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CIVIL CONSTRUCTION WASTE IN THE MUNICIPALITY OF TUCURUÍ-PA: ANALYSIS AND CONTRIBUTIONS FOR A GENERIC PROPOSAL FOR A MANAGEMENT PLAN

Resíduos de construção civil no município de Tucuruí-PA: análise e contribuições para uma proposta genérica de um plano de gestão

Residuos de la construcción civil en el municipio de Tucuruí-PA: análisis y aportes para una propuesta genérica de plan de gestión

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ABSTRACT

The reality of many Brazilian municipalities, including Tucuruí in the State of Pará, Brazil, does not present a CCR management adequate to its situation. Even if it is necessary to comply with the legal requirements that punctuate the management of RCC, such as the elaboration of a management plan for civil construction waste that is accessible and applicable to the real needs of each municipality. As a way of understanding the situation, the research in question was proposed, with the main objective of subsidizing the creation of a generic RCC management plan. For the realization of the work, the methodology used in terms of the type of approach is qualitative and quantitative, in terms of its nature, it is considered applied and in terms of technical procedures, it is characterized as a case study. Within this line of reasoning, with a view to identifying the impacts caused, indirect interviews were carried out with managers of public and private bodies, as well as on-site analysis. Therefore, the work through the analysis of the scenario found reaffirms the need for reduction, reuse, recycling, reuse and the environmentally correct destination of RCC. This way, the strategies proposed in the plan will be able to assist in the physical, political, socio-environmental and economic aspects of Tucuruí-PA.

RESUMO

A realidade de muitos municípios brasileiros, incluindo o de Tucuruí no Estado do Pará, Brasil, não apresenta uma gestão de RCC adequada a sua conjuntura. Mesmo sendo necessário o cumprimento das exigências legais que pontua a gestão de RCC, tal como a elaboração de plano de gestão de resíduos da construção civil que seja acessível

e aplicável à real necessidade de cada município. Como forma de compreender a situação, foi proposta a pesquisa em questão, tendo como principal objetivo subsidiar para a criação de um plano genérico de gestão de RCC. Para a concretização do trabalho, a metodologia utilizada quanto ao tipo de abordagem é qualitativa e quantitativa, em relação a sua natureza, é considerada aplicada e, quanto aos procedimentos técnicos, caracteriza-se como estudo de caso. Dentro dessa linha de raciocínio, com aspecto de identificar os impactos causados, foram realizadas entrevistas indiretas com os gestores de órgãos públicos e privados e também análise in loco. Portanto, o trabalho mediante análise do cenário encontrado reafirma a necessidade da redução, reutilização, reciclagem, reaproveitamento e a destinação ambientalmente correta de RCC. Desse modo, as estratégias propostas no plano poderão auxiliar nos aspectos físicos, políticos, socioambientais e econômico de Tucuruí-PA.

RESUMEN

La realidad de muchos municipios brasileños, incluido Tucuruí en el Estado de Pará, Brasil, no presenta una gestión de CCR adecuada a su situación. Incluso si es necesario cumplir con los requisitos legales que marcan la gestión de RCC, como la elaboración de un plan de gestión de residuos de construcción civil que sea accesible y aplicable a las necesidades reales de cada municipio. Como una forma de entender la situación, se propuso la investigación en mención, con el objetivo principal de subsidiar la creación de un plan de manejo genérico de RCC. Para la realización del trabajo la metodología utilizada en cuanto al tipo de enfoque es cualitativa y cuantitativa, en cuanto a su naturaleza se considera aplicada y en cuanto a los procedimientos técnicos se caracteriza como un estudio de caso. En esta línea de razonamiento, con objeto de identificar los impactos causados, se realizaron entrevistas indirectas a directivos de organismos públicos y privados, así como análisis in situ. Por lo tanto, el trabajo a través del análisis del escenario encontrado reafirma la necesidad de la reducción, reutilización, reciclaje, reutilización y el destino ambientalmente correcto de los RCC, de esta forma, las estrategias propuestas en el plan podrán auxiliar en el desarrollo físico, político, aspectos socio ambientales y económicos de Tucuruí-PA.



1 INTRODUCTION

At the present time, the technological development of industries is essential to support the demands of the consumer market. However, in parallel to this need, there has been an increasing growth in environmental pollutants, compromising the quality of life of society and the environment.

One of the sectors that has a history of being a major cause of waste generation is the civil construction sector. It is known that the sector is one of the largest contributors of waste and is known as civil construction waste (RCC). In this sense, Guarnieri (2011) and Leite (2009) explain that the imbalance between discarded quantities and reuse is one of the most serious problems to be solved today, especially when it comes to the civil construction industry.

