

## THE CHALLENGES OF REVERSE LOGISTICS MANAGEMENT OF END-OF-LIFE VEHICLES IN BRAZIL

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### ABSTRACT

*In a scenario of denial of patterns of use and proliferation of products with increasingly faster life cycles, the solution has been to seek alternatives to retrieve and leverage these post-consumer products. In the automobile sector of many countries such as Japan, United States and the European Union, there are already systemic practices of recycling of end-of-life vehicles. Brazil is in the initial stage of this process, despite counting on high rates of recycling of some materials. It is in this direction that this study sought to find out how the management of reverse logistics of end-of-life vehicles in Brazil and what is the final destination of these vehicles. The general objective of this work was to analyze the current situation of reverse logistics of a fleet of buses at an advanced age in Federal District-Brazil (where approximately 2,800 buses left the system) and from there, along with the other research sources, presenting the Brazilian challenges in the deployment process of reverse logistics of end-of-life vehicles. In order to achieve the objectives of this research, at first, bibliographic research, secondary data collection and, subsequently, several interviews and technical visits to bus companies in Brasilia and dismantling companies in the State of Goiás (due to the proximity with the Federal District) were used. Also it was sought to answer what was done with these buses. The study showed that much of the old fleet buses were reused and the ones in end-of-life dismantling companies were sold. Storage centers do the entire manufacturing process to reuse reverse both parts for the aftermarket and the materials that are sold for recycling, particularly ferrous scrap. And finally the main challenges of reverse logistics of end-of-life vehicles in Brazil are presented.*

**Keywords:** Management; Reverse Logistic; End-of-Life Vehicles.

### 1. INTRODUCTION

With the beginning of the industrial revolution, to the extent that the capitalist and liberal postulates were conducting the market, there has been an exponential growth of launching new products on the market. Especially in light of fierce competition and technological innovations in recent decades, the new products have come on the market with life cycles increasingly shorter (LEITE, 2009). Consequently, these factors have caused one of the biggest dilemmas of society of this century, which is to face the dichotomy between mass consumption versus environmental sustainability. Denial of change of consumer behavior has resulted in increasing the speed of disposal of products after the first use, and therefore, the imbalance between the quantities discarded and reused and generation of huge volumes of post-consumer products, so-called solid waste or even garbage. For example, about 62,730,096 tons of municipal solid wastes were produced only in Brazil, in 2012. The generation grew 1.3%, from 2011 to 2012, index which is higher than the urban population growth rate in the country in the period, which was of 0.9%. Despite the increase in collection, 6.2 million tons of municipal solid waste were no longer collected in the year 2012 and, consequently, had improper destination (ABRELPE, 2013).

In addition to the above placed dilemma and the problems arising from inadequate final disposal of municipal solid waste, unbridled consumption and the constant technological innovations have boosted other sectors of the economy worldwide, as is the case of the auto industry. According to OICA - International Organization of Motor Vehicle Manufacturers (2014), the number of vehicles produced in the world has been increasing continuously in the past decade. World production of cars and light commercial vehicles was approximately 87 million in 2013. Only in Brazil were got their plates in the same year about 4,474,781 vehicles. It is worth noting that the average age of the Brazilian fleet is: 43% of vehicles with up to 5 years of age, 39% between 6 and 15 years and 4% with over 20 years of age (SINDEPEÇAS, 2014).

Thus, the big question which has been done worldwide in the last two decades is: what to do with these vehicles after reaching the end of life? It was in this sense, in order to answer this and other questions about adequate final disposal of post-consumer products, that the reverse logistic appeared - a new tool of sustainability management and use of those products.

For this work, the problem arose from the following question: How does the management of reverse logistics of end-of-life vehicles (ELV, the acronym in English End of Life Vehicle) in Brazil and what is the final destination of these vehicles? The general objective was to analyze the current situation of reverse logistics of a fleet of buses at an advanced age in Federal District-Brazil and from there, along with other sources of research, present the Brazilian challenges on this issue. The motivation for the development of this work was the current scenario of the public transportation fleet in the country's capital. Due to the bidding process occurred in 2013, the Federal District is in the final stage of change of its fleet of buses. Most companies that operate in the public transport system won the bidding, which represents about 2,800 buses removed from lines in operation and, mostly, with advanced age. What was done with these buses?

## 2. OVERVIEW OF BRAZILIAN FLEET

According to the National Department of Transit-Denatran (2014), the fleet of vehicles, by type and with plate, according to the Major Regions and Units of the Federation until March 2014 was 83,683,119, of which: 46,445,672 are automobiles (55.50%) 22,038,393 motorcycles and mopeds (26.34%) 11,625,016 trucks, tractor trucks, pickup trucks and vans (13.89%) 558,173 bus (0.67%) among others. According to the Report on Circulating Fleet, elaborated by Sindipeças (2014) with data up to 2013, there was an increase of 5.7% in Brazilian vehicle fleet, as compared to 2012, registering 40.1 million units on the streets, between cars, light commercials, trucks and buses.

