REGMPE

Revista de Empreendedorismo e Gestão de Micro e Pequenas Empresas

ANALYSIS OF THE APPLICATION OF REVERSE LOGISTICS IN THE CIVIL CONSTRUCTION SECTOR FOR THE RECOVERY OF PUBLIC ROADS

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SUMMARY

Civil construction is one of the industrial activities that most consume natural resources such as wood, minerals, water and energy worldwide and, consequently, produces large amounts of waste that often ends up being disposed of inappropriately. The implementation of reverse logistics in civil construction consists of an organizational tool with the objective of making the reverse chains technically and economically viable, in order to contribute to sustainability. Thus, this work aims to define the concepts of reverse logistics, describe some processes for recycling materials generated by civil construction and report the application of reverse logistics in the recovery of public roads.

Keywords: Reverse logistic; Construction; Recycling.

1. INTRODUCTION

The activity of civil construction, which is one of the biggest contributors to socioeconomic development in Brazil, generating income, jobs, enabling infrastructure and housing, and is also responsible for major impacts on the environment. These impacts are related to the high consumption of raw materials and energy and also to the large generation of waste that occurs throughout its entire production chain. The construction industry generates waste in the production of materials and components, in the activity of the construction site, during maintenance, modernization and demolition.

There are several factors that provide for the generation of waste in civil construction, among them we can mention the problems related to the poor elaboration of the projects, in addition to the low qualification of the workforce, due to the inadequate handling,

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Dantas, PAR, Costa, RAT; Analysis of the Applicability of Reverse Logistics in the Civil Construction Sector for the Recovery of Public Roads. Magazine of Entrepreneurship and Management of Micro and Small Enterprises V.1, Nº5, p.28-48, Sep./Out.2016. Article received on 08/15/2016. Last version received in 01/10/2016. Approved on 10/16/2016.

transportation or storage of materials, up to the lack of reuse and recycling processes at the jobsite.

In view of this, Federal Law 12,305 / 2010 was created, which instituted the National Solid Waste Policy, establishing the principles, objectives, instruments and guidelines for the management and management of solid waste, the responsibilities of generators, public authorities, and consumers, as well as the applicable economic instruments. This law defines reverse logistics as an instrument of economic and social development characterized by a set of actions, procedures and means designed to enable the collection and return of solid waste to the business sector, for reuse, in its cycle or in other productive cycles, or other environmentally appropriate final destination.

Reverse Logistics is a relatively new area for companies and societies, mainly in Brazil. The increase in interest in this field was due to the growing concern with the environment and above that, with the concern to meet the wishes of customers and reduce costs and problems with waste from civil construction.

This article aims to analyze the application of reverse logistics in the civil construction sector for the reuse of materials that were previously discarded and apply them in the recovery of public roads. In addition, the study seeks to briefly address the evolution and current scenario of logistics, define the concept of reverse logistics, address how reverse logistics can be applied in civil construction, report on the flows and processes of recycling solid waste construction and report the application of reverse logistics in the recovery of public roads.

For the preparation of this study, an extensive bibliographic research was carried out, consisting of consulting books, dissertations, theses and scientific articles. The documents were obtained in libraries and on the internet, which provided support to address the main concepts on the topic addressed.

2 - THE EVOLUTION OF LOGISTICS

Contrary to what many people think, logistics is not a new process or an administrative methodology. Barbosa and Muniz (2008) affirm that logistics has always existed, since the most remote times, when man began to produce more than he needed, starting to need storage locations, as well as transportation to allow for the need to exchange surpluses with your neighbors. The authors claim that this was already logistics in a potential way, not as technologically advanced and integrated as the modern one, but it was already logistics, which has evolved to be used in wars and industries over the centuries.

For a long time the processes and principles of reverse logistics were not treated and named as such and often, as it is today, for various reasons, among which we can highlight the main ones, which are the environmental, social, economic and global issues involved. , as well as the benefits that are currently provided by reverse logistics, in the internal and external environment of organizations.

Technological development has led to the progress of reverse logistics, driven in large part by environmental, social and economic issues related to the issue of disposal and reuse of solid waste both in public and private organizations and in society.

Currently, there is growth in this area of logistics, not only due to the issues already mentioned above, but also due to all environmental legislation and the awareness of public and private organizations, consumers and the increasingly demanding global market.

For Carvalho (2012), "reverse logistics is on a development scale, and shows great potential for emerging business for public and private organizations, as environmental policies are increasingly strict".