CONAMA Resolution No. 307/02 establishes guidelines, criteria and procedures for the correct management of RCC waste, delegating forms of reduction, reuse, recycling, treatment and final disposal to generators. However, even though the RCC has full legal support, it is still a barrier to be overcome both business and socially.

Based on these considerations, within this scenario, the municipality of Tucuruí-PA, located in the Southeast of the State of Pará, 480 km away from the State Capital, Belém-PA, has a history of major civil construction works, followed by a RCC generation. Currently, the municipality does not have any effective management model aimed at RCC, and this reality persists in public management.

Henceforth to this premise, according to Freitas et al. (2020) the measures and guidelines set out in the National Solid Waste Policy (PNRS) are not put into practice in the municipal management of Tucuruí-PA. In view of this, it is plausible to study strategies to contribute to the environmental issue of the municipality, so the purpose of the present work is to propose a generic manual of action for the management of RCC.

The term “generic manual” highlights a pilot proposal made up of stages to provide a basis, to implement a future CCR Management Plan as a premise. It is a process that requires dedication, culture, alignment between the actions and duties of society. In summary, the evidenced conceptual base can help with the reduction, reuse and recycling for the municipality of Tucuruí-PA.

2 CURRENT SCENARIO OF CIVIL CONSTRUCTION IN BRAZIL

The civil construction sector is consecutively responsible for a large portion of the country's economic development. In 2021, according to the Brazilian Construction Industry Chamber (CBIC, 2021), the country's Gross Domestic Product (GDP) grew by 4.44%. The creation of jobs in the sector grew as well, specifically 111,987 new jobs in 2021. However, since March 2020, the sector has been undergoing a transformation due to the emergence of a health pandemic that affected all economic and social areas of the country.



To contain COVID-19, two of the measures are social isolation and the stoppage of some sectors considered non-essential. According to the Fundação Instituto de Administração (FIA, 2020), there was 20% idleness in the civil construction sector due to the reduction of its activities. Even though the sector is considered an essential activity, as defined in the Federal Law to combat COVID-19, n° 13.979/2020 (Brazil, 2020), it had impacts, such as reduction of positions, increase in the payment of labor, shortage of raw materials and high growth in the acquisition of materials.

However, even though the sector has shown instability in its production chain, the civil construction industry was fundamental in guaranteeing income and generating thousands of jobs. The sector managed to close 2020 with the implementation of 112,174 jobs, thus highlighting the great contribution of this segment to the Brazilian economy in the period of uncertainty of the COVID-19 Pandemic (CBIC, 2020).

From that event, to contain the impacts and help the economy, the sectors adopted the digitalization trend, although it is already a reality, some areas did not use it as a way to leverage their businesses. In these perspectives, specifically in the construction sector, the use in the context of the pandemic accelerated the production process, so some tools stood out with the aim of bringing support to this sector, one of which can be highlighted by Building Information Modeling (BIM), technology that allows representing the building in a three-dimensional model and associating data with each of its components. Another tool that was also widespread during this period was off-site construction, which consists of producing standardized components in a controlled environment that is not subject to bad weather, while the land is being prepared to receive the project.

Zanatta (2021) points out that this modality, during the pandemic, began to be practiced as a quick solution for the construction of field hospitals, which was very susceptible in the civil construction production chain, thus reinforcing that the future of the sector will have a great deal of impact potential with excessive use of technology.

2.1 CIVIL CONSTRUCTION VERSUS SUSTAINABILITY

Since the dawn of history, human beings have used countless inputs, such as stones, clay, water, wood, fur, wool, among other items that have guaranteed their survival over time. Man has come a long way from archaic methods to technology-based production. Under these circumstances, Mottin (2019) clarifies that until the middle of the third industrial revolution, humanity was only concerned with production and consumption, underestimating the capacity of the planet. With the assimilated exploitation of natural resources, consequences such as environmental degradation, increased pollution, disorderly growth in cities are present today.

Thus, one of the sectors that requires a large amount of natural resources is the civil construction industry. As explained by Fonseca and Maintinguer (2019), it is a sector that



exerts excessive growth and development of a country, causing economic, cultural, social and environmental impacts.

Thus, civil construction versus sustainability battle is focused on adapting sustainable development practices. Therefore, this means producing the greatest number of goods with the least amount of natural resources and the least pollution. Also noteworthy is the reuse of materials that have already been used, but still have the possibility of being inserted into the production chain again. Picolli et al. (2022) explain that sustainable development allows meeting the basic needs of the individual, satisfying their desires without compromising the use of resources for future generations.

In this scenario, the new ways of managing the means of production in the civil construction sector need to focus on correct handling, seeking the best sustainable uses. Thus, as clarified by the Ministry of the Environment (MMA, 2012), to minimize environmental impacts, the agency proposed the principles of the 3R's, namely:

- i. Reduce: reduce the consumption of products and give priority to those that offer a lower risk for the generation of waste and are more solid.
- ii. Reuse: is to use again an item that has already been used in some process.
- iii. Recycle: it is the transformation of materials to produce raw materials that will then be used in other products.

