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**CHALLENGES AND DIFFICULTIES OF DESTINATION AND RECYCLING OF
USED TIRES IN BRAZIL**

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ABSTRACT

The outdoor waste of tires is very aggressive to the environment, and such fact is the main point of this paper.

This paper has as its main purpose to discuss the environmental issues which comprise the waste of used tires, investigating what is their real destination in Brazil and which are the sustainable alternatives for their reuse.

It was also carried out an exploratory research by consulting traditional bibliographical references. In addition, a field research in waste areas without any treatment, landfills and a tire manufacturing company was performed. Both researches aimed at investigating what the current destination of used tires in Brazil is. It was also applied a survey with a questionnaire to 58 pedestrians in Brazil's most economically important avenue (Avenida Paulista), randomly selected, with the purpose of verifying the depth of awareness of this specific population about this topic.

Keywords: Environment, Recycling, Garbage, Environmental management.

1. INTRODUCTION

Environmental questions directly affect population's life quality and there is society's concern on preserving the environment because the costs to recover areas with environmental degradation are high and it becomes cheaper to preserve than to regenerate environmental damages.

In the 1988 Brazilian Federal Constitution, environmental issues are considered a national asset and they belong to future generations. It has provisions related to obligations therefore mainly related to solid residues that are produced in great daily amounts. It determines the maintenance of environmental quality, whose jurisdiction power jointly concerns the Federal Government, States and Municipalities. However, even though responsibilities are defined in the legislation, there is too little seen effectively from public bodies regarding environment preservation. Problems of air and water pollution and the rising of solid residues are increasingly moving people, enterprises and even governments, on regard of the effects of undue use of products that damage nature.

Even with the creation of measures and procedures that aim at the reduction of indiscriminate use of products and actions that damage the environment, difficulties on urban garbage disposal are still one of the most serious environmental problems, especially in Brazil.

In this focus, it is important to underscore the great amount of discarded tires and their long lifetime until their decomposition by the environment, whereof it has motivated the development of measures that adjust the significant increase of tires production, which is a consequence of economic growth in comparison with environmental variables, in order to soften its serious impacts to the environment.

Since they are hard to compact, collect and eliminate, tires occupy a large physical space. Big warehouses occupy vast areas and are subject to accidental or provoked burning therefore causing damages to air quality due to smoke liberation that contains high proportion of sulphur dioxide, among other toxic substances.

Degradation time for tires is undetermined and their composition present heavy toxic metals and cancerous substances, besides becoming ideal sites for the proliferation of yellow fever and dengue mosquitoes.

Besides many studies made on recycling, issues involving used tires destination and the damages that their wrong destination may cause to nature and people are still not fully known by the population.

In view of the situation described, this paper has as a main purpose to discuss the theme concerning used tires destination, to investigate how their discarding effectively occurs in Brazil and to study which are the sustainable alternatives for their reuse.

In this work, an exploratory research was performed by consulting traditional bibliographical references and also, a field research was executed on waste embankments,

landfills and a manufacturing tire enterprise. Both were aimed at investigating which is the present practice of used tires destination in Brazil.

A Survey was made with 58 pedestrians, randomly chosen, on the most important economic avenue in Brazil (Avenida Paulista), with the purpose of verifying what was the depth of consciousness of this specific population concerning this matter.

The Survey may be described as the obtainment of data or information about features, actions or opinions of a determined group of people, indicated as representatives of a target population, by using a research instrument, usually a questionnaire (Pinsonneault & Kraemer, 1993).

Fink (1995 a; 1995 b) argues about what this method is, its usefulness and when it should be used, as well as about the main aspects related to a Survey. As main features of the Survey research method, it may be mentioned: the interest in producing quantitative descriptions of a population; by using a predefined instrument.

2. THE SUSTAINABLE DEVELOPMENT

The formalization of the sustainable development concept occurred in the report produced by Brundtland Committee – Our Common Future (1991: p.49) and it is a transformation process in which resources exploration, investments direction, technological development orientation and institutional changes are harmonized and reinforce present and future potentials, in order to serve human necessities and aspirations”.

Kilbourne (2004) reports that it is possible to begin an evaluation on globalization process with the assumption that it is more than an international marketing strategy, but in fact, a complex and multidimensional project with economic, financial, cultural and environmental aspects. However, in premodern society there were no concerns about thinking on environment-related issues and this uncommitted relation to the nature was

responsible for an anthropocentric culture, with the belief that natural resources were inexhaustible.

