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REVERSED LOGISTICS OF THE WASTE USED ON AUTOMOTIVE LUBRICATING OILS IN GAS STATIONS OF FORTALEZA CITY

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ABSTRACT

The study aims to analyze the reverse logistics process of the waste from lubricating oils used in automotive vehicles by gas stations located in Fortaleza city, the state capital of Ceará, Brazil. Reverse logistics is gaining gradually increased visibility and importance for their relevance regarding the environmental and economic issues. Therefore in this study, there was a theoretical approach to reverse logistics, lubricants and the National Solid Waste Policy. The method used was a qualitative research with a exploratory descriptive character and a multi case study in Fortaleza gas stations. Based on a review of literature and the information obtained through the collection of data, it was identified what's occurring in reverse logistics at gas stations. It is suggested that some points should be improved in order to fit the reverse logistics process of waste from lubricating oil given the current legislation in Brazil.

Keywords: *Automotive Vehicles. Brazil. Fortaleza. Gas Station. Lubricants Oils. Reverse Logistics*

1. INTRODUCTION

In the current context of the twenty-first century and with a focus in a globalized economy and strong competition, enterprise logistics represents competitiveness gain in organizations since it improves the levels of services offered, winning and retaining more customers (Craco, Remussi, Cruz & Camargo, 2011). The Logistics are formed by numerous processes and according to Bowersox and Closs (2001) it can be defined as an integration of information, transports, stock, warehousing and handling of material as well as packaging, with the ultimate goal being the availability of products and services in times and locations requested by customers.

One area of enterprise logistics is the reverse logistics that "extends the traditional concept of logistics, adding a set of connected transactions and actions, from reducing primary raw materials to the final correct destination of products, materials and packaging with your consecutive reuse, recycling and/or energy production" (Pereira, Boechat, Thaddeus, Silva & Campos, 2012, p. 14).

Besides the ecological awareness of the negative impact that the waste has on the environment, the main reasons for the impending advance of reverse logistics are: "the enterprise strategies that target the improvement of consumer relationship and the need to save manufactured raw materials with non-renewable resources" (Caixeta-Filho & Gameiro, 2011, p. 12).

The lubricating oils are examples of such products, which wastes are potentially harmful both to the environment as well as humans. Due to its risk, collection activities, disposal and reuse of automotive oils are foreseen and regulated in the National Policy on Solid Waste [PNRS], established by Law n. 12.305, of August the 2nd, 2010 (BRAZIL, 2012).

Some regulations have contributed to the increase in the collection rate of contaminated oils in Brazil, which reached 35.81% in 2011, reaching 99.7% of the target set for the year according to a report prepared by the Ministry of the Environment [MMA] and presented to the National Environmental Council, CONAMA (BRAZIL, 2013b).

According to Almeida and Ferreira (2013) the main waste deriving from the use of lubricants are: automotive oils, plastic and metal packaging contaminated, used filter besides cloths, cotton waste, sand, sawdust and personal protective equipment [PPE] that have come in contact with the lubricant. They are all pollutants and need to be carefully disposed of.

Because it is so dangerous both for the environment as well as humans, it is necessary that the product has a correct and controlled destination. A study by the United Nations World Health Organization [UN], between the years 1991 and 1993, concluded that the solution for safe disposal of lubricating oil waste, is the practice of recycling made through a process called re-refining (BRAZIL, 2013f).

Thus for these residues to do their reverse flow and be able to reach the point of recycling or re-refining, a correct and efficient reverse logistics which meets and obeys the safety standards is required (SINDIREPA-SP, 2012).

This research, concerning the reverse logistics of lubricating oil waste, is highly relevant and urgent because in addition to the economic losses of its incorrect disposal, since the lubricant has the raw material the basic oil, which can be achieved by the process of recycling of used oil. This waste poses many risks both to the health of human beings as well as for the ecosystem. The concern comes from the fact that many people unaware of these dangers, both consumers and those working with the handling of lubricants oils. The impact of improper disposal can be devastating and irreversible for the city of Fortaleza and its inhabitants, a fact that confirms the importance of this research.

Therefore, based on this construct, this research aims to analyse the way the reverse logistics process is done with the waste from lubricating oils used in automotive vehicles by gas stations located in the city of Fortaleza, Ceará state capital, Brazil.

2. LITERATURE REVIEW

2.1 Reverse Logistics Post Consumer

The enterprise logistics can be considered one of the oldest human activities, seen by the aspect that tries to supply the goods and services in place, time, quantities and qualities required by its users. It's entry in the corporate world has been done gradually and has its origins in the military, where it was decisive for the victory in battle since it was responsible for all materials handling (Leite, 2009).

So the enterprise logistics is an important factor of differentiation and competitiveness since it studies how the administration can provide a better level of profitability in distribution services to buyers (Ballou, 1993).

With the increase of production capacity of enterprises and the constant release of new products and models, the useful lives of the assets has decreased considerably and these became to be discarded with a shorter life span. This premature disposal generated higher quantities of products which somehow need to return to the production cycle. Allied to this the growing awareness of the population and the governors to the need for preservation of the environment, makes it increasingly necessary to apply another branch of logistics, which is the reverse logistics (Leite, 2009).