Another factor of fundamental importance, related to the increase in the concepts and principles of reverse logistics is the relationships of acquisitions (purchases), through the internet. There is currently a growth in online shopping, of all types of products and in all industrial segments and in the construction sector is no different, in this sense there must be a management in the return, reuse and reuse of products (waste).

Online purchase (purchase) is generally characterized by ease, but at the time of purchase, it is not possible to "visualize and handle" the product physically acquired, in a tangible way, in this sense most products are returned, as they do not satisfy the customer, this is where the entire organizations reverse logistics system comes into play. It is possible to state that most cases of reverse logistics enter the scene because of returns (LINO, 2013).

When the products do not satisfy the customer, due to some technical requirement, it triggers the return system, which is increasingly available in organizations, in order to assist and assist the customer in a quality and after-sales network, with the objective of exceeding customer expectations, making it possible to retain customer loyalty, as these well-assisted and attended will prefer to have few suppliers.

2.1 - LOGISTICS TODAY

Logistics is a term with a lot of evidence in all business sectors. Currently, all the leading companies in the most diverse sectors use logistics as a way to manage their production flows, with satisfactory results.

The companies have a logistics department that takes care of materials management, manufacturing and physical distribution, with the various related activities, but as totally watertight, independent and discrete functions. Knowing that the intrinsic characteristic of logistics is the integration, coordination and control of these activities, it can be concluded that real logistics is not being used, since it does not lead to an increase in productivity, service level and a reduction of costs (BARBOSA and MUNIZ, 2008).

Among the manufacturing industries, civil construction, in the buildings sub-sector, is the industry that least uses logistical technology in its management, a fact that has a significant impact on productivity, quality, deadlines, in addition to having high levels of waste. According to Gomes (2014), the rates of losses and waste in the constructed buildings can reach up to 30% of the total quantities.

The view of current logistics can no longer be concerned only with addressing physical informational and traditional flows, from the point of origin to the place of consumption. For Carvalho (2012), the current logistics should cover from physical flows, production management (materials, inputs and finished products) and all information induction, both in the direct and in the reverse direction.

Reverse logistics, nowadays, plays a fundamental and extremely important role in the decisions of public and private organizations, in this new concept of doing logistics, it appears

that due to the globalized environment that we live in, logistics is more global and more comprehensive.

The new concept of logistics in the globalized environment that organizations and society are inserted in has several names. For Campos and Brazil,

> The CSCMP (Council of Supply Chain Management Professionals), logistics is defined as being the part of the supply chain or supply process that strategically plans and coordinates the program and efficiently and effectively controls the flow in the forward and reverse direction, the storage of products, services and the entire information relationship, from the point of origin to the point of consumption, thus providing the satisfaction of customers and the entire organization (CAMPOS; BRASIL, 2007. pg. 26).

Campos and Brasil (2007) summarize that reverse logistics is the area of logistics that aims to manage and monitor the flow of a given product, from the point of sale or consumption to the place of origin.

In this globalized environment in which public and private organizations as well as society are inserted, currently reverse logistics has as priority, to plan, apply, program, drive, propose and efficiently control, the recovery and return of a product at the end of its life cycle, proposing a reduction in the consumption of natural resources, proposing the reuse of the recovered material, proposing the disposal and storage of this waste and the possibility of proposing actions for the reapplication or a new manufacture of another product, before this the circle the entire supply and supply chain becomes closed, thus becoming a complete logistical cycle (PEREIRA, 2010).

3 - REVERSE LOGISTICS

According to Santos (2014), the mission of logistics is to dispose of the right goods or service, in the right place, at the right time and under the desired conditions, while providing the greatest contribution to the company / institution / organization. A modern branch of business logistics emerges, in response to a new requirement from society, reverse logistics, which, according to Leite (2009), is the space of business logistics that plans, operates and

controls the flow and the corresponding logistics information, of return from post-sale and post-consumer goods to the business cycle or the production cycle.

For Razzolini Filho and Berté, logistics is,

> The activity that plans, executes and controls the flow of inputs (raw material), products in processes and finished products (as well as the entire flow of economic, social and environmental information in this relationship), from the point of consumption to the point of origin , in an effective and efficient manner, which aims to recover waste or eliminate value in an appropriate manner, taking care of the impact and costs of this strategic relationship interconnected with economic, social and environmental factors. (RAZZOLINI FILHO; BERTÉ, 2008. p. 40).

