Articles

Circular economy for the management of disused tyre waste in Chongón - Guayaquil

Economía circular para la gestión de residuos de llantas en desuso en Chongón – Guayaquil

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ABSTRACT

Scrap tyres can cause a severe environmental impact on the community. To describe the contribution of the circular economy model to the management of scrap tyre waste in Chongón - Guayaquil. Quantitative, descriptive, correlational study, using a survey of 20 vulcanisers in the parish of Chongón in the city of Guayaquil. A high level of reliability was obtained with a Cronbach's alpha of 0.883, as well as a significant correlation between the variables of waste management of scrap tyres and the circular economy model, with a bilateral sig. of <0.05. The disposal of scrap tyres causes severe environmental impacts in the parish of Chongón-Guayaquil, however, the application of an optimal waste management of these wastes, recycling and reusing them in the manufacture of other products, corresponds to the circular economy model, promoting economic development, sustainability and environmental protection.

Keywords: Waste management, circular economy model, recycling, reuse, environmental damage.

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JOURNAL OF BUSINESS and entrepreneurial studies
ISSN: 2576-0971

Journal of Business and entrepreneurial
October - December Vol. 8 - 4 - 2024
http://journalbusinesses.com/index.php/revista
e-ISSN: 2576-0971
journalbusinessentrepreneurial@gmail.com
Receipt: 09 May 2024
Approval: 12 July 2024
Page 1-12

Journal of Business and entrepreneurial studies
ISSN: 2576-0971
http://journalbusinesses.com/index.php/revista

RESUMEN

Las llantas en desuso pueden causar un severo impacto ambiental en la comunidad. Describir la contribución del modelo de economía circular a la gestión de residuos de llantas en desuso, en Chongón – Guayaquil. Estudio cuantitativa, descriptivo, correlacional, con uso de la encuesta a 20 vulcanizadoras de la parroquia Chongón de la ciudad de Guayaquil.

Se obtuvo un elevado nivel de fiabilidad con alfa de Cronbach de 0,883, así como correlación significativa entre las variables de la gestión de residuos de llantas en desuso y el modelo de economía circular, con sig. bilateral <0,05. La eliminación de llantas en desuso, ocasiona severos impactos ambientales en la parroquia Chongón-Guayaquil, sin embargo, la aplicación de una óptima gestión de residuos de estos desechos, reciclándolos y reutilizándolos en la fabricación de otros productos, se corresponde con el modelo de economía circular, promoviendo desarrollo económico, sostenibilidad y protección ambiental.

Palabras clave: Gestión de residuos, modelo de economía circular, reciclaje, reutilización, daño ambiental.

INTRODUCTION

The United Nations has designed the 2030 Global Agenda to promote high levels of sustainability in industry, equal rights for different social groups, greater development and well-being of society in general, for which 17 Sustainable Development Goals (SDGs) have been proposed, where 11 and 12 refer to the maintenance of sustainability standards in communities, as well as in production and consumption.

In order to achieve these SDGs, the United Nations Development Programme has alerted public authorities in each state to plan and implement work to achieve high levels of sustainability, based on the use of efficient systems for recycling solid waste that can cause pollution in the environment, with disused tyres being one of the most severe problems that can affect the biotic and abiotic components of the different global and national ecosystems.

Bernal et al. reported that there are currently around 2.9 billion tyres on the world market, which at some point will become obsolete, and that the governments in power have not bothered to plan and execute an efficient management of this solid waste, which

has a high polluting power and affects the biotic and abiotic components of nature. The problem is so worrying that the United States Environmental Protection Agency itself reported the existence of 275 million tyres piled up, with the probability of causing environmental impacts, if no plan is designed to transform them into other goods of benefit to the population. Meanwhile, Rocha et al. have expressed their concern that in Colombia there has been no planning, let alone the execution of activities inherent to waste management, with respect to the management and disposal of tyres that have passed through obsolescence and, not being considered as a polluting object by the public authorities of this country, have not been adequately treated, once they are no longer in use.

Also in the national context, the theoretical literature points out that the production and importation of rubber products, including tyres, contribute 2% of greenhouse gases from industrial activity, with another problem being the current difficulty in recycling and reuse by vehicle owners and vulcanisation companies that work with these tyres, favouring the generation of negative environmental impacts.

In this regard, Raudales et al. have stated that a strategy of essential interest for the optimisation of waste management consists precisely in the application of the circular economy, one of the options closely linked to sustainability models in industry and in the communities themselves.

Based on this, Carlos et al. have conceived of the circular economy as a regenerative model, which focuses on renewable energy and therefore seeks to eliminate waste and implement a new system for business. For his part, Palma argues that the circular economy is based on the reduction of waste and elements that serve to develop a new product, so that this system implements the reuse of materials during the industrial process, so that the consumption of non-renewable resources that are vital for the survival of ecosystems is reduced, given that the environmental impact is reduced.