Today, a very complete and modern definition of reverse logistics is presented by Dornier, Ernest, Fender and Kouvelis (2009) when it states that besides the traditional direct flows, logistics today also includes the return flows of products that will be repaired, returned or that will go to the recycling process, besides taking care of the proper destination thereof.

Reverse logistics can be analyzed by three aspects: the **economic, ecological** and **legal** standpoints. Regarding the **economic aspect** "the economic objective for the implementation of reverse logistics of post-consumer is understood as the possibility of financial revaluation of post-consumer product through the reuse of its constituent materials and savings occurred from their use, as well as the revaluation of the products in good condition directly or after remanufacturing" (Leite, 2009, p. 107).

From an **ecological** point of view, the analysis is done through a holistic approach emphasizing the interdependence between the focuses of reverse logistics. "The ecological revaluation of post-consumer products is seen as a way for the company to recapture value through reverse logistics, reducing the impact of its products on the environment. It reveals a enterprise responsibility position relative to the environment [...] for which the enterprise continuous to be responsible for its product, extending its life cycle in addition to deliver to the consumer market as a modern way of keeping your corporate image and perpetuate their business. [...] The

strategic objectives of the reverse logistics implementation are not independent of each other and in general actions with ecological objective result in economic gains and other benefits" (Leite, 2009, p. 130).

Regarding the **legal** aspect reverse logistics utilization, it has to "when natural market conditions do not provide efficient balance between the reverse flows and direct flows, it is necessary the intervention of government legislation, so that the conditions are changed permitting a better balance of the return post-consumer goods and their constituent materials [...] the legal revaluation of post-consumer goods will be achieved through obedience to the environmental laws concerning the impact of products on the environment" (Leite, 2009, p. 146).

For a better understanding of the practice of reverse logistics, Leite (2009) separates two distinct areas of actions classified from the phase or life spam of the returned product. This distinction is necessary because the logistics product, the means of reverse distribution utilized, the organizational objectives and operational tactics are different from each other. The first area is the logistics of post-selling that plans, operates and controls the return path of the products without or almost with no use. The reason for this return may be due to expired validity, error in ordering, defect or failure, damage in transportation, stock problems, marketing policies or guarantees (Leite, 2009).

Now the reverse logistics post-consumer products only operates with products at the end of their life spam and with their waste so called materials not utilized in human activities that derived from industries, commerce and residences, as defined by Langanke (2013). She is responsible for the reverse flow of these post-consumer waste made through the reverse supply chain of reuse, recycling or the remanufacturing, reintroducing them to the production cycle (Leite, 2009).

Although still suffering some resistance from the entrepreneurs, justified by Leite (2009), due to the fact that a financial return would be easier to understand in the direct distribution channels and not the reverse, the tendency is that there will be growth in the utilization and development in the practice of reverse logistics of post-sales, mainly from post-consumer as a consequence of the excessive increased of new products launches, and the reuse of materials found in these post-utilization rejects.

2.1.1 Reverse Logistics of the National Policy on Solid Waste

On August the 2nd, 2010 the Law n. 12.305 was approved establishing the National Policy on Solid Waste [PNRS], ruling for its principles, objectives and instruments as well as on the guidelines on integrated solid waste management, the responsibilities of its generators, the government and the applicable tools (BRAZIL, 2012).

The main PNRS objectives are: the reduction, the reutilization and the treatment of solid waste as well as the final destination of environmentally correct disposal of waste; decreased use of natural resources such as water and energy in production; enhancing actions of environmental education; increase of recycling in the country; promoting social inclusion, generating employment and income for waste pickers. In addition it designates the shared responsibility where the obligations of each waste generator are individualized aiming at minimizing the amount thereof and reduce the negative impact on the environment establishing the concept that everyone who is part of the chain production (manufacturer, importer, distributor, marketer and the consumer) are responsible for the correct destination of rejects (BRAZIL, 2012).

The PNRS initially defined how to delegate that responsibility in the treatment of six types of waste and mandated the creation of a steering committee to address these specific cases and working groups whose role is to plan the reverse logistics of these materials and ensure the return of their waste to appropriate places of origin or appropriate destination. They are: tires; batteries; pesticide containers and lubricating oils in addition to the fluorescent lamps and electronics, because they have great potential for pollution and risk to human health (BRAZIL, 2012).

The National Environmental Council [CONAMA] already establishes, through resolutions the procedures for the environmentally correct disposal of four groups of waste: tires (Resolution n. 362/2005); batteries (Resolution n. 257/1999); lubricating oils (Resolution n. 258/1999) and pesticide containers (Resolution n. 334/2003 and Law n. 9.974/2000) (BRAZIL, 2013c).

The existence of these regulations, however, do not override the importance of the National Solid Waste Policy [PNRS], since they focus, almost exclusively, on proper destination of this waste, while PNRS focuses on

management and integrated management of these wastes, considering the whole life spam of the product and aiming thus beyond the proper disposal, ending production of the same and control the quality of environmental processes (Aguiar, Christofoletti, Ruiz & Ruiz 2013).

The regulation of PNRS is made by Decree n. 7404 date the 223rd of December 2010, that establishes the norms for it's execution, creates the Inter-ministerial Committee of the National Policy on Solid Waste and the Steering Committee for the Implementation of Reverse Logistics Systems (BRAZIL, 2013e).

