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Solid Waste Management in a Civil Construction Company in Amazonas

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Abstract*— *The construction industry occupies a prominent position in the Brazilian economy, but it is a major generator of environmental impacts that result in the formation of degraded areas. Thus, the development of construction activities that are more appropriate to the principles of sustainable construction, which do not cause so many degrading actions, is inevitable. Concern with the environment has brought an alert where various sectors of society are involved, promoting environmental education actions, so it is called for the strong and effective participation of all agents involved (public sector, owners, companies, engineers and architects, teachers and students, collectors' associations) for a common good - the sustainability of cities. Therefore, there was an initiative to verify if the construction companies are actually reusing to reduce waste and extracting more raw materials and offer subsidies so that the environmental problem can be faced in this construction company by giving appropriate waste disposal.

Keywords*— *About five key words in alphabetical order, separated by comma.

I. INTRODUCTION

Taking into account society's growing concern with environmental preservation and sustainable development, civil construction has a gum of needs, given the amount of waste generated.

To carry out the study of a solid waste management plan of the companies, we observe the different forms of treatment, material used and thus contribute to reducing material waste and incorrect disposal in the environment, in order to minimize the impact caused by these. waste, which highlights its importance in the management process, since civil construction is necessary for urban development.

Still, it is justified to understand this analysis by the fact that all unsustainable issues that impact the environment on people's lives should verify the effectiveness of the process seeking to mitigate the negative effects caused by inappropriate actions.

The transformation process that society is going through today leaves significant consequences on the environment that arouse society's attention. This transformation has increased the production of solid waste resulting from increased buildings and new building standards.

Law 12.305 [1], established the National Policy of Solid Waste (PNRS), proposing the prevention and reduction of solid waste production, where in article 3 it is observed that the amount of this material generated by civil construction has been the subject of discussions. , given its quantity causing numerous urban, social and economic problems.

The environmental problem generated by the waste that is unregulated in clandestine landfills, shoulders and highways must be solved in order to preserve the environment. Actions have been created to reverse this situation, such as Resolution [2], which establishes guidelines, criteria and procedures for the Management of Construction Waste and creates the chain of responsibilities: generator - transporter - municipalities.

Solid waste, according to [3], is all material discarded from commercial activities, industries, domestic, among others, i.e. products for which there is no economic interest. In the case of civil construction, the disposable result is rubble, which comes from the enlargement, reconstruction, alteration, conservation and demolition of buildings.

According to [4] construction wastes can be classified into class A, wastes that can be reused even in construction; Class B, used for other purposes; Class C, which has no economic demand; Class D hazardous waste and Class E common waste.

The current consumer culture contributes to the productive development of various sectors. Where according to [5], it provides an increase in the amount of

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waste to be disposed of. Thus, according to the PNRS, described by [1], all regions of Brazil should be able to reuse their waste, have recovery sites and eliminate irregular disposal by 2027, minimizing the impacts generated by the lack of articulation for a correct management.

Waste produced by construction requires greater attention, especially aggregate volume debris, which according to [6] may account for more than half of solid waste generated in urban areas. This construction waste causes important environmental problems, such as the siltation of urban drainage systems and also important social problems, as their irregular deposition in the urban network imposes heavy costs on society, diverting scarce resources.

For [7], environmental management is on the agenda of government and companies, seeking alternatives to minimize the effects of economic development on the environment, aiming to reduce the consumption of raw materials and solid waste production.

Construction is one of the fastest moving branches of the economy. Thus, [4] says that construction companies should proceed according to a PGRCC construction waste management plan, meeting the plan guidelines. For [8], the management of solid waste GRS, must collect, transfer, treat, recycle, recover resources and release them even in urban areas, involves cooperation between public and private sectors.

The solid waste management plan in civil construction is foreseen by law, since it is part of actions that aim to minimize the impacts of this waste on the environment, besides contributing to the reduction of the high expenses by the public administration with cleaning in the uneven dumping sites.

Resolution 307 of [2], later amended by [9], established important references for the management of this waste and that are already beginning to generate demands for manufacturers of different materials. The construction project must estimate the waste to be generated and specify legal destinations for the material generated.

According to [1], debris generators are responsible for the reintegration of the material into the production process and may be disposed of in appropriate places for temporary storage. The only inert waste sent to landfills is from excavations. The implementation of a reverse logistics network for the processing of construction waste that caters to small generators scattered around the city, with the creation of adequate infrastructure for segregation of materials at source, seems to be the only viable way to provide the same type of waste. treatment currently given to the residues of major works with installed sites.

