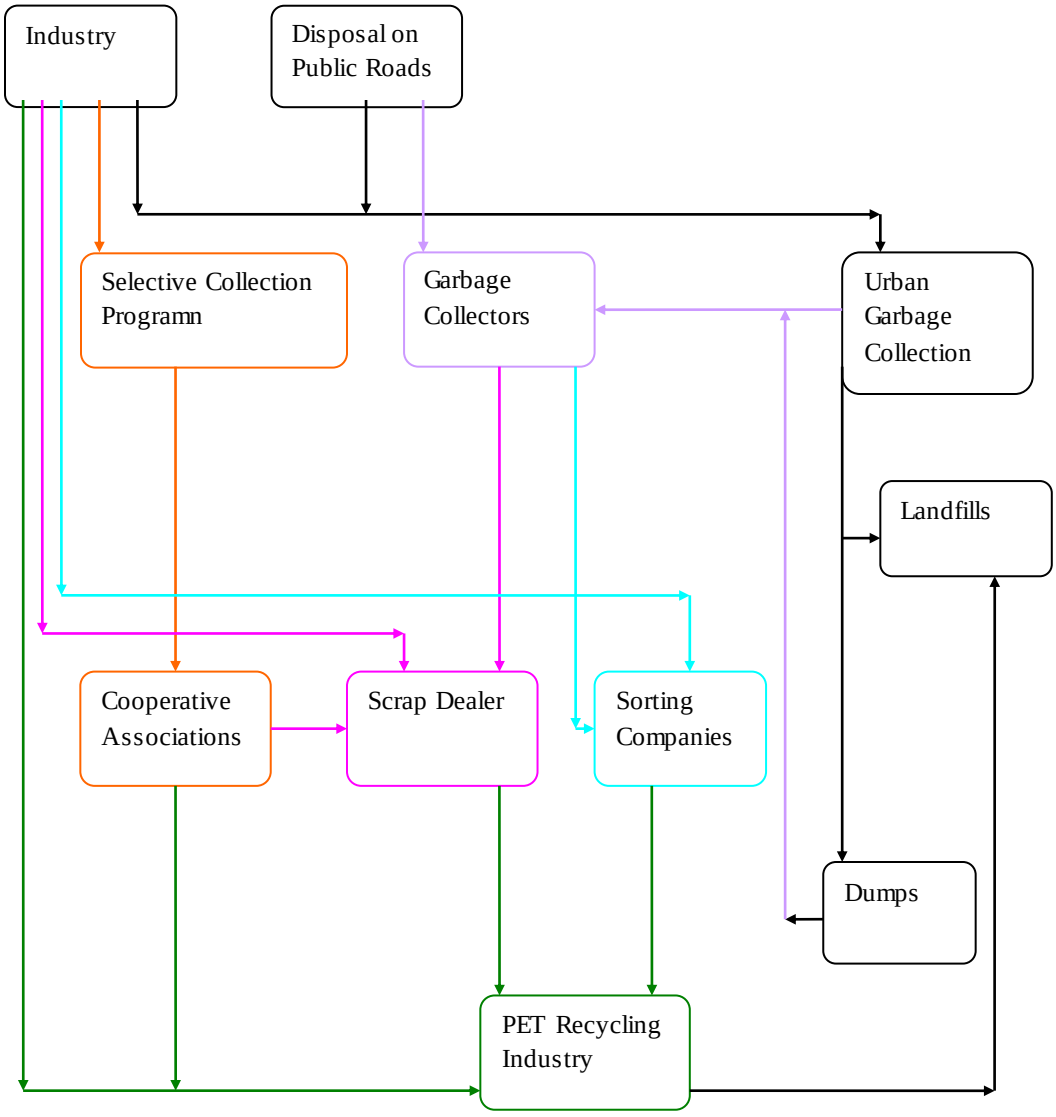


Fig. 6: Mapping the PET Recycling Process of the company RGC.
Source: Own.

In addition to the process mapping, the flowchart was developed for the company under study. The purpose of the flowchart was to highlight the sequence of the work developed. The steps in the flowchart can be seen in Figure 7.

https://dx.doi.org/10.22161/ijaers.6.6.40 ISSN: 2349-6495(P) | 2456-1908(O)

1. Transportation bringing to the company the garbage for the recycling process

2. Product control scale

3. Process of separation by type and color

4. Pressing process

5. Grinding and rinsing process

6. Drying process

7. Drying process passing through the air tube

8. The flakes already dry and ready to be packed

https://dx.doi.org/10.22161/ijaers.6.6.40 *ISSN: 2349-6495(P) | 2456-1908(O)*

9. Semi-finished product

Fig. 7: Steps of the recycling process of the PET bottle. Source: Own.

From the process mapping and the analysis of the work stages, a flowchart was constituted to analyze the processes from the collection to the semi-finished product, as shown in Figure 8.

