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Abstract

Waste generation has become one of the most important issues of the century, every production process has significant losses due to the lack of proper management, especially wood waste, which becomes environmental liabilities, given the search for low environmental impact solutions, such as Microusina. Briquettes The scenario for initial investments that would be R $ 63,706.62 in fixed costs for implementation purposes and R $ 109,274.02 in variable costs for the first month, added up to R $ 792,980.64 (20%) of the amount spent in the year. 2018. The results of this research reflected that briquetting is an economically viable technological alternative that sets precedents for sustainable development in the Amazon, and may prove to be a powerful instrument for environmental compensation and cooperation among generating agents, collectors and the public authorities. , where it successfully fulfills its social function, generating cultural change and change and attitude towards waste disposal, reduction of generation, reduction of pressure under native forests, and minimization of environmental liabilities.

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1. Introduction

A considerable portion of the sawmill industries and logging companies in the country are unaware of the potentials for the proper utilization of their residues and by-products, due to the low technological level employed in their industrial processes. some effective use (MELO et al. 2016).

The National Industry Confederation (CNI) Profile Report (2016) states that the state of Amazonas has the second largest industrial GDP in the northern region, and its industry represents 34.8% of the state's economy, where it denotes high technological levels developed by the local industry that allows the promotion, organization and development of the waste recycling industry. Efforts to convert waste into raw materials are bringing environmental improvements and generating income for people from vulnerable social groups.

In this context, the reuse of wood due to favorable chemical and physical factors allows it to be applied in several recycling segments, besides promoting high advantages in terms of homogenization, burning control, high calorific power, density and humidity (SANTOS). , 2015).

Silva (2014) points out that the demand for these wastes is for use in composting centers, lining farms or ends up being discarded without any specific and effective use.

In 2010, the National Solid Waste Policy (PNRS) was sanctioned by Law 12.305 / 2010, which seeks to mitigate environmental impacts through its objectives, generating, reducing and reusing waste management regardless of material. Since then it has been trying to achieve investments in technological innovations to improve product manufacturing that generally result directly in the reduction of waste production.

Therefore, in order to properly treat waste we need to classify and characterize it and its condition, origin, physical, chemical and biological characteristics need to be observed in order to properly dispose of all waste generated according to with their relevant legislation and technical standards.

Technical standard NBR 10.004 / 2004 classifies the waste according to the potential for environmental and public health contamination, wood waste is classified as non-hazardous Class II waste, which is divided into inert and non-inert IIA and IIB respectively for IIA waste wood waste, biodegradability, combustibility or water solubility are considered.

Noting that wood residues that are present in Construction and Demolition Waste (RCD) and are considered according to PNRS as Class I - Hazardous Waste, being inert waste and cannot be disposed of in landfill.

Wood waste is generally characterized by its variable size, high humidity index, low density index and large volume; Plant waste requires large areas for storage, in addition to the difficult access to this raw material in remote places, which makes collection and transportation difficult, being some of the reasons that underuse this material (DONATO, 2016).

Surveys carried out Trugilho (2010) find that Brazil has attractive and favorable conditions for the briquettes segment, that is, by a combination of factors, such as the high concentration of vegetal residues and the high calorific power (PC) associated with these residues.

In this context, the Amazon region has vast residual logging potential, which is little explored that can bring many benefits to the region through the appropriate use of available timber resources (MELO et al. 2016).

According to the Institute for Conservation and Sustainable Development of Amazonas (IDESAM) and Vianna (2013), Manaus and Itacoatiara are municipalities that concentrate the largest number of wood processing companies, which, because of this, present significant amounts of waste and byproducts during their processing. Therefore there is an intrinsic relationship between your income and the end performance, in a sustainable way.

According to Vianna (2013), from 2010 to 2011, wood processing in the Amazon generated 61,000 m³

(10,980,000 t) of waste, the largest source in Itacoatiara, with a 31% share, followed by Manaus representing 17%. , and Iranduba, with a relative share of 13% of the total, this amount only for the timber industry.