Razzolini Filho and Berté (2008), exemplify that the reverse logistics is responsible for making possible the return of materials and products, after their sale and consumption, to the productive and business centers, through the reverse distribution channels adding value to them.

The speed with which a product is launched on the market, the rapid advance of technology, together with a large flow of information; the high competitiveness of companies and the growth of ecological awareness regarding the consequences caused by products and their discharges in the environment, are contributing to the adoption of new behaviors by organizations and society in general, thus signaling a greater appreciation return processes for products and materials discarded in the environment.

Although many companies, in different parts of the world, still do not care about the reverse flow of products, many have already started to understand that Reverse Logistics is an important and strategic part of the business mission. Silva (2007) states that the administration of good Reverse Logistics not only results in cost savings, but can also increase revenues. Although it is often referred to as refuse and is not the main basis for a company's competition, much value can be obtained in the efficient management of the returned products and the effective cost of the reverse flow.

With the increase in control measures and ecological restrictions, along with the population, giving greater attention to more sustainable companies and, of course, the possible economic gains, cause many researches to be developed today with a focus on reverse logistics. According to Vale and Ramos (2013), this demand is mainly due to the fact that a

large quantity of products to be sent to landfills and landfills still having a possible economic value to be explored.

For Marcondes and Cardoso (2015), the Civil Construction production chain must promote sustainable development, that is, it must develop in a way that does not compromise the ability of future generations to do so as well. Where responsibility with the use of natural resources and the destination of residues from industrial activities should be emphasized. Also according to the authors, who highlight the relevance of the study of reverse logistics applied to civil construction due to “the industrial processes in the Civil Construction production chain generate industrial wastes of diverse characteristics and in high volume and mass, which cause significant environmental impacts".

The initiatives related to reverse logistics have brought considerable returns to companies. Silva (2007) states that:

> The savings with the use of returnable packaging or the reuse of materials for production have brought gains that encourage the use of reverse logistics. Thus, the implementation of reverse logistics is revealed as a great opportunity to develop the systematization of the flows of waste, goods and discarded products - either at the end of its useful life, whether due to technological obsolescence or another reason - and its reuse. , inside or outside the productive chain that originated it, contributing to reduce the use of natural resources and other environmental impacts (SILVA, 2007. p.05).

Silva (2007) still claims that the reverse logistics system consists of an organizational tool with the aim of making the reverse chains technically and economically viable, in order to contribute to the promotion of the sustainability of a production chain.

Thus, reverse logistics appears as a great opportunity to develop the systematization of an entire supply chain of products or services that were previously discarded where they can once again be part of the business cycle, contributing to a reduction in the extraction of virgin raw materials, in addition to reducing costs for companies and contributing to the sustainability of the environment, also improving the company's social image within my consumer market.

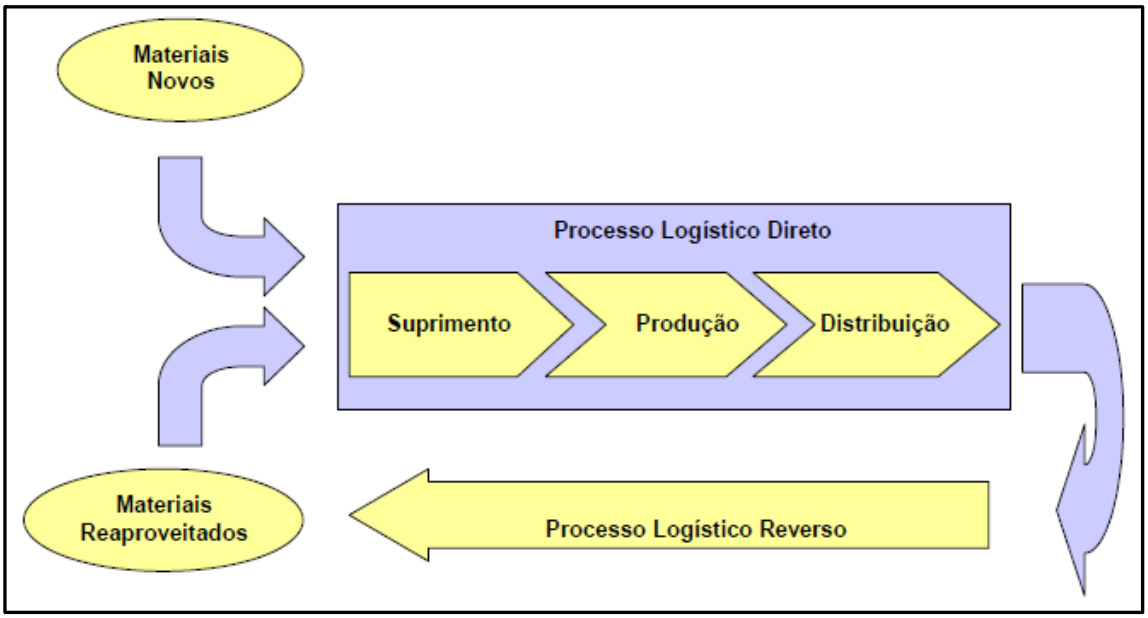
For Leite (2009), reverse logistics is the area of business logistics that plans, operates and controls the flow and corresponding logistical information, from the return of post-sale and post-consumer goods to the business cycle or the production cycle , through reverse

