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Economic valuation of the proper management of municipal solid waste in an educational space

Valuación económica del manejo adecuado de los residuos sólidos urbanos en un espacio educativo

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Abstract

The correct management of Municipal Solid Waste (MSW) in any population center is essential to guarantee the quality of life of its inhabitants and the surrounding environment. The study carried out involved the quantification of MSW generated in specific areas of the Juan Pablo II campus of the University of Guanajuato, with the use of two complete recycling stations with primary and secondary labeling, graphically specifying a subclassification with infographic type posters. For 5 weeks we separated and sold the most commercially valuable solids in Celaya, delivering the proceeds to the corresponding university agency, and the lids of the different food containers were donated to an association that supports children with cancer. With the amount obtained, an economic feasibility analysis was carried out using the financial evaluation criteria Net Present Value (NPV) and Internal Rate of Return (IRR) to know the feasibility in monetary terms; to complement this, the equilibrium point (Q) and the sensitivity analysis were used; trying to exploit the maximum recycling capacity and move to the circular economy.

Economic feasibility, Municipal solid waste, Circular economy

Resumen

El manejo correcto de los Residuos Sólidos Urbanos (RSU) en cualquier centro de población es indispensable para garantizar la calidad de vida de sus habitantes y del ambiente circundante. El estudio realizado, implica la cuantificación de los RSU generados en áreas específicas de la sede Juan Pablo II de la Universidad de Guanajuato, con el uso de dos estaciones completas de reciclaje adecuadas con una rotulación primaria y secundaria, precisando gráficamente una subclasificación con carteles tipo infografía. Durante 5 semanas se llevó a cabo la separación y venta de los sólidos valorizables más comercializados en Celaya; entregando lo recaudado a la instancia universitaria correspondiente, aunado las tapas de los diferentes envases alimenticios fueron donadas a una asociación que apoya a niños con cáncer. Con el monto obtenido se realizó un análisis de factibilidad económica utilizando los criterios de evaluación financiera Valor Presente Neto (VPN) y Tasa Interna de Retorno (TIR) a fin de conocer la viabilidad en términos monetarios; para complementar se utilizó el punto de equilibrio (Q) y el análisis de sensibilidad; intentando explotar la capacidad de reciclaje máxima y transitar a la economía circular.

Viabilidad económica, Residuos sólidos urbanos, Economía circular

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Introduction

The increasing volume and complexity of waste associated with the modern economy is posing a serious risk to ecosystems and human health. Poor waste management (ranging from non-existent collection systems to inefficient disposal) leads to air, water and soil pollution. Open and unsanitary landfills contribute to the contamination of drinking water and can cause infections and transmit diseases (United Nations Environment Programme, 2023).

"Don't waste to avoid scarcity". This old adage has much validity as world leaders, as well as local communities, increasingly call for an amendment to the so-called "throwaway culture" (World Bank, 2018). One of the solutions to this problem comes through recycling, where the aim is to convert some of the materials that make up waste into materials that can be reused in production processes. From an environmental and public health point of view, the proper management of waste in the stages following its generation allows mitigating its negative impacts on the environment and health, in addition to reducing pressure on natural resources (Secretaría de Medio Ambiente y Recursos Naturales, 2017a).

It is undeniable that there is economic importance in MSW, but it is directly conditioned by the correct separation of these, if done successfully, it transitions to the circular economy; Belda Hériz (2018) defines that the circular economy intends that our products are always in circulation, not only extending its useful life but getting that, both during this, and once it is over, they serve to generate new products, so that it is not necessary to extract large amounts of natural resources, but to use again those that were already once used or extracted, thus avoiding so much dependence.

The Universidad de Guanajuato in its different campuses is committed to primary and to some extent secondary separation, although it is imperative to point out that there is a disproportionate rate of waste generation, as well as little culture of integral separation.

The reason for carrying out this study, by sampling the MSW generated at the Juan Pablo II Campus of the Celaya-Salvatierra Campus of the University of Guanajuato in key areas, is to find out the patterns in the composition of the waste, quantify the valuable waste and look for an economic return by selling it in collection centres. The aim is to show the community that it is possible to move towards circularity, without separation being considered an unacceptable economic practice in the environment, but rather as an urgent necessity in the face of environmental deterioration.