However, Iranduba consumed almost the same 31% of Itacoatiara generation in waste, this is due to the large ceramic pole of the

33%, but Iranduba is in second position because of the movement and consumption of the municipality of Itacoatiara that consumes 95% of its waste for local energy generation and charcoal production.

With the report released in 2019, Semulsp showed survey data, considering that in the previous year approximately 8,570 t / year were collected, being 725,874 t / month and 0.011 kg / inhabitant of pruning and urban afforestation waste with participation of 0 , 9% of the total waste disposed in the landfill in the year, was spent on collection / transportation approximately R $ 3,187,303.94, and it is estimated a final disposal cost of R $ 731,792.3 / year, considering the average value. R $ 85.39 t, charged by the two concessionaires responsible, totaling R $ 3,919,096.24.

However, in contrast to other types of waste, urban wood waste such as caskets, sawdust, wood shavings, cuttings, saw dust, twigs and logs from public pruning and those originating from civil construction have potential and their direct burning does not. is exclusively one of them, it is necessary to use technical studies of alternatives for better use of these wastes (DONATO, 2016).

Although urban logging waste is of little significance compared to that generated by the large logging industry, it is important in the urban context as a whole (FERRO, 2018). Where the Municipality as a social / environmental actor does not have, or does not have sufficient sorting mechanisms in place, temporary or definitive packaging of bulky waste and large generators, such as: Transhipment and Screening Areas (ATT), Voluntary Delivery Points (PEVs), Voluntary Delivery Locations (LEVs).

According to the Municipal Secretariat of Cleaning and Public Services (SEMULSP) (2017), Manaus has only four Voluntary Delivery Points (PEV's) and seven storage sheds, while the Transshipment and Sorting Areas (ATT) are. non-existent, violating laws and retreating to the National Council of the Environment (CONAMA) which, through Resolution Conama No. 307/2002, makes its implementation in all municipalities of the country mandatory, as a way to eliminate the impacts of the lack of control of related activities. environmentally inadequate generation, transportation and disposal.

In this context, the municipality does not dispose of Class IIB inert waste landfill, Complementary Law No. 01 in its Art.2, paragraph III, limits the disposal, however, does not prohibit, that is, by programming the collection service of Construction and Demolition Waste (RCD) up to 50 Kg packed in plastic bags, these can be disposed of in the landfill.

Therefore, it is necessary to create (ATT), (PEV´S), (LEV´S) and construction and demolition waste recycling centers that will meet the needs of the municipality, as well as organize and develop a new model. management of recyclable solid waste, with real compensation to the citizen.

The lack of proper management by the Government, and non-compliance with federal determinations, are one of the determining factors that make waste into environmental liabilities (FERRO, 2018).

Technical Standard NRB No. 15.515-1 / 2011 conceptualizes environmental liabilities as: “Damages inflicted on the natural environment by a given activity or by the set of human actions, which may or may not be economically evaluated”. In this context it is constituted to create ways and means of environmental compensation to minimize environmental damages, applying penalties for infringement to the environmental legislation.

In this theme, Mello; Annunciation (2015), emphasize the need to achieve high efficiency rates and improve the production process, as well as highlight the search for the development of new mechanisms and systems of environmental protection, this is due to the new market model and high figures presented in the balance between yields and waste generated in production.

According to Hartmannet al (2009), the best solution for waste disposal is that in which the binomial environment and profit are combined in such a way that both the environmental guidelines and the financial result are satisfactory, consolidating this vision as the manufacture of wood waste briquettes.

According to Lopes (2017), briquette is an ecological firewood that effectively replaces gas, electric power, charcoal and mineral and firewood, as well as other fuels used in various industrial processes.

Briquette is a direct substitute for firewood in many applications, including residential use, in industries and commercial establishments such as

ceramics, ceramics, bakeries, pizzerias, dairy, food factories, chemical, textile and cement industries, among others.

Santos (2015) points out that the advantages of the compaction of agricultural and forest waste presented are of an imprint, energy, environmental, logistic, operational, and in contrast to the logging in the Amazon, these advantages are seen as obstacles due to the low utilization of the material. raw materials and inefficient outflow logistics.