The report also showed that the fleet of vehicles in Brazil nearly doubled in the last decade. Despite the entry into service of new vehicles, still there is a large number of old vehicles circulating in towns and country roads. The average age of the total Brazilian fleet went from 8 years and 7 months in 2012 for 8 years and 5 months in 2013. As mentioned, approximately 43% of vehicles (17,203,877) is up to 5 years of age, 24% (9,509,485) between 6 and 10 years, 15% (5,949,684) between 11 and 15 years and 15% (5,808,008) between 16 and 20 years old, being 4% over 20 years. The renewal is slow because, despite the new vehicles entering the fleet annually, the basis of circulation is large (SINDEPEÇAS, 2014). According to data from the National Register of Road Transport of Cargo, almost half of the registered fleet (about 400 thousand) has over 20 years of use. The average age of national the fleet is 12 years, where the autonomous vehicles feature 16.7 years (ANTT, 2014). In this sense, the pressure of some transportation agencies to create a national policy of fleet renewal is great and this would increase the potential for recycling the vehicles.

The National Confederation of Transport (CNT) launched in 2009 the National Plan for the Renewal of Truck Fleet, called RenovAR. The plan aims to reduce the average age of vehicles operating in the transport of cargos and provides that the carrier delivers his old truck, from a pre-established age range, to the recycling centers and, in return, receives a bonus to be used in the purchase of new truck or a truck newer than that first one (CNT, 2013). As seen, Brazil faces the challenge of the renewal of its fleet, especially that of trucks which is quite aged. If this occurs, many will be the gains as reducing accidents, breakage of vehicles, congestion, fuel consumption, transportation costs and problems such as greenhouse gas emissions arising from the movement of old vehicles on the roads of the country. But, above all, the amount of existing vehicles in the country and the age of the fleet is one of the great opportunities for the industry of recycling of end-of-life vehicles.

## 3. REVERSE LOGISTICS OF END-OF-LIFE VEHICLES IN BRAZIL

### 3.1 Reverse logistics and the recycling in automobile industry

The concept of reverse logistics refers initially to the first term, i.e. Logistics, that according to the Council of Logistic Management *apud* Ballou (2006, p. 27) “is the process of planning, implementing and controlling the efficient and effective flow of goods, services and information from the point of origin to the point of consumption in order to meet the clients’ requirements”.

“Later, in the 70s and 80s, the concept of Business Logistics expanded and began to think of the reverse flow of after-sales and post-consumer products, adding the idea of reverse logistics, which can be defined as the area of business logistics planning that operates and controls the flow and the corresponding logistics information, the return of the goods and after-sales business cycle post-consumer or the productive cycle by means of the reverse distribution channels, adding them value of various natures: economic, ecological, legal, logistics, corporate image, among others” (LEITE, 2009, p. 16 and 17). Stock (1992) referred to the term as: return logistics products, source reduction, recycling, materials substitution, material reuse, waste disposal, reform, repairing and remanufacturing. That is the reverse logistics arose as one of the main tools of implementation of sustainable development, enabling, through reuse and recycling, the return of products especially from post-consumer for the productive chain and several gains.

According to Guarnieri (2011), the reverse logistics is very relevant in the automotive sector, since it is the great generator of waste at the end of their production processes and logistics, such as: parts or components that are rejected in quality inspections, storage packaging and transport; parts or components returned by end customers in recalls, among others.

When it comes to sustainability, the concept of reverse logistics gains even more importance in the automotive industry, because the production and operation of vehicles demand excessive extraction of non-renewable natural resources, accumulation of discarded materials when the vehicles reach the end of its useful life and increased greenhouse gas emissions due to increased fleet of vehicles throughout the world.

According to Castro (2012), the vehicle is one of the products that should be managed as a priority according to their life cycle because of the complexity of their systems and the diversity of materials involved in their manufacture. A vehicle has approximately 15,000 pieces, and practically 80% of all materials used in the composition of the vehicle are metals and plastics that vary between 7% and 10%. The steel that today have the highest participation in the composition of vehicles will continue to be the main component for a long time, by the fact of having a low cost and can be recycled indefinitely.

In order to enable the recycling of a vehicle, generally are required five well-defined steps (IREC, 2010 apud Castro, 2012):

1. Reception of vehicles to be recycled: storage, inspection, record as vehicle in use, etc.;
2. Disassembly of vehicles: initial decontamination and drainage of fluids, removal of safety devices and manual disassembly of the components of the vehicle;
3. Classification of the disassembled components of the vehicles;
4. Fragmentation of vehicles: the fragmentation process reduces the material to be recycled into smaller pieces or parts, which can be easily transported and processed by recycling companies;
5. Recycling of fragmented materials of the vehicles: before thinking about recycling the components that can be reused as an engine and its components, gear box, doors, bumpers, headlights, glasses (front and rear), mirrors and mirrors, sound systems, banks and some internal finishes, etc. should be considered. The automotive components, which for security reasons cannot be reused, must be properly segregated, dismantled and sent to the separation and subsequent fragmentation processes to ensure that they will not be marketed. The metal parts may be directed to the companies which fragment metals, along with the carcasses of the bodywork of vehicles. Batteries and tires, which are included in the list of non-reusable components extracted from the vehicles, require special care in removal routines, storage, transport and recycling due to its high risk of environmental impact.

