v. 4, n. 4, 2024

Journal of Engineering Research

MINING AND CIVIL CONSTRUCTION: AN ECONOMIC EVALUATION OF CERAMIC BRICK PRODUCED IN JURUTI-PA

Simara Sousa do Nascimento
Universidade Federal do Oeste do Pará (UFOPA)
Juruti - PA
https://lattes.cnpq.br/8857417865698826

Mairon Rodrigues Marques
Pontifícia Universidade Católica de Minas Gerais (PUC-MG)
Juruti - PA
http://lattes.cnpq.br/0688046424277507

Elden de Albuquerque Marialva
Universidade Federal do Oeste do Pará (UFOPA)
Juruti - PA
http://lattes.cnpq.br/2098634375497760

Abstract: Ceramic bricks are commonly used in civil construction and are of great importance in the national economy. The interest of small and medium-sized producers arises as a result of this factor, since this system does not require major changes or high investments for its implementation, favoring good profitability and rate of return. In this work, the objective was to economically evaluate the production of ceramic bricks at Olarias in the municipality of Juruti-PA, surveying production costs for a five-year scenario. The results revealed that the production of ceramic bricks is economically viable, but the gross revenue is low considering the lifespan of the projects. Based on the results obtained, it was possible to help improve production processes, with suggestions for ideas for better working conditions and technological adaptation, thus highlighting the importance of mining, this economic activity begins with the mining of clay.
Keywords: ceramic production; economic viability; construction; clay mining

INTRODUCTION

Humanity has always been linked to the use of mineral resources since the earliest times in history. In the current situation, basically everything that man uses comes from mining – an activity that extracts these substances from the subsoil for the benefit of society. The ceramic sector is a large consumer of minerals, whether fresh or processed. With influence on the primary sector of the economy, due to the use of clay as a raw material in its production.

The manufacture of ceramic materials began around 10 thousand years ago, with the production of pieces and artifacts useful for society. Traditional ceramics are the most common, used in the manufacture of bricks, various coverings and other essential materials in civil construction. In Brazil, the brick manufacturing industrial sector began around the 16th century, in the Brazilian northeast, specifically in the states of Bahia and Pernambuco, and occupies a prominent place in the country's economy. According to Prado & Bressiani (2013), in recent decades, the Brazilian ceramics industry has experienced intense growth due to the expansion of civil construction in the country.

Studies carried out by Rocha et al. (2013), pointed out that the state of Pará has the largest number of companies manufacturing traditional ceramics in the northern region of the country, distributed in approximately 07 micro-regions and which are significant from an economic point of view. Until mid-2014, the state had approximately 200 registered companies, generating around 15 thousand direct jobs and 40 thousand indirect jobs.

In this regard, in the municipality of Juruti, northern region of Pará, the expansion of the exploration of civil aggregates has grown in recent years. According to Marques (2023) "during the implementation of the Mining Activity for bauxite exploration in Juruti-PA, several enterprises were attracted to the city, causing high economic growth and giving the population access to numerous products, goods and services". However, this factor caused the expansion of the urban area with the emergence of new neighborhoods, and, consequently, the demand for construction products also increased. The municipality's ceramics companies are responsible for meeting part of the municipality's demand and the other part goes to companies in Vila Socorro in the municipality of Santarém-PA.

In view of the above, this work aims to analyze the economic viability in the manufacturing industry of three companies in the Pottery Sector in the municipality of Juruti-PA, surveying production costs, with the purpose of defining strategies for the company, which generate results suitable to maximize the useful life of projects on the

market. The feasibility analysis was based on estimating the annual production quantity of each company and the costs of producing ceramic bricks.

MATERIAL AND METHODS

The study was divided into three stages, initially a bibliographical research was carried out to collect data, in this survey articles, academic works and other scientific publications that met the objective of the research were selected, these being Brazilian ceramics, economic feasibility study and viability indicators.

Next, technical visits were carried out at the three pottery companies in the municipality of Juruti-PA, named (A, B and C) for the research, with the aim of monitoring the ceramic brick production process and collecting data for analysis. To identify economic viability, a quantitative questionnaire was applied to those responsible for the projects, analyzing a scenario of five years of production, considering the rate of product loss due to some type of defect caused in the manufacturing process. This way, it was possible to estimate the average factory expenses, with fixed production costs, on a national basis.