Used tyres are not considered hazardous waste, but they contain important substances that, if not treated according to regulations, could have a negative impact on people's health and the environment. In fact, disused tyres can be recovered and reused for the production of a new product which, although it benefits the systems, prevents its components from being degraded to the point of affecting the flora and fauna due to the toxicity emanating from it.

In fact, the life cycle of the products covers a route that goes from the production of the fibres to their commercialisation, therefore, their use and disposal involves compliance with regulations to avoid contamination of the ecosystem. This process avoids the well-known linear economy, which for years has been involved in the use and disposal of products without considering the impact this has on the environment.

In addition to this, the circular economy in connection with the recycling of scrap tyres allows the process of restructuring and regeneration to be obtained, i.e. the product waste is given a second chance, extending its useful life as long as possible, thus ensuring maximum benefit for the execution of other manufactured products.

Some of the studies related to the circular economy that demonstrate their contribution to the management of scrap tyre waste have been described in the following paragraphs, with the intention of justifying the development of this study.

For this reason, the study by Palma and Vásquez was reviewed, in which the poor management of tyre waste is reflected, due to the fact that the saturation of physical, chemical and biological elements in the environment was evidenced, producing negative alterations in living beings, for which reason an alternative was sought to eliminate, suppress and minimise pollution efficiently.

For its part, it has been necessary to link the research of Aguilar, because, there was a bad management of used tyres, affecting the environmental and sanitary part, so, to maintain the circular economy has been proposed alternatives to contribute to the mitigation of impacts, being these recovered for the raw material used for the production of other derivatives, and in this way, it was possible to recover 100% of the waste.

Likewise, the author Rosas stated the lack of policies for the treatment of disused tyres, which has caused the disposal of this tyre to release toxic pollutants for people's health, so, in order to contribute to the circular economy, the elaboration of new products from waste was proposed, reducing production costs and reusing other materials, thus avoiding environmental consequences.

Another research by Padilla shows that the owners of the vulcanisers do not have the necessary knowledge about the management of tyre disposal, which is why their management was deficient. For this reason, it was proposed to make use of them through recycling and reuse, benefiting the economic and environmental sector, which resulted in the improvement of people's quality of life.

For their part, Abugattas and Carnero argue that the poor management of tyre disposal represented a threat to sustainable development, so that, through the implementation of the circular economy, it was possible to obtain benefits, in order to ensure that resources reach the end of their life cycle, so that the development of new products minimised the negative impact and generated new opportunities. Finally, Vallejo emphasises that the circular economy offers benefits to society, however, the lack of policies and regulations that contribute to the efficient disposal of waste had a negative influence on environmental pollution, therefore, through reuse, recycling and circular design, the most important sectors of the region benefit, as it improves the quality of life and contributes to sustainability.

Therefore, it is observed that the beneficiaries of this research, not only refers to the surrounding community, in this case, the Chongón parish of Guayaquil, who will be able to live in better health conditions, but also benefits nature itself, which needs to be protected and preserved without pollutants, in full respect for their rights and compliance with the SDGs of Agenda 2030 of the United Nations.

In addition to this, a better performance in the maintenance of ecosystem protection standards by the Ecuadorian environmental authority is expected, in the hope that tyre waste can be managed for the manufacture of other products, to boost the national productive matrix and generate sources of employment for the population, based on the use of the circular economy model, in the solution of this environmental problem under analysis.

In addition, the main objective of this study was to describe the contribution of the circular economy model to the management of disused tyre waste in Chongón - Guayaquil, for which the environmental impacts caused by these obsolete tyres were estimated, as well as the importance of properly managing this waste, through an option linked to the circular economy, for the solution of this problem.

MATERIALS AND METHODS

Indeed, this article addresses the problem of the circular economy for the management of scrap tyre waste, therefore, the quantitative approach was implemented, which according to Rasinger is a method that seeks to measure the variables of the study, being these quantifiable that allow determining the affectation of the phenomenon in the field where the study is developed. In this case, the tools can be used to measure the environmental pollution caused by the disposal of waste tyres and the acceptance of the circular economy.

In addition, the descriptive and correlational study was associated, which according to Guevara et al. is based on the analysis of the variables, in a succinct manner, to show their behaviour in the problematic aspect and subsequently, to estimate their level of association. Therefore, we proceed to expose the characteristics of environmental pollution caused by disused tyres, as well as the importance of waste management and its relationship with the circular economy model.