### *3.2. Legal and regulatory aspects in Brazil and in other countries*

Recycling of vehicles is carried out in a almost systemic manner in Europe, the United States and in Japan, where vehicles damaged with total loss conditions are recycled, and whose repair is not economically feasible, or vehicles whose traffic condition is no safer anymore, i.e. vehicles that are not approved in compulsory vehicle inspection routines. In each region there are different criteria and laws for the characterization of the condition of end-of-life vehicles or ELV, but in all countries it is possible to detect the existence of a series of minimum necessary regulations to facilitate the process of reuse of parts of vehicles through the recycling process (CASTRO, 2012).

In the European Union - where the ELV creates annually around 9 million tons of waste-with the creation of the Directive 2000/53/EC, Member States are obliged to take measures to ensure: (1) the establishment, by economic operators, of collection, treatment and recovery of end-of life vehicles systems; (2) that the last owner can deliver the end-of-life vehicle to an authorized treatment unit without any cost as a result of the vehicle having a negative or null market value.

In addition to the specific implementation guidelines, the policy had as targets for 2006 recycling/reuse of components of 80% and 85% of total valuation and for January 2015, 85% of recycling/re-use of components and 95% of total recovery. Still, the policy has defined goals that countries should reduce the use of heavy metals in vehicles like lead, mercury, cadmium and hexavalent chromium; review the vehicular projects to facilitate the processes of dismantling, recycling and recovery of materials; encourage the use of recycled materials in the projects of new vehicles. Member countries like Spain and Italy have followed this policy.

In Japan, the law of ELV was established in 2005. In 2007, the country had a current fleet of 79.5 million vehicles, of which 3.5 million are estimated to have been recycled, thus representing 4.4% of the fleet. The law stipulated that Japan would achieve a recycling rate of 50% of residual fragmentation until 2010 and 70% by 2015, which will be achieved the goal of 95% of global recycling of vehicles, the same value established on 2000/53/EC Directive for 2015 (CASTRO, 2012). Yet, according to him, the law defines that:

- 1 - Vehicle manufacturers are obliged to receive, properly handle and recycle three specific items for vehicles they manufactured: wastes arising from vehicles' fragmentation, airbags, gases containing chlorofluorocarbons used in air conditioning systems and damaging to the ozone layer;
- 2- When buying a new vehicle, vehicle owners are required to pay a fee established by the Government, which is destined for the recycling of the three items mentioned above. The value of the fee is returned to the user in the act of sale or exchange of the old vehicle for a new one;
- 3- All companies responsible for vehicle recycling activities (reception, disassembly and sorting of components, pressing and fragmentation of carcasses, incinerators, etc.) must officially enroll in vehicle recycling system of the country and its activities be approved by competent organs;
- 4- All information pertaining to the handling and processing flows of materials during the recycling process shall be supplied and controlled by a central WEB system, which is managed and audited by the competent public body.

In the United States, although there is no national legislation which treats about recycling of vehicles, there are however, several State and municipal laws that introduce some aspects related to this theme and that give incentive to exchange old vehicles for less polluting new. About 95% of the ELV are forwarded to recycling companies and the percentage by weight of recycled materials by vehicle is approximately 75%, i.e. 25% are still intended as tailings to landfills or incinerated. Only 30% of the recycled materials are reused again in the automotive industry, generally in less noble than the originals, except for the case of metals (CASTRO, 2012).

Countries such as Argentina, Mexico and Colombia have also made efforts to solve the problem of the existence of an ancient fleet, therefore, recycling of ELV. In the case of Argentina, the first initiative to roll out a vehicle recycling program was the promulgation of Law No. 25,761, in 2003, which defines the legal framework for the dismantling of vehicles and for the marketing of parts used in the country. However, there are no specific rules on the disposal of parts that cannot be reused. The Center of Experimentation and Road Safety (Cesvi-Argentina) maintains, since 2005, a vehicle recycling center in the country. In partnership with automotive insurers, cars that were involved in accidents and can no longer circulate are disassembled. The Center has the capacity to dismantle about 100 cars per day and storing 24.5 thousand pieces. Once the process of documentation registration is done, the parts that can be reused are selected and what remains of vehicles is forwarded to different sectors, such as recycling aluminum, plastic, copper, etc. In 2011 2,915 vehicles were disassembled and selected for reuse of parts 22,041 with 75% of reuse of these pieces (CNT, 2012).

In the case of Brazil, one of the biggest challenges for the recycling of end-of-life vehicles was the absence of specific legislation that, after nearly a decade of legal proceedings, on May 20, 2014, the Law 12,977/2014 which regulates the activity of disassembly of land vehicles, as well as the marketing of its parts as spare parts used or scrap without prejudice to the other legal provisions applicable to it was sanctioned. Dormancy for the adoption of specific legislation of salvage yards late in a decade the solution of the problem pointed to.

That law came to supply the lack of Law 12,305/2010 which instituted the National Solid Waste Policy and that had not approached the salvage yards. However, for the transport sector, the law soon demanded the structuring and implementation of reverse logistics systems for tires and lubricating oils and their waste and packaging. Even so, the implementation of the Law for Salvage Yard will need to follow many of the guidelines of the Law 12,305/2010.