For the National Plan for Solid Waste to be effective and waste management programs operate it's necessary to have a infrastructure capable of making the flux of materials to the point of reuse remanufactured or recycled or its final correct destination (Bel & Salgosa, 2013).

According to the aforementioned authors is in this context that the reverse logistics of post-consumer products, it is extremely necessary, because it will be responsible for the process of planning, implementation and control of the products and materials fate on the market. The National Policy of Solid Waste, Law n. 12.305/2010 defines in article 3, clause XI reverse logistics as: "an economic and social development tool characterized by a set of actions, procedures and means to enable the collection and recovery of solid waste to the business sector for reuse in your cycle or other productive cycles or other final destination environmentally suitable" (BRAZIL, 2012).

The instruments to operate the reverse logistics systems are: sectoral agreements; regulations issued by the government; or terms of engagement. Through these statements it is clear that by establishing a "**shared responsibility**" the National Policy on Solid Waste [PNRS] necessarily linked to reverse logistics by demarcating all functions within the product chain not leaving no gaps for liability exemptions of any party involved in the process (BRAZIL, 2012).

2.2 Reverse Logistics of Lubricant Oils Waste

According to the Federation of Industries of Rio de Janeiro [FIRJAN] (2013) developing and implementing the Waste Management Plan [RMP] is essential to maximize opportunities and reduce costs and risks associated with solid waste. The classification of waste substances is the first step to structure an adequate management plan. According to their characteristics and legal requirements, a plan is drawn up on the handling and disposal of rejects, including the reverse logistics process.

The waste from automotive lubricants presents a major concern with regards to management and control due to be considered harmful to human's health and the environment as well as for its economic value since it is from the contaminated oil that the basic oil, which makes up about 80% to 90% of lubricant ready for use, is extracted (SINDILUB, 2013).

The lubricating oils main function is to reduce the friction and wear and tear of the mobile parts of certain pieces of equipment or machine. They may, however, also be used for: refrigeration and the cleaning of movable parts, transmission of mechanical force, sealing, insulation and components protection as well as in the transfer of physical-chemical characteristics to other products. Therefore, there are various types of lubricants which differ very much in the matter of viscosity as in other specifications to meet these various ways of use (SINDIREPA-SP, 2012).

Over time, with its normal use, the lubricating oil suffers deterioration or contamination and loses its main properties, so to ensure the integrity and proper functioning of the engine or equipment it needs to be replaced periodically. The substance removed from the motor or engine shall be classified as a hazardous waste, termed as used lubricating oil or contaminated. It is popularly known as "**burnt oil**" due to burning of its main components. That denomination is not correct, because the deterioration of the oil is only partial, allowing its residue to be re-refined transforming it into basic oil (SINDIRREFINO, 2013).

In addition to the oil removed from the vehicle other materials that are used in the process, also become waste pollutants, since they come in contact with contaminated oil. Examples of these materials: lubricant packaging, changed filters, cloths, cotton waste, sawdust and personal protective equipment (Almeida & Ferreira, 2013).

The main waste generators, particularly the used oils from the lubricants are the gas stations, car dealerships, maintenance areas in companies and automotive repairs among others. All these establishments are responsible

for the reverse logistics of these post-consumer products and their proper final disposal. In the case of oils, CONAMA Resolution n. 362 dated June 23rd, 2005 determines that the oil has to be recycled through re-refining process (Adissi, Cardoso, Simões, Pereira & Xavier 2013).

According to Guarnieri (2011), the re-refining process is the category of industrial processes that remove the contaminants, the products of degradation and the additives of used lubricating oils. This removal gives them characteristics of basic oils which, added to appropriate amounts of additives, become suitable to be reuse.

According to Almeida and Ferreira (2013) the reverse flow of lubricant is divided into the following stages. In the first stage are all those that generate the waste directly or indirectly and which are classified as "generators". In this category the vehicle owners and those who perform oil changes are included. To them, the legislation attributed two fundamental obligations, the first is to take care that the waste is correctly stored awaiting their final destination, preventing it from contaminating the environment, humans, itself making it difficult or even preclude their recycling. The second obligation is to return their waste to the dealer or a collector authorized by the National Agency of Petroleum, Natural Gas and Bio-Fuels [ANP] (BRAZIL, 2013f).

In the second stage is the "**reseller**" who is all those marketing lubricants. They are the link between the first link, which are the generators, and the third which are the "collectors" and its obligations are. To receive the contaminated oils, maintain adequate facilities and licensed to do this receipt, make the correct storage, alienate waste oils only to licensed collectors, maintain the evidential documents of purchase and collection certificates, keep a copy of the license given by the environmental agency and attach warnings stating destination regulated by CONAMA n. 362/2005 (Almeida & Ferreira, 2013).

The so-called "*collectors*" are responsible for the recovery and recycling of waste. The main duty of this group is to comply with the requirements of legislation from the appropriate transport, which should be done in special and well marked trucks, to the correct way of handling. In addition, they are also responsible for issuing the collection the certificates (SINDIREPA-SP, 2012).

Regarding the collection at gas stations, which is the focus of this research, it is made by member companies of the National Union of the Industry of Mineral Oil re-refining, the SINDIRREFINO and are authorized by the National Agency of Petroleum, Natural Gas and Fuel [ANP] to carry out the recycling process (Guarnieri, 2011).