2.2 NATIONAL SOLID WASTE POLICY

The National Solid Waste Policy (PNRS) is governed by Law 12.305/2010 in Brazil. The legislation explains the principles, objectives, instruments and guidelines related to integrated management, solid waste management and the responsibilities of generators and the public sphere and the applicable economic instruments.

The Ministry of the Environment (MMA, 2010) clarifies that the PNRS prevents the care and reduction in waste generation, targeting the exercise of sustainable uses and a set of instruments to encourage increased recycling and reuse of solid waste and the environmentally appropriate disposal of waste.

In this sense, the PNRS (2010) highlights the main guidelines related to Civil Construction Waste (RCC). They are: (i) Eradication of irregular areas for the final disposal of RCC throughout the national territory; (ii) Insertion of areas for transshipment and sorting, recycling and adequate reserve of RCC throughout the national territory; (iii) Practice of inventory of civil construction waste; (iv) Development of RCC reuse and recycling activities in public and private undertakings throughout the national territory; (v) Improvement of measures to reduce the generation of tailings and civil construction waste in undertakings throughout the national territory.

2.3 CIVIL CONSTRUCTION WASTE

According to CONAMA Resolution 307 of 2002, civil construction waste comes from construction, renovations, repairs and demolitions (CONAMA, 2002). And according to the resolution, the RCC are classified into four groups (Table 1).



Table 1. Classification of waste groups.

Class	Origin	Management
A	Construction, demolition, renovations and repairs of paving and other infrastructure works, including soil from earthworks; Ceramic components (bricks, blocks, tiles, cladding plates, etc.), mortar and concrete; manufacturing process and/or demolition of precast concrete parts (blocks, tubes, curbs, etc.) produced at construction sites.	They must be reused or recycled in the form of aggregates, or sent to landfill areas for civil construction waste, being disposed of in such a way as to allow their future use or recycling.
B	Plastics, paper, cardboard, metals, glass, wood, empty paint packaging and plaster.	They must be reused, recycled or sent to temporary storage areas, being arranged in such a way as to allow their future use or recycling.
C	These are wastes for which no economically viable technologies or applications have been developed that allow recycling/recovery, such as gypsum products;	They must be stored, transported and disposed of in accordance with specific technical standards.
D	Paints, solvents, oils and others, or those contaminated from demolitions, renovations and repairs of radiological clinics, industrial facilities and others.	They must be stored, transported and disposed of in accordance with specific technical standards.

Source: Adapted from (CONAMA, 2002).

According to the resolution, the attributions of responsibility belong to both the public authorities and the private sector and both need to be in common agreement for a full development of techniques for the use of sustainable practices.

2.4 REVERSE LOGISTICS IN CIVIL CONSTRUCTION

Leite (2009) explains that Reverse Logistics is an area of Business Logistics that organizes the process of returning post-sale and post-consumer goods to the production cycle, through reverse distribution channels. This flow adds economic value to the provision of services, such as ecological, legal, sustainable, corporate image, among others.

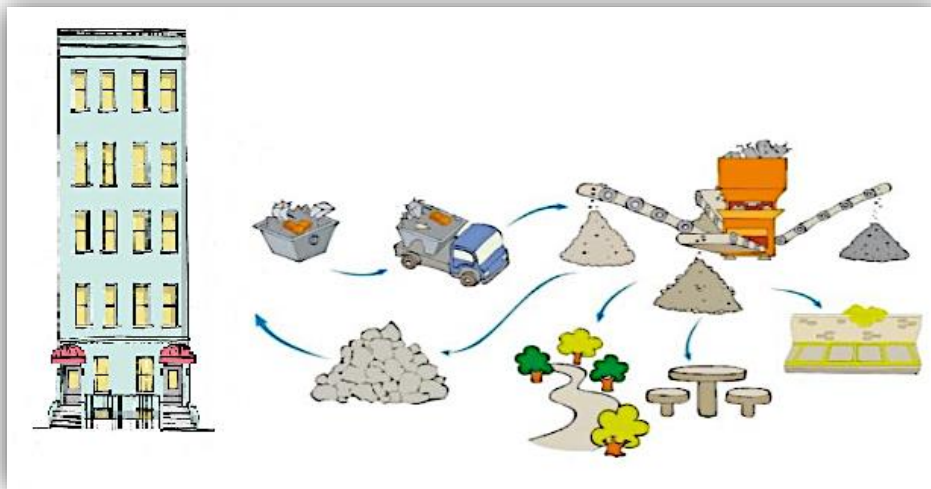
The civil construction segment is one of the areas that most generate monetary gains and job opportunities, however, due to this expressive reality of works, demolitions and repairs, the accumulation of rubble portrays the existence of serious environmental problems. This reality is confirmed by Ribeiro (2021) the civil construction sector is a major waste generator.