The meaning of “environment” or “greening” is ambiguous, according to Gupta (1994), and it may be interpreted, in many ways, by professionals from different areas. Internationally, the term refers to quantity and quality of natural resources, that consists on water, air, land and atmosphere. The author emphasizes that, when defined like this, environment is a critical determinant of quantity, quality and sustainability of human activities and industrial development.

This way, the “sustainable development” theme becomes an increasingly emerging situation and it is featured, in this context, as a process of resources exploration, in a way that satisfies human necessities and aspirations, without extinguishing such resources.

Gupta (1994) points out that there are multiple implications of passing from a predatory developing model to a sustainable one, therefore changing our vision and relation to nature, as a necessary environment for human existence. The author also highlights that 25% of the world population living in industrialized countries uses around 70% of the natural resources of the planet. As developing nations industrializes, urging their economic growth, this leads to a tremendous increase of resource demands and pollution. In addition, developing nations deplete environment resources in order to serve population growth and problems such as poverty, thus reaching urban environment.

Human ambition for profit and commercial gains has become the price of the progress model, which is very high on environmental terms. For this reason, according to Quazi et al (2001), in other words, sustainable development aims at a balance between economic growth and environment protection. The pace of consciousness on cares that should be taken regarding environment sustainability capacity is very slow; however, a world effort is being verified regarding environment protection and the importance on the search by

generations for self-sustainable development means. Anyway, even without full consciousness on environment impacts, those living in cities suffer from water and electricity shortage, and those living in the country observe the disappearance of vegetable and animal species. In the last 10 years, according to Melnyk, Sroufe and Calantone (2002), a radical change has begun towards the understanding pollution and the need to decrease it, and consequently, the best way to make environment management. This interiorization of the ecological dimensions occurred as a consequence of population growth, environment education and changes in social values, which stimulated an interest revival in environment issues by people and organizations, as emphasized by Miles and Russel (1997). Within this context, so that enterprises could put into practice the sustainable development concept, and also, due to commercial and legislative pressures according to this new point of view, a process of implementation concerning environment management systems has begun.

Dolan (2002) describes the limitations in the concept of sustainable consumption regarding inadequate attention given to social, cultural and historical contextualization of consumption. For the author, sustainable consumption concept has the connotation of a speech that tries to present a solution for ecological problems associated to industrial and economic production, to the theoretical idea of a unidirectional causal relation between sustainable consumption and sustainable development.

According to Quazi (1999), the sustainable development seeks a balance between economic growth and environmental protection. This implies that countries and businesses need to integrate economic, biological and human systems in order to create a sustainable system of commerce, and the governments need to incorporate flexibility that rewards proactive environmental management.

3. PROBLEMS REGARDING SOLID RESIDUES

Across the development history of the cities, man's action on the urban environment has completely altered natural characteristics as well as the pollution of the air, water and soil, thus compromising the mankind's current and future quality of life.

Countries that guide their developing model only based on economic issues are searching for growth and intensification of their economic activities in an uncontrolled manner. As a result, they contribute to an accelerated urbanization process and continuous nature changes. In addition, they cause enormous unbalance because if on one side they produced technological advances, on the other, contributed to increase poverty, environment degradation and pollution (CAVALCANTI, 1995).

In the international context, according to Mahmood and Victor (2001), there are many variables involved on managing solid residues, making difficult the decision-making process for implementing policies dealing with solid residues. According to ISO 10.004 (ISO 10.004, 2004a), solid and semi-solid residues comprehend residues that result from society activities, such as industry, household, hospital, commerce, agriculture and sweeping. It is also included the definition of mud, from the water treatment systems – those generated in equipments and pollution control installations – as well as certain fluids, whose specific features do not enable their disposal into the public sewerage system.

One of the evident problems in Brazil refers to the management of urban solid residue, mainly when it comes to environmental impacts and natural resources preservation. Impacts caused in the environment by uncontrolled production of solid residues have led the government to promote studies oriented to alternatives that aims at minimizing nature degradation and increasing the community well-being as a whole.

Human civilization processes and uses materials from the nature, but part of them is not used and is rejected as being garbage.