Municipal solid waste

A waste is the "part or portion that is left of a whole" (Rondón Toro et al., 2016), municipal solid waste (MSW) is the waste generated in households, resulting from the disposal of the materials used in their domestic activities, the products they consume and their containers, packaging or wrapping; as well as waste from any other activity within establishments or on public roads that generates waste with household characteristics, and waste resulting from the cleaning of roads and public places (Secretaría de Medio Ambiente y Recursos Naturales, 2017c).

According to the World Bank report What a Waste 2.0, 2010 million tonnes of municipal solid waste is generated annually worldwide, and at least 33% of it is not managed without risk to the environment (World Bank, 2018). In Mexico according to INEGI in 2018, an average of 107,056 tons of rubbish were collected daily, that is, 854 grams per person; the state of Guanajuato ranks sixth, with a generation of 4,481 tons daily, contributing 4.2 % of the total generation (Instituto Nacional de Estadística, Geografía e Informática, 2019). Particularly, in the municipality of Celaya, Turcott and Aguilar (2020) indicate that 0.78 kilograms of waste are generated per inhabitant per day, highlighting that there is 96% coverage in the collection service.

Reuse and recycling simultaneously reduce the use of energy and water needed for extraction and processing, as well as the need for space to finally dispose of the waste. From an economic point of view, a lower volume of waste requiring final disposal reduces operating costs; according to OECD estimates (Secretaría de Medio Ambiente y Recursos Naturales, 2017a).

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Municipal solid waste management

In 2015, 17 Sustainable Development Goals (SDGs) were created in an effort to move towards a reconciliation between human lifestyles and the planet, with 15-year targets that allow us to continue to thrive as a species, but with the least possible environmental impact. Goal 12: Ensure sustainable consumption and production patterns and its target 12.5: By 2030, significantly reduce waste generation through prevention, reduction, recycling and reuse (United Nations, 2022), state the need for proper MSW management.

Providing integrated MSW management in Mexico is based on the Political Constitution of the United Mexican States; the General Law on Ecological Balance and Environmental Protection; the General Law for the Prevention and Integrated Management of Waste and its regulations (Government of Mexico City, 2023); as well as multiple regulatory instruments at the federal, state and municipal levels.

For the state of Guanajuato, the legal instruments are extensive; in particular, there is the Good Housekeeping Practices label, which is a model promoted by the Environmental and Land Management Office, which promotes the participation and responsibility of society to improve environmental performance and reduce the impact of the effects of climate change. It is aimed at micro, small businesses, business chambers, service providers, the tourism industry and public (such as the University of Guanajuato) and private institutions; it is a set of actions or activities that allow the reduction in the use of natural resources such as energy, water, waste generation, environmental risks, consumption of resources and raw materials (Procuraduría Ambiental y de Ordenamiento Territorial de Guanajuato, 2023).

For Mexico, basic MSW management still predominates, which consists of collecting and disposing of waste in sanitary landfills, wasting waste that can be reincorporated into the productive system (Secretaría de Medio Ambiente y Recursos Naturales, 2017b); this is the responsibility of the municipality.

Toledo Cervantes and Quintero Castellanos (2022) show that the problems they essentially face are budgetary control, the absence of operating manuals and technical expertise, resulting in a profound ambiguity in the definition of MSW policy and its management. In addition, there is little or no culture of waste separation at source.

Economic value of municipal solid waste

The general economic definition of waste "is something that has no use value, and therefore no exchange value. Moreover, because waste is a nuisance, we are willing to pay to be rid of it" (André and Cerda, 2006).

MSW generates a considerable expense for municipalities, the costs of waste collection reported in the PPGIR (Programmes for the Prevention and Integral Management of Waste) corresponding to 167 municipalities in 13 federal entities; they amount on average to $434.03. 03 per tonne collected and only consider the operation of the collection service; in the case of the costs for final waste disposal, reported by 84 municipalities in 10 states, they indicate an average cost of $121.58 per tonne deposited in the final disposal sites (including only the salary of the workers who work at the site and the fuel for the machinery used), according to the Ministry of Environment and Natural Resources, (2020).