Being a sector with significant waste generation, the factor that requires more attention is in aspects of public policies, at the federal, state and municipal levels, as there is still a lack of care with the laws that aim to provide an effective management of these wastes in the environment.

In this scenario, Reverse Logistics has as its methodology the appropriate destination for waste that has exhausted its life cycle and reinserting it into the market through recycling. In civil construction, waste can again be included in the production process of this sector (Figure 1).



Figure 1. Insertion of waste into the production cycle.



Source: Adapted from the integrated construction waste management plan (2017).

At this point, the processes in Reverse Logistics in civil construction are the collection, separation, processing of waste and shipment for insertion into a new product. Santana et al. (2020) points out that Reverse Logistics is important for social, economic, technological and sustainable development, as it brings financial returns to companies that adopt environmentally correct practices in their businesses.

3 METHODOLOGY

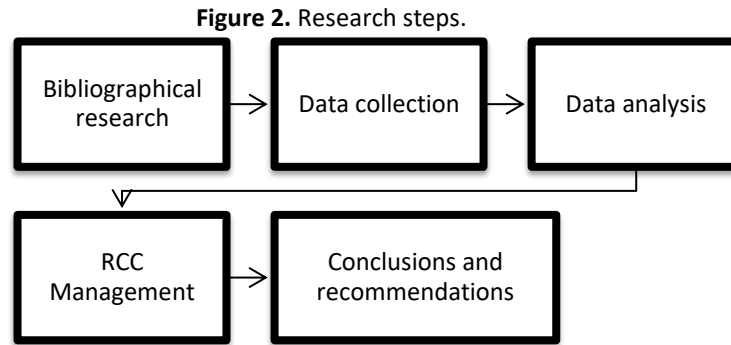
The present study, in scientific terms in relation to its nature, can be considered as applied research. Silva and Menezes (2005) explain that applied research aims to generate new knowledge for practical application and is directed to specific problems.

Thus, from the point of view of approaching the problem, this is qualitative and quantitative. Richardson (2007), qualitative research considers the environment as a direct source of data and the researcher as a key instrument. As for quantitative research, according to Gonçalves and Meirelles (2004), “the data are represented by quantitative metrics, with mathematical language as the main support element”.

It is also ensured that the research has a pragmatic character. As stated by Gil (1999), the study is a formal and systematic process of development of the scientific method. Thus, it has an exploratory and descriptive character, as it develops, changes concepts and ideas with the purpose of formulating problems or raising hypotheses for further studies.

For technical procedures, research is identified as a case study. Mello et al. (2012) highlight the case study as the deep and exhaustive analysis of one or a few elements in order to accept its broad and detailed knowledge. In short, to achieve the proposed objective, the work was developed in stages (Figure 2).





Source: Authors (2023).

- I. Bibliographical research: the first part of the work consisted of bibliographical research on civil construction waste, reverse logistics and sustainability.
- II. Data collection: for the diagnosis and presumption of the generic management proposal, it was necessary to know the estimated volume of generation in the municipality, a part carried out in the database of the National System of Information on the Management of Solid Waste and another part through indirect interviews with builders in the municipality and with representatives of the Secretary of Work, Environment and Sanitation.
- III. Data analysis: the municipality of Tucuruí-PA has a Solid Waste Management plan that was developed in accordance with Federal Law 12.305/10. However, the municipality presents unfavorable conditions of principles, instruments and guidelines set out in the PNRS, for not creating a policy that fits the provisions of the current legislation. From this situation, it was evident in the analysis the need for the specific creation of an efficient management of Civil Construction Waste.
- IV. RCC Management: definition of the steps that will be present in the generic creation of the RCC management manual.
- V. Conclusions and recommendations: implementation of the idea of the generic manual for CCR management.

4 RESULTS AND DISCUSSION

4.1 CHARACTERIZATION OF THE STUDY AREA

The research will be carried out in the municipality of Tucuruí-PA, located in the Mesoregion of Southeast Pará. The Municipality has a population estimate of 116,605 inhabitants (IBGE, 2021), having an area of 2,084.289 km² (IBGE, 2021). The municipality, according to the Companhia Paraense de Turismo (2011) is limited to the north by the municipality of Baião; to the south with the municipality of Novo Repartimento; to the east with Breu Branco and to the west with Pacajá.