Before the Law 12,977/2014 there were some projects in the National Congress that sought to regulate the dismantling and subsequent steps to this process. For instance, the Law of Salvage Yard N°. 345/2007 was vetoed in 2011, being its veto justified by the absence of satisfactory criteria to regulate the marketing of auto-parts safely used.

In the case of the Brazilian automotive sector, despite the lack of official data on the quantity of vehicles that are taken out of circulation, it is estimated that approximately 2% only of the vehicles in the fleet that leaves are recycled. Despite the country relying on various industries that use steel scrap ferrous alloys in the production of steel, automotive repair centers, disassembly and parts sales, and the recycling process is still limited. Thus, the law came to strengthen the recycling market and solve problems like car theft, larceny, and illegal salvage yards and also stop vehicles scattered and abandoned in vacant lots, old irons and in the courtyards of the State Transit Departments (Detran). When a vehicle reaches its end of life often ends up being abandoned on the streets, occupying public space inappropriately. Today, in Brazil, there are thousands of vehicles in all Brazilian States, which because of seizures by irregularities, rust at the Detran under the action of bad weather. This reality has increased the levels of environmental contamination and caused old scraps, because over the years have been no longer suitable for recycling.

The Law 12,977/2014 has a year to come into force and will tend to eliminate the clandestine procedure associated with stolen cars. In addition to the full regulation of the company, will be required the registration of all vehicular entry, as well as the final destination of each piece or material. The National Transit Council (Contran), will be responsible for the implementation and management of the database, as well as the regulation and enforcement detailing, because it establishes that:

- Disassembly activity may only be performed by dismantling company registered before the executive body of the transit of the states;
- Companies must register in the database to be created, or sets of parts used parts that are intended for reuse, those that meet the technical requirements;
- Companies should issue the receipt of entry of the vehicle at the time of entering into company's outbuildings;
- The vehicle may only be disassembled after the certificate of registry issuing;
- The vehicle must be fully dismantled or receive modifications that let it completely unable to move.

#### 4. RESEARCH METHODS AND TECHNIQUES

With regard to objectives, this study is an exploratory research that aims to expand the knowledge regarding certain phenomenon, exploring a specific reality (GIL, 2008). Now from the point of view of the technical procedures of collection, in part, is a bibliographical research, since this type of study is developed based on material already prepared, consisting mainly of books and scientific articles, which allow the researcher to cover a range of facts much bigger than if it were investigating through direct observation (GIL, 2008).

So, in order to achieve the objectives of this research were used the following methods and techniques: bibliographical research, especially legislation and regulations queries applied to management of municipal solid waste and end-of-life vehicles; secondary data collection; interviews with companies of the former bus fleet of Brasilia and technical visits to companies of scraps, that is, which buy end-of-life buses.

In all cases were applied questionnaires with closed and open questions and, when fit, on-the-spot observation. In total:

- 4 interviews with managers of the bus companies of the old fleet, representing 14 companies of the line. It was observed that the public transportation system of buses in Brasilia was operated by groups that had more than one company on the line. This is, in a universe of 14 bus companies, there were 4 groups, and the interview covered 7 companies.
- 3 technical visits and interviews on companies that came to buy some old fleet bus and observing other points of abandonment and illegal chop shop.

#### 5. FIELD RESEARCH: Data Presentation and Analyses

##### 5.1. *Renewal of Bus Fleet in Brasilia*

The renewal of the bus fleet in Brasilia came with the Edict nº 01/2011. In total, five companies won the bidding and operate the public bus transport system in the Federal District and only two companies of old fleet remained in the system. The renovation included new cars, "brand new", and with a maximum permanence of 7 years. According to the Edict 001/2008, the age of the fleet in the Complementary Rural Public Transportation System is 8 years to get into the system and the period of permission to operate the system is of 10 years and may be renewed once for an equal period. Today, in Brazil, this permanence varies from state to state and from city to city.

The bus fleet of the Federal District entered into its final phase of total renovation of 2,580 vehicles. However, approximately 2,800 bus came out of the lines, this research study object. As noted in Table 1, attached, before the renewal of the fleet, only 25% of the bus was to 5 years, 30% ten years and 46% over ten years. It should be emphasized that the vehicles were not downloaded to the system by the management body, for this reason presents an amount greater than that effectively owned by companies.

The following graph shows that most buses were purchased between 2004 and 2010 and between 1994 and 2000. Therefore, nearly half of the buses are over 10 years and as shown in Table 1, nearly 22% of the bus was operating for more than 15 years in the system.