2.2.1 Reverse Logistics of Lubricant Oils Waste and the National Policy on Solid Waste

Reverse logistics of lubricating oil waste, as already explained above, is of paramount importance, both for economic reasons as for environmental reasons. Taking into account the parameters and definitions set out in the National Solid Waste [PNRS] Policy, residual substances of lubricating oils are classified as "industrial waste generated in production processes and industrial facilities" (BRAZIL, 2013g).

In relation to its danger are considered: "hazardous waste: those who, because of their flammability characteristics, corrosiveness, reactivity, toxicity, pathogencity, carcinogenicity, teratogenicity and mutagenicity, they present a significant risk to public health or environmental quality according to law, regulation or technical standard" (BRAZIL, 2013g). All commercial or service establishments, hazardous waste generators, including lubricating oils, are required to develop a management plan of these rejects consisting of a reverse logistics plan, as required by article 20 of PNRS.

Therefore, the logistics of lubricating oils is foreseen in the National Solid Waste Policy by correlation, taking into account their classification since the law rarely specifically addresses a product, but, product groups. Therefore and emphasizing the reverse logistics activity article 31 reads that "without prejudice to the obligations established in the solid waste management plan and in order to strengthen the shared responsibility and its objectives, manufacturers, importers, distributors and marketers have responsibility covering: II - collection of products and residual waste after use as well as its subsequent final destination environmentally appropriate, in the case of reverse logistics system object products under art. 33" (BRAZIL, 2013g).

Complementing the regulation, article 33 provides that "are required to structure and implement reverse logistics systems by return of products after use by the consumer, independently of the public service of urban sanitation and solid waste management, manufacturers , importers, distributors and marketers of: lubricating oils their waste and packaging" (BRAZIL, 2013g).

As for lubricating oils and its residues and packaging, it is determined, through article 37 that the installation and operation of the project or activity that generates or operate hazardous waste can only be authorized or licensed by the competent authorities if the person in charge proves, at least, technical and economic capacity and conditions to provide the necessary care to the management of such waste. In relation to juridical persons that operate with hazardous waste at any stage of its management, these are required to register with the national register of hazardous waste operators (BRAZIL, 2013g).

As already mentioned earlier, waste lubricating oils are highly toxic and harmful both to the environment as well as human beings, making it necessary to its correct destination which is the re-refining (Almeida & Ferreira, 2013). Allied to this environmental issue, is also the economic issue. Brazil has some shortages for some petroleum products, including basic oil, which is the main component of lubricating oils and can be extracted from the lubricant already used and contaminated (SINDILUB, 2013).

For these reasons the reverse logistics of the residue on the lubricating oil is so important and has its implementation and control foreseen in the National Policy on Solid Waste [PNRS].

3. METHODOLOGICAL PROCEDURES

The research can be classified as to their goals, their nature, as to where it is held and the procedures used. As to the **objectives** this research is exploratory and descriptive. Exploratory because it uses a literature review and interviews to make the initial characterization of the problem studied (Gil, 1999). Already the descriptive research, objects the description of the facts and phenomena of a given reality (Triviños, 1987), in the case that are the processes involved in reverse logistics of waste lubricating oil at gas stations in the city of Fortaleza.

Due to its **nature** the research is qualitative as it doesn't seek to measure the events studied nor employs statistical instrumental in the development of the results. Regarding the **procedure**, the research is classified as bibliographic, since we used a wide search for preparation of the scientific literature review on the central theme of this article (Marconi & Lakatos, 1999).

Regarding the **location**, the data collection tool of this study is the field research through the multi case study. The multi case study of this research shall be delimited to two gas stations that exchange lubricating oil located in the city of Fortaleza. Just the reverse logistics process of lubricating oils was analyzed in this study.

For sampling of this research, we used the non-probabilistic method and classified also as accessibility and purposeful, since the sample was chosen because the researchers reside in the city of Fortaleza and have easy access to necessary information (Gil, 1999; May, 2004). In each gas station was interviewed a manager responsible for the oil exchange service and an employee who performs the actual exchange of lubricating oil.

For this research we opted for the intensive direct observation method, through data collection technique called semi-structured interview. Two interview scripts were elaborated, one for managers composed of thirty-four questions. The second script, for operational staff, composed of nineteen questions. In relation to the processing of data we used the content analysis method because the answers collected in the interviews were analyzed from the message itself, regardless of subjectivity in which it is produced (Souza, Melo & Santiago, 2010).

4. ANALYSIS OF RESULTS

In this section we analyzed the main aspects of the reverse logistics of lubricating oils waste in the two gas stations in Fortaleza, through the analysis made from the information collected in the field research.

The interviews focused on mainly three aspects: the profile of employees executing the exchange service of lubricating oil and stations offering the service; knowledge about the lubricating oil, its impacts and its relation with the National Policy on Solid Waste both management and operational staff; and finally how the process is done itself exchange of automotive oil and the disposal of its waste.

4.1 Study Objects - Petrol Stations of the City of Fortaleza

According Adissi et al. (2013), the main generators of lubricant oils waste are the gas stations, car dealerships and the companies providing automotive repair services.