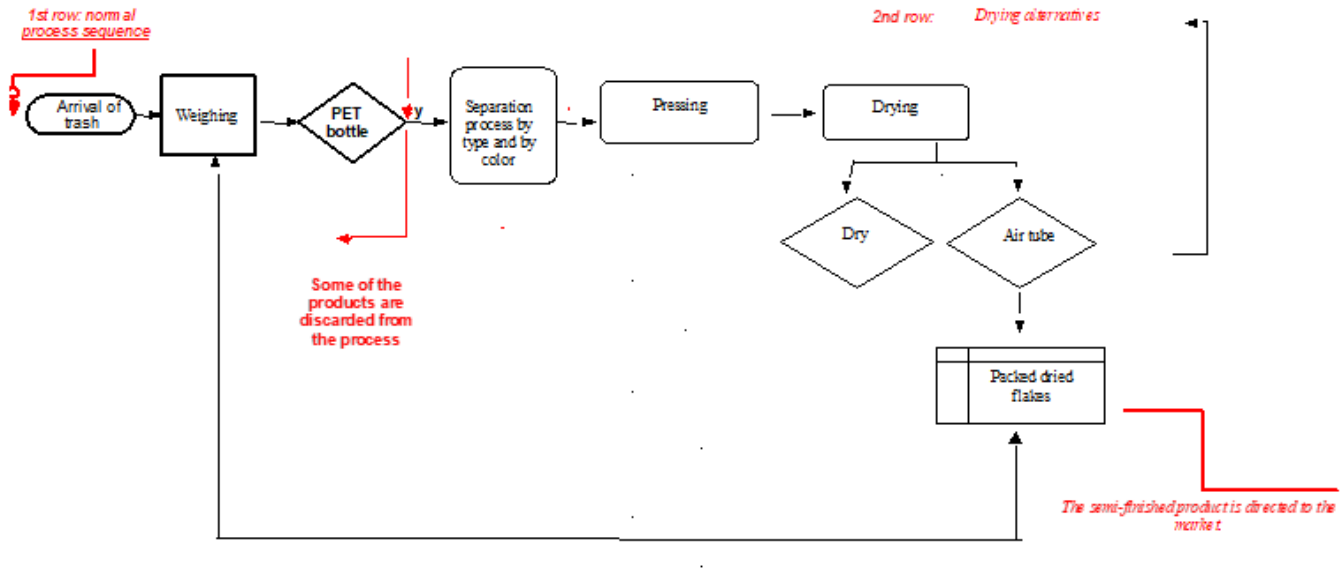


Fig. 8: Flow chart of PET bottle recycling process Source: Own.

VI. CONCLUSION

This work showed the recycling process of the PET bottle in a company in the northern city in the state of Rio de Janeiro, Campos dos Goytacazes. It revealed that the company is aware of the importance of reverse logistics for the country, society and the environment.

Through the application of the questionnaires to the manager and also to the employees, it was identified that the company has no. The mapping of processes allied to the costing by activities can contribute to a method to describe its production process. On the contrary, it follows the trend of most companies that rely on folders filled with procedures and instructions that don't really reflect how the company works and does not lead to identification of improvements.

The process flowchart and mapping were developed to provide subsidies for a better quality in the performance of the recycling process. It was considered that a more rational operational planning contributes to greater organizational efficiency and identification of opportunities for improvement. Thus it was proposed the development of process mapping to be used with a tool of deep evaluation of the business object, allowing processes to be modified, canceling or redesigning. The Flowchart was developed considering it to be a visual tool that allows a detailed understanding of the parts of the process in which some type of flow occurs.

REFERENCES

[1] ABEPET-Brazilian Association of PET Packaging Manufacturers (Online). Available from: <http://www.abepet.com.br> Access on: August 16, 2009.

[2] ABIPET. Brazilian Association of the PET Industry. Corporate Website (Online) Available at: <www.bipet.org.br>. Accessed on: 01 September 2009.

https://dx.doi.org/10.22161/ijaers.6.6.40 *ISSN: 2349-6495(P) | 2456-1908(O)*

[3] ABRE-Brazilian Packaging Association, 2004 (Online). Available from: <www.abre.org.br> Accessed on: 26 October 2009

[4] ANDERSON, J. C.; NARUS, J. A. A model of distributor firm and manufacturer firm working partnerships. Journal of Marketing, v. 54, n. 1, p. 42-58, 1990.

[5] ARBACHE, F. S. et al. logistics, distribution and trade marketing Management. Rio de Janeiro: FGV, 2004.

[6] BALLOU, R.H. business Logistics: Transportation, materials management and physical distribution. São Paulo: Atlas, 1993.

[7] _____. Supply Chain Management/business logistics; Translation Raul Rubenich. 5. ed. Porto Alegre: Bookman, 2006

[8] BARRATT, M. Understanding the meaning of collaboration in the supply chain. Supply Chain Management: at International Journal, v. 9, n. 1, p. 30-42, 2004

[9] BOWERSOX, D. J.; CLOSS, D. J. Business Logistics. São Paulo: Atlas, 2001.

