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Quantification and commercialization of inorganic household solid waste during the pandemic in the district of Barranca
[Cuantificación y comercialización de los residuos sólidos domiciliarios inorgánicos durante la pandemia en el distrito de Barranca]

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Resumen

La investigación trata sobre la cuantificación y comercialización de residuos domiciliarios inorgánicos durante la pandemia en Barranca. El objetivo fue determinar el beneficio de la comercialización en la cuantificación de los residuos inorgánicos. Se basa en el método descriptivo, para lo cual se estableció la muestra de 50 casas aplicando el método de Kunitoshi Sakurai. Se evaluaron las características de los residuos, se clasificó, se cuantifico por día, mes, se obtuvo la utilidad y rentabilidad. Los resultados determinaron que en la clasificación de residuos por mes el papel y cartón obtuvo 36.90 %, per cápita de residuos inorgánicos destaco el viernes con 0.423 Kg/persona/día, clasificación de los residuos por día destacó materiales de vidrios con 40.43%, cantidad de residuos inorgánicos en enero obtuvo 1106.33 Kg/50 casas/mes, cantidad de residuos inorgánico aprovechable obtuvo 1032.08 kg/ 50 casas/mes, valoración de residuos inorgánicos aprovechables con S/. 564 Soles y utilidad, rentabilidad por mes con S/. 264.00 Soles y 25.60%. Se concluye que en la pandemia se incrementaron los residuos inorgánicos aprovechables en enero con 1032.08 kg/ 50 casas/mes obteniéndose mayor utilidad con 264 soles que equivale a 25.60% de rentabilidad, lo cual evidencia que es beneficioso para generar trabajo.

Palabras clave: Residuos domiciliarios inorgánicos, cuantificación, comercialización, utilidad, pandemia.

Abstract

The research deals with the quantification and commercialization of inorganic household waste during the pandemic in Barranca. The objective was to determine the benefit of commercialization in the quantification of inorganic residues. It is based on the descriptive method, for which the sample of 50 houses was established applying the Kunitoshi Sakurai method. The characteristics of the residues were evaluated, classified, quantified by day, month, utility and profitability were obtained. The results determined that in the classification of waste per month, paper and cardboard obtained 36.90%, per capita of inorganic waste stood out on Friday with 0.423 Kg/person/day, classification of waste per day highlighted glass materials with 40.43%, amount

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of inorganic waste in January obtained 1106.33 Kg/50 houses/month, amount of usable inorganic waste obtained 1032.08 kg/50 houses/month, valuation of usable inorganic waste with S/. 564 Soles and utility, profitability per month with S/. 264.00 Soles and 25.60%. It is concluded that in the pandemic, usable inorganic waste increased in January with 1032.08 kg/ 50 houses/month, obtaining greater utility with 264 soles, which is equivalent to 25.60% profitability, which shows that it is beneficial to generate work.

Keywords: Inorganic household waste, quantification, commercialization, utility, pandemic.

1. Introduction

The event of the Covid-19 pandemic has caused confinement and at the same time mandatory compliance with biosecurity measures when traveling or staying outside their homes in order to reduce the spread of the virus. This event limited the operation of companies in the public and private sectors, which reduced the workload. Obtaining as a result the economic crisis in the world and as a consequence the shortage of basic necessities and some medicines, according to Araújo (2020), he states that it is a health crisis without precedent in current history, which has forced governments of many countries to take restrictive measures regarding business activity and mobility of citizens.

In Peru, by Supreme Decree No. 044-2020 - PCM, a state of emergency was declared at the national level on March 15, 2020, and mandatory social isolation was ordered. From that moment, circulation was restricted and it was forced to use materials for the prevention of Covid-19. These prevention measures have drastically impacted the economy of people who work independently; that is to say, those who work in marketing daily in the streets, those who work dependently in private companies if they are older adults have been separated without a return date until the pandemic is overcome and in the case of state personnel the situation is similar, because many of these people jointly develop informal work activities. This statement is based on what was stated by Palza (2020), who determined that the formulated work identifies that the collection of internal taxes for the period from January to August 2020, which has been reduced by 22.98% (but 24.21% in real terms), which, based on the analysis formulated, would imply a contraction in the GDP (Gross Domestic Product) of 22.44% and an increase in unemployment of 32.06%.

Due to this situation, the government projects the reactivation of the economy throughout the country, for which it must be taken into account that it has the conditions of labor gradualness, compliance with basic biosecurity measures. Therefore, one of the few alternatives for the informal sector of the unemployed population is the segregation, reuse and commercialization of organic and inorganic solid waste from domestic and industrial sources. This analysis is supported by Ramírez (2017), who in his research on the sustainable use of solid waste aimed at the industrial sector, highlights that China has a lot of research on this topic, since the importance of the use of solid waste begins to acquire greater importance. dimension due to the accelerated urban and industrial growth.