To carry out a broader survey, covering all these generators it would require a longer period of time for the development and its conclusion. Therefore for this research it was determined as a study objects only the gas

stations. The selected sample were two establishments in the city of Fortaleza, Ceará state capital of Brazil, as detailed in the following sections.

4.1.1 Gas Station A

The gas station A, founded in 1996, located in the noble neighbourhood of the city is considered one of the most popular stations in the city of Fortaleza. Since January 2012, the oil change service was offered as complement activities already available to its customers. Two employees are responsible for such activity, not having, however, exclusivity which means that they also have other functions within the post.

All receive periodic training conducted every six months, which addresses mainly the technical, safety and environmental aspects linked to the product. Courses are administered by the company who resells the lubricants that issues certificates to the participants.

The employee interviewed works for 15 months at gas station A, that is, from the beginning of lubricant change activity. However, his experience in this service is of 13 years previously acquired in other establishments.

Both the manager and the employee claim that there aren't any guidelines of the lubricant change process, which means that there isn't a source of information to clarify any doubts concerning the procedures regarding the handling and disposal of the products.

The employee claims to have knowledge of the risks that lubricating oils waste present both for his health as well as the for the environment, there is even a warning attached in a visible place, warning of these dangers and guiding about the proper disposal of contaminated lubricating oil [OLUC]. This claim is ratified by the manager. However, despite the knowledge of the risks, still the employee admits to have some resistance in using the individual protective equipment [EPI's].

The employee admits using sometimes, boots, gloves, goggles and apron. Nevertheless, some essential equipment that's missing needs to be considered such as cotton overalls and the protective skin cream of oil-resistant (SINDIREPA-SP, 2012). The management admits struggling to control the use of EPI's, as many employees claim that the equipment hinder the execution of the service. As for security, the gas station has artefacts to contain leaks, such as sand, sawdust and there are rails surrounding the place where the oil change is performed. The employee claims never to have seen a lubricant leakage.

Graphic 1 illustrates all stages of reverse logistics of lubricating oil wastes process made by consulted gas stations. In the text, the activities are listed according to the stage in which they happen.

To meet monthly demand of 240 vehicles that perform the oil change, are bought 670 litters of lubricating oil (1). As a result of this service, 630 litters of oil contaminated are generated [OLUC] (11), an average of approximately three litters per car, and 640 packaging units used (5). It is noteworthy that the difference between litters purchased, generated and used packaging can not be calculated proportionality because there are several situations that affect the final count of waste. For example, there are cases where the oil is only completed which does not generate contaminated oil, there are cases where the lubricant content is not fully utilized (4), and the customer takes the package, thus, not making part of the calculation of the used containers (9), another situation occurs when the customer brings its own lubricant (2), therefore, there are several cases that interfere with the final count of waste.

For other types of waste, there are no records of the quantity produced. This lack of monitoring happens mainly because of management and operational staff, recognize as tailings of this operation, only the oil used, the discarded filter and so-called oily rags, as they are called dirty rags. The parameter to classify them as waste is limited to the fact that no more use for these objects. However, according to Almeida and Ferreira (2013), all materials that come into contact with the lubricant, used or new, should be considered as the exchange process waste and have its subsidiary destination.

The stages of the oil change process were described by the manager and the employee as follows: after checking the need for lubricant change, taking into account the mileage or the maximum period of six months (10), the customer is led to the place of exchange where the hydraulic lifts are located. Then, the oil sump is drained (lowered), the filter is removed and replaced and only then it's filled with new oil according to the vehicle specifications (3).

After withdrawing the oil, the contaminated oil flows through an oil draining pan, located under the vehicle and descends to the underground tank where it is stored (12) until it is collected. At the end of the exchange process, the site is washed with soap and water. This water goes to the separator box responsible for separating the used oil from other substances including water.

At this stage, the reverse logistics itself begins from that residue. The collection of the OLUC is made by Lwt (13) that according to the manager is the largest company collecting in the region of Northeast, certified by the regulatory bodies. The collection is done approximately every three months, as it is the time that the tank is approaching its maximum capacity which is 2 000 litters. There is no payment for OLUC collected and the transportation is done via suitable trucks, for this type of hazardous substance, at no cost to the gas station.

Regarding the used oil, both the employee and the manager know their final and proper destination, which is the re-refining. However, the gas station makes no monitoring to assess whether this residue, after collected, in fact gets to re-refineries for the recycling process. The National Solid Waste Policy provides in its guidelines the so-called "shared responsibility", which requires all generators to be consumers, sellers or anyone who is connected in any way in the production of waste, not only to see to the correct destination of the rejects but also follow that all components of this chain are fulfilling their duties and that the waste is going in fact to the destination specified in the Law n. 12.305/2010 (BRAZIL, 2013d).

With regard to packaging, the employee reports that after opening and emptying (6) they are deposited in iron drums (7) to prevent leakage and are collected by independent collectors (8). In these bottles certain amount of the product is still deposited, so to prevent this oil to be improperly disposed, the practical use of draining residual lubricant is necessary, which is done by means of a oil draining pan that collects and stores oil to be given its correct destination (Almeida & Ferreira, 2013). This practice however is not used by the gas station A. No accompaniment to its destination is conducted, and both the employee and the manager believe that the final destination of the packaging is recycling. Once again the question of "shared responsibility" is not observed.