Meanwhile, field research, as defined by Robledo, consists of the researcher going to the place or space where the facts were evidenced. Therefore, it was necessary to go to the vulcanisation plants in the parish of Chongón for the application of the survey, in this way, the informative data were obtained from the same main source. As for the population and sample, defined by Mucha et al. the universe consists of the elements linked to and affected by the problem, while the sample is the subset of the population that presents the same characteristics, according to Rodríguez and Pérez. In this case, the population and sample of this study consisted of 20 vulcanisation plants located in the parish of Chongón, which are included in the list of the study area, 2022.

Regarding the technique for data collection, it was related to the survey, which according to Feria et al., closed questions with options are used to trigger the behaviours of the problem, through the answers obtained from the injured parties. Therefore, this article used the survey because it is intended to know the management of waste from disused tyres, in order to propose in response to a circular economy where tyres are used, avoiding environmental pollution. To this end, we proceeded to survey the owners of

Journal of Business and entrepreneurial studies
ISSN: 2576-0971
http://journalbusinesses.com/index.php/revista

the 20 vulcanizadoras in the parish of Chongón, to create a database in the Excel spreadsheet, to continue using the SPSS programme, with which we calculated the level of reliability and correlation of the variables under study.

RESULTS

The results obtained after conducting the survey of the owners of the vulcanisers in the parish of Chongón in Guayaquil were as follows:
1) They have sufficient capacity to store all the disused tyres that arrive at their establishment.
According to 80% of the owners of the vulcanisers, their economic establishments do not have sufficient structure to store all the tyres that arrive at their premises.
2) The disused tyres that cannot be stored on their premises are disposed of by the public anywhere in the sector.
According to 70% of the owners of the vulcanisers, the tyres that cannot be stored in their establishments are mostly disposed of in the streets, landfills or desolate places in the sector.
3) There is environmental damage from disused tyres that are disposed of anywhere in the sector.
According to 90% of the vulcanizer owners, there is severe environmental damage due to the tyres that are disposed of in the environment.
4) This environmental damage caused by discarded tyres that are disposed of anywhere in the sector can be mitigated or minimised by recycling them.
According to 85% of the vulcanisation plant owners, waste management is necessary to encourage the recycling of scrap tyres and prevent them from being disposed of on local streets causing severe environmental damage.
5) The environmental damage caused by discarded tyres that are disposed of anywhere in the sector can be mitigated or minimised by reusing them in the production of other items.
According to 75% of the vulcanisation plant owners, the application of the circular economy model, through the reuse of disused tyres as raw material for the production of other products, can avoid their disposal on the streets of the locality and minimise the severe environmental damage caused by them.
Based on these results, a statistical correlation test was carried out to establish the association of the variables under study, but first the validity of the instrument was defined using Cronbach's alpha.
A high level of reliability was obtained, above 0.70 points, i.e. 0.883, a result that allows us to continue with the correlation exercise, although, previously, the normality test was used to determine whether a parametric or non-parametric correlation test should be used. In this respect, if the asymptotic sig. <0.05, then it will be non-parametric (Spearman's coefficient), otherwise it will be parametric (Pearson's coefficient).

Journal of Business and entrepreneurial studies
ISSN: 2576-0971
http://journalbusinesses.com/index.php/revista

Once the Kolmogorov - Smirnov or K-S test was applied, the following results were obtained:

Table 1. Prueba de normalidad K-S

		Eliminación de llantas en desuso en las calles	Daño ambiental	Gestión de residuos	Modelo de economía circular
N		20	20	20	20
Parámetros normales[a,b]	Media	2,5500	2,8500	2,8000	2,6500
	Desviación	,75915	,48936	,52315	,67082
Máximas diferencias extremas	Absoluto	,423	,520	,499	,449
	Positivo	,277	,380	,351	,301
	Negativo	-,423	-,520	-,499	-,449
Estadístico de prueba		,423	,520	,499	,449
Sig. asintótica(bilateral)		,000[c]	,000[c]	,000[c]	,000[c]

a. La distribución de prueba es normal.
b. Se calcula a partir de datos.
c. Corrección de significación de Lilliefors.

Since, the distribution of the data has a normal trend, then, Spearman's non-parametric coefficient test was used, which decides to accept the following hypotheses, according to the following restrictions:

Null hypothesis: 'The disposal of disused tyres in the streets does not cause environmental damage'. 'The waste management of end-of-life tyres does not correspond to the circular economy and environmental protection model'.

Alternative hypothesis: 'The disposal of scrap tyres on the streets causes environmental damage'. 'Waste management of end-of-life tyres corresponds to the model of circular economy and environmental protection'.

Restriction: if bilateral sig. <0.05, the alternative hypothesis is accepted and the null hypothesis is rejected, otherwise, the alternative is rejected and the null hypothesis is accepted.