It is important to mention that, as a result of the confinement of the population, the supply and storage of food products and other necessities in households increased, in order to reduce the frequency of going to the markets and thus reduce the probability of get infected by the virus. He also observed the continuous use of bags, packaging that was used for waste collection and the unusual waste of food due to the greater proportion in storage. This excess of products increased the per capita of solid waste during the pandemic, for which it can be used for marketing and generate economic resources; since previous years the per capita indicator was lower than it is today. This correlation between population and waste generation is explained by Cruz et. to the. (2019), who determined that the highest production per capita is in the Population Center of Caleta de Carquín is 0.506 kg/person per day.

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Likewise, other investigations on household waste such as the Santa María district, which is located in the Province of Huaura and is close to the district and province of Barranca, can be evidenced as a precedent that before the pandemic it reported a low percentage of inorganic waste according to León et al. (2018), determined that the total amount of waste they collected was 15,906 kg/day; with a per capita production of 0.515 kg/inhabitant per day and with percentages of inorganic paper and cardboard with 33.29%, glass with 16.15%, metal with 11.76%, hazardous waste with 0.57%, styrofoam with 1.70% and plastic with 36.54%.

In the Barranca district, the economic situation has had a considerable impact; since the opening of companies, shopping centers and other private businesses is gradual; since this situation has increased labor informality; unemployment in the pandemic being increasingly evident, according to Jaramillo and Ñopo (2020), they state that in any case, it is extremely likely that, during the second stage of the pandemic, a scenario of high unemployment will be faced, tempered by an increase informal employment and depressed aggregate demand.

For this reason, research was carried out on the quantification and commercialization of inorganic household waste during the pandemic in Barranca, which aimed to determine the benefit of commercialization in the quantification of household inorganic solid waste during the pandemic. Therefore, these results allow us to know the diagnosis and profitability of this waste, which is a favorable alternative for the creation of a job in the district of Barranca.

2. Materials and Methods

Location

The district of Barranca is located in the province of Barranca, Lima region, bordering to the north with the district of Pativilca, to the south with the district of Supe Puerto and Supe Pueblo, to the east with the department of Ancash, and to the west with the Pacific Ocean. . At the coordinates of south latitude 10°45'3.1" and west longitude 77°45'51.1" and altitude of 84 meters above sea level (see figure 1).

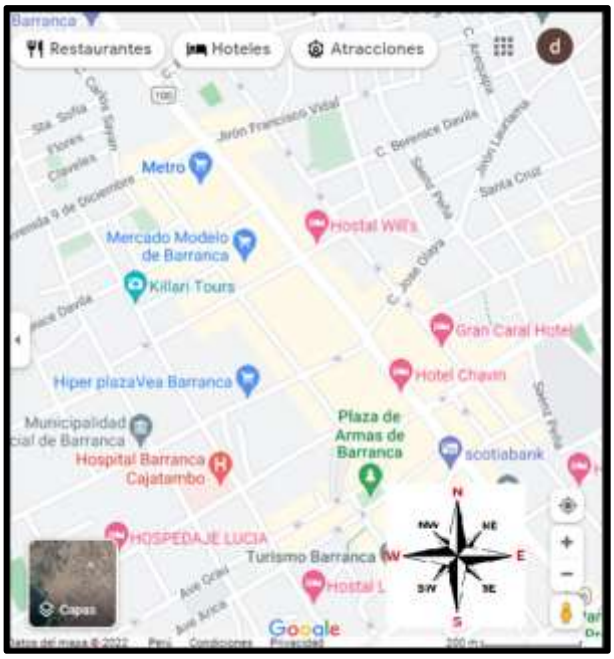

Figure 1. Location of the investigation in the district of Barranca
Source: Google maps, 2021

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Research
The research is based on the descriptive method; since through evaluations the inorganic residues were classified, quantified and valued, this allowed to determine the profitability.

Population
In the district of Barranca, the population is 71,383 inhabitants according to data from (INEI, 2016) and the number of dwellings is 17,129 in the entire district, according to data from (INEI, 2017). It is worth mentioning that these data were taken into account for the development of the research that was from November 2020 to January 2021.

Sample
To determine the sample of houses for the evaluation of inorganic solid waste, the Kunitoshi Sakurai method was taken into account and processed using the finite sampling formula that obtained 50 houses. Likewise, it is mentioned that to obtain this result, standard confidence values of 95% were used, then Z1-α/2 = 1.96, according to the Pan-American Center for Sanitary Engineering and Environmental Sciences (CEPIS), (Cantanhede et al., 2005).