The historical event of Tucuruí-PA was the construction of the Hydroelectric Power Plant, carried out during the military government. This fact existed due to the great emphasis on turning the west of the State of Pará and the Amazon region into an industrial and ore distribution center (Eletronorte, 2010). In addition to the Hydroelectric Plant, Tucuruí-PA also has other economic sources, such as agriculture, livestock, plant removal and fishing.



4.2 MUNICIPAL LEGISLATION

Solid waste management in the city of Tucuruí-PA, in accordance with Federal Law 12.305/10, together with Municipal Law No. 7.137/06 – which provides for the Municipal Environmental Policy – have actions for emergencies and contingencies on solid waste.

Accordingly, for civil construction waste, the plan emphasizes as goals the possibility of management according to the guidelines established by legislation and also the search for innovative techniques and technologies. In the same plan, they highlight actions that can be exercised in the short or long term, for example (Semma, 2014):

- I. Guide organizations that operate with RCC, regarding equivalent documents;
- II. Supervise the transport operations and final destination of RCC, in order to comply with current legislation;
- III. SEMMA's technical support to act in the guidance and supervision of the public and private sectors
- IV. Make the quantitative and qualitative diagnosis of RCC generation;
- V. Create legal instruments that establish criteria for the use of products from the recycling of RCC in works and services performed or contracted by the Tucuruí City Hall;
- VI. Environmental and health education actions at the municipal level;
- VII. Require in the licensing of works, solid waste management plans;
- VIII. Elaborate programs for the dissemination of adequate RCC collection and disposal services.

4.2 GENERATION OF CONSTRUCTION WASTE IN THE MUNICIPALITY

According to the Brazilian Federal Constitution (1988), it is the common competence of all Federal agents: Union, States, Federal District and Municipalities, to protect, care for and combat all forms of degradation of the environment. In this premise, the municipality of Tucuruí-PA, experienced a process of unbridled growth, a consequence of the works of the Hydroelectric Power Plant. From this fact, it can be said that the municipality is affected by actions that reflect on the environment and society in the region. It is true to confirm that currently Tucuruí-PA presents divergences in the management of solid waste, given that, according to the PNRS, the instruments and guidelines set out in the current legislation are not adequate, an example of this is the dump installed in an area of environmental preservation with the location close to the urban area.

It is known, therefore, that Law 12305/2010 prohibits the existence of open dumps. In the specific case of the municipality, until now, it has never had a definitive location. The sites used for waste disposal are identified as “Itinerant Dumps”. Itinerant landfills are places that have displacement as a characteristic, that is, based on the perception that that environment no longer has the possibility of receiving garbage, another location is chosen. In addition to landfills, waste is also disposed of irregularly by the population itself, in urban streets or in some land on the perimeter of the city, this reality is present in all neighborhoods and it is possible to highlight numerous difficulties, from lack of water drainage rainfall, presence of animals and, consequently, the appearance of diseases.



Figure 3. Airport road RCC waste.



Source: Authors (2023).

Figure 3.1. RCC waste in the urban core.



Source: Authors (2023).

