Global Scientific and Academic Research Journal of Economics, Business and Management
ISSN: 2583-5645 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journals-gsarjebm-home/

Feasibility study of a company for the manufacture of products based on waste tires in Tamaulipas México

BY

Guillermo García Vega [1], Reyes Gallegos María Magdalena [1], Maldonado Reyes Araceli [2], López García Ricardo Daniel [2*] Coronado Reyes Héctor [1]

[1] Postgraduate and Research Department, Tecnológico Nacional de México/Campus Cd. Victoria, Avenida Tecnológico No. 1301 Pte., Cd. Victoria C.P. 87010, Tamaulipas México

[2] Department of Mechanical Engineering, Tecnológico Nacional de México/Campus Cd. Victoria, Avenida Tecnológico No. 1301 Pte., Cd. Victoria C.P. 87010, Tamaulipas México

Article History

Received: 10/02/2024
Accepted: 17/02/2024
Published: 19/02/2024

Vol – 3 Issue – 2

PP: -98-102

Abstract

End-of-life tires represent a serious environmental pollution and public health problem, which continues to increase exponentially around the world. The above has been attributed to various factors such as population growth, economic growth in the main world economies, and mainly the increase in demand in the production of vehicles in the automotive industry. Because waste tires are non-biodegradable polymers, their decomposition takes up to 500 years, coupled with poor management and waste management, most of which end up in landfills, open-air warehouses, or on the streets, leading to contamination of soil, water, and air, in addition to health problems because of the generation of pests and mosquitoes that affect the health of the population. In 2018, it was reported that in Mexico about 36 million tons of tires were discarded each year and due to the lack of regulations and information about their reuse and recycling, only 10% of this volume is recycled properly, leaving several waste tires latent to cause environmental problems. Currently in Tamaulipas Mexico, there is no company dedicated to the collection, treatment, and recycling of out-of-use tires. To mitigate this situation, a percentage of these tires are stored and transferred to other cities for treatment. However, it is estimated that nearly 100 thousand tires each year are accumulated in landfills without any type of treatment. Therefore, the objective of this research is to present a solution to the problem of waste tires which contributes to reducing this condition. For this purpose, a market study was used to analyze the feasibility of implementing a business model that in addition to mitigating environmental problems, represents an economic benefit in the state of Tamaulipas. The project presents an economically profitable model, and the most important financial aspects are considered.

Keywords- *Waste tires, environmental pollution, recycling, feasibility, ground rubber*

INTRODUCTION

The final disposal of solid waste especially waste tires has become a serious environmental pollution problem that affects the public health of the population. In recent years, it has been the focus of attention of many first-world countries due to the complexity of the problem it represents (Fazli and Rodrigue, 2020). Globally, waste tires represent more than 12% of all solid waste in the world, and due to their complex structure and chemical composition, they have become the most difficult polymer materials to eliminate naturally, which makes them resistant to many external factors when they are deposited in landfills or the open, causing a high risk to the environment and health (Sathiskumar and Karthikeyan, 2019). Currently, in most developing countries there is no control over the management and disposal of urban solid waste, including waste tires, and recycling is far below compared to developed countries.

Although at first waste tire disposal practices consisted of collection centers and deposits in municipal landfills, as the volume of waste rubber increased, the storage and treatment of this problem required special attention for its handling and final disposal. With the increase in demand for tires in the

*Corresponding Author: **López García Ricardo Daniel.**

world, it is estimated that in a few years, landfills will not be a viable alternative for tire waste management (Mohajerani et al., 2020). Therefore, it is urgent to have strategies for the recycling of waste tires, the disposal and management of this waste in landfills, and the implementation of effective processes for the generation of other energy sources and their reuse for the manufacture of products.