### 5.2. Final Destination of Former Fleet

With the renewal of the fleet, most companies that operate in the system have failed to win the bidding. So, buses with advanced age were withdrawn from operation. Research has shown that the buses that left the lines had the following destinations:

1. Worked temporarily in a few lines of Brasília, awaiting the arrival of the rest of new bus fleet;
2. Worked in some nearby cities of Brasília (cities in the State of Goiás, in the surroundings of the DF-RIDE/DF) and were employed in other states of the country. The retail situation for companies that comply with notice on municipalities that allow the movement of vehicles in age than that is best for the entrepreneur and the second worse for the environment. By the side of the entrepreneur, is usually where he gets the best trading price. For environment is difficult for the same reasons that make the Edict requires the disposal of vehicles. It is a technology already overcome and whose lifetime usually is already showing signs of lapsing. Technology obsolescence is given also by the emission of toxic gases to the environment, which overcomes each new test, because it is a global concern: air pollution and the consequences of global warming;
3. Have remained stationed in the courtyards of the companies, as shown in Figure 2, waiting for other market opportunities as new sales, bids in other cities and allocations for private companies and/or public agencies when appropriate (for example, emergency coverage of a given line);
4. Were sold to bus companies from other states and cities. Namely, some of the old fleet buses are running on other systems of neighboring states and or very distant;
5. Were sold to individuals and/or small entrepreneurs who work especially with school transport and rural transport. This category also enters the purchase of buses that are employed in functions such as transportation of rural workers;
6. Were sold for bus scrap and salvage yard companies;
7. Sustained reuse, because it is possible that in a few moments parts be reuse during broken buses repair.

Still, the survey showed that:

- The bus companies usually explore other business opportunities before they are in dismantling companies' sales because the sales values are smaller for these. Namely, the negotiation of the fleet of vehicles with dismantling companies is typically the last company's strategy of metropolitan transport ex-dealership;
- For dismantling companies, most buses were sold in lots, which can compensate for both parties;
- The negotiation is free and relies on especially good expertise of buyers to make a good buy because the product is visual checked and there is no guarantee from the moment when the buses come out of the courtyard of the company;
- Transport of buses sold to final destination is the position of buyers and can give problems on the way and, when necessary, are taken by other vehicles;
- For most bus companies, sale to disassembly is an opportunity and no difficulties in final destination;
- Until the time of the interviews with the bus companies, almost 455 buses had already been sold for dismantling and recycling companies and others were to be sold.

### 5.3. Chop Shops for End-of-Life Vehicles

After the interviews with managers of buses, the research continued with the technical visits and interviews in companies of chop shops. According to these, the buses are purchased in several Brazilian states, and many of those who left the lines in Brasília were found at sites of chop shops by researchers.

Shortly after the sale of the buses, before their departure or immediately to its output to the local salvage yard, these vehicles need to be registered by Detran because will continue generating tax and this value is too high, which could derail the company's chop shop operation. In many cases, the purchase of vehicles to chopping is made directly on behalf of the owner and not the company, which complicates even more the legality and transparency of the process. The correct interpretation is fiscal failure, given that the service offered by the chop shops companies is the withdrawal from circulation of vehicles and hoarding of natural person. Systematic failures like this are allowed from the legal gap, feasible with the recent correction the sector legislation, although the owners of the chop shops are not aware of this new commitment.

After the arrival of the bus, the process of dismantling starts. One of the major concerns in the initial step is the removal of oils. According to the interviewees, there are auditing held by companies responsible for environmental regulation, which receive the gallons and undertake with the appropriate disposal of the substance. If not proceeding in this way, the chop shop company is blamed and fined. The fanfare is due to the high toxicity, high combustion product capacity and ability of environment pollution mainly from groundwater.

However, the technical visits did not confirm that the remaining unsold materials such as wood, plastics, rubber, glass, have right destination. The parts that have no economic value, that is, which are not sold, are passed on to the small scrap dealers and possibly improperly discarded in landfills and dumps. As seen, many of these materials could be recycled but due to factors such as transportation costs to the point of recycling, which can be in other more distant states, number of buyers of scrap metals and product characteristics can hamper the appropriate destination. In markets such as in Sao Paulo there is greater reuse of materials for recycling. There is no recycling company of glasses and rubbers in the midwest and the cost of transport to the southeast of the country makes recycling and these products tend to be discarded improperly, due to precarious public power supervision and lack of appropriate places for this purpose.

Research has shown that many companies are familiar, with little skilled professionals and feature a simple dismantling infrastructure, where the soil is used in its natural state and without any treatment, either there's coverage in the area of vehicle handling. In a place visited the area of 20,000 square meters comes undone; the work is performed without systematic use of any kind of personal protective equipment (gloves, boots, masks, goggles, belts, etc.), even with the handling of flammable materials such as oils, welding and cutting torch.

The companies visited, when chopping up the buses, essentially (1) reuse parts (motor, gear boxes, lanterns, differentials, etc.) for resale in the secondary market, with prices to negotiate and (2) recyclable materials for sales to recyclers, i.e. intermediate markets of these materials to the recycling companies located in the state of São Paulo in Brazil. That is, the dynamics of business deals with two different products and with different features and prices, buyers (parts for trucks, buses and private vehicles). In some cases the tires are recycled and sold. In the places visited, there is virtually a single intermediate trader who buys raw materials by weight and receives already separated by material in the bucket that holds at the chop shop.