The current linear industrial process, with construction waste generating significant waste and environmental impacts on the urban environment, must be replaced by a sustainable circular logistics in which waste generated, segregated by class, can be incorporated back into the production chain. , or properly disposed of, producing social, economic and environmental benefits.

Waste management of any kind must be treated seriously to avoid harmful and irreversible consequences. Regarding social relevance, the study will show the importance of waste management for the environment and the quality of life of people. As a scientific contribution, the study will be based on technical standards, in order to describe the management of solid waste quality in a construction company in Manaus / AM.

II. METHODOLOGY

The methodology to be applied for the analysis will be used a qualitative approach, aiming to make a description of the findings about the solid waste management plan of the company that will be object of study of this work that consists basically of five steps: observe, measure, sketch, think and correct.

Experience shows that the great tool of rationalization is thinking, stopping in a given situation and not being afraid to dare. You have to try to go beyond everyday life, venture into unusual solutions, and test and record your results. The analyzed process will be observed, the necessary mediations will be made, time spent in each process, distances traveled, number of people and machines involved.

Rationalization only works if it is viewed as a whole, not just by sticking to one part of the production process, but by joining all the projects together so that they can achieve a good result (Figure 1). When not working in isolation, everything becomes more accessible until resources generate better income. In a work that has a very limited site area, for example, it is paramount to think of the work as a whole, paying attention to the moment when each stage of the work must begin and end, if one stage can be done at the same time. how long does it take, how long does it take to use a certain amount of raw material during the production process, how much available space does it have to store, how many people will be needed to complete this work.

According to [10], rationalization must methodically analyze existing structures and processes in order to discover weaknesses, such as unnecessary waiting times, failures in the preparation and transmission of information,

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avoidable intermediate stocks and excessively long transport routes, Then, it is to perceive the possibilities for improvement, analyze them and introduce them to test them and be accepted by those involved. Evolution in the system is the main progress of rationalization implemented in the company.

It is then understood that rationalization is divided into three steps: verification of the company's failures; analysis of the possibility of improvements and; Finally, these are implemented, and each of these steps has methods of working. In the construction industry, rationalization is one of the major factors for success in the industry, as it is highly targeted by the amount of solid waste produced and the image of environmental aggressor [11].

In civil construction the loss and failure are basically related to the waste of materials, but the losses extend beyond this concept and should be understood as any lack of efficiency reflected in the use of equipment, materials, labor and capital, that is, any resource, in quantities greater than those required for the production of the building [12]. According to [13], the waste begins, or originates from all stages of the construction process, which are: planning, design, manufacture of materials and components, execution and use and maintenance.

It is of utmost importance to undo the idea that for the rationalization of the processes to be successful, a large financial investment on the part of the organization is necessary, with the introduction of new construction technologies or the implementation of new equipment in the construction site. The rationalization does not always have complex actions, can be made with small changes in the work routine of workers that will produce better quality in the construction process, saving time, material and labor, and may even end the generation of waste.

According to [10], a methodology for promoting rationalization on the construction site is presented, highlighting that production in civil construction is marked by a series of particularities: individual product, each product has a new production site, short-term projects, workplace subject to climate variations, customer interfering in the production process, among others.

This process makes the construction management always busy keeping the work in progress and managing the issues that arise most actively. With these difficulties, there is little time left to analyze the processes and make improvements, it becomes minimal, where at this point the methods developed in this case study intend to provide subsidies to promote rationalization.

The entire rationalization process takes place at three distinct levels, namely: Type 1 (R1) r rationalization - efforts that aim at material flow, minimizing transport distances, optimizing the machines employed, improving information exchange, and empowering personnel. involved, focused on the most important factors at the moment - the production process and the construction site; rationalization type 2 (R2) g - efforts that target the overall processes of a company, and the framework that surrounds it, includes the management of support functions: procurement, logistics, new technologies, resource availability, information management, administration and staff development, strategies; rationalization of type 3 (R3) g - organizes the production chain and its interferences in the company's focus. (Figure 1).