Equation:

$$\frac{\left(Z^2_{1-\frac{\propto}{2}}\right)(N)(\sigma^2)}{(N-1)E^2+\left(Z^2_{1-\frac{\propto}{2}}\right)(\sigma^2)}$$

Where:
N = Number of houses = 17,129 according to data from (INEI, 2017)
$Z^2_{1-\frac{\propto}{2}} = 1.96$. (The confidence coefficient$\left(1-\frac{\propto}{2}\right)$ of 95% standard values of waste generation).
E = 0.056 kg/inhab., per day; the permissible error at 10%. Therefore, the result at the national level = 0.56 kg /inhabitant, per day.
σ = 0.2, standard deviation, in the variation of household waste generation
n: sample for evaluation = 50 houses.

Data collection techniques
For data collection, observation techniques were used, for which inorganic waste was recycled, classified and quantified by day and month.

Statistical analysis
After carrying out the waste classification evaluations and the quantification of waste per day and month, the data was processed with basic statistics. Tables and bar graphs were also prepared for interpretation and analysis.

Procedures
At the time of carrying out the evaluations of household waste, biosafety implements were used carefully in order to avoid damage.

The sample of 50 houses will be extended by applying the formula designed by Kunitoshi Sakurai, for which confidence coefficient values will be used with 95%, which is Z1-α/2 = 1.96, standard deviation σ = 0.2 and per capita 10% loss of waste loss, then 10 houses were divided into sectors for each street and from there the organic and inorganic waste was evaluated and characterized.

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The evaluations of each house that consisted of 4 people on average were carried out. These evaluated and classified inorganic waste such as plastics, glass, metals, styrofoam, paper and cardboard waste by day and month.

Followed, the usable inorganic residues were quantified and valued per 1 kg of glass with S/. 0.6 Soles, 1 kg of metal with S/. 0.5, 1 kg of plastics with S/. 0.6 Soles, and 1kg of cardboard paper with S/. 0.5 Soles, in order to determine the utility and profitability per month.

Finally, the data was processed using basic statistics in bar graphs and tables and the results were interpreted and analyzed by day and month.

3. Results

Classification of inorganic household waste

According to the results of the classification of inorganic household waste shown in table 1, the following percentages were obtained: glass with 13.72%, metal with 17.17%, plastic with 24.63%, paper and cardboard with 36.90%, and others. These results show that in the pandemic, materials with a higher percentage were obtained, such as paper, cardboard, metal, plastic, and glass. Therefore, it is highlighted that these materials can be used as alternatives to obtain economic resources, for which they must be recycled, classified, quantified and marketed. Therefore, these results indicate that a higher percentage of inorganic waste was obtained in the pandemic in relation to what was recorded in previous years, and that by marketing it an economic benefit is obtained. This analysis is supported by Valiente Y., et. to the. (2020), who conclude that in 2020 the classification of household solid waste in the district municipality of Víctor Larco Herrera was determined: 58% organic waste, 10% cardboard, 9% plastic, 6% paper, 6% packaging, 5% glass, 4% metals and 2% textiles. In the year 2021, the percentage of inorganic waste continues to be favorable, which according to Requena et al (2021) conclude that in 2021 it obtained the composition of waste with 72.71% of organic waste, 14.25% usable inorganic and 13.05% non-usable.

Table 1. Classification of inorganic household waste per month

Classification of inorganic waste	Components	Components Weight according to the components (Kg/month/50 houses)	Weight according to their classification (Kg/month/50 houses)	Percentage (%)
Glasses	Beer bottles	55.6	105.7	13.72
	Personal soda bottle	32.8		
	Small soda bottle	17.3		
Metal	Bottle cap	7.6	132.32	17.17
	Can of soda	12.3		
	Can of tuna	24.85		
	Large milk can	43.62		
	Small milk can	29.32		
	Beer can	14.63		
Plastic	Bottle of oil	23.3	189.76	24.63
	Bags	8.3		
	Plastic cap	5.63		
	Wrapper bag	5.2		
	Noodle wrap	7.3		
	Oatmeal wrap	9.3		
	Sachet	3.5		
	Shampoo bottle	15.6		

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	Plastic cup	5.5		
	Plastic covered	9.63		
	Alcohol bottle	18.6		
	Water bottle (500 mL)	25.6		
	Plastic pot	32.6		
	Visors	8.2		
	Face mask	11.5		
Hazardous waste	AA battery	19.63	32.43	4.21
	AAA battery	12.8		
Tecnopor	Chicken tray	22.36	25.86	3.36
	Tecnopor glass	3.5		
Paper and paperboard	Diary paper	110.6	284.25	36.90
	Office paper (sheet)	17.85		
	Paperboard	155.8		
	Total	770.32	770.32	100.00