In most countries around the world, the accumulation of waste tires is considered a serious environmental and public health problem; In addition to this, there is no satisfactory response to control this problem by the industrial sector, which is why the recycling of waste tires has become a potentially profitable and growing business in the last decade. For this reason, governments, and environmental organizations in many parts of the world have promoted the management, recovery, and final disposal of waste tires to adopt effective measures that improve rubber recycling and care for the environment (Yang et al., 2018). It is important to highlight that effectiveness and success depend on the degree of participation of all those involved (manufacturers, importers, industries in general, consumers, and governments of each country). The growth of global tire production demand is closely influenced by population growth, the development of most of the world's economies, and mainly, the strong development of the automotive sector. According to several researchers (Roychand et al., 2020; Chen et al., 2022), global tire production has grown exponentially in the last 10 years, on the order of 17.5% since 2012. Currently, tire manufacturing exceeds 3.3 billion units per year and is expected to increase to 4.1 billion per year until 2028. In this sense, the countries that consumed the most tires in 2022 were the United States and China with 450 and 320 million tires respectively. While in Mexico, documented tire consumption in 2020 was 33.2 million (Ramarad et al., 2015).

Currently, about 1.4 billion tires are discarded into the environment each year and this amount continues to grow Some researchers (Raffoul et al., 2017; Yadav and Tiwari, 2016) mention that the growth in waste tires has increased by around 13% annually, from 300 million in 2016 to more than 1,300 million waste tires in 2020. Although Mexico reports 36 million waste tires by 2018, if this trend continues, within a decade there will be another 250 million waste tires. To reduce the problems generated by waste tires, many countries in the world are using various efficient methods of reusing rubber due to its physical and mechanical properties. (Khan et al., 2020) These methods consider retreading, applications in civil engineering, construction of playgrounds and sports pavements, and ground rubber applications, in addition to energy recovery (Imbernon and Norvez, 2016). Today, rubber from waste tires has an increasingly wide range of applications in engineering, energy generation, and transformation into useful products.

One of the most popular alternatives in the industry in many countries is the recycling of rubber from unused tires and transforming them into useful products. In this sense, a significant number of studies have been carried out focused on the use of waste tires for energy generation, the reuse of metals, and the reuse of rubber for the manufacture of products. The main contributions have been in establishing future research bases on the management of waste tires, their use as raw material, the generation of new sources of income for the industry, and the reduction of environmental problems caused by poor management.

The objective of this study is to carry out a feasibility study for the implementation of a company for the manufacture of products from ground rubber from waste tires in Ciudad Victoria Tamaulipas, Mexico. The results obtained in the study can be used by investors and already-established companies for business expansion, data trends on unused tires and effective recycling methods are shown.

METHODOLOGY

For the development of the research, market analysis, technical analysis, and economic-financial analysis were addressed, the results obtained at each stage were studied, and subsequently, with reliable data, decisions can be made on the viability of creating a company. Figure 1 shows the procedure that was carried out for this project.

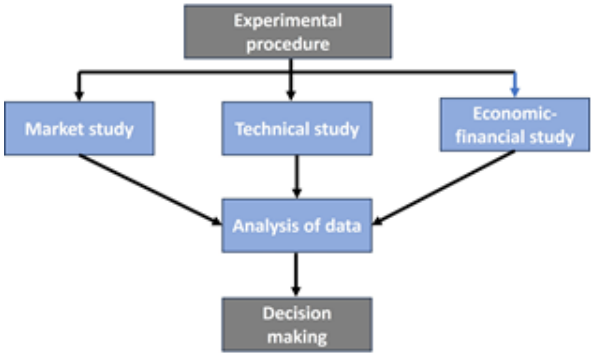

Figure 1 Experimental design used in the research. The authors.

Market study

The business model and the area of interest were analyzed through a market study to obtain a general overview of the commercialization of granulated rubber in Mexico and mainly in Tamaulipas. Another important aspect to highlight is the final disposal and treatment of unused tires, which will be the most important raw material in the production process. For this, a survey was carried out on the population of the area of interest, in this case, the municipality of Ciudad Victoria, a total of 386 people between 20-70 years old and with their vehicles were surveyed, and this data was obtained based on the current population. which according to INEGI 2020 data was 349,688 inhabitants, subsequently people with ages outside the range were discarded and the formula of equation 1 was applied, with them a confidence level of 95% and an error margin of 5% obtained.

$$n = \frac{N * z_a^2 * p * q}{e^2 * (N-1) + z_a^2 * p * q} \qquad (1)$$

where n is the sample size; N is the population size; Z is the value for a 95% confidence level; p is the estimated proportion of the attribute present in the population; E is the margin of error.