Finally, the economic viability of companies was studied, investment analysis evaluates the effect of the capital invested in a given project and maps its future results. According to Ferreira (2005), this analysis is a technique that allows the evaluation of different alternative economic decisions and their results, by comparison, to make the best decision that meets the company's objectives. In this context, for the economic evaluation of companies, the indicators of Net Present Value (NPV), Internal Rate of Return (IRR) and the Minimum Attractive Rate (MAR) were used with a MARR of 15% per year, considering the conditions of the construction sector in the Brazilian economy.

NET PRESENT VALUE (NPV)

"It is a dynamic method of economic evaluation, which considers the time value of money and depends on the selected interest rate" (MIRANDA JÚNIOR, 2011). The selection criterion is the project that has the highest NPV.

INTERNAL RATE OF RETURN (IRR)

It is the rate of return on a given project, based on the investment and the discount rate return that a cash flow must have for its NPV to be zero. For Miranda Júnior (2011), unlike NPV, the IRR method allows measuring the efficiency of capital use.

MINIMUM ATTRACTIVE RATE (TMA)

It represents the minimum return expected for an investment, taking into consideration, the source of capital (own or through loans), and the profit margin expected to be obtained from the investment. A general reference for the AMR of companies in Brazil is the SELIC rate, the basic interest rate of the Brazilian economy, as it affects both the fundraising side and financial investments (VIEIRA, 2017).

RESULTS AND DISCUSSION

ECONOMIC VIABILITY OF CERAMIC BRICKS

Considering the average monthly production of the brickworks studied, we have that company A produces 150,000 bricks monthly, with a loss of 10% in production, resulting in a total value of 1,620,000 bricks sold per year. Company B produces 180,000 bricks per month, with a loss equivalent to 10%, its annual commercial production is 1,944,000 per year. The annual costs (Table

1) consider the entire annual production, including the amount of loss and the use of ceramic bricks from the three companies.

Company C has a monthly production of 15,000 bricks, and a 10% loss in production, making a total of 162,000 bricks available to consumers annually. Table 2 shows the corresponding values:

To calculate the revenue from the sale of the product, production was considered according to the quantity of bricks produced annually times the value of the thousand bricks sold on the market.

RETURN ANALYSIS AND INDICATORS

To calculate the viability indicators, a production scenario of 05 (five) years was considered for companies A and B, and for company C a scenario of 03 (three) years and the non-existence of production in year 0 of the activities, thus the initial value of the Net Cash Flow (FCL) corresponds to the first production investment, with the initial value invested by small producers in the Municipality of Juruti being the equivalent of R$ 150,000.00 for company A, R$ 200,000.00 for company B and R$20,000.00 for company C.

Company A has a useful life of 20 (twenty) years, the economic viability analysis (Table 3) considered the last five years of activities. Costs represent 75.6% of revenue and the annual result is enough to cover the initial investment, with an average cash flow of R$316,000.00 annually, after five years the total value is R$1,580,0000.00, thus exceeding the amount invested at the beginning.

Company B has a useful life of 21 (twenty-one) years, the research also considered the last five years of activities (Table 4). The percentage of costs over revenue is 77% and the annual result is enough to cover the initial investment, with an average cash flow of R$355,200.00 annually, after five years the total value is R$1,776,000.00, thus exceeding the amount invested at the beginning.

Company C is in the initial phase of production, with a useful life of 3 (three) years. The analysis considered the three-year scenario (Table 5) for the enterprise that had costs of 84% of its revenue, after the second year of production the result is sufficient to cover the initial investment, with the cash flow on average for R R$19,300.00 annually, after the second year the total value will be R$38,600.00, thus exceeding the amount invested at the beginning.

The current situation of the factories made it possible to detect several flaws that could be improved during the processes. The study carried out showed that the three companies have economic viability, the cash flow presents positive values, the NPV greater than zero and internal rates of return higher than the minimum attractiveness rate of 15%. On the other hand, the results are not satisfactory considering the useful life of companies A and B, the gross revenue is low, with low profitability in the sum of the three projects totaling R$2,972,700.00 for the municipality's economy.