Nowadays, as the recycling industry grows, the definition of “garbage” as disposable and useless material is regarded as relative, for a residue may be useless for some people, however, useful for others.

The Brazilian Association of Enterprises for the Treatment, Recovery and Disposal of Special Residues reports that 2.9 million tons of solid residues are generated in Brazil annually and, out of it, only 600 thousand tons – corresponding to 22% - have proper treatment. From treated industrial waste, 16% are referred to landfills, 1% is incinerated and the remaining 5% is co-processed, which means that they are partly transformed into raw material for cement manufacturing through burning.

It is calculated that the destination market of industrial residues in Brazil is of \$500,000.00 per year. However, currently waste treatment and disposal profits approximately \$120,000.00, a value that is five times less than its potential. Activities of solid residue management, according to Cunha and Caixeta Filho (2002), may be grouped in six functional elements, as illustrated on Figure 1.

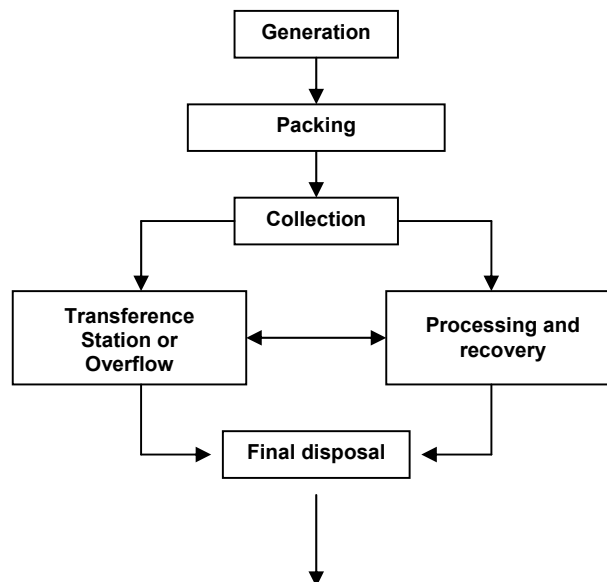


Figure 1 - The collect process for solid residues and its interrelations

Source: Tchobanoglous (1977).

Final destination and garbage treatment can be performed through the following methods, according to Scholz (1993):

- Landfill (disposal in the soil of domestic residues);
- Energetic recycling (incineration or dangerous residues burning, with the reuse of the generated energy);
- Organic recycling (organic material composting);
- Industrial recycling (reuse and transformation of recyclable materials); and
- Steam sterilization and microwave disinfection (treatment of pathogenic, septic and hospital residues).

Educational programs or industrial processes, which have the purpose of reducing the amount of residues produced, may also be considered as forms of treatment.

Melnyk, Sroufe and Calantone (2003) evaluated the impact of environment systems on corporate execution measures of an enterprise. Information was obtained on the attributes of the European Monetary System, environment options and impacts of these kinds of systems in managing operations and execution.

The results obtained showed that these types of environmental systems are critical, regarding management and the decrease of residues, and also, the existence of many significant relations between one formal European Monetary System and an ISO 14001 certified European Monetary System, with reduced prices, improved quality and decrease of residues in design and in equipment selection process.

There was an increasing interest regarding corporate activities directed to the reduction or elimination of residues created during product manufacturing of the enterprise. The study showed that certification brings actual benefits to the enterprise.

Nowadays, many developed countries are efficiently treating waste. Selective collection is a simple method, however very efficient. In Japan, the selective collection is entirely

performed in all big cities. TV sets, air conditioners and refrigerators should not be thrown into trash cans. Instead, they must be taken by the consumers to the recycling enterprises.

Selective collection and residue recycling allow for the decrease in garbage volume for final disposal in landfills and incinerators, thus extending the lifetime of such landfills.

4. TIRES: RECYCLING AND DESTINATION

For more than a century, humanity has been enjoying a useful and necessary invention that provides performance, economy and comfort to the circulation of automotive vehicles: the tire.

According to the Brazilian Tire Industry Association – BTIA (2007), the building of a tire goes through a very complex productive process from the preparation of the rubber to the production of items to make up the final product.