According to Trugilho (2015), native wood has variable calorific value, depending on the forest species, being the chemical composition responsible for this variation, being directly related to the lignin, ash and extractives contents. Therefore to measure the calorific equivalence between materials, for viability purposes, we will use the Lower Calorific Power (PCI) among materials used for direct burning purposes which are: wood in logs, chips and sawdust.

Second (Quirino, 2007); (Donato, 2014), briquettes have Lower Calorific Power (PCI) averaging 4,553 kcal / kg, and compared to crate and drywood firewood, according to the LPF / IBAMA Forest Products Laboratory, these firewoods have Lower Calorific Power (PCI) averaging 1,450 kcal / kg. (Table1):

Table 1 - Comparison of properties between briquette and wood.

FACTOR	WOOD / WOOD	BRIQUETTE
MOISTURE	80.00%	12%
CALORIFIC POWER	1,450 kcal / kg	4,553 kcal / kg
DENSITY	314 kg / m³	700 kg / m³

Source: Donato (2014) and Quirino (2007).

Where according to the data 3.0 t of firewood would be needed to supply the energy demand, contained in 1 t of briquettes.

• 1 t Briquette = 18,966,072KJ
• 1 t Firewood = 6,066.80KJ

Thus, this research aims to analyze as potential environmental and social incentive the implantation of waste compaction Microusin (briquetting) in a composting plant existing in the municipal landfill of Manaus / AM, as it presents a better logistic and operational solution with interconnection with the municipalities of the Manaus Metropolitan Region (RMM), based on real data provided by the Municipal Secretariat of Cleaning and Public Services (SEMULSP).

2. Materials and Method

The project is classified in bibliographic research, which consists of theoretical references previously analyzed (GIL, 2010). Exploratory, seeking to provide greater familiarity with urban waste wood (PRODANOV; FREITAS, 2016). The deductive method is also used, based on data through public policies and reports, always making use of the previously acquired logical and purely formal reasoning (Gil, 2010).

2.1 Study area

Manaus Municipal Landfill is located at km-19, state highway AM-010 (Manaus-Itacoatiara), located in the western region of the city of Manaus / Amazonas (Figure 1).

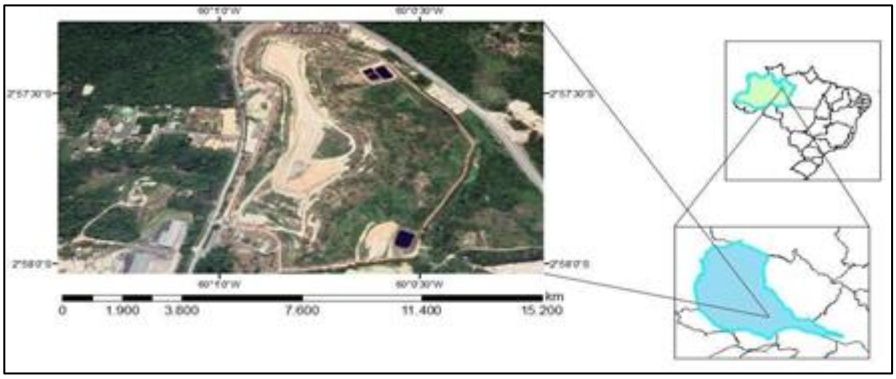

Figure 01. Manaus Municipal Landfill.
Source: Own authorship (2019).

2.2 Data collect

For the implementation of the mini-briquetting plant on the perimeter of the Manaus Municipal Landfill, it is necessary to estimate the actual amount of waste that is disposed of in the landfill and to analyze the management plans according to the effective compliance with the municipal legislation regarding the studied waste. in this research, which are: urban cleaning waste, construction waste, and urban commercial waste from small and large generators, those from sawmills and trades in general, located in the city of Manaus.