The economic activity that is linked to the use of municipal solid waste in Mexico is known as "pepena". Generally, these groups do not carry out their activities in a hygienic manner, nor with the appropriate equipment, nor do they adhere to labour legislation, nor do they pay taxes or have social security. Among them, there are often minors and elderly people who are exposed to various diseases, infections and contagions (Pineda Pablos and Loera Burnes, 2007). This is why it is not considered a widely accepted job in society, but this does not imply that it is poorly paid compared to other informal or even formal jobs. A pepenador or pepenadora in Mexico can earn from $350.00 to $1,800.00 pesos per day collecting rubbish, according to information from NTR, a website from Zacatecas, which interviewed people who work in this trade. (Grupo Fórmula, 2022).

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Generalising, we can consider and model as an ongoing business the integrated management of MSW, with primary and secondary separation, for the subsequent sale of the recoverable waste and thus reduce the amount that reaches final disposal. Given that there is an economic value and a market for MSW, of course undervalued in Mexico, the study seeks to evaluate the economic feasibility of integrated waste management within a given area at the Juan Pablo II campus of the Celaya-Salvatierra Campus of the University of Guanajuato.

Research design

Solid urban waste generated during 5 weeks of the January-June 2023 semester was collected, separated and quantified in the cafeteria area and the Civil Engineering laboratory building of the Juan Pablo II campus of the Celaya-Salvatierra campus, belonging to the University of Guanajuato. Two complete recycling stations were used, with primary and secondary separation signage, poster type in a visual range for any user (Figures 1, 2 and 3) being: organic, non-recyclable inorganic, PET, non-PET plastic, glass, cans, paper and cardboard; in addition to providing a description of each type, conditions for their deposit and examples of these wastes.

Figure 1 Organic and inorganic container

Figure 2 PET Container

Figure 3 Non-PET plastic, paper and cardboard, glass and cans containers

During the days of the study, the waste from both stations was collected in the afternoon, re-sorting those deposited incorrectly, and then throwing away liquids or any other solid waste that did not belong to the recoverable containers. After weighing, they were transported to a temporary warehouse awaiting a larger quantity to be sold at a collection centre close to the institution. The selected facility was REPLAFI, Recicladora de Plásticos y Fibras del Bajío, located at Paseo de San Nicolás de Parra, Lagos, 38060 Celaya, Gto. approximately 2.5 kilometres away with an estimated time of 4 minutes by car (Figure 4).

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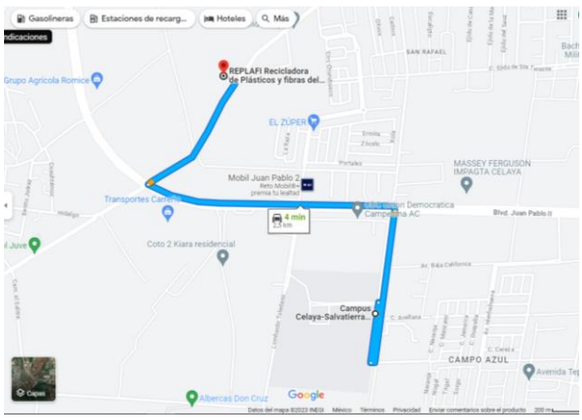

Figure 4 REPLAFI
Source: (Google Maps, 2023)

The money collected from the sale was handed over in its entirety to the Campus Sustainability Management Liaison, as well as the receipts issued by the collection centre; a document necessary to keep the Good Housekeeping Practices Distinction, in verification aspect three: Responsible use of Materials and Inputs, Reduction in waste generation; issued by the Environmental and Land Management Office (PAOT) of the State of Guanajuato.

Methodological considerations

The weights recorded are composed exclusively of what was collected in the containers of the two recycling stations, leaving out sanitary waste, those that were highly contaminated by other waste (due to difficult cleaning and sale) or that did not belong to the designated categories; Sampling was carried out from Monday to Friday, observing official suspensions. Sanitary precautions were implemented for the handling of MSW with the volunteers, such as: polyurethane-coated nylon gloves, lab coat and antibacterial gel. An electronic scale with an accuracy of 0.05 kg, provided by the Civil Engineering laboratories of the Celaya-Salvatierra Campus, was used for weighing.