Tire parts have different physical and chemical properties. Each detail is studied to always achieve optimal performance. Every item is fundamentally important in tire manufacturing, with special emphasis on the tread (the part of the tire that makes contact with the ground), the body (or carcass) and the bead (part of the tire that has contact with the wheel), which provide better resistance to asphalt, stability on curves and quick maneuvers, as well as the shoulder, sidewall, plies and stabilizers and outer thread.

From the beginning of tire making, vulcanization proved to be one of the most important processes: rendering consistency to the rubber. After that, the tire is placed in a press at a specific temperature and pressure and for a certain amount of time. In this press, there is a mold with specific characteristics for each product to determine the final shape and design of the tread.

After this process, the tire goes through final inspection. This is when all verifications and tests are performed for tire approval, guaranteeing reliability in performance. Tires also go through balancing, a force variation test and X-ray examination until being stored and

finally distributed and reaching the final user.

The tire is an essential product for user safety, guaranteeing better performance, stability and vehicle performance. It is also worth mentioning that each tire is manufactured to satisfy consumption habits as well as climatic conditions and the characteristics of the existing highway system in each country.

However, its material is hard to decompose, taking approximately 600 years, and they are not biodegradable. The weight of a car tire varies between 2.49 and 3.16 lbs and a truck tire between 24.95 and 36.29 lbs. In the figure 2 it is possible to visualize the proportion of the elements that it composes a tire for automobile and in the Figure 3 it is possible to see its cross-cut.

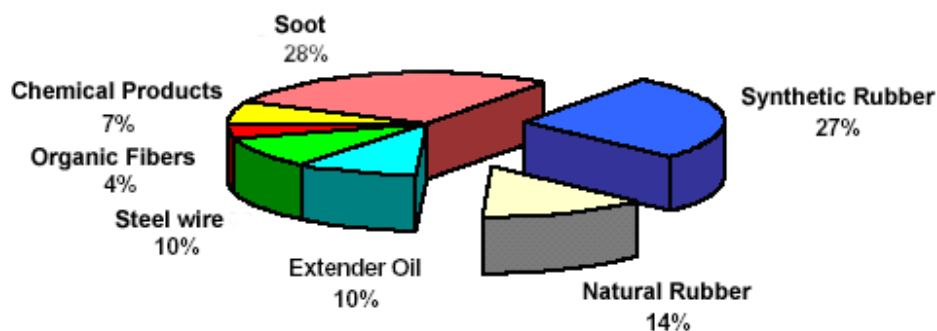


Figure 2 – Composition of Radial Tires for Automobiles

Source: Paula (2004).

The environmentally appropriate management of useless tires, seeking to prioritize the use of new technologies for reuse and recycling becomes necessary according to Blumenthal (1993) and Wagner and Caraballo (1997), due to the environmental impacts they cause.

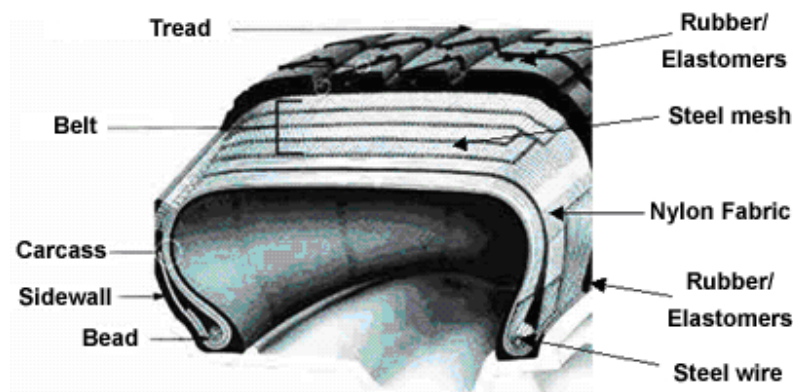


Figure 3 – Cross-cut of an automobile’s radial tire with its parts and respective component materials

Source: Andrietta (2002).

Tires are perfect places for the *Aedes aegypti*, the mosquito that transmits dengue, one of the main diseases transmitted by virus in the world and most especially in tropical countries like Brazil, to lay its eggs. The incubation period is three to seven days after being bitten and it disseminates in the blood (viremia). Initial systems are nonspecific, such as an abrupt high fever (frequently exceeding 104°F), not feeling well, loss of appetite, headaches and muscle aches and sometimes easy bleeding of gingiva and nose. The growing number of dengue cases is directly linked to the inappropriate disposal of useless tires, affirms Jang *et al.* (1998).