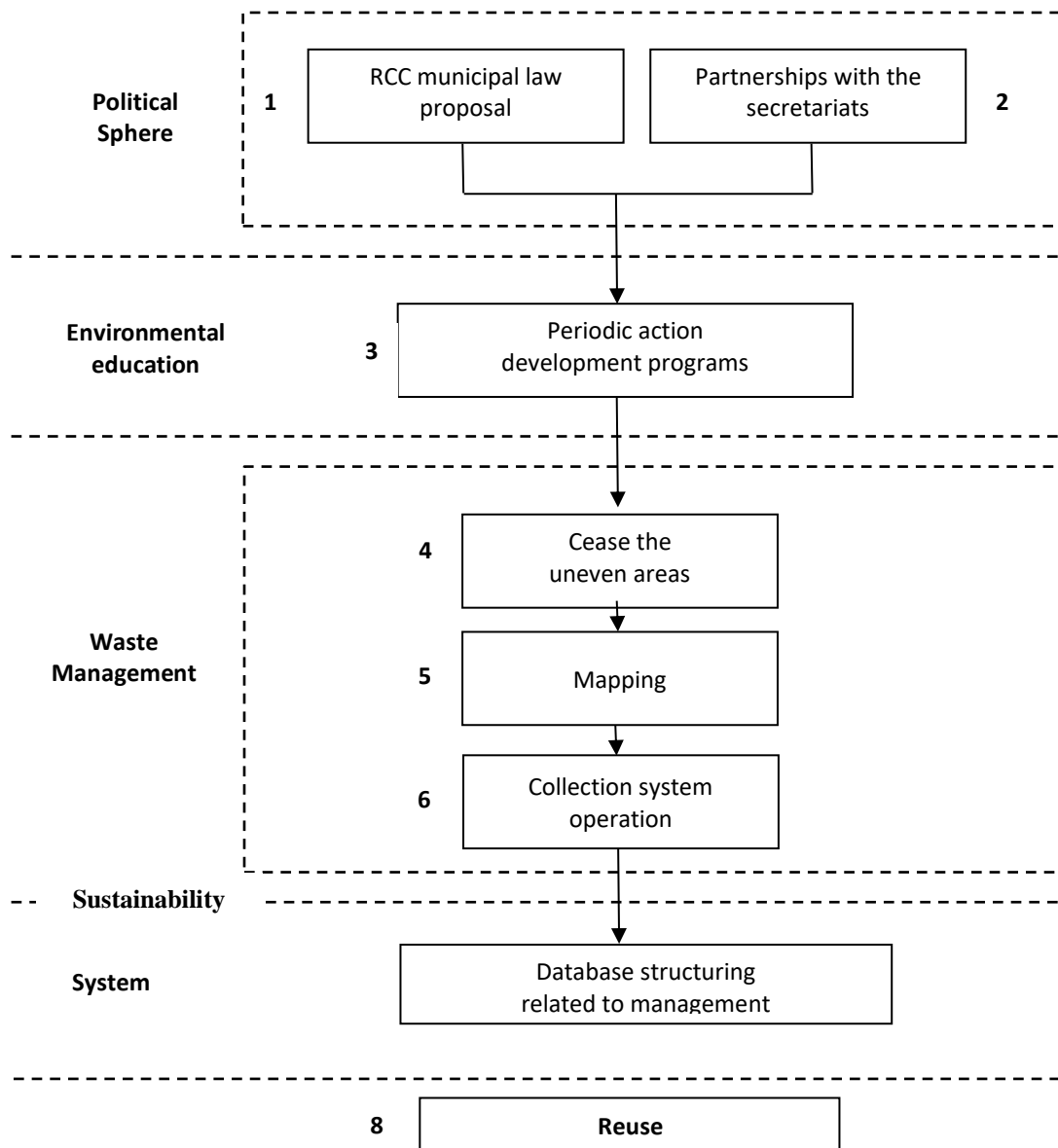
According to data obtained from the National Information System on Solid Waste Management (SINIR, 2019), the situation of the final disposal of civil construction waste in the municipality in 2019 was 30,961.41 tons, and according to the interview carried out at the agency public, there is no action regarding the differentiated collection of RCC in Tucuruí-PA. Analyzing, then, the last data generated in SINIR in the year 2019 for the year 2022, the population grew 2.7%, thus the RCC projection is approximately 31,797.36 tons.

4.3 PROPOSED MANAGEMENT PLAN

In order to reduce and subsequent eradication of irregular areas to occur, the municipal government, through the body of the secretary of works, environment and sanitation, must present efficient measures and work in partnership with society. For this to happen, there is a need to adjust the current legislation and prepare a RCC management plan adapting to the reality of the municipality. In this way, each step to be carried out in the municipality was detailed.



Figure 4. Generic plan steps.



Source: Authors (2023).

- a) Political sphere: (1) so that the generic model can be transformed into reality, it is necessary to mobilize society and public administration. Therefore, the first step should be the discussion and approval of a municipal law for the management of RCC. (2) Partnerships with the departments: indirect interviews were carried out with those responsible for the Departments of Works, Environment and Sanitation, together with this procedure, five managers of builders present in Tucuruí-PA were interviewed. From this contact, the real needs that contributed to the proposal of the manual became evident, such as the implementation of a specific law for RCC and environmental education through training. Both points reported by public and private agency managers were already commonplace in the manual's contributions (first step being the elaboration of the law and second step environmental education).
- b) Environmental education: among the contributions to the construction of the plan, the training of public and private agents and the entire civil society is extremely important.



In the meantime, it is necessary to have a continuous technical improvement, this will happen through partnerships with the colleges present in the municipality, which will be disseminating knowledge. This proposal depends a lot on the engagement of public agency managers. Investing in a culture of improvement with the development of periodic action programs.

- c) Waste management: (i) cease irregular areas; one of the focuses for the city of Tucuruí-PA is to gradually eliminate irregular disposal and contain the creation of new vicious points. This process takes place through step three, which is why we invest in environmental education programs, as everything starts with raising awareness of the problem in order to seek solutions. (ii) Mapping: as the works take place periodically, it becomes necessary to create partnerships with the waste generators to inform the location and, subsequently, the responsible bodies can correctly map the process and place formalized procedures for better performance. (iii) Collection system operation: will consist of the *Milk system run* where basically the waste collection points will be predetermined, with times and days. *Milk run* is explained by Pires (2004) the system is a cyclical process of supply with certain routes and schedules for the collections. Thus, the system will optimize vehicle routes and reduce operating costs.
- d) System: one of the difficulties encountered was the issue of data available for access, as those accessible to society are not necessary and are often outdated. The idea of the proposal guides the creation and standardization of a database aiming at the reliability of the information. The system will assist in the registration of generated waste, mapping, possible areas of receipt, sorting, storage, reuse and correct disposal. The municipality of Tucuruí-PA will have to strive for the faithful fulfillment of this procedure, so that both parts of the manual can flow and, in the future, come true.
- e) Sustainability: the last step (8) is aimed at generating environmentally correct practices. Many of the wastes generated have the possibility of being reinserted into the production cycle, so the suggestion is to implement a recycling plant for the waste generated and establish partnerships with recycling cooperatives in the region to support the development of good practices and, in addition, generate economy for the county.