Surveys and studies conducted by the Ministry of Environment and Sustainability (MMA), Brazilian Institute of Environment and Natural Resources (IBAMA), Brazilian Agricultural Research Corporation (EMBRAPA), and the effective compliance with the resolutions of the National Council of Environment (CONAMA) to the Manaus Solid Waste Master Plan (PDRS-MANAUS), and the performance of the

Municipal Secretariat of Cleaning and Public Services (SEMULSP).
In the availability of the data used in this research, the reports available on the websites of the observed companies are not disclosed in detail data such as: packaging waste disposal, and construction wood, where these two types of waste are included in the waste category. not specifying which types of waste are present.
Adopted the methodology for feasibility analysis based on the studies by Quirino (2014); Rodrigues (2014); Silva (2007); We sought to observe and follow all the basic and conditioning issues for the sizing of the briquetting plant of the Forest Products Laboratory - LPF / IBAMA. Also in this context, we consulted the Brazilian Journal of Agrotechnology, which deals with content on clean technology for production and sustainability, Revista da Madeira (REMADE), Brazilian Journal of Agrotechnology (REBAGRO) with their studies focused on construction, export and alternative studies technologies for waste wood use in the Brazilian market.

3. Results and Discussion

From the analysis of the reports for the technical / financial feasibility for implantation of briquetting plants, the project fits in the industrial sector and consists of the implantation of a production system, that is, were studied: installed capacity of production, average prices of the region, labor cost, production and labor regime, as well as the structure of total monthly costs, where, according to Quirino (2014), the basic project is characterized by the calculation of the total value of investments from more detailed engineering studies. to subsidize the contracting of the works.
For sizing and installation briquette machine area (Table 2), we will follow the calculation basis based on production capacity per month, hours worked, packaging capacity for storage and turnover.

Table 2 - Production of Briquettes per kg / month and H / month.

MACHINE PRODUCTION	3,060 Kg / h	
WORK REGIME	8h / day (WEEK) 4h / day (Saturdays)	176 h/mês
TOTAL BRIQUETTES / MONTH	538,560 Kg / Month	

Source: Own authorship (2019).

The nominal values informed by the manufacturers were considered: Biomax Machinery and Equipment Ltda and LIPEEL - Integrated Solutions for Biomass, for calculations of productive capacity, as follows: Specific Weight of wood waste considered on average 180 kg / m³ and humidity of 16% according to equipment supply companies.
The production and storage area will be 280 m², and for its construction, prices related to the civil construction of the state of Amazonas were consulted, which is R $ 1102.38 considering labor and materials employed (IBGE, 2019).
The construction of briquettes storage and production warehouses requires a considerably small covered area, and according to Revista da Madeira (2010), only 50 m² is required to hold 30 tons of packed

briquettes. However, a total area of 200 m² will be built, considering public use areas and areas for better circulation of personnel and equipment.

While the solar dryer will be 100 square meters and will meet the criteria described above, however it will be installed in a pavilion apart from the production area, free of any solar and air barrier. The solar dryer to be built will be the black pepper solar dryer, developed by the Brazilian Agricultural Research Corporation (EMBRAPA), where it comes up with an innovative architecture that employs simple materials such as wood and plastic, which eventually becomes an alternative to low costs and great drying efficiency of various raw materials.

The area to accommodate the shredder and its operators will be in an outdoor area near the solar dryer pavilion for operational management purposes, and will have 100 m² to obtain higher quality of the produced shavings.

Thus, based on the synthesis presented, the following sizing and projections for the installation (Table 3).

Table 3 - Costs per m² for the construction of the storage shed and production of briquettes.

PLACE	PRICE (R $) / m²	AREA m²
SHOP FOR PRODUCTION	1102,38	100 m²
STORAGE SHED	1102,38	100 m²
SOLAR DRYER	1102,38	30 m²
GRINDING AREA	-	100 m²
AMOUNT	R$253.547,40	300 m²

Source: IBGE (2019), Research Directorate (2019), Price Index Coordination (2019), National System of Costs and Indexes for Civil Construction Research (2019).

The briquette machine has the production capacity equivalent to the amount of waste received per day at Manaus Municipal Landfill, about 23 t / day. Figure 02 demonstrates the basic mechanisms of a briquette machine.