The results obtained with the application of Spearman's test, highlighted the following data:

Journal of Business and entrepreneurial studies
ISSN: 2576-0971
http://journalbusinesses.com/index.php/revista

Tablae3. Resultados de correlación entre las variables del estudio.

		Eliminación de llantas en desuso en calles	Daño ambiental
Eliminación de llantas en desuso en calles	Correlación de Spearman	1	,506*
	Sig. (bilateral)		,023
Daño ambiental	Correlación de Spearman	,506*	1
	Sig. (bilateral)	,023	
		Modelo economía circular	Gestión de residuos
Gestión de residuos	Correlación de Spearman	1	,710
	Sig. (bilateral)		,000
Modelo de economía circular	Correlación de Spearman	,710	1
	Sig. (bilateral)	,000	

Nota: tomado de la encuesta a los vulcanizadores.

Finally, the alternative hypothesis is accepted, i.e., the disposal of disused tyres on the streets causes environmental damage, therefore, the waste management of disused tyres corresponds to the circular economy model and environmental protection, through the recycling and reuse of these tyres, to transform them into new products that can serve for the development of the community, both in the generation of sources of employment, income for the population, and to improve sustainability and the preservation of natural resources. The results obtained showed that 70% of the owners of the vulcanizadoras are aware that the public should eliminate disused tyres in the streets of the parish of Chongón in Guayaquil, because 80% of these commercial establishments do not have sufficient infrastructure to accumulate these obsolete tyres, which, according to 90% of those investigated, causes severe environmental damage. From these findings, a significant correlation was obtained between both variables, with bilateral sig. <0.05, demonstrating that the disposal of disused tyres on the streets causes serious environmental impacts to biotic and abiotic components.

These results are concatenated with the expressions of Bernal et al. , who indicated that there are around 275 million tyres piled up in the United States alone and 2.9 billion in the world market, which can cause potential environmental impacts. In addition, Fariño considered that disused tyres can cause greenhouse gases, especially if they are incinerated in public places or on the streets of a locality.

For this reason, Arana also found an association between the disposal of scrap tyres and the environmental damage that results from this decision by industry and/or community members. This finding was concurred with by Palma and Vásquez, who also found that obsolete tyres abandoned in rubbish dumps, streams or anywhere on public roads

contribute to the saturation of physical, chemical and biological environmental components.

In the same way, it was determined that the waste management of disused tyres is perfectly in line with the circular economy model and promotes environmental protection in the community, by obtaining a bilateral sig. <0.05 in the Spearman correlation test.

Indeed, the collection of disused tyres through recycling can be promoted as a raw material for the production of various products that can generate sources of employment and economic development for the community of Chongón and mitigate the environmental impacts generated by tyres that are disposed of on the streets, in full compliance with the principles of sustainability and preservation of natural resources.

Given this situation, Córdoba and Vera also emphasised the need to recover and reuse tyres that have exceeded their useful life, demonstrating that waste management of obsolete tyres can be one of the most relevant strategies associated with the circular economy model, finding significant correlations between the two variables, with bilateral sig. <0.05. According to Gómez and Fuenmayor, the rubber and other materials that are part of the disused tyres can be used to make other products, therefore, an optimal management of the waste from these tyres, through their correct recycling, can contribute to the application of the circular economy model, to manufacture new products from these tyres that ceased to serve their original function, but can be reused for the manufacture of other items necessary for the community.

Vallejo also corroborated the importance of an optimal waste management of the tyres that no longer serve for what they were designed for, because from this activity, the reuse of this waste material can be guaranteed, as raw materials for the manufacture of new or current products that are on the market, taking advantage of this waste, in accordance with the circular economy model, not only to improve the economic development of the community, but also to protect the rights of nature and ensure the sustainability of ecosystems.

In view of this, it should be noted that the management of waste from disused tyres is closely associated with the circular economy model, which can ensure compliance with the SDGs of the United Nations 2030 Agenda, respect for the constitutional principles that protect the rights of nature and, above all, contribute to the economic growth of the community of Chongón, through entrepreneurship.

CONCLUSIONS

It was concluded that the inhabitants of the parish of Chongón are disposing of disused tyres in various sectors of the streets of this community, due to the fact that the vulcanisers of this parish do not have sufficient infrastructure for the storage of all the obsolete tyres that arrive at their establishment, causing a severe environmental impact on the parish ecosystem. Therefore, it was possible to corroborate that the viable alternative to overcome this problem is the implementation of an optimal waste

management of disused tyres, through the recycling of these obsolete tyres, to then reuse them as raw materials for the manufacture of other products, giving new uses to these wastes, in accordance with the circular economy model, so that, in addition to generating economic development by promoting entrepreneurship, nature is also protected, the sustainability of the industry is guaranteed and the maintenance of a healthy ecosystem for the benefit of the local population is ensured.

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