The caps of the PET, glass or other bottles found were not quantified for sale, with the opportunity to donate them to a support centre for children with cancer that helps in the city of Celaya. This reduced on average 14.12% of the total weight of the PET type container, as for a 0.5 litre bottle with a weight of 17 grams the cap weighs approximately 2.4 grams according to Remsa plásticos (2023).

Financial evaluation

a) Net Present Value (NPV)

The first financial evaluation criterion to be used is the Net Present Value (NPV), which is a practical method, because future expenditures or inputs are transformed into monetary units of the current equivalent rate considered, in the present (Arbones Malasani, 2009). The NPV is the monetary amount resulting from the difference between the net income derived from the sale of the present value of the valuables and the initial investment in inputs and materials:

$$VPN = \sum_{n=0}^{N} \frac{A_n}{(1+i)^N} = \sum_{n=0}^{N} \frac{A_n}{(1+TREMA)^N} \quad (1)$$

Where:

VPN = Net Present Value

A_n= net cash flow at the end of the period

i = TREMA TMinimum Acceptable Return Handle

N= service life of the project

Source: (Moreno-Martínez et al., 2022).

A positive NPV indicates that the present value of the net income fully covers the cost of the investment; a negative NPV means that the present value of the net income does not cover the cost of the initial investment (Alvarado Verdín, 2015).

a) Internal Rate of Return (IRR)

The second criterion to be used is the Internal Rate of Return (IRR), defined as the interest rate that makes the net present value equal to zero, i.e. when the TREMA is equal to the IRR (Vidaurri Aguirre, 2013), to deduce it we follow the method of trial and error or iteration, until converting the NPV to zero, mathematically (Moreno-Martínez et al., 2022):

$$VPN = \sum_{n=0}^{N} \frac{A_n}{(1+TREMA)^N} = 0 \quad (2)$$

When IRR > TREMA the alternative is accepted, if IRR = TREMA the alternative is reconsidered and if IRR < TREMA the alternative is rejected. (Alvarado Verdín, 2015).

a) Sensitivity analysis

Economic analysis uses estimates of future values of a parameter to help make decisions; which is the objective of this study, to identify possible scenarios for action. Therefore, performing a sensitivity analysis to visualise the effect of variation in the amount of recoverable MSW, its market price or TREMA becomes relevant. Sensitivity analysis determines how a value measurement is altered when one or more parameters vary over a certain range of values. Usually one parameter is varied at a time, and independence from other parameters is assumed (Blank and Tarquin, 2011).

b) Equilibrium point

For the purpose of deepening and providing a broader picture of the research, it is necessary to resort to the determination of the break-even point, as Blank and Tarquin (2011) show, this analysis finds the value of a parameter that makes two elements equal, it is determined from mathematical equations, such as the revenues and costs of a product, the supply of materials, and supply and demand parameters:

$$Q = \frac{CF}{r-v} \quad (3)$$

Where:

Q = equilibrium quantity

CF = fixed costs

r = revenue per unit

v = variable cost per unit

Knowing Q, aims to illustrate how the market for the sale of recoverable MSW in the city of Celaya works and to detect areas of opportunity.

Financial considerations

The financial generalities applicable to the study are described below:

Useful life

The weighing of recoverable MSW in the 5 weeks for calculation purposes translates to one month, given that it is only monitored from Monday to Friday and respecting official suspensions.

The useful life of project N is proposed at 20 months, which would be equivalent to 2 school years, given that there are 2 holiday periods and days off, as well as any other setbacks. In addition, as it is a pilot test that may or may not be continued.

Income

For the income per kilogramme of recoverable MSW, the average purchase price on the days on which it was taken to the collection centre (at the end of each week) was used, as it was noted that there were fluctuations in the amount received per kilogramme from one week to the next.