In this case, as for the other waste, all other objects that have come in contact with used oil (14) are deposited into ordinary bins (15). This procedure is at odds with what is required by law, in relation to the forms of storage and disposal of waste from the exchange of automotive oil. For example, the cotton waste and dirty rags should be packed in identified containers and stored in an appropriate location until its destination, in which case, still remains licensed landfills for hazardous waste (SINDILUB, 2013).

According to the manager of gas station A, to offer the service of oil exchange it is required the registration with the National Petroleum Agency, Natural Gas and Biofuels [ANP] and the environmental license granted by the State Superintendent of Environment [SEMACE], whose main objective is to license the installation, expansion, modification and operation of activities and enterprises that use natural resources or are potentially polluters and cause environmental damage (Panizzi, 2013).

Regarding the internal inspections, the manager does not perform them; he just makes periodic assessments of customer satisfaction in the provision of the oil exchange service. As for the external inspections, the manager states that inspections by government agencies are unknown to him. However, contradicting this information, the employee himself provided a certificate of contaminated oil collection which shows that the gas station seeks to maintain the documentation required by the agencies overseeing the activity of oil exchange.

The manager considers regular his knowledge about the Law n. 12.305/2010 and the main guidelines of the National Policy on Solid Waste [PNRS]. On the other hand the operating employee confesses to be unaware of such law.

Taking into account the manager point of view, he believes the gas station works according to PNRS, and does not need any adjustment to comply with the current legislation. However, at various points mentioned in this analysis, differences were found between what is required in the National Policy on Solid Waste and what actually is practiced with regards to the implementation of the oil exchange activity, the management and allocation of waste from this process, concluding mainly that the knowledge of managerial staff for PNRS can be considered poor unlike the regular, as he himself claimed.

Finally, respondents were permitted to give some collaboration on the topic of this research. The manager suggested the process of selective collection should be accelerated. The operating employee suggested that other

types of waste, other than contaminated oil and filters removed from vehicles were incinerated, as it is his belief that discarding of the same into ordinary bins is very dangerous which confirms the employee's lack of knowledge relating to legislation that rules over the proper disposal of these wastes as the Resolution n. 362/2005 of the National Council on the Environment [CONAMA] prohibits the burning and incineration of contaminated oil and dirty objects due to its high potential of air pollution (BRAZIL, 2013c).

4.1.2 Gas Station B

The gas station B situated on the outskirts of the city of Fortaleza, has been established since the 70s. At first its main objective was to serve as a fulcrum for the refuelling of machinery used for the construction of neighbourhoods. Then, in 1982 it was purchased by the current proprietors who also started focusing on the general public. Since then the gas station also started offering the automotive oil exchange service.

Currently three employees are responsible for such activity not having, however, exclusivity which means that they also have other functions within the station. They take turns at different times to prevent interruptions in service provision from 6 till 21hours.

They all receive periodic training, carried out every two months, which mainly address the technical and environmental aspects. Courses are renderer by the reseller company of lubricants in this case by Mobil.

The employee interviewed, in particular, has worked for 15 years in gas station B and has the same experience in the oil exchange service. Both the manager and the employee, claim that there are no guidelines in the lubricant exchange process so there isn't a source of information to clarify any possible doubts. What are available to employees are the so called technical conversion tables which only indicate the adequate type of oil for each vehicle. The lack of a manual can increase the likelihood of improper handling and disposal of waste lubricating oils.

The employee claims to have knowledge of the dangers that lubricating oils waste have either to his health as well as the environment, there is even an attached notice in a visible place warning of these dangers and advising about the proper destination of OLUC. However the risks, only the possibility of burns and irritations were mentioned by the employee. This fact indicates that he is unaware of any damage that could suffer in case of contact, inhalation or ingestion of contaminated oil, since it contains a number of toxic elements that can cause several severe health problems, such as lead which accumulates mainly in the bones being carcinogenic to the kidneys and lymphatic system as well as causing malformations in foetus. Another example is that arsenic is carcinogenic to skin, lungs and liver (Almeida & Ferreira, 2013).

Among the personal protective equipment [EPI's], the respondent states to use in this case, boots, gloves, goggles, are still missing cotton clothing, protective apron and cream skin protector and oil-resistant (SINDIREPA-SP, 2012). He is a member of the Internal Commission for Accident Prevention [CIPA]. On the other hand, the manager claims to have problems for an effective use of EPI's, the employees claim that the equipment difficult at the time of execution of the service. Employees have to sign a indemnity form to use protective equipment, which proves the employees resistance in using the equipment.

As for security against leaks, the gas station has artefacts for the containment in case of accidents such as sand, sawdust and it is already providing the placement of gutters on the oil exchange site. The employee claims he has never seen a lubricant leakage.

To meet monthly demand of 270 vehicles which perform the exchange of fluid, 800 litters of different types of lubricating oils are purchased (1). As a result of this service 750 litters of contaminated oil are generated [OLUC] (11) and 760 packaging units are used (5). Recalling that, as mentioned before, the relation between the amount of purchased oil, the amount of OLUC generated and the amount of packaging used (9) cannot be calculated proportionality due to factors that interfere in the final count of these rejects (2; 4).