The research data corroborate the statement of Castro (2012) that currently the only materials showing a relatively significant residual commercial value are metals, i.e. scraps of iron, copper and aluminum, which can be withdrawn from an ELV. The rest of the vehicle materials (plastics, glass, fabrics, etc.), still has some commercial value, but much smaller than the metals, due to its difficulty of recycling. In the companies visited, the best-selling materials are iron, aluminum and copper wires peeled. The most precise metal is copper, despite the small amount compared to steel and aluminum, the latter found in large quantity and covers usually the floor, handrail, tipper and in some vehicles even the roof and sides. Rubber is one of the products of less commercial appeal being usually disposed of improperly.

In terms of economic feasibility of the business, the businessmen agreed that the dismantling of vehicle is an opportunity, however, understand that the sector needs incentives and nearest recycling points, which would decrease the cost of crossing and would increase the recycling of other materials. For example, there is great difficulty in selling the glass: first by the distance of the potential buyers – concentrated in Sao Paulo, which makes transportation of the sale; second by low price sold, 10 cents a pound. Still, for one of the entrepreneurs interviewed, the monthly minimum return is \$ 300,000 but affirmed that taxes on the operation are around 30%.

## **6. THE CHALLENGES OF END-OF-LIFE VEHICLES' MANAGEMENT IN BRAZIL**

As an initial demand of this work, it is important to emphasize primarily the lack of official data and a diagnosis of the real situation of the reverse logistics of end-of-life vehicles in the country. In part, that is associated with the need for a national level planning how to handle the growing volumes of ELV that exist in the country. This planning is necessary because, despite some efforts to improve public transportation and creation of sustainable transport alternatives, the trend is the growing increase in the fleet, primarily as a result of the increase in the purchase of private vehicles and the national policy geared towards the automotive industry.

With the new law, one of the first challenges to be faced by Brazil on reverse logistics of end-of-life vehicles is the illegal dismantling. Just as happened in Argentina, the main motivation of Brazil with the creation of the law of salvage yard is to combat automobile theft, hence the illegal chop shops. However, even with the creation of the law, these illegalities and crimes should be, for some time, challenges associated with the implementation of reverse logistics of ELV to be faced. In addition, many companies are not legal to work in the sector and, even if it is potentially one of the best environmental solutions, the legal obscurity that involves dismantling prevents the advancement of recycling process of vehicles whose lifetime has already exhausted.

The law will enter into force in 2015. Therefore, an immediate challenge concerns the regulation and standardization to be made by Contran regarding security requirements; the list of parts or set pieces that may not be intended for replacement; the parameters and criteria for verification of the conditions of the piece or set of pieces used for the purpose of reuse; the form of traceability, etc.

After the regulation of law by Contran, some challenges will be related to its implementation, especially the issue of dismantling centers supervision and suitability of these towards the law. For example, the law requires that the company acting in the business must possess operating permit issued by the local authority and that is mandatory on-the-spot inspection by the executive body of the state before the concession, the supplementation or the renewal of registration, as well as conducting periodic inspections, regardless of prior communication. On-the-spot inspection, the executive body of transit shall assess, inter alia, the conformity of the structure and activities of each disassembly workshop with the norms of Contran. In Art. 19, the Law requires that dismantling units of existing vehicles before the entry into force of the law should conform to its provisions within three months. However, as has been shown previously, the infrastructure of many chop shops centers do not have minimum conditions to meet possible legal requirement of regulatory bodies and supervisory bodies. This salvage yard site suitability for businesses which already work there will be another challenge for Brazil to put into practice some of the law's requirements as the disassembled parts control and decrease of illegal chop shops.

In Brazil, when a vehicle is seized for any reason, the owners need to pay some expenses and face some bureaucracy before obtaining the release of the vehicle taken to the courtyard of the Detran. According to the current legislation, if the vehicle is not removed from the courtyard, within 90 days, it will be auctioned off, however, as the auctions, in general, don't happen as often as necessary and there are also other actions to be taken before the auctions, such as notification to the owner giving even an opportunity to recover the vehicle and check the conditions of the same. Still, in case of the auction, the vehicles remain during a long time in the Detran-accredited courtyards. Since in many cases it's not worth it to get the car back, the courtyards of these bodies end up being one of the places of inadequate disposal of vehicles, outbreak of diseases, environmental contamination and one of the sources of recycling of vehicles. Still, in its article 7, the Law of Salvage Yard says "the vehicle may only be disassembled after issued the certificate of registry law". Therefore, it is necessary to put an end to the lethargy and improve the legal arrangements of release of these vehicles for recycling.

It is necessary to increase the supervision and vehicular inspections, so as to minimize the air pollution in cities and increase recycling of vehicles which are not in a position to circulate.

In this sense, as has been shown, there is a need for renewal is made a good part of the fleet. The National Plan for the Renewal of the Fleet of Trucks, RenovAR should be boosted. Just as happened with some old fleet bus Brasilia, if there is an effect on national fleet renewal, particularly of cargo, the dismantling and recycling companies will benefit from numerous recyclable materials and parts.