distribution channels, adding values of different types: economic, service, ecological, legal, logistical, corporate image, among others.

Thus, reverse logistics consists of a process of planning, implantation, operation and control, of goods and information related to a flow, which have peculiar characteristics and also challenges of gathering various products and services consumed after their useful life and forwarding them. in general to the same manufacturer or for recycling processing and future application in secondary markets such as the recovery of public roads.

In this context, we can illustrate the reverse logistics process, according to Lacerda (2011), as follows:

Figure 1 - Schematic representation of the reverse logistics process



Source: Lacerda (2011)

First, the direct logistical process is carried out, where the material has its first use, passing through the areas of supply, production and distribution. Then the reverse logistics process takes place, generating materials that are reused that return to the traditional process of supply, production and distribution, as shown in figure 1. This process is usually composed of a set of activities that a company performs to collect, separate and dispatch used materials from consumption points to reprocessing, resale or disposal sites.

3.1 - REVERSE LOGISTICS IN CIVIL CONSTRUCTION

In most of the developing cities in Brazil, it is common to find on certain streets or in vacant lots, large amounts of construction waste that are generated from the construction of homes, buildings and industries, which demonstrates the importance of the sector in the Brazilian economy and as well as evidence of material waste, neglect of the environment, neglect of public health, neglect of cleaning and neglect of energy expenditure.

The inappropriate destination of these materials ends up resulting in social and environmental problems for society. With that, an important alternative to correct this problem would be the reuse of these materials using them in a more productive way as in the recovery of public roads.

Due to the growing competition present in both domestic and foreign markets, as a result of globalization, Marcondes and Cardoso (2015) state that organizations have shown greater concern in relation to maintaining the competitive advantages that determine their strategies, the creation of opportunities that enable them to reach larger and larger markets and to add value to existing businesses.

In this context, the Civil Construction sector is not experiencing a different reality. There is a great concern with sustainability because it is seen as a competitive differential, before customers. In addition, in this sector, both the production processes at the construction sites and the product that derives from it are potentially impacting on the environment.

Also according to Marcondes and Cardoso (2015) who highlight the objectives and benefits of the role of reverse logistics within the production chain of Civil Construction from the point of view of sustainability:

A. Goals

- Mitigate the environmental impact of manufacturing waste;
- Save natural resources;
- Formalize existing businesses, raising more taxes;
- Increase business volume;

- Reduce costs by replacing primary raw materials with secondary ones;
- Direct rejected products to secondary markets;
- Save energy and waste disposal costs;
- Generate new jobs

B. Benefits

- Reduction in the volume of deposits both safe and illegal;
- Meeting / anticipating the requirements of legal regulations / legislations;
- Energy savings in the manufacture of new products;
- Improvement of the corporate image - Ecological awareness;
- Ease of disposal of "stranded" products in the direct distribution channel;
- Obtaining financial resources through the commercialization of industrial waste;
- Encouraging the creation of new businesses in the production chain;
- Reduced investment in factories;
- Improving the performance of existing businesses;
- Decrease in visual pollution;
- Reduction of health and hygiene risks from landfills;
- Lower costs of products with recycled content;
- Improving the corporate image - Social responsibility

4 - FLOWS AND PROCESSES OF RECYCLING OF SOLID WASTE FROM CIVIL CONSTRUCTION

During the construction activity, several solid residues are generated, mainly due to leftovers or waste, which ends up being dumped as garbage in landfills or even in vacant lots.