Through Brazilian Environmental Council Resolutions (CONAMA, 2002 and CONAMA, 1999) regulated by Brazilian Institute for the Environment and Renewable Natural Resources – IBAMA’s Normative Instruction # 8/02, procedures and goals for useless tires have been established in Brazil.

Lin and Teng (2002) state that the difficulties related to tire recycling are due to their complex structure and the rubber composition.

The application of pyrolysis in tire disposal is one of the alternatives for reuse and several studies have shown carbon manufacturing with adsorption properties. Merchant and Petrich (1993) showed that the gases from pyrolysis can be used as fuels and the carbon as a raw material in the production of activated carbon.

According to Leite (2003), new environmental protection principles are being propagated, such as the EPR (Extended Product Responsibility). In other words, the producing industrial chain, or the producer itself, who somehow harms the environment, must be held accountable for its product until the correct decision is made concerning its use or disposal.

4.1 Destination of Useless Tires

Taking advantage of waste contributes to the reduction in environmental problems. Considering that tires cause impacts in the form of carcass disposal, several forms of taking advantage of this carcass, or recycling, can be underscored, according to Andrietta (2002):

- Recapping or retreading: the tire must not have cuts, deformations and the tread must be in condition to permit adherence to the ground to proceed with retreading.
- Recovery: chopping up of tires and grinding the residue, reducing it to a fine powder. The recovered tires are used with asphalt for paving and in cement factories.
- Regeneration or devulcanization: the rubber is separated from the other components and devulcanized, undergoing changes that make it more plastic and ready to receive new vulcanization, without the same properties as raw rubber.
- Pyrolysis: chemical decomposition by heat in the absence of oxygen, aimed at reusing tire components as raw materials and/or fuels.
- In the open air, in fields, woods, rivers, creeks, lakes and desert areas: aggressive to the environment, with serious threats to human health.

- Disposal in landfills: makes compacting difficult and they accumulate gases (methane) from the decomposition of organic material that comes to the surface even after being buried.

- Burning the tire as fuel in ceramic ovens and others, without any treatment of the gases in the burning.

Pyrolysis is a recycling process used in several countries. In environmental terms, the process is considered clean and more than 90% of the tire's material components are reused. It recovers materials that would otherwise be extracted from nature as non-renewable sources and that also have power generation potential.

According to BTIA (2007), the entity that represents new tire manufacturers in Brazil, in 2005, a total of 100 million tires were disposed of in an environmentally correct manner. This number corresponds to approximately 500 thousand tons of old or useless tires that were collected and destroyed in an environmentally correct manner. The program was implemented in 1999 and today it reaches several regions of Brazil, from Amazonas to Rio Grande do Sul, and passing through capitals such as Vitória, São Paulo, Rio de Janeiro and Macapá. Up until now, more than US\$ 22 million have been invested, US\$ 10 million of which in 2005 alone.

The most promising solution for useless tires is to put the old tire back on the road. But now as asphalt. The idea is not all that new. It was first developed in the 1960s by a scientist from Arizona in the United States, but it only recently arrived in Brazil.

Today, the technology is patented by two companies - Petrobrás and Greca Asfaltos, from Paraná, Brazil – and it is now being put into practice, rubberizing some of the nation's highways. Researchers discovered it was possible to add a percentage of ground up tire rubber to the asphalt composition. This measure increases asphalt durability more than twofold.

The manufacturers of rubberized asphalt promise even more benefits, with greater adherence and a significant reduction in friction noise. Although the market price is 30% higher than conventional asphalt, according to manufacturers, rubberized asphalt is well worth the investment, because it can last up to three times longer depending on the climatic conditions and highway traffic load.

The Federal University of Rio Grande do Sul attests to this durability. Greca Asfaltos was the first company to apply the product in Brazil, on a highway in Rio Grande do Sul. Today, concessionaires from Paraná, Santa Catarina, Rio de Janeiro, Ceará and São Paulo are also using the rubberized asphalt on highways run by the company.

In every kilometer of rubberized asphalt, considering a 7-meter wide, 4-cm thick lane, 4200 tire carcasses are used, after removal of the steel wire and plies. Apparently, the concessionaires are convinced the product is reliable and profitable. But it is not sufficient for the private sector to approve. Of the 165 thousand kilometers of paved Brazilian roads, 160 thousand belong to the government. The Figure 4 presents a photo of a road asphalted with this kind of technology.