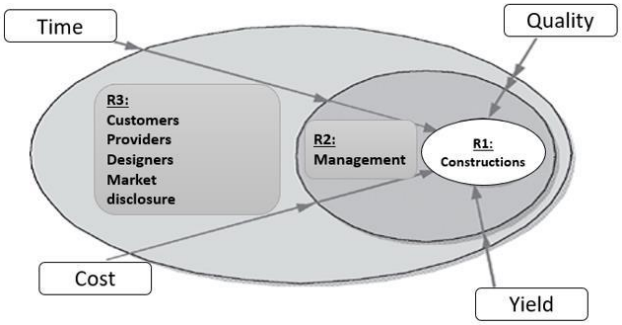

Fig. 1: Rationalization process scheme
Source: engenhafrankweb.wordpress.com

III. RESULTS AND DISCUSSION

Table 1 shows the indication of all waste generated on site, according to resolution [2], and, finally, the amount of waste in a month, indicating which materials should be given more attention.

Table. 1: Types and quantities of waste generated

WASTE TYPE	QUANTITY GENERATED (M3 / MONTH)
MORTAR	1,95
CERAMIC COMPONENTS	7,35
CONCRETE	9,75
PLASTER	3,00
WOODS	2,10
METALS	0,75
ORGANIC	0,30
PAPER / CARDBOARD / PLASTICS	0,30
PAINTS AND SOLVENTS	1,35
GLASSES	0,30

Source: Own authorship

For [14], waste generation is directly linked to lifestyle, culture, work, diet, hygiene and human consumption. In Brazil, the transportation of solid waste is regulated by

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[15], created with the purpose of regulating parameters to avoid damage to the environment and to protect public health. It was found that the internal transportation of waste is performed by employees with the aid of wheelbarrows, garbage bags or winches, according to the need of the type of waste handled. External transport is carried out by the specific companies that transport each type of waste, which is closely related to the final destination of the waste.

Organic waste, together with paper, plastic and cardboard is collected by the public collection truck and destined for the landfill; construction debris, that is, ceramic components, mortar, concrete and plaster are transported by companies that carry construction debris, the wood is collected by professionals in the bakery industry for use in ovens; Metals are collected by waste pickers or scrap traders. The paints and solvents are placed directly on the ground of the construction site without any treatment.

The following instruments can be adopted: environmental education; environmental monitoring; social and environmental responsibility; waste minimization and recycling; environmental audit; risk analysis; laws, rules and regulations, among others. This whole procedure must be applied to the study of a given process, under the conditions in which it is performed, which we call the existing situation.

After the observation, measurement and recording of the existing situation is completed, we go to the stages of thinking, developing process improvement and if possible simulating the operations in the spreadsheet to have an overview of the effect it will cause. The results are compared, and if they are positive enough to justify the change, a field management plan is implemented. The company needs to reformulate spending so that it can make this management plan without cost and without reaching the environmental plan.

The methodology used in the elaboration of the theme was systemic; seeking to understand information within a context and establish the nature of their relationships. Any action proposed to reduce the impacts of construction on the environment ultimately contributes to the sustainability of the entire planet. Therefore, it is clear that the engineering processes of works to achieve sustainability should not be isolated. The processes should involve various sectors of society, promoting environmental education actions, allowing all involved to have knowledge of the importance and scope of their actions in the pursuit of sustainability as a whole.

During the research period it was found that companies with PBQPHA certification still do not manage the waste of municipal works according to the guidelines recommended by [2]. The most commonly implemented procedure by companies is the screening of their RCD as a way to market them and thus make some profit, so companies do not place the environmental issue as a priority.

In carrying out the observation, a Waste Management Plan was created, which should establish specific conditions for initial packaging, internal transportation and final packaging of each identified and collected waste.

The initial packaging should take place as close as possible to the waste generation sites, disposing them in a manner compatible with their volume and preserving the good organization of the spaces in the various sectors of the work. In some cases, waste should be collected and taken directly to the final packaging sites. (Table 2).