5 FINAL CONSIDERATIONS

The civil construction industry has greater implications for nature due to the indiscriminate use of natural resources. Each year, population growth results in the generation of large amounts of waste that are discarded inappropriately during the process, a reality that is often seen in Brazilian cities.

The municipality of Tucuruí-PA is known for having received one of the greatest engineering works, thus, it has a history full of waste generation. And over time there was no effective action to meet the needs of the city. According to the diagnosis raised in the Municipality, different problems were identified, followed by a solution, the proposal of a generic manual for waste management.

That said, in CONAMA Resolution No. 307 of 07/05/2002, the management of Civil Construction Waste is a municipal obligation, therefore, it consists of the municipality's duty to discipline the collection, treatment and disposal of waste from human activity, in a



manner to avoid possible harm to the environment and the health of the population. Therefore, it is up to the municipality of Tucuruí-PA to discipline all the agents involved with civil construction waste, creating subsidies to implement the appropriate management plan and put it into practice.

REFERENCES

- Brasil. (2010). *Lei Nº 12.305. Política Nacional de Resíduos Sólidos*, de 2 de Agosto de 2010. Recuperado de http://www.planalto.gov.br/ccivil_03/ato2007-2010/2010/lei/l12305.htm
- Brasil. (2002). *Leis. Conselho nacional do meio ambiente - CONAMA resolução n. 307*, de agosto de 2002.
- Brasil. [Constituição (1988)]. *Constituição da República Federativa do Brasil de 1988*. Brasília, DF: Presidência da República, [2016]. Recuperado de http://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm
- Brasil. *Lei nº 13.979*, de 6 de fevereiro de 2020. Dispõe sobre as medidas para enfrentamento da emergência de saúde pública de importância internacional decorrente do coronavírus responsável pelo surto de 2019. Brasília, DF: Presidência da República, [2020]. Recuperado de http://www.planalto.gov.br/ccivil_03/ato2019-2022/2020/lei/l13979.htm
- Câmara brasileira de indústria da construção - CBIC. (2020). *CBIC. Crescimento de vendas de imóveis em meio a pandemia*. Recuperado de <https://cbic.org.br/pesquisa-da-brain-aponta-crescimento-de-vendas-de-imoveis-emmeio-a-pandemia/>
- Câmara brasileira de indústria da construção - CBIC. (2021). *Banco de dados: estoque de trabalhadores na construção civil*. Recuperado de <http://www.cbicdados.com.br/menu/emprego/rais-secretaria-especial-de-previdencia-e-trabalho-ministerio-da-economia>
- Câmara brasileira de indústria da construção - CBIC. *Crescimento no setor: Gestão de Resíduos*. Recuperado de <https://cbic.org.br/construcao-preve-maior-crescimento-para-o-setor-desde-2013-e-diz-que-avanco-poderia-ser-ainda-maior/>
- Centrais Elétricas do Norte do Brasil-Eletronorte. 2010. *Histórico da Construção da Usina*. Recuperado de: <http://www.eln.gov.br>
- Companhia Paraense de Turismo. (2011). *Inventário da oferta turística de Tucuruí*. Recuperado de http://www.setur.pa.gov.br/sites/default/files/pdf/inventario_tucuruí_0.pdf.
- FAPESPA. (2022). *Radار de indicadores das regiões de integração 2022*. Recuperado de <https://www.fapespa.pa.gov.br/sistemas/radar2020/tabelas/7-lago-de-tucuruí/tabela-1-populacao-area-territorial-e-densidade-demografica-2019-ri-lago-de-tucuruí.htm>
- Fundação Instituto de Administração - FIA. *Mercado financeiro e o coronavírus: histórico, impactos e projeções*. Recuperado de <https://fia.com.br/blog/mercado-financeiro-e-ocoronavirus>
- Fonseca, M. J. M. & Maintinguer, S. I. (2019). *Aplicação da logística reversa na construção civil como mecanismo ambiental sustentável em políticas públicas*. *Brazilian Journal of Development*, 5(1), 140-149.
- Freitas, P. V., Queiroz, D. P., de, Ishihara, J. H., Neto, A. F. L., Silva, C. A., da, Junior, J. A. R., ... & Puccini, P. R. P. (2020). *Gerenciamento de resíduos da construção e demolição em Tucuruí-PA*. *Brazilian Journal of Development*, 6(8), 62649-62658.
- Gil, A. C. (2002). *Como elaborar projetos de pesquisa* (Vol. 4, p. 175). São Paulo: Atlas.
- Gonçalves, C. A., Meirelles, A. M. P Gonçalves, C. A., & Meirelles, A. D. M. (2004). *Projetos e relatórios de pesquisa em Administração*. São Paulo: Atlas.
- Guarnieri, P. (2011). *Logística reversa: em busca do equilíbrio econômico e ambiental*. Recife: Editora Clube de Autores.
- Instituto Brasileiro de Geografia e Estatística - IBGE. 2021. *Recuperado de https://www.ibge.gov.br/cidades-e-estados/pa/tucuruí.html*
- Lei municipal nº 7.138*, de 12 de dezembro de 2006. Criação e regulamentação da conferência municipal e alteração da lei 4.104/97 criação do conselho municipal do meio ambiente - COMDEMA e dá outras providências. Prefeitura municipal de Tucuruí.
- Leite, P. R. *Logística reversa: meio ambiente e competitividade*. São Paulo: Prentice Hall, 2009, 2ª edição.
- Ministério do Meio Ambiente - MMA. (2010). *Política Nacional dos Resíduos Sólidos*. Recuperado de <https://antigo.mma.gov.br/cidades-sustentaveis/residuos-solidos/politica-nacional-de-residuos-solidos.html>
- Ministério do Meio Ambiente. *Princípio dos 3R's*. Recuperado de <http://www.mma.gov.br/responsabilidade->