Expenditure

Among the expenditures considered are the initial investment in gloves, posters and containers, which appeared to be a new acquisition, but these were already in the possession of the infrastructure department, where the purchase price and the length of time they were stored are unknown. As monthly expenses, gasoline and ecological bags. Since the fieldwork was carried out by students and teachers who voluntarily wished to join the project, the applicable salaries and taxes are omitted, as well as the depreciation of the containers and the vehicle for transport.

Choice of the TREMA

For the calculations of the financial evaluation, a TREMA equal to the one-month (28-day) Certificados de la Tesorería de la Federación (CETES) rate of 11.25 % as of 14 September 2023 (Secretaría de Hacienda y Crédito Público, 2023) is assumed. As this is an investment rate considered to be safe.

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Results and discussion

The initial investment that simulated the acquisition of the two recycling stations and other materials was $15,897.85 and the monthly operating expenses amounted to $42.01 as shown in Table 1.

a) Initial investment	Quantity	price	Total
50 gallon container	1	$3,388.00	$3,388.00
Eco bottle	1	$4,516.37	$4,516.37
Recycling station	2	$3,702.74	$7,405.48
Nylon gloves (pairs)	6	$68.00	$408.00
Signs	12	$15.00	$180.00
Total			$15,897.85
b) Monthly income	**Quantity**	**price**	**Total**
Ecological bags	120	$0.11	$13.64
Petrol (km travelled)	10	$2.84	$28.37
Total			$42.01

Table 1 General expenditure of the investment project

From the sale of recoverable MSW, a total of $339.53 pesos was obtained (Table 2), with the PET container collecting the highest amount of $156.96, while the heaviest weight collected was cardboard with 42.86 kg, for a total of 98.88 kg (Table 3).

	kg	Price	Income
PET	19.62	$8.00	$156.96
Latas	2.12	$18.00	$38.16
Cartón	42.86	$0.50	$21.43
Papel	30.24	$4.00	$120.96
Vidrio	4.04	$0.50	$2.02
Total income/month			$339.53

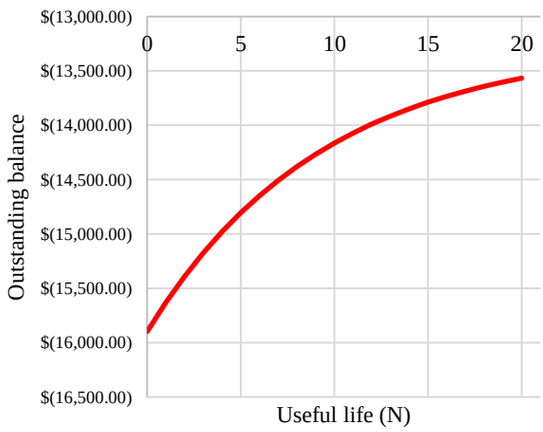
Table 2 Total income from the sale of recoverable MSW

For the calculation of the cash flows in period N= 0 the initial investment was used, from periods 1 to 20 the difference of the total income and expenditure per month was obtained; when calculating the sum of the PV it shows an unfavourable behaviour with a value of -$13,566.81 < 0, consequently, the IRR exhibits a rate of -7.96% < TREMA, the outstanding balance was calculated herewith (Table 3);

Both criteria show that an investment in these conditions should be rejected, as the initial expenses are disproportionate in consideration of the monthly income (in the case of not having the containers previously, such as those that were loaned for the study); while the outstanding balance corroborates this, because after the useful life (N=20) there is no positive balance, $13,566.81 is still owed; this behaviour is exemplified in Graphic 1.

N	Cash flow	TREMA	VP
0	-$15,897.85	11.25%	-$ 15,897.85
1	$297.52	11.25%	$ 267.43
2	$297.52	11.25%	$ 240.39
3	$297.52	11.25%	$ 216.08
4	$297.52	11.25%	$ 194.23
5	$297.52	11.25%	$ 174.59
6	$297.52	11.25%	$ 156.93
7	$297.52	11.25%	$ 141.06
8	$297.52	11.25%	$ 126.80
9	$297.52	11.25%	$ 113.98
10	$297.52	11.25%	$ 102.45
11	$297.52	11.25%	$ 92.09
12	$297.52	11.25%	$ 82.78
13	$297.52	11.25%	$ 74.41
14	$297.52	11.25%	$ 66.88
15	$297.52	11.25%	$ 60.12
16	$297.52	11.25%	$ 54.04
17	$297.52	11.25%	$ 48.58
18	$297.52	11.25%	$ 43.66
19	$297.52	11.25%	$ 39.25
20	$297.52	11.25%	$ 35.28
TIR	-7.96%	VPN	-$ 13,566.81
Outstanding balance			-$ 13,566.81