For other types of waste there are no records of the quantity produced. This lack of monitoring happens mainly because the management and operational staff only recognize as rejects of this operation the used oil, containers with lids and the discarded filters. The parameter to classify them as waste is basically limited to lack of use thereof. This form of classification is not in accordance with what the current regulations provides, since all the material that gets into contact with contaminated oil acquires hazardous waste classification (Almeida & Ferreira, 2013).

The stages of the oil exchange process were described by both the manager and the employee in the following manner: firstly the employee guides the client as into what type of oil must be used in accordance with the specifications of the client's vehicle (3). Then the client is directed to the location reserved for the exchange. Afterwards the employee verifies if the "plug" is in good condition so that the exchange of fluid can take place, if by any chance there are any cracks or damage of any kind this prevents the execution of the service as the oil might leak. If everything is in order for the exchange the contaminated oil is drained the used filter is replaced by a new one and the new oil is placed (10).

After withdrawing, the contaminated oil flows through an oil draining pad located under the vehicle and flows to the underground tank where it is stored (12). In this tank there is no separation process since the substance that is deposited there is only the contaminated oil without contact with other substances. This reservoir is protected; it is surrounded by a layer of fibreglass to avoid the risk of oil leakage and absorption of the contaminated oil by the soil or by aquifer reserves. At the end of the exchange process the site is washed with soap and water. This water goes into a reservoir of water separation with other substances then returns for reuse in the general cleaning of the gas station. From there begins the actual reverse logistics of this waste.

The collection of this OLUC is also made by Lwt (13), which is a company certified and registered with the National Agency of Petroleum, Natural Gas and Biofuels [ANP]. The collection is made every two months and is payable to the gas station an amount according to the volume in litters collected. Transportation is done by trucks especially suitable for this type of hazardous substance. They suck the oil contaminated from the underground tank to the drums that are inside, allowing better packing and measurement of the amount collected.

Regarding the used oil, both the employee and the manager know their final and proper destination which is the re-refining. However, the post does not make any monitoring to assess whether this residue, after collected, in fact gets to re-refineries for the recycling process. The manager claims that after leaving the waste leaves the station the supervisory responsibility is the ANP, demonstrating unknowing the issue of "shared responsibility" where all the participants in the chain of solid waste generation, are responsible for the reverse logistics of waste and for monitoring to final destination appropriate thereof (BRAZIL, 2013a).

With regards to packaging, the employee reports that after opening and emptied they are placed in a kind of oil draining pad (6), they are placed upside down to collect the rest of the lubricant that was left in the container. This practice is important because it prevents the improper disposal of large amounts of OLUC (Almeida & Ferreira, 2013). Thereafter, they are deposited in dumps (7) in order to be collected by collectors (8). Both the employee and the manager believe that the final destination of the same is recycling. No monitoring is made to confirm if the final destination is being fulfilled. Both the issue of "shared responsibility", which is not obeyed as well as the lack of a reverse logistics process of packaging used are points of disagreement that the PNRS states.

In this case, as for the other waste, all other objects that have come in contact with used oil (14) are deposited into ordinary bins (15), otherwise they are cleaned and reused. Within this attitude it is evident two flaws in reverse logistics process of lubricating oils, the first is on the classification of objects in the waste, as all the materials have come in contact with the lubricant, secondly, it shouldn't reuse the materials contaminated because they are highly toxic.

According to the manager in the gas station B, to offer the oil exchange service the business license is required issued by the Fortaleza City Hall and an environmental license granted by the State Superintendent of the Environment [SEMACE], whose main objective is to license the installation, expansion, modification and operation of activities and enterprises that use natural resources or are potentially polluters and can cause environmental degradation (Panizzi, 2013). In the case of gas station B, which has passed through all the licensing stages only periodic renewal of the operating license is made.

Both the employee and the manager claim they have knowledge of the Law n. 12.305/2010 and the main guidelines of the National Solid Waste Policy. For the management the only point that "escapes" the guidelines of PNRS is the reverse logistics of the lubricants packaging, whose suitability is already under study. This statement, however, does not agree with the analysis of the results of the interviews where it was established several points of improvement and not only the relation to packaging.