*Corresponding Author: **López García Ricardo Daniel.**

The survey applied was related to the frequency of changing tires and the final disposal of out-of-use tires. This allowed us to estimate the number of unused tires that can be captured and used as raw material in the business.

Technical study

The design of the production line to obtain rubber powder from unused tires was carried out considering obtaining a particle size between 1.5 to 4 mm, having the following design stages for the process line:

Reception and storage of tires; ripping machine to remove steel; guillotine to cut and obtain the appropriate particle size; feeding and extraction conveyor belt; crushing machine with double shaft; magnetic separator; mill for granules; vibrating band; dust extractor; powder storage; worktables; quality inspection area; finished products storage area.

Within the technical study, a forecast of the acquisition of raw material was made, to have an overview of the tire potential in the study area. Information was obtained from different information sources as well as public and private organizations. A linear regression analysis was carried out with the number of vehicles registered from 1980 to 2020, the types of vehicles considered in the study were cars, trucks, passenger trucks, and vans. Free software was used to manipulate the information, and the equation used for this purpose is shown below:

$$\hat{y} = a + bx \qquad (2)$$

where: ŷ = dependent variable (calculated value of the variable to be predicted); x = independent variable (time in trend analysis); a = intercept on the y-axis; b = slope of the trend line.

Once the vehicle fleet was forecast for the years 2022-2025 with the sole purpose of projecting, a value of 4 waste tires was estimated for each vehicle registered over 4 years. The weight per tire was estimated based on data in the literature and references from the main tire companies in the world, an average per tire/type of vehicle was obtained, being 8,025 Kg per tire. Likewise, a calculation was made of the use of rubber per tire, eliminating steel, textile fibers, and oxides. In the end, the rubber obtained is equivalent to 55% of its weight, this data is important in predicting production. To obtain a more precise economic analysis, within the technical analysis a production forecast was made, the processing capacity of the proposed machinery was used as a reference, which has a maximum capacity of 1 Ton/Hr, for the projection 800 Kg/Hr were considered, working 8 hours a day for 25 days a month for 1 year.

Financial study

The project that is being proposed in this research deals with the sale of a product made with great added value thanks to its low cost of raw materials, so the yields and benefits are high. The cost analysis was carried out considering direct manufacturing costs (raw materials, labor, administrative expenses) and indirect (electric energy, water, services). The total investment cost considers both types of costs, and thus the economic viability of the project can be determined.

RESULTS AND DISCUSSION

A feasibility study was carried out for the installation of a company to manufacture products from tire recycling in Ciudad Victoria, Tamaulipas, through market, technical and economic analysis using the NPV and IRR as economic indicators of profitability. Below, the analysis results of each investigated variable are presented.

Market study

Figure 2 shows the result of the surveys related to the frequency of changing tires, 62% of those surveyed responded that they change their tires every 3 to 5 years, 26% from 1 to 2 years. and only 12% answered that more than 5 years. This information and according to the vehicle fleet registered in the city, the number of tires out of use in each period can be estimated.

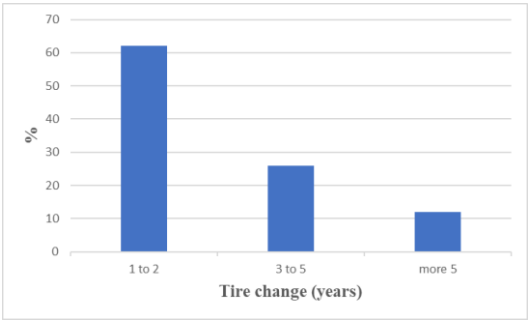

Figure 2 Tire change frequency.

Figure 3 shows the results of the final disposal of out-of-use tires. 75% of those surveyed responded that they leave their tires in the tire shops where they change them, 17% deposit them in the garbage collector, 5% deposit them in the municipal garbage dump, and 3% reuse them. This information is useful to determine the strategies to be followed for tire collection.