Table 3 Calculation of NPV, IRR and outstanding balance



Graphic 1 Outstanding balance of the project over time

Since the behaviour is unfavourable, the sensitivity analysis can show the variables that have more or less impact; it was decided to use as a comparative parameter the NPV with respect to an increase in the useful life of the project from 20 months to 70 months (2 to 7 school years). Consequently, the IRR shows changes, which can be seen in the sensitivity graph (Figure 2).

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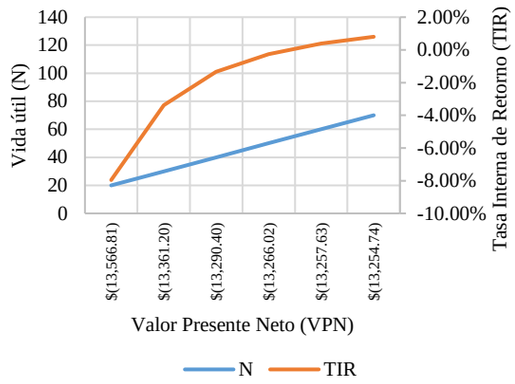

Graphic 2 NPV vs. N and IRR sensitivity analysis

The sensitivity curves indicate that the time N is not sensitive, i.e. despite increasing the useful life of the project considerably, the NPV does not move, as it only decreases by $312.07, while the IRR indicates sensitivity, going from -7.96% to 0.8003% (Table 4).

N	VPN	TIR
20	-$ 13,566.81	-7.96%
30	-$ 13,361.20	-3.38%
40	-$ 13,290.40	-1.34%
50	-$ 13,266.02	-0.26%
60	-$ 13,257.63	0.3881%
70	-$ 13,254.74	0.8003%

Table 4 Calculation of NPV and IRR with increasing N

If the market for recoverable MSW continues to behave with the same average purchase prices (r) that were collected during the time of sale, it is possible to use the break-even point (Q) to know how many kilograms approximately need to be collected and sold in the same originally budgeted useful life (20 months), amounting to 3,700.87 kg per month (Table 5); under the same conditions, the fixed costs (FC) were distributed over the useful life of the project (20 months) and the monthly costs for petrol were added. It is necessary to indicate that the variable costs per unit (v) were disregarded as they are minuscule.

	Q	CF	r
PET	155.50	$823.27	$8.00
Cans	46.49	$823.27	$18.00
Cardboard	1646.53	$823.27	$0.50
Paper	205.82	$823.27	$4.00
Glass	1646.53	$823.27	$0.50
Total	3700.87		

Table 5 Calculation of break-even point Q (kg)

Favourable scenario

While conducting the study, it was possible to observe that students mostly ignored the signs and posters; they preferred to deposit their waste in the wrong container or in other containers outside the two service stations, some of them located continuously, these circumstances provide an area of opportunity. Again using the expression of the break-even point (Q) and the revenue per unit (r), an idealisation of these two parameters was carried out, reinforced by the viva voce expressions made by the workers of the collection centre, where they indicated the highest value of the purchase prices at which all the recoverables have been maintained (Table 6).

	Kg	Price	Income
PET	65	$15.00	$975.00
Cans	15	$22.00	$330.00
Cardboard	84	$3.00	$252.00
Paper	60	$8.00	$480.00
Glass	15	$3.00	$45.00
Total income/month			$2,082.00

Table 6 Idealisation of the purchase price and kilograms harvested

With the data obtained and simulating a favourable scenario, the NPV and IRR were recalculated, with the same useful life and TREMA, visualising in Table 7 that the NPV increases to $85.22 > 0, the same happens with the IRR, which acquires a value of 11.33% > 11.25% just above the safe investment rate.