It is noted that the production carried out by the three companies is unable to meet the municipality's demand for ceramic bricks, meaning that construction companies need to purchase the product from another municipality to resell in local commerce. In addition to this factor, the percentage of product loss due to failures during production is high, generating losses for companies and environmental damage caused by waste. Both companies do not have a disposal plan and this waste is discarded close to the projects.

Based on the observation of ceramic brick production processes, it was found that companies are not suited to the use of new technologies for the production process. Companies A and C use production

Description	Company: A (R$)	Company: B (R$)	Company: C (R$)
Labor	187.200,00	200.000,00	32.050,00
Clay Extraction	115.200,00	178.000,00	14.800,00
Transport costs to warehouse	48.000,00	72.000,00	10.100,00
Firewood	106.976,00	153.000,00	13.450,00
Fuels and lubricants	522.624,00	97.000,00	31.800,00
Electricity	0,00	500.000,00	0,00
Total	980.000,00	1.200.000,00	102.200,00

Table 1 – Annual cost for the production of ceramic bricks from companies A, B and C

Source: Author himself (2023).

Company	Quantity Produced (bricks/year)	Loss Amount (%)	Yield (bricks/ year)	Number of Thousands/Year	Price per thousand units (R$)	Annual Gross Revenue (R$)
A	1.800.000	10%	1.620.000	1.620	800,00	1.296.000,00
B	2.160.000	10%	1.944.000	1.944	800,00	1.555.200,00
C	180.000	10%	162.000	162	750,00	121.500,00

Table 2 – Yield and revenue from the annual production of ceramic bricks

Source: Author himself (2023).

ITEM	TIME (YEARS)					
	0	1	2	3	4	5
Investment (R$)	-150.000,00					
Income (R$)		1.296.000,00	1.296.000,00	1.296.000,00	1.296.000,00	1.296.000,00
Costs (R$)		980.000,00	980.000,00	980.000,00	980.000,00	980.000,00
Cash flow (R$)	-150.000,00	316.000,00	316.000,00	316.000,00	316.000,00	316.000,00
VPL (R$)	909.281,01					
TIR (R$)	210%					
TMA	15%					

Table 3 – Cash flow from the production of 1800,000 bricks per year for company A

Source: Author himself (2023).

ITEM	TIME (YEARS)					
	0	1	2	3	4	5
Investment (R$)	-200.000,00					
Income (R$)		1.555.200,00	1.555.200,00	1.555.200,00	1.555.200,00	1.555.200,00
Costs (R$)		1.200.000,00	1.200.000,00	1.200.000,00	1.200.000,00	1.200.000,00
Cash flow (R$)	-200.000,00	355.200,00	355.200,00	355.200,00	355.200,00	355.200,00
VPL (R$)	990.685,49					
TIR (R$)	177%					
TMA	15%					

Table 4 – Cash flow from the production of 2,160,000 bricks per year for company B

Source: Author himself (2023).

ITEM	TIME (YEARS)			
	0	1	2	3
Investment (R$)	- 20.000,00			
Income (R$)		121.500,00	121.500,00	121.500,00
Costs (R$)		102.200,00	102.200,00	102.200,00
Cash flow (R$)	- 20.000,00	19.300,00	19.300,00	19.300,00
VPL (R$)	24.066,24			
TIR (R$)	80%			
TMA	15%			

Table 5 – Cash flow from the production of 180,000 bricks per year for company C

Source: Author himself (2023).

machinery with a diesel engine for their operation, burning around 2,600 liters per week, generating high carbon dioxide (CO2) emissions, gases responsible in greater abundance for global warming and the effect stove. Another factor is the brick drying process, which is done naturally for the three companies, where the bricks are deposited on open-air shelves in the companies' own production warehouse. This process is slower and very empirical, and abrupt drying may occur, causing the appearance of stresses and cracks, which make it impossible for the piece to go to the oven for firing.

Another issue related to these factors is the quality of the clay used to manufacture the bricks. There is a lot of inconsistency in the production process, which may be due to the quality of the clay or the treatment given during production. The brick breakage rate per batch is high. Companies do not have study results that define the ideal quality of clay for the manufacture of ceramic tiles. It is worth highlighting the importance of research to improve product quality, including waterproofing, compression resistance and reducing the breakage rate of the bricks produced.