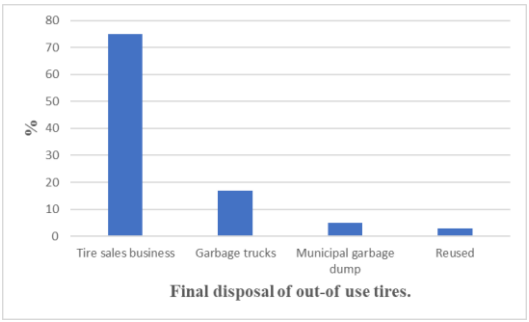

Figure 3 Final disposal of out-of-use tires.

Technical study

A study was carried out focused on the type of equipment, the technical characteristics, and the cost of these, the minimum equipment necessary and contemplated in the production process which was calculated to produce between 800 and 1000 Kgs per hour, are steel remover 30 KW, cutter with 10 HP motor, feeding and extraction belt with transport capacity of 1000 kg, 60 HP double shaft shredder, 40 HP ripper, magnetic separator, 30 HP granulator mill, 0.75 KW vibrating belt, dust and fiber extractor, dust collector, PLC board.

*Corresponding Author: **López García Ricardo Daniel.**

The capacity of the equipment and its cost was used to calculate production in a hypothetical 12-month exercise considering the minimum production capacity (800 kg/hr), resulting in 160 Tons per month, and 1920 Tons per year, in the assumption of continuous production without equipment failures.

According to the vehicle fleet registered in Ciudad Victoria, a forecast was made to estimate the amount of rubber per type of vehicle that can be obtained in the next 4 years. Table 1 shows the results obtained, showing that about 3000 Tons per year could be obtained as raw material for manufacturing rubber-based products from recycled tires.

Table 1. Rubber forecast by vehicle type.

Raw material forecast				
Year	Automobile rubber (Kg)	Truck rubber (Kg)	Passenger rubber (Kg)	Total
2023	1,781,547	1,002,350	104,077	2,887,975
2024	1,827,355	1,024,688	106,715	2,958,758
2025	1,873,162	1,047,025	109,354	3,029,542
2026	1,918,970	1,069,362	111,993	3,100,326

Financial study

The economic analysis was carried out by using the NPV and IRR as economic indicators of profitability. First, gross profits, net profits and production costs were calculated. 30% of gross profits were used as production costs, including 15% inflation due to the changing situation in the world. On the other hand, profits were calculated according to the production forecast and the average sales cost obtained from the national market, which was USD 200 per ton of granulated rubber, resulting in USD 30,100. Net profits were obtained by subtracting production costs and 40% income taxes, resulting in a total of USD 11,800 per month.

On the other hand, to calculate the net present value, the initial investment budget derived from the sum of fixed assets, such as machinery, furniture and equipment, in addition to fixed and administrative expenses, was used. The value of administrative, personnel and maintenance expenses were calculated over a period of 6 months of operation. After the initial investment was calculated, the investment amount of the project was obtained, being USD 518,000. The following table shows the result of the initial investment budget.

Once the cash flow and present value were calculated in the 24-month financial year, the Net Present Value was calculated by subtracting the value of the initial investment from the sum of the present value of the cash flows in 24 months by the NPN formula which was equal to USD 128,978. Subsequently, the TIR was calculated using the initial investment along with the different cash flows calculated over 24 months. The TIR obtained for this operation was 11.73% higher than the 10% interest used in the study.

CONCLUSIONS

In this research, the feasibility of installing a tire recycling company in Ciudad Victoria, Tamaulipas, was analyzed; three types of analysis were used; market, technical analysis, and economic analysis. It began with an initial budget considering the sum of fixed assets, furniture and equipment, administrative expenses, personnel expenses, and maintenance. The forecasted cash flow for 24 months was calculated for the application of the NPV and the IRR, and then the following conclusions are mentioned from the results obtained:

- ✓ At a global level, the granulated rubber market is increasing; Mexico currently acquires a greater amount of rubber than it produces, creating an important market opportunity.
- ✓ According to the registered vehicle fleet and the amount of tire waste per year, the projection of rubber raw materials for the years 2023 – 2026 are estimated positively for the start-up and operation of the company.
- ✓ The tire recycling company can produce net profits of USD 11,800 in crumb rubber, with a 2-year return of USD 95,388, resulting in a positive value for the NPV operation.
- ✓ The IRR calculated for the project is 11.73%, higher than the 10% interest used in the exercise.
- ✓ The project presented is feasible in the current world market, technically feasible, and economically attractive as a business model.