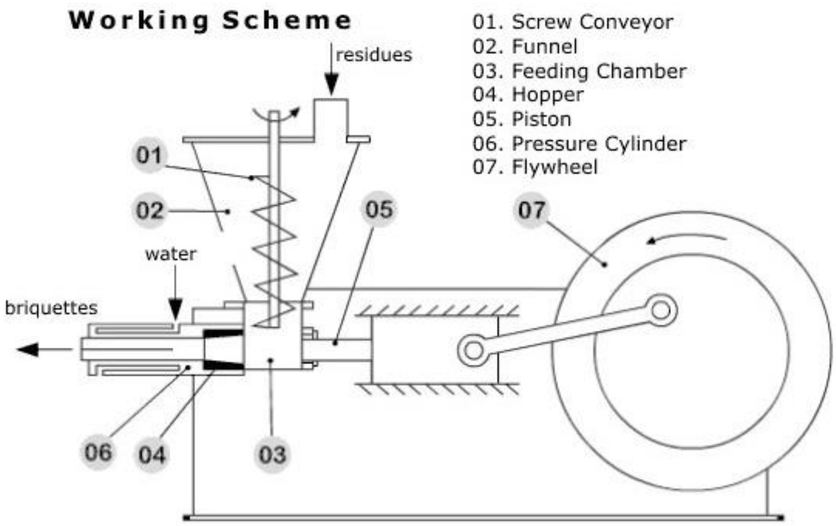

Figure 02. Mechanisms for compaction.

Source: Biomax Machinery and Equipment Ltda (2019).

The shredder model has the capacity to handle a larger volume of waste than the collected and generated, about 36 t / day, that is, where considering the need to shred logs up to 300 mm in diameter. The use and acquisition of chainsaws are necessary to reduce the branches and larger logs for subsequent shredding ensuring the useful life of the equipment.

According to quotations made with the national manufacturer in 2019, the values of initial investments in machinery (industrial equipment) were acquired (Table 4).

Table 4 - Costs to acquire machinery to start the production of briquettes.

QTD	EQUIPMENT	BRAND	MODEL	CAPACITY	VALUE (R$)
1	BRIQUETTER	BIOMAX	B115/220	24 t / day	238.100,00
1	CENTRAL COMMAND FRAME	OWN	PADRÃO	X	16.900,00
1	DIESEL CRUSHER	LIPEEL	PDU/300	36 t / day	129.500,00
2	Chainsaw	NAGANO	MN6000	X	395,1
AMOUNT					CAPACITY

Source: Lippel (2019), Biomax (2012), Nagano (2019).

The plant fits into an industrial scale and it requires expenses with initial industrial facilities for its full operation as water, electricity, telephone, internet among others. The cost of these facilities is projected at 10% of the value of purchased machinery and equipment as adopted by Silva (2007); Rodrigues (2014).

For the acquisition of machinery, furniture, office supplies and Personal Protective Equipment (PPE), investments of R $ 7,000.00 were estimated considering the demand for these utensils in daily activity.

The depreciation of assets, for Hosset al. (2008, p. 213), can be attributed to the process of allocation of expense or cost due to the useful life of goods acquired by companies, ie loss of initial value due to wear, being 10% for machinery, furniture and utensils and 4% for buildings, determined by the IRS and adopted in studies by Silva (2007); Gomes; Pepper (2010); Rodrigues (2014) (Table 5).

Table 5. Initial Fixed Costs for operation and annual depreciation values of assets.

SPECIFICATION	FIXED COST (R $)	ANNUAL DEPRECIATION (R$)
INDUSTRIAL EQUIPMENT	384.690,20	38.469,02
INDUSTRIAL INSTALLATION	38.469,02	3.846,90
MOBILE AND EQUIPMENT	7.000,00	7.00,00
BUILDINGS (SHeds AND DRYER)	253.547,40	63.386,75
TOTAL VALUES	683.706,62	105.702,67

Source: Own authorship (2019).

For the composition of Variable Costs (CV), according to Rodrigues (2014)
production, packaging utensils and industrial labor, and from this we can estimate and project on a monthly scale all Variable Costs (CV), the annual energy power required by Microusina de Briquetes, evaluated by Rodrigues (2014), According to previous studies, it is estimated at 446772.48kWh / year.