Due to the nature of the components and manufacturing of vehicles, the dismantling and recycling of ELV is a complex process and requires specific activities in each step of the process. Thus, many Brazilian companies need to modernize and meet the challenges associated with the acquisition and updating of technologies that maximize the dismantling process steps such as separation, fragmentation, decommissioning, etc. Associated with this, as noted in the technical visits, there is a need for greater professionalization of the people involved in the dismantling process and more attention to vehicle handling, since it deals with a variety of hazardous substances.

With respect to the Law N° 12,305/2010, which instituted National Solid Waste Policy and Decree No. 23 of 7,404 that regulated, the implementation of the recent Law of Salvage Yard must meet the following points:

- Be linked to general guidelines of these laws, as well as to its principles and instruments;
- Establish measures and inducing credit lines to meet also the demands involving the ELVs. That is, public policies and incentives for the creation of companies qualified to work with end-of-life vehicles is required;
- Creation of sectorial agreements involving the auto industry and the ELVs;
- Stick to "shared responsibility for the lifecycle of products". That is, the need for government action and political will, since the theme is not priority tariff until then, and articulation of the sector and of the stakeholders involved in the process – whether with automakers, dealers, consumers, automotive centers, workshops, regulatory agencies, dismantling and recycling companies, etc.

In Brazil, the older is the vehicle less taxes are paid by owner. However, mechanisms that facilitate the delivery of the ELV in a collection center/chop shop/recycling and no longer the abandonment or environmental contamination by the use of old vehicles must be created.

So great are the challenges in logistics of recycling in Brazil and little progress has been made. Recently, some movements such as the certification of auto parts, the dismount of vehicles, vehicle inspection and deployment



of energy efficiency programs and cleaner and more efficient engines have contributed to improve the scenery. Considering a country of continental dimensions really like Brazil, the transport of materials for recycling can, by itself, economically derail the process. For this reason, the participation of the public authorities is crucial. Tax incentives and other benefits can and should be applied to make the activity is economically attractive for investments of private initiative (COSTA, 2012).

## 8. FINAL CONSIDERATIONS

The objective of this paper is to analyze the current situation of reverse logistics of a fleet of old buses in Brasilia-Brazil and from there, along with other sources of research, present the Brazilian challenges on this issue.

First, it has been shown that the age of the bus fleet, specified in the Edict with invitation to bid, the concessionary companies metropolitan transport service are required to remove expired vehicles out of circulation. The obligation does not link the fate that the operator shall give the vehicle down, which makes the discretionary act and environmentally dangerous. Because it is a free choice, the fate of each fleet varies between each company and each specific situation.

Three common practices observed in the disposal of vehicles whose term of circulation has been exhausted. At first, the vehicles are kept off-line in deposits the company itself or in cemeteries of buses. On Monday, companies resell the vehicles to other conforming Edict in municipalities that allow the movement of vehicles in age than that. In the third, the vehicles are traded for dismantling companies.

The worst situation is one in which the vehicles are kept off-line in deposits the company itself or in cemeteries of buses. In addition to the entrepreneur to have no financial return with that big capital asset, it should bear the costs of keeping them in a deposit large enough to accommodate the bus fleet. The cemeteries of buses are illegal and inappropriate disposal of vehicles is a great irresponsibility, because years of corrosion and decomposition imply immediate damage to environment that will receive the most diverse types of chemical waste.

Secondly, this survey showed that, in the case of bus in end of life, they travel a long way to reach the recycling points – leaving patios, they are chopped and then sold as pieces and scraps for intermediate traders. As seen, the chain of these vehicles in Brazil depends on the city, state and region, because in many cases there are no recycling points near the site of generation even with the supply of materials. Thus, a challenge still present is to map sources of opportunities, create new recycling facilities in order to reduce the transportation costs of crossing, thereby increasing the amount and types of recycled waste in the country.

It is said that, although some states already regulate the disposal of automotive glass, Brazilian Senate clears the PL 8005/2010 that regulates the liability of companies that manufacture, import, sell or install automotive glass for environmentally appropriate collection and final disposal of discarded products.

Therefore, in order to improve the reverse logistics of end-of-life vehicles in Brazil is crucial the regulation and implementation of the recent law of salvage yard and the Brazilian Solid Waste Policy. To do this, the country needs diagnosis, planning, articulation of the actors involved and creating strategies that facilitate the reuse and recycling of automotive materials and thus be able to contribute, finally and effectively, for sustainability in transport.

## REFERENCES

- ABRELPE (Associação Brasileira de Empresas de Limpeza Pública). *Panorama dos resíduos sólidos no Brasil 2012*. São Paulo, 2013.
- ANTT (Agencia Nacional de Transportes Terrestres). *RNTRC em Números*. Disponível em: [http://appweb2.antt.gov.br/rntrc\\_numeros/rntrc\\_emnumeros.asp](http://appweb2.antt.gov.br/rntrc_numeros/rntrc_emnumeros.asp). Acessado em julho de 2014.
- BALLOU, Ronald H. *Gerenciamento da cadeia de suprimentos/logística empresarial*. 5. ed. São Paulo: Bookman, 2006.
- BRASIL. Presidência da República do Brasil. *Lei nº 12.305/2010. Institui a Política Nacional de Resíduos Sólidos; altera a Lei no 9.605, de 12 de fevereiro de 1998 e dá outras providências*. Brasília, 2010.
- \_\_\_\_\_. *Lei 12.977/2014. Regula e disciplina a atividade de desmontagem de veículos automotores terrestres; altera o art. 126 da Lei no 9.503, de 23 de setembro de 1997 - Código de Trânsito Brasileiro; e dá outras providências*. Brasília, 2014.
- \_\_\_\_\_. *PL 8005/2010. Dispõe sobre a responsabilidade das empresas que fabricam, importam, comercializam ou instalam vidros automotivos pela coleta e destinação final ambientalmente adequada dos produtos*