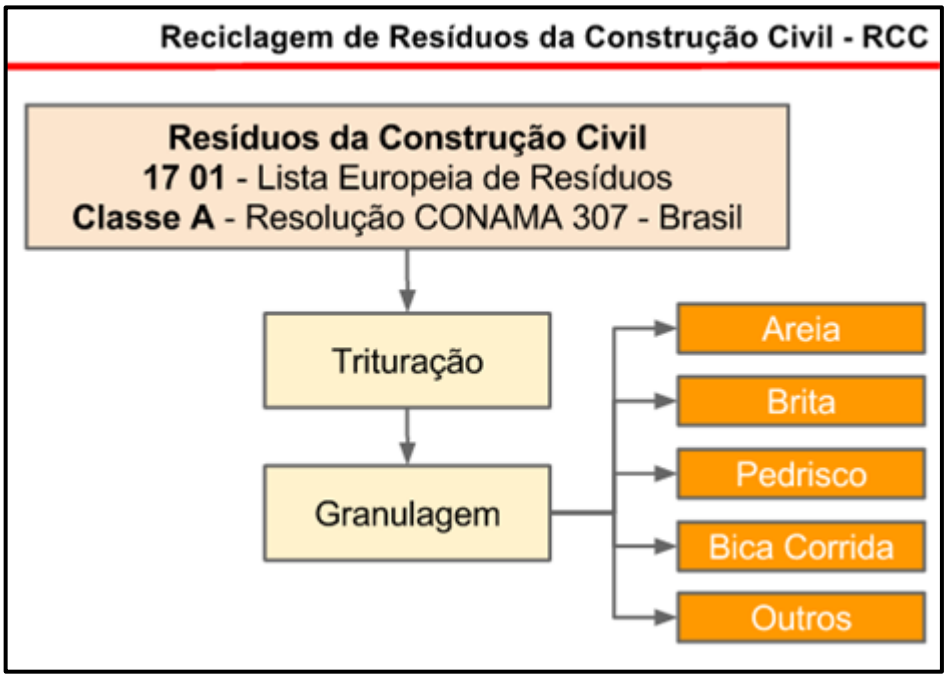
The recycling process of these materials is of great economic and environmental importance, both for the company itself and for the environment, as stated by Barbosa and Muniz (2008).

Technological solutions for the recycling of Solid Waste from Civil Construction - RSCC vary depending on the type of waste to be treated. The recycling flows and processes addressed according to the author Blumenschein (2014), are used for waste defined byCONAMA Brazilian Resolutionas Class A Civil Construction Waste and equivalent waste Nr. 17.01 defined by European Waste List which include the following residues:

- Construction, demolition, renovation and repair of paving and other infrastructure works, including soil from earthworks;
- Construction, demolition, renovation and building repairs: ceramic components (bricks, blocks, tiles, cladding plates, etc.), mortar and concrete;
- From the manufacturing and / or demolition process of precast concrete parts (blocks, tubes, curbs, etc.) produced at construction sites;

The collected waste can then be processed and transformed into raw material at the source itself or at a recycling plant. The recycling process was developed by Blumenschein (2014), which is shown in figure 2.

Figure 2 - Recycling process



Source: Blumenschein (2014)

Also according to the author, who states that after selective collection, the waste undergoes a crushing process. At this stage, the fractions are mixed and the residues have little added value. Only after granulation, that is, the separation of the fractions, can an appropriate destination be given to the new materials. According to the fraction size, the waste will be classified into sand, gravel, gravel, spout and others and from that, it can be sold as a secondary raw material.

In a third moment, the raw material may be used to manufacture basic products for civil construction, such as bricks, cement blocks, gravel and also for the recovery of public roads.

For Blumenschein (2014), there are RCC recycling plants that can be divided into 2 categories according to their mobility. These are the fixed and mobile plants, let's see:

A. Fixed Plants

Fixed plants are built on land with an area that varies depending on the plant's processing capacity, that is, the greater the capacity, the greater the area needed to build. They are usually installed in open fields and because they are fixed, they have greater capacity for processing materials. An example of this type of plant can be seen in figure 3.

Figure 3 - Fixed Recycling Plant for Civil Construction Solid Waste

Source: Blumenschein (2014)

These plants need the preparation of a foundation where they will be installed and their installation until the moment of operation takes around 30 days. They are the most economically accessible versions of the market, however the most limited when it comes to commercial competitiveness.

B. Mobile Plants

A Mobile Recycling Plant for Civil Construction Waste - URM-RCC is basically composed of 3 components: A Roll On Roll Off type truck, a Mobile Crusher and a Mobile Rotating Screen normally docked as a trailer on the truck. The definition of the Business Model is essential to ensure profitability.