ACKNOWLEDGMENT

The authors are very grateful to the Tecnológico Nacional de México for the financial support received to carry out the project with identification number 18585 23-P.

REFERENCES

1. Fazli, A., and Rodrigue, D. (2020). Recycling Waste Tires into Ground Tire Rubber (GTR)/Rubber Compounds: A Review. *Journal of Composites Science, 4(3), pp. 103-145.* Doi: 10.3390/jcs4030103.
2. Sathiskumar, C., and Karthikeyan, S. (2019). Recycling of waste tires and its energy storage application of by-products-a review. *Sustainable Materials and Technologies. 22, e00125.* Doi: 10.1016/j.susmat.2019.e00125.
3. Mohajerani, A., Burnett, L., Smith, J V., Markovski, S., Rodwell, G., Rahman, M T., Kurmus, H., Mirzababaei, M., Arulrajah, A., Horpibulsuk, S., and Maghool, F. (2020). Recycling waste rubber tyres in construction materials and associated environmental considerations: a review. *Resources, Conservation and Recycling, 155, 104679.* Doi: 10.1016/j.resconrec.2020.104679.
4. Yang, Z., Ji, R., Liu, L., Wang, X., and Zhang, Z. (2018) Recycling of municipal solid waste incineration by-product for cement composites preparation. *Construction and Building Materials.*

*Corresponding Author: **López García Ricardo Daniel.**

162, 794-801. Doi: 10.1016/j.conbuildmat.2017.12.081.

5. Roychand, R., Gravina, R., Zhuge, Y., Ma, X., Youssf, O., and Mills, J. (2020). A comprehensive review on the mechanical properties of waste tire rubber concrete. *Construction and Building Materials. 237, 117651*. Doi: 10.1016/j.conbuildmat.2019.117651.
6. Chen, Z., Liang, Y., Lin, Y., and Cai, J. (2022). Recycling of waste tire rubber as aggregate in impact-resistant engineered cementitious composites. *Construction and Building Materials. 359, 129477*. Doi: 10.1016/j.conbuidmat.2022.129477.
7. Ramarad, S., Khalid, M., Ratnam, C T., Luqman Chuah, A., and Rashmi, W. (2015). Waste tire rubber in polymer blends: A review on the evolution, properties, and future. *Progress in Materials Science. 72, 100-140*. Doi: 10.1016/j.pmatsci.2015.02.004.
8. Raffoul, S., Garcia, R., Escolano-Margarit, D., Guadagnini, M., Hajirasouliha, I., and Pilakoutas, K. (2017). Behaviour of unconfined and FRP-confined rubberized concrete in axial compression. *Construction and Building Materials. 147, 388-397*. Doi: 10.1016/j.conbuildmat.2017.04.175.
9. Yadav, J S., and Tiwari, S K. (2016). Effect of inclusion of crumb rubber on the unconfined compressive strength and wet-dry durability of cement stabilized clayey soil. *Journal of Building Materials and Structures, 3(2), 68-84*. Doi: 10.34118/jbms.v3i2.25.
10. Khan, S R., Zeedhan, M., and Masood, A. (2020). Enhancement of hydrocarbons production through co-pyrolysis of acid-treated biomass and waste tire in a fixed bed reactor. *Waste Managagement, 106, 21-31*. Doi: 10.1016/j.wasman.2020.03.010.
11. Imbernon, L., and Norvez, S. (2016). From landfilling to vitrimer chemistry in rubber life cycle. *European Polymer Journal. 82, 347-376.* Doi: 10.1016/j.eurpolymj.2016.03.0165.

*Corresponding Author: **López García Ricardo Daniel.**