descartados. Disponível em: <http://www.camara.gov.br/proposicoesWeb/fichadetramitacao?idProposicao=489572>. Acessado em julho de 2014.

CASTRO, D. E. *Reciclagem e Sustentabilidade na Indústria Automobilística*. Belo Horizonte: [ s.n.]. 2012.

CNT. *RenovAR - Plano Nacional de Renovação de Frota de Caminhões*. Brasília: CNT.

\_\_\_\_\_. Argentina precisa de lei específica para promover reciclagem de veículos. Disponível em: [http://www.cnt.org.br/Paginas/Agencia\\_Noticia.aspx?n=8112](http://www.cnt.org.br/Paginas/Agencia_Noticia.aspx?n=8112). Acessado em julho de 2014.

\_\_\_\_\_. Renovar a frota de caminhões é essencial, defende presidente da CNT. Disponível em: [http://www.cnt.org.br/Paginas/Agencia\\_Noticia.aspx?n=8772](http://www.cnt.org.br/Paginas/Agencia_Noticia.aspx?n=8772). Acessado em julho de 2014.

DENATRAN. Frota Nacional. Disponível em: <http://www.denatran.gov.br/frota2014.htm>. Acessado em julho de 2014.

DIEHL, A. A.; TATIM, D. C. *Pesquisa em ciências sociais aplicadas: métodos e técnicas*. São Paulo: Pearson Prentice Hall, 2004.

GIL, A. C. *Métodos e técnicas de pesquisa social*. São Paulo: Atlas, 2008.

GUARNIERI, P. *Logística Reversa: Em busca do equilíbrio econômico e ambiental*. Recife: Clube de Autores, 2011.

LEITE; P. R. *Logística Reversa: Meio ambiente e competitividade*. São Paulo: Pearson Prentice Hall, 2009.

OICA. 2013 *production statistics*. Disponível em: <http://www.oica.net/category/production-statistics/>. Acessado em julho de 2014.

SINDIPEÇAS. *Relatório da Frota Circulante de 2014*. Disponível em: <http://www.sindipecas.org.br>. Acessado em julho de 2014.

STOCK, J. R. *Reverse Logistics*. Oak Brook, IL: Council of Logistics Management, 1992.

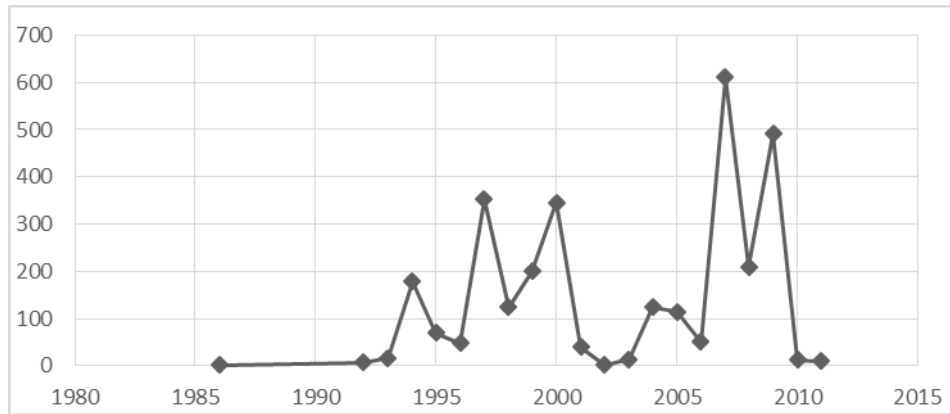
**ANNEXE**

**Graph 1: Age of the old fleet**

Year	Age of fleet	Amount of buses	5 years	10 years
2012	1	0	723 (24%)	1,936 (54%)
2011	2	9		
2010	3	13		
2009	4	491		
2008	5	210		
2007	6	611	913 (30%)	1,381 (46%)
2006	7	50		
2005	8	114		
2004	9	124		
2003	10	14		
2002	11	1	709 (24%)	1,381 (46%)
2001	12	39		
2000	13	345		
1999	14	200		
1998	15	124		
1997	16	353	672 (22%)	1,381 (46%)
1996	17	48		
1995	18	69		
1994	19	178		
1993	20	16		
1992	21	7		
1986	22	1		
<b>Total</b>		<b>3,017 buses</b>		

Source: Research data

**Table 1 – Age of the old fleet**



Source: Research data

**Figure: Places of Chop Shops of ELV**



Source: Research data

**Figure 3: Reused parts and container of scraps for recycling**



Source: Research data