Mobile crushers are built in a single block, usually with a size ranging from 1 20 ”to 40” container according to their processing capacity. They can be used in a fixed project or even be rented for works in different locations. According to the manufacturer, these plants can be easily transported in Roll On Roll Off trucks as shown in figure 4:

Figure 4 - Mobile Building Waste Recycling Plant with granulator (mobile sieve)

Source: Blumenschein (2014)

Still in figure 4 you can see a complete mobile Civil Construction Waste Recycling Plant, basically composed of 3 components: The Roll On Roll Off type truck, theMobile Jaw Crusher model BMD RA 700/6and a Mobile Rotating Screen.

The great advantage of this model is that the entrepreneur will be able to take the entire enterprise to regions where his service is needed. If used correctly, the project can be highly profitable and extremely versatile.

Among the advantages of mobile plants, we can mention:

- Its mobility makes the enterprise extremely competitive;
- It can act at a fixed point or attend large works directly on site;
- Decreases logistics costs and construction of basic foundation;
- High capacity for geographic adaptation of the market;
- Diesel or electric power versions;
- It can be rented completely by companies in the sector;
- High processing capacity;

5 - APPLICATION OF REVERSE LOGISTICS IN PUBLIC ROAD RECOVERY

A major problem for landfills and dumps in urban areas of large Brazilian cities, is undoubtedly the large accumulation of waste from civil construction, as it takes up a large volume and space when disposed of in urban dumps or in landfills.

Another drawback is that this type of waste, also serves as breeding grounds for venomous animals such as snakes, spiders and scorpions and also as breeding grounds for the aedes aegypti mosquito that causes dengue and rats that cause leptospirosis, which are usually present in urban areas of large cities and near residences.

However, through the correct storage, disposal and when these residues are sent to recycling units, stored, selected and properly processed, they are transformed into raw material (mixed aggregate compound, earth, concrete, stone and ceramic) as shown in figure 5 that can be used in the recovery of public roads.

Figure 5 - Material ready for use on public roads

Source: Lino (2013)

According to Lino (2013) the recovery of public roads is an excellent alternative to the application of reverse logistics in civil construction and, according to the author, this activity is already being carried out in the interior of the state of São Paulo. This experience uses civil

construction waste after being collected, recycled and processed. Figure 6 shows the detail of the material already compacted on the track.

Figure 6 - Compacted material used in the recovery of public roads

Source: Lino (2013)

The author also states that the project is still in an experimental phase in the rural area of the municipality of Piracicaba in the interior of the State of São Paulo. However, it has already shown great satisfaction with the results and can already be applied in other regions of Brazil. The material is the result of the processing of mineral waste, consisting of a type of mixed aggregate (rest of concrete, stone, ceramics, earth and sand), from the waste produced in the civil construction sector.

Figure 7 - Material used to recover the road

Source: Lino (2013)

Figure 7 shows the result of the application of the material on the road, which can be used mainly to plug holes and correct imperfections on public roads. In addition to all the environmental and public health issues involved, another relevant one highlighted by Lino (2013) was regarding the compactness and durability of the product, which reduce maintenance costs (movement of machinery and personnel), thus, the ways will be in good condition for a long period.

6 - FINAL CONSIDERATIONS

Logistics is an important competitive advantage for the country and especially for companies that adopt it in a planned and organized manner. It stands out as a new and relevant competitive differential for organizations, considering all the stages and interactions between the participants in the supply chain who need to work in an integrated manner seeking to optimize resources and create value for the customer.

Civil construction is an important sector of the world economy that is expanding more and more each year. In view of the large amount of materials generated in this activity, which most of the time are disposed of inappropriately, damaging the environment, reverse logistics is an important environmental and economic tool for the reuse of these materials and reuse them in others. sectors.

This study sought to show the importance of the application of reverse logistics in the recovery of public roads. This environmentally correct activity still needs further testing and studies for its improvement, however, it is already being adopted in some regions of Brazil and has been showing satisfactory results.

Thus, for the growth of this idea, the government must propose, implement and invest financially in programs for the recycling of construction waste, providing technical assistance by training people and creating cooperatives of recycled material, providing collection points for the generated waste and, mainly, to raise awareness among the population through educational campaigns and lectures on the importance of reverse logistics in civil construction, thus integrating the entire system.

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