N	Cash flow	TREMA	VP
0	-$15,897.85	11.25%	-$ 15,897.85
1	$2,039.99	11.25%	$ 1,833.70
2	$2,039.99	11.25%	$ 1,648.27
3	$2,039.99	11.25%	$ 1,481.59
4	$2,039.99	11.25%	$ 1,331.77
5	$2,039.99	11.25%	$ 1,197.09
6	$2,039.99	11.25%	$ 1,076.04
7	$2,039.99	11.25%	$ 967.23
8	$2,039.99	11.25%	$ 869.42
9	$2,039.99	11.25%	$ 781.50
10	$2,039.99	11.25%	$ 702.47
11	$2,039.99	11.25%	$ 631.43
12	$2,039.99	11.25%	$ 567.58
13	$2,039.99	11.25%	$ 510.19
14	$2,039.99	11.25%	$ 458.59
15	$2,039.99	11.25%	$ 412.22
16	$2,039.99	11.25%	$ 370.53
17	$2,039.99	11.25%	$ 333.06
18	$2,039.99	11.25%	$ 299.38
19	$2,039.99	11.25%	$ 269.11
20	$2,039.99	11.25%	$ 241.90
TIR	**11.33%**	**VPN**	**$ 85.22**

Table 7 Calculation of NPV and IRR idealising income

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Donation of lids

Donating caps from various disposable containers to associations that help children with cancer, whose families are unable to afford treatment, allows the circular economy to continue. Mexico is among the countries that produce the largest amount of polyethylene terephthalate (PET), due to the high consumption of soft drinks and bottled water. It is estimated that 200 PET bottles are produced per year for every Mexican (Comisión Nacional de Áreas Naturales Protegidas, 2018). After completing the sampling time, 3.06 kilograms (Table 8), approximately 1,530 caps, were collected and separated by colour, which were donated to the Asociación Mexicana de Ayuda a Niños con Cáncer (AMANC), as part of the "Destapando Esperanza" Campaign at the Celaya collection centre, located at Calle Presa de la Amistad #111, Colonia Buenfil, Celaya, Guanajuato.

Color	Weight (Kg)
Blue	0.95
Red	0.72
White and transparent	0.71
Yellow and gold	0.21
Other colours	0.47
Total	3.06

Table 8 Collected lids

Acknowledgement

To the Liaison for Sustainability Management of the Celaya-Salvatierra Campus, University of Guanajuato.

Conclusions

The results found, unfortunately, show that the university community at the Juan Pablo II Campus did not respond as expected, due to the behaviour they showed when depositing waste, without separating it and ignoring the recycling stations; this indicates that users are not willing to follow an integrated MSW management plan. This had an impact on the amount of recoverable waste and therefore on the amount of waste collected at the end of the sampling period.

The financial analysis is highly unfavourable, it is not even close to being considered an investment that would allow for large-scale implementation, since the NPV was equal to -$13,566.81 and the IRR was -7.96%. It must be stressed that the purchase prices of marketable products are low, and even from one week to the next it was observed that they were declining. In Mexico, as in other Latin American countries, "pickpocketing" is a stigmatised economic activity, an idea that is probably shared by the student community, hence probably the attitude visualised in the study.

In an attempt to generate a favourable scenario for the future, it was simulated to estimate a greater amount of recoverable waste in the different categories of MSW, as well as to expect an increase in the purchase price of MSW; at least to achieve a NPV greater than zero and compensate the initial investment by going from a monthly income of $339.53 to $2,082.00. Although it requires a huge effort from all involved, this could be the opportunity to establish a circular economy model that transcends the school space into everyday life. This effort should be underpinned by the creation of new legal instruments on environmental issues, to try to eradicate the inefficiency and lack of knowledge on the proper management of MSW; directly related to the number of available containers, adequate labelling, collection periods, but especially to education on the issue of separation, which is not higher at higher educational levels, according to what was observed during the study.

Despite the fact that a business model such as the one analysed is not financially feasible, efforts should not cease in order to continue strengthening integrated MSW management programmes, the value of change is there, only disguised as hard work and apparently without economic retribution.

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