Citation (APA): Siqueira, R. R. & Macedo, N. A (2023). Civil construction waste in the municipality of Tucuruí-PA: analysis and contributions to a generic proposal for a management plan. *Brazilian Journal of Production Engineering*, 9(2), 01-13.

[socioambiental/producao-e-consumo-sustentavel/consumo-conscientede-embalagem/principio-dos-3rs.html](#)

Mottin, J. F. (2019). Programa patentes verdes: o sistema patentário a serviço do desenvolvimento sustentável. Recuperado de

<https://www.lume.ufrgs.br/handle/10183/221388>

Painel de destinação dos municípios. Recuperado de

<https://sinir.gov.br/paineis/destinacao/>

Picoli, I. R. A., Schmitt, T., Alberton, A., & Almeida Ramôa, C. E., de. (2022). Práticas para os objetivos de desenvolvimento sustentável: o caso do bairro da juventude. *Desenvolvimento em Questão*, 20(58), e12094-e12094.

Plano Integrado de Gerenciamento de Resíduos da Construção Civil. (2017). Reciclagem de resíduos sólidos da construção civil: diagnóstico e prognóstico. São Paulo. Recuperado de

https://www.piquerobi.sp.gov.br/arquivos/plano_integrado_de_gerenciamento_de_residuos_da_construcao_civil_02085618.pdf

Ribeiro, T. B. (2021). *Revisão bibliométrica sobre gestão de resíduos no setor de construção civil*. 46 f. Trabalho de Conclusão de Curso (Graduação em

Administração) – Universidade Federal de Uberlândia, Uberlândia, 2021. Recuperado de

<https://repositorio.ufu.br/handle/123456789/32087>

Santana, R. F., de., Aragão, W. R., Jr., El-deir, & Giovanetti, S. (n.d.). *Resíduos sólidos: desenvolvimento e sustentabilidade*. Recife:

EDUFRPE; Gampe, 2020. 479 p., il. Recuperado de

<https://repositorio.ufrpe.br/handle/123456789/2342>

Secretaria Municipal de Meio Ambiente de Tucuruí-PA - SEMMA. (2014). *Plano de gestão integrada de resíduos sólidos urbanos - PGRSU - Tucuruí-PA*.

Da Silva, E. L., & Menezes, E. M. (2005). Metodologia da pesquisa e elaboração de dissertação. UFSC, Florianópolis, 4a. edição, 123p.

Mello, C. H. P., Turrioni, J. B., Xavier, A. F., & Campos, D. F. (2012). Pesquisa-ação na engenharia de produção: proposta de estruturação para sua condução. *Production*, 22, 1-13.

Zanatta, B. (2021). Construção 'off-site' ganha força no Brasil com a pandemia. *Radar Imobiliário: Estadão*, São Paulo, 4 de abril de 2021. Recuperado de

<https://economia.estadao.com.br/blogs/radar-imobiliario/popular-no-exterior-construcao-off-site-ganha-forca-no-brasil-com-a-pandemia/>