Table. 2: Initial packaging considering waste type

TYPE OF WASTE	INITIAL PACKAGING
CONCRETE BLOCKS, CERAMIC BLOCKS, MORTARS, OTHER CERAMIC COMPONENTS, CONCRETE, BRICKS AND THE LIKE.	In piles formed near the generation sites, in the respective floors.
WOOD.	In piles formed near the site and arrangement for vertical transport (large pieces).
PLASTICS (PACKAGING SACKS, PIPE SHAVINGS, ETC.)	In raffia bags.
CARDBOARD (BAGS AND PACKAGING BOXES OF INPUTS USED DURING THE WORK) AND PAPERS (OFFICE)	In raffia bags, for small volumes. As an alternative to large volumes: the bales.
METAL (IRON, STEEL, COATED WIRING, WIRES ETC.)	In signposted packaging.
CLADDING PLASTER, CARDBOARDS AND ARTIFACTS.	In piles formed near the waste generation sites on the respective floors.
FAÇADE AND PROTECTIVE SCREENS.	Collect after use and dispose of properly.
HAZARDOUS WASTE IN PLASTIC AND METAL PACKAGING, APPLICATION INSTRUMENTS SUCH AS BRUSHES, BRUSHES AND OTHER AUXILIARY MATERIALS SUCH AS CLOTHS, RAGS, TOW.	Handling with care observed by the manufacturer of the input in the safety data sheet of the package or contaminant of the working instrument. Immediate transport by user to final packaging location.

Source: Own authorship

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Internal transport should be specifically assigned to workers who take charge of waste collection at workplaces. They are responsible for exchanging the raffia bags with waste contained in the pails for empty bags and for transporting the raffia bags with the waste to their final packaging sites. Internal transport may use conventional and available means: Horizontal transport (trolleys, manual transport) or vertical transport (freight elevator, rubble conductor). Waste collection routines at established pavement levels should be adjusted to the availability of equipment for vertical transport (crane and freight lift, for example).

For [16], the solution or reduction of environmental problems must start with new attitudes of entrepreneurs and managers who should expand their projects taking into consideration the environment and adopt new administrative and technological measures that contribute to a better lifestyle in the environment. planet.

Ideally, in planning the implementation of the work, there should be specific concern with the movement of waste to minimize the possibility of formation of "bottlenecks". Equipment such as the rubble conductor, for example, can provide better results, speeding up the internal transport of masonry, concrete and ceramic waste (Figure 2).

Fig. 2: Rubble conductor
Source: Own authorship

The final packaging is reserved for defining the size, quantity, location and type of device to be used in the final process of waste rationalization in which this set of factors should be considered: volume and physical characteristics of the waste, facilitation for collection, control of the use of the devices (especially when disposed outside the site), safety for users and preservation of the quality of the waste under the conditions necessary for disposal. During the execution of the work the solutions for final packaging may vary (Table 3).

Table. 3: Final packaging by type of waste generated

TYPE OF WASTE	FINAL PACKAGING
CONCRETE BLOCKS, CERAMIC BLOCKS, MORTARS, OTHER CERAMIC COMPONENTS, CONCRETE, BRICKS AND THE LIKE.	Preferably in stationary buckets.
WOOD	Used stationary buckets.
PLASTICS (PACKAGING SACKS, PIPE SHAVINGS, ETC.)	In identified bags.
CARDBOARD (BAGS AND PACKAGING BOXES OF INPUTS USED DURING THE WORK) AND PAPERS (OFFICE)	In signposted packages or bales, both kept in a covered place.
METAL (IRON, STEEL, COATED WIRING, WIRES ETC.)	In signposted packaging.
CLADDING PLASTER, CARDBOARDS AND ARTIFACTS	In stationary buckets, respecting the condition of segregation in relation to masonry and concrete waste
FAÇADE AND PROTECTIVE SCREENS	Dispose of in an easily accessible place and immediately request withdrawal from the recipient.
HAZARDOUS WASTE IN PLASTIC AND METAL PACKAGING, APPLICATION INSTRUMENTS SUCH AS BRUSHES, BRUSHES AND OTHER AUXILIARY MATERIALS SUCH AS CLOTHS, RAGS, TOW.	In duly signposted bays and for restricted use by people who, during their tasks, handle this waste.

Source: Own authorship

Based on the observations we have seen that this practice not only reduces the amount of waste, but also recovers already produced products, saves raw material, energy and arouses conservationist habits, and reduces environmental degradation [17].

Considering thus the segregation of waste at source prior to transport for any quantity generated; reuse planning and final disposal of waste as part of the project; waste reception points (copoints) in locations scattered throughout the city's neighborhoods; implementation of an efficient infrastructure for the treatment of construction waste aimed at the production of recycled materials; and raising public awareness of the benefits of the initiative and encouraging their participation to ensure the creation of a sustainable culture in relation to building materials.

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IV. CONCLUSION

The treatment of construction and demolition waste requires a new approach, such as circular logistics with recycling and reuse of materials. Based on the following assumptions, the strong and effective participation of all actors involved (public sector, owners, companies, engineers and architects, teachers and students, waste pickers associations) is called for a common good - sustainability of the cities.