Furthermore, because production is on a low scale, employment and income records are also low, adding the three companies together there is a total of 31 direct jobs, the majority of the workforce is unqualified for the pottery production sector, as they work in an empirical way based on practice and experience. It is necessary to take into consideration, the benefits that such an activity offers to the municipality of Juruti, since a company independent of the sector in which it operates must offer the population employment and income.

CONCLUSIONS

The research shows that companies present economic viability based on the construction of Cash Flow, calculation of the Net Present Value and the Internal Rate of Return. However, companies A and B have gross revenue below expectations considering the useful life of the two projects. Company C has a useful life of three years, and is in the initial phase of its production, which is relatively low, but considerable for the time of activities on the market.

In the study, some limitations were identified, the companies are considered small businesses, they use procedures with artisanal characteristics to produce the brick, there are no technological innovations, financial management system and lack of product quality analysis, leaving consumers with doubts. However, the entire annual production of the companies surveyed cannot meet the municipality's demand for ceramic

bricks for civil construction.

Among the solutions that can be adopted, the importance of exchanging information between producers in the same sector stands out, with research institutes, equipment suppliers, entities and financing bodies being among the alternatives to promote the development of the ceramic industry. Representative entities must be proactive, go beyond simple formal and legal representation, and do their best to provide services and consultancy that add value to ceramics.

Incentives through competent bodies, unions, associations and other partners can promote greater profitability for the municipality's pottery sector, since the partnership between companies and interested parties can lead to increased productivity, generating employment and income. Leading to the development of the sector, market competitiveness, improvement of working conditions and the environment, with technological innovation and sustainable processes for the sector.

This article presented real information collected, with research into the quantity of ceramic bricks produced and production costs. This provides an opportunity to continue the study for greater depth on the topic. In future work, it is suggested to study mechanical analysis with compressive strength for companies aiming to improve the quality of the product on the market, thus resulting in a reduction in the loss rate, increasing production, and consequently increasing revenue and cash flow.

THANKS

I would like to thank the Potteries for providing information for the economic feasibility study. The Amazon Foundation for the Support of Studies and Research (Fapespa) for financing the Project's Scientific Initiation Scholarship.

REFERENCES

FERREIRA, J.O., **Estudo da viabilidade técnico-econômica da produção industrial da aguardente do "licor" de laranja**, Dissertação de M.Sc., Faculdade de Ciências Farmacêuticas/UNESP, Araraquara, SP, Brasil, 2005.

MARQUES, M.R. **Os Impactos Sociais Provocados pela Atividade Mineradora No Município de Juruti/ Pa**. 2023. 27 f. Trabalho de Conclusão de Curso (Graduação em Engenharia de Minas.) – Departamento de Engenharia de Minas da Universidade Federal do Pará, Juruti, 2023

MIRANDA JÚNIOR, I. S. **Diretrizes Fundamentais para um Estudo de Avaliação Econômica de Empreendimentos de Mineração**: Um Estudo Bibliográfico. 2011. 161 f. Dissertação (Mestrado em Engenharia Mineral) – Escola de Minas da Universidade Federal de Ouro Preto, Ouro Preto, 2011.

ROCHA, A. L., BARTOLOMEU, A. O., BOTELHO, J. L., et al., **A produção industrial da cerâmica vermelha em São Miguel do Guamá e as recentes inovações adotadas pelo segmento em âmbito nacional.** Revista IMED, v. 2, n 1, pp.01-09, ISSN 2318-1109, 2013.

PRADO, U. S., & Bressiani, J. C. (2013). **Panorama da indústria cerâmica brasileira na última década.** Cerâmica Industrial, 18, (1), 7-11.

VIEIRA, S. J. F. N. A. **Análise de Viabilidade Econômica de um Empreendimento de Água Mineral na Região Metropolitana do Recife**. 2017. 32 f. Trabalho de Conclusão de Curso (Graduação em Engenharia de Minas) – Departamento de Engenharia de Minas da Universidade Federal de Pernambuco, Recife, 2017.