Only the Brazilian government can truly drive this new technology. And up to now, the Brazilian Department for Infrastructure and Transportation (former Brazilian Department of Highways) has not given any sign ecological asphalt will be used in the federal highway recovery program (ECO, 2005).



Figure 4 - Road with asphalt made with tire rubber

5. FIELD STUDY

The study was applied in a random sample of pedestrians from Paulista Avenue, São Paulo, Brazil, for a period of 5 days and it allowed the verification and analysis of knowledge about useless tire recycling and the technologies that exist for its minimization and in this text we will present part of its results.

The age group that predominated in this study was between 31 and 40 and 70% of those interviewed were men. With regard to profession, most were employed in private companies.

60% of those interviewed had no idea concerning the destination of used tires. Those who said they knew believed that recycling was truly the appropriate final destination for used tires as a raw material for asphalt.

When asked about where they leave their used tires, 62% said where they change them, 23% throw them in waste embankments and 15% give them to selective garbage collection programs.

The next question was whether when turning over their tires they would give preference to a company concerned with preservation of the environment and only 36% said yes, whereas 64% said they had never thought about it.

Those who answered yes said they would do the same even if the product (tire) was more expensive. In other words, those who are truly concerned about environmental issues do not change their mind, at least not easily, because of economic issues. There is a stronger ideal. However, unfortunately, this is still a minority of the Brazilian population.

Most of those interviewed are against disposing of tires in waste embankments and have an evident concern with environmental pollution and the risks it can have on public health.

All those interviewed are unaware of the need for legislation concerning disposal, and consequently are unaware of Resolution # 258 of the Brazilian Environmental Council (CONAMA, 1999), which determines that tire manufacturers and importers should be responsible for the final disposal of used tires.

In 2002, this legislation initially made it obligatory to correctly dispose of one useless tire for every four new ones produced. Every year since then, this obligatory action kept growing until reaching five for every four starting in 2005.

Because they are unaware of legislation, 100% of those interviewed agree with the need for a law that obliges the manufacturers to receive used tires for recycling.

8% of the interviewees destine their tire used for the selective collection, 15% deposit in the garbage, 15% leave in the in the moment of the change, 62% leave at the place of the change, that not always it is a tire repair garages. 30% of the interviewees answered that use tires recapped in your cars.

The results shown refer only to one part of the study due to the format limitations for this paper.

6. FINAL CONSIDERATIONS

The literature presents several solutions with regard to used tire recycling some of which are being used with economic success such as the use of the tires' raw material. Nevertheless, these are still very small and punctual actions when considering the number of used tires thrown away yearly in Brazil.

Even with the CONAMA Resolution concerning obligatory and progressive recycling until 2005, there is still no true mobilization in this sense. It was verified that the destination given to waste from rubber manufacturing is still mainly the waste embankments. Besides polluting the environment, this destination serves as a nest for disease-transmitting insects.

The reuse of used tires, although increasing, is still very small. This study showed that people are well-informed and concerned with environmental issues, driven by a concern about the degradation of nature. However, it seems that their concern stops there, because there is no movement or collective engagement for change. In reality, this stagnation is generalized and seen in the companies, the government and consequently the population.

Along general lines, the minimizing the disposal of useless tires requires a significant change in behavior at the industrial process as well as consumer levels, associated with an appropriate, environmentally managed plan.

The methodology used proved adequate for the study's proposal, geared towards knowledge about the environmental impact caused by useless tires, as well as the legislation in effect to minimize this impact.

It can be observed that the population's knowledge about the environmental impact of some waste is still, in general, very limited. But, from the bibliographic research, it is possible to observe the existence of work with satisfactory results concerning the use of tire recycling.

This new perspective from the business world is a result of a change in the development model taking place in society redirecting the focus from the economic to the social, valorizing aspects such as quality of life, personal relationships and the environment. In order to satisfy the demands of this new paradigm, countries and companies have aligned, forcing themselves to improve their processes and products within this new perspective of their life cycle. It is fundamental to optimize productive processes, articulate the productive chain and rethink the products themselves.

Although environmental legislation does exist, there is a lack of public policies at several levels of government aimed at more effectively eliminating the environmental liability.

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