Companies must adapt to the environmental requirements currently imposed, for this adaptation, an environmental management system (EMS) can be adopted in the company, it is the way it has to achieve the desired environmental quality by reaching a goal with the lowest cost. The EMS acts correctly on the due impacts that are occurring to the environment, with preventive and viable measures for the company and, mainly for its image.

In view of the shared responsibility established by Law 12.305 of 2010, it is up to companies to adopt the guidelines and procedures of CONAMA Resolution 307/2002 as a way to improve their management, and the Municipality to support companies by providing transshipment, sorting and processing areas (plant). recycling), thus introducing a cyclical system for the use of the RCD.

The PGRCC final evaluation of the completed executive projects should propose viable alternatives for the correct reduction of waste on the site. And so, all issues that affect the city, whether environment or unsustainable or unsustainable buildings, would have gradually corrected their distortions to achieve ecological and sustainable balance.

REFERENCES

[1] BRASIL. Lei 12.305, de 2 de agosto de 2010. Institui a Política Nacional de Resíduos Sólidos; altera a Lei n. 9.605, de 12 de fevereiro de 1998; e dá outras providências. Diário Oficia da República Federativa do Brasil, Brasília, DF, 2 ago. 2010.

[2] CONAMA nº 307, de 5 de julho de 2002 Publicada no DOU no 136, de 17 de julho de 2002, Seção 1, páginas 95-96

[3] GIMENEZ, Maria Eugenia Boscov. Geotecnia ambiental. 1. ed. São Paulo: Oficina de Textos, 2008. GOV

[4] CHAHUD, E.; ALCÂNTARA, P. L.; LAHR, F. A. R. Os Resíduos Sólidos da Construção Civil. 1. ed. Belo Horizonte: Fumec/FEA , 2007.

[5] EDGARD de Souza (2000) : São Paulo, SP). In: ENCICLOPÉDIA Itaú Cultural de Arte e Cultura Brasileiras. São Paulo: Itaú Cultural, 2019.

[6] JOHN, Vanderley Moacyr. Reciclagem de resíduos na construção civil – contribuição a metodologia de pesquisa e desenvolvimento. São Paulo, 2010. 102p. Tese (livre docência) – Escola Politécnica, Universidade de SP.

[7] DIAS, S. M. Trajetórias e memórias dos Fóruns Lixo e Cidadania no Brasil: experimentos singulares de justiça social e governança participativa. 2009. 326 p.

[8] BARROS, R. T. de V. Elementos de Gestão de Resíduos Sólidos. Belo Horizonte: Ed. Tessitura, 2012. 424 p.: il.

[9] RESOLUÇÃO Nº 348, DE 16 DE AGOSTO DE 2004. Altera a Resolução CONAMA nº 307, de 5 de julho de 2002, incluindo o amianto na classe de resíduos ...

[10] GEHBAUER, Fritz; EGGENSPERGER, Marisa; ALBERTI, Mauro Edson; NEWTON, Sérgio Auriquio; Planejamento e Gestão de Obras- Um Resultado Prático da Cooperação Técnica Brasil- Alemanha. Editora CEFET-PR, Curitiba, 2002.

[11] PEREIRA S. S., MELO J. A. B. Gestão dos resíduos sólidos urbanos em Campina Grande-PB e seus reflexos socioeconômicos. Revista Brasileira de Gestão e Desenvolvimento Regional, vol. 4, n. 4, p. 193-217, set-dez. 2008.

[12] CT Formoso, L Soibelman, C De Cesare, EL Isatto 2006

[13] MESEGUER, A. Controle e garantia da qualidade na construção. São Paulo: Sinduscon, Projeto/PW, 1991, 179p.

[14] AMORIM, A.P. et. Al. Lixão municipal: abordagem de uma problemática ambiental. Disponível em http/ www.seer.furg.br

[15] NBR 13.221. Comitê Brasileiro de Transporte e Tráfego. Projeto NBR

[16] BARBIERI, J.C. (2004). Gestão ambiental empresarial: conceitos, modelos e instrumentos. 1. ed. São Paulo: Saraiva.

[17] CARLATO, Francisco Capuano. Do nicho ao lixo: ambiente, sociedade e educação. (Série Meio Ambiente) São Paulo: Atual, 1992.