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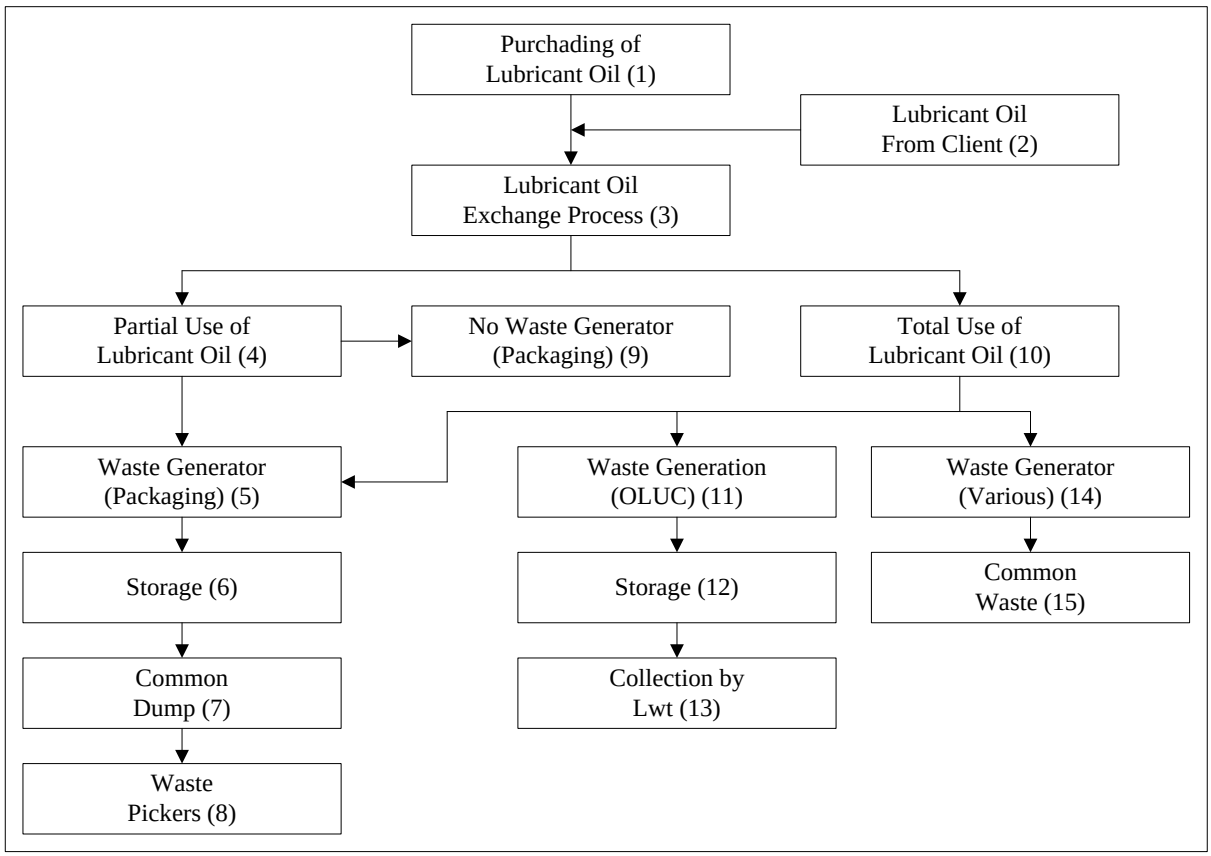
Graphic 1 illustrates the entire process of reverse logistics lubricating oil waste carried by the two stations.

Graphic 1 – Reverse logistics process after consumption of lubricating oil carried by stations A and B



Source: prepared by the authors.

Despite the gas stations A and B complying with most legal requirements with regards to the handling and reverse logistics lubricating oil waste, there are some points that need to be worked on in order to improve and be adequate to the current legislation such as: **(1)** elaboration of procedure manual; **(2)** dissemination of information to those involved; **(3)** the proper treatment of lubricants packaging; **(4)** retaining rails in the event of oil leakage; **(5)** proper destination of other wastes generated by the oil change process; **(6)** effecting the use of EPI's; **(7)** improvements in the process of exchange of lubricating oil; **(8)** implementation of an organizational culture oriented to waste management; **(9)** effective participation in relation to shared responsibility; and **(10)** investment in specific facilities for washing uniforms and contaminated clothing and shower for use in case of accidents.

5. CONCLUDE REMARKS

This research, through a multi case study with the gas stations A and B sought answers to attain the general objective of the research related to reverse logistics of lubricating oils at gas stations in the city of Fortaleza. This study provided a better understanding about the central theme of this research, allowing the identification of difficulties, and presenting some suggestions for improvement with the intention of eliminating or mitigates the difficulties reported.

Therefore, the process of reverse logistics of post-consumer were it was possible was described to realize its growing importance mainly caused by the need to return products being generated to the production cycle in an increasing amount. These goods reached the end of its life span or do not have more usefulness to the original owner. They may return to the market through the total or partial reuse of its components or through recycling. In addition, environmental awareness whose concern became the minimization of waste production, in the valorisation of this process also became an important point. The increase in the number of goods available on the market is due mainly by the increased productive capacity of enterprises, reducing the time of launching new products on the market, thus, increasing the speed with which they become obsolete and decreasing the life span thereof. This type of logistics enterprise started to gain greater visibility from August 2010, with the introduction of Law n. 12.305/2010, which provides for the National Policy on Solid Waste [PNRS].

As for the reverse logistics process of post-consumption of lubricating oils created specifically consulted by the two stations, A and B, it can be seen that despite the management believe that there aren't so many adequate points in relation to the PNRS, they exist and are essential for the process of reverse logistic to happen in an appropriate manner. Amongst the main points we can mention: the lack of information about the National Solid Waste Policy, incorrect allocation and classification of waste materials, such as cotton waste and contaminated materials, non-use of protective equipment, the small number of enterprises that offer contaminated lubricating oil collection service [OLUC] and the lack of knowledge of those involved in the waste generation chain with regards the "shared responsibility".

Within the general framework, the gas stations present concerns and seek to adapt to the requirements established by law but the conclusion is that there is still lack knowledge about the production of waste arising from the lubrication oil exchange service and its correct destination. In order to adapt the companies with regards to lubricating oil waste a few suggestions for improvements were presented taking into account the weakest points of the two gas stations studied.

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