The tariff modality for the demand and consumption of electricity is the green tariff where, with a cost of 0.721060 (ICMS free) R $ / kWh, totaling R $ 322,149.76 per year and R $ 26,845.81 per month, with electric power. According to Amazonas Energia S / A (2019) this modality is applied to Group A consumer units (Switched on Medium and High Voltage) supply voltage below 69 kV and contracted demand equal to or above 300kW.

Uses of packaging for briquettes packaging correspond to the production of 538,560 t / month of briquettes, packaging of briquettes by 10 kg paper packaging, correspond to 53,853 packages / month. According to the company MF RURAL (2019), the cost of packaging is around R $ 1.31 (unit), where monthly total of R $ 70,548.21 would be spent on packaging.

At Microfine Briquetting the cost of industrial labor includes the payment of eight (8) employees, who are responsible for assisting in the loading and lowering of branches, logs and leaves on the shredder machine three (3), operating the machine and briquettes logistics three (3), and administrative staff two (2). For a salary of R $ 990.00 per month, with a payroll of R $ 11,880.00 / month, which equals a payroll of R $ 142,560.00 / year, including social charges and other benefits that according to Rodrigues (2014) is 50% of the salary paid (Table 6).

Table 6. Variable enterprise costs for the first month.

SPECIFICATION	QNTD	VALUE (UNT)	VARIABLE COST (R$)
ELECTRICITY	446.772,48 kWh/ano	1,07 (R$)/(kW/h)	26.845,81
PACKAGING (10KG)	53.853,60	1,31 (R$)	70.548,21
LABOR + CHARGES (50%)	8	990,00 (R$)	11.880,00
AMOUNT			109.274,02

Source: Own authorship (2019).

The results of this research reflect briquetting as an economically viable technological alternative, based on the composition of briquetting plant implementation costs, representing approximately 20% of the amount spent in the same year, compared to the values destined for collection / transportation and final destination. , from pruning waste in the previous year, totaling R $ 3,919,096.24 in expenses (Table 7).

Table 7. Breakdown of Fixed Costs and Variable Deployment Costs.

SPECIFICATION	FIXED COST (R $)
INDUSTRIAL EQUIPMENT	384.690,20
INDUSTRIAL INSTALLATION	38.469,02
MOBILE AND EQUIPMENT	7.000,00
BUILDINGS (SHEDS)	253.547,40
TOTAL	683.706,62
SPECIFICATION	**VARIABLE COST / MONTH (R $)**
ELECTRICITY	26.845,81
PACKAGING (10KG)	70.548,21
LABOR	11.880,00
AMOUNT	109.274,02
TOTAL VALUE COMPOSITION OF COSTS (CF AND CV)	792.980,64

Source: Own authorship (2019).

By projecting variable costs over the annual range, R $ 1,311,288.34 would be spent to keep Microusina fully operational, considering the minimum depreciation data, the fixed costs would remain the same over the ten year interval, so the fixed annual costs and variables revolve around R $ 1,994,994.96, representing only 51% of the value spent today, plus collection / transport and final destination. No investment scenarios were analyzed for briquettes commercialization, such as unit cost and sales price. However, it is possible to make comparisons of costs and economic indicators, simulating different scenarios of a wood waste compaction system exclusively intended for commercialization.

4. Conclusion

This research approached a budget proposal, for the implantation of the plant of an urban wood waste briquetting Microusina in the municipal landfill, as a way of expanding the capacity of reuse and reduction of losses in the destination process.

This work enhances a viable alternative for urban waste utilization, adding environmental and social value. By simulating scenarios it was shown that it is possible to produce a new product, which could replace part of the wood consumed in small businesses and homes as a form of sustainable economic attraction in compensation for the correct disposal of their waste.

The scenario for initial investments revolves around R $ 683,706.62 in fixed costs for implementation purposes, and R $ 109,274.02 in variable costs for the operation in the first month, added up to R $ 1,994,994.96 annually. 49% economy, translating into green economy, efficient and shared management and social / environmental responsibility.

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