[10] CEMPRE – Business Commitment to Recycling. PET Recycling in Brazil. Available from: www.scielo.br Access: On 15 September 2009.

[11] CHING, Hong Yuh. Inventory Management in the integrated logistics chain. São Paulo: Atlas, 1999.

[12] CHRISTOPHER, Martin. Supply chain Logistics and management: strategies for reducing costs and improving services. São Paulo: Pioneer Thomson Learning, 2002.

[13] _____. Logistics and Supply Chain Management: Strategies to reduce costs and improve services. São Paulo: Pioneer, 1997.

[14] FIGUEIREDO, K. F.; ARKADER, R... "From the physical distribution to Supply Chain Management: The thought, the teaching and the needs of logistics training". Technologic Magazine, São Paulo, 1998.

[15] FLEURY, P. F. Supply chain management: conceitos, oportunidades e desafios de implementação. Technologist, n.39, fev.1999.

[16] GRIMAS, Washington. Flowcharts. Available from: <http://engenhariasaomarcos.files.wordpress.com/2008/03/fluxogramas1.pdf> Access on: April 13, 2010.

[17] LACERDA, Leonardo. Reverse Logistics, a vision of basic concepts and operational practices. Center for Logistics Studies-COPPEAD-UFRJ-2202. Online Available from: <www.cel.coppead.efrj.br> Access on: 08 October 2009.

[18] LAMBERT. Fundamentals of Logistics Management. Columbus, McGraw-Hill, 1993. Disponível em: <www.scielo.br> Acesso em: 25 de Outubro de 2009.

[19] LEITE, Paulo Roberto. Reverse Logistics-Environment and competitiveness. Sao Paulo: Prentice Hall, 2003. _____. Reverse Logistics – Panorama 2004. Technologic Magazine, May 2004.

[20] LEITE, Paulo R. and BRITO, Eliane Z.. Reverse Logistics of Products not consumed: a description of the practices of companies working in Brazil. SIMPOI 2003 Congress. Accessed on: August 19, 2009.

[21] LUMMUS, R. R., VOKURKA, R. J. Managing the demand chain through managing the information flow: apturing "moments of information". Production and Inventory Management Journal, First Quarter, 1999.

[22] MAYLETT, T.; VITASEK, K. For closer collaboration, try education. Supply Chain Management Review, v. 11, n. 1, p. 58, 2007.

[23] MEIRELES, Nino Ricardo, 2008. Business Logistics. Accessed: September 18, 2009

[24] MORASH, E. A.; CORNELIA, L. M. D.; SHAWNEE, K. V. Strategic logistics capabilities for competitive advantage and firm success. Journal of Business Logistics, v. 17, n. 1, p. 1-21, 1996.

[25] NOVAES, A.G. Logistics and distribution chain management. 3. ed. São Paulo: Elsevier, 2007.

[26] OLIVEIRA, D.P. Systems, organization and methods: a managerial approach. 11. ed. São Paulo: Atlas, 2001.

[27] OLIVEIRA, Veronica M.; CÂNDIDO, Gesinaldo A. Logistic Management: The case of a food industry. In: NATIONAL MEETING OF PRODUCTION ENGINEERING, 26 º, 2006, Fortaleza. Available at: <Http://www.abepro.org.br/biblioteca/enegep2006_tr450302_7010.pdf>. Access on: 06. June 2009.

[28] SANDBERG, E. Logistics collaboration in supply chains: practice vs. theory. International Journal of Logistics Management, v. 18, n. 2, p. 274-293, 2007.

[29] SIMATUPANG, T. M.; SRIDHARAN, R. The collaborative supply chain. International Journal of Logistics Management, v. 3, n. 1, p. 15-30, 2002.

[30] SPINACÉ, M. A. S; PAOLI, M. Polymer Recycling Technology. New Chemistry, v. 28, 2005. Available from: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-40422005000100014. Accessed on: October 28, 2009.

[31] TERPEND, R. et al. Buyer-supplier relationships: derived value over two decades. Journal of Supply Chain Management, v. 44, n. 2, p. 28-55, 2008.

[32] VILLELA, C. S. S. (2000)-Process Mapping as a Tool for Restructuring and Organizational Learning, Dissertation of M.Sc. PPEP/UFSC, Florianópolis, SC, Brazil.

[33] VOSS, C.; TSIKRIKTSIS, N.; FROHLICH, M. Case Research in Operations Management. International Journal of Operations & Production Management, v. 22, n. 2, p. 195-219, 2002.

[34] WHIPPLE, J. M.; FRANKEL, R.; DAUGHERTY, P. Information support for alliances: performance implications. Journal of Business Logistics, v. 23, n. 2, p. 67-82, 2002.