Per capita of inorganic household waste

Regarding the per capita of inorganic solid waste that can be seen in figure 2, the gradual increase of this waste is indicated, highlighting Friday with 0.423 kg/person/day. Therefore, it is interpreted that at the end of the week an increase in these residues was noted, which is an indicator that shows as an economic alternative; since it can be used obtaining significant economic gain, since in relation to the per capita of previous years the amount of inorganic waste did not decrease. This analysis is based on the research of Cruz et al. (2021) who concluded that in the year 2020 the per capita evaluation specified that on Thursday and Friday the greatest amount of inorganic waste was obtained with 0.518 Kg/person/day and 0.556 Kg/person/day, which defines that the end during the week there is greater consumption.

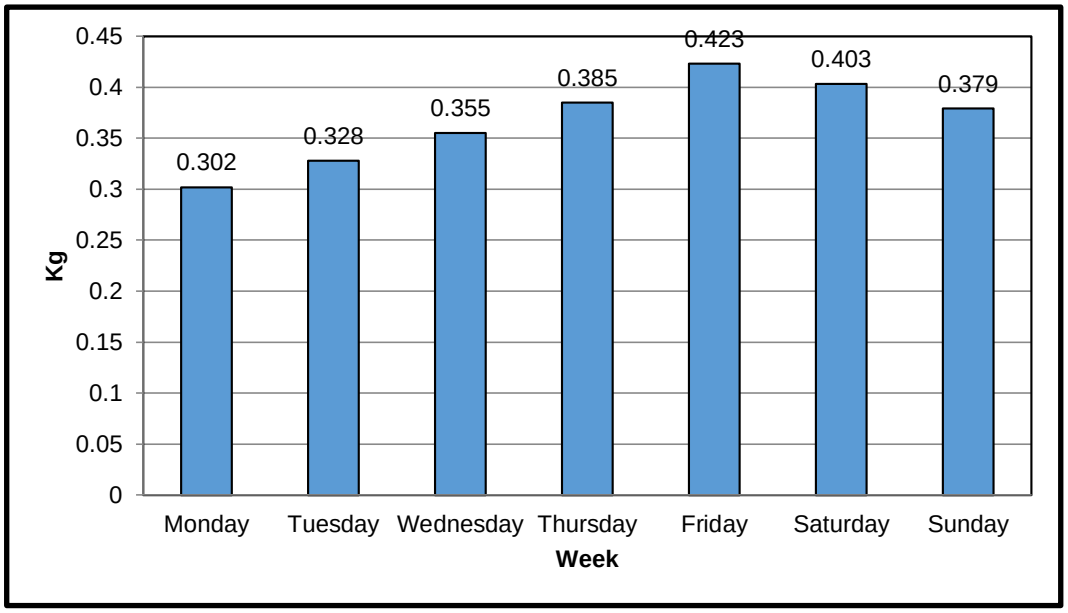

Figure 2: Per capita household inorganic waste Kg/person/day

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Classification of inorganic household waste per day

In relation to the per capita results, the percentages of the classification of inorganic waste that are observed in table 2 were detailed, which indicates that on Friday the highest percentage of glass was obtained with 40.43%, metal with 18.91% and on Saturday plastics with 39.95% and others. Therefore, it is evident that at the end of the week there was an increase in waste from plastic, metal, glass and other containers, which is due to the consumption of edible products that contain these materials. Therefore, these results indicate the increase of these residues that is favorable; since it can be used to market it. This analysis is supported by what happened and evaluated by Boggiano Burga (2021), who during the pandemic determined the percentage composition of waste from the second analysis: batteries with 1.15%, paper with 8.43, cardboard with 2.25%, glass with 4.60%, plastics with 10.38%, styrofoam with 8.60%, tetra pack with 9.72%, metals with 0.02%, hazardous medical waste with 3.51%, sanitary waste with 8 .00%, organic waste with 40.72% and others with 2.62%.

Table 2. Classification of inorganic waste per day (%)

Waste classification	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Glasses	0.00	0.00	52.96	36.36	40.43	32.26	47.49
Metal	40.07	0.00	28.17	11.17	18.91	18.61	19.26
Plastic	22.85	15.24	10.70	23.12	17.73	39.95	5.80
Dangerous residues Peligrosos	0.00	0.00	2.25	6.23	2.84	2.73	0.00
Tecnopor	7.28	3.05	3.10	4.42	3.31	4.47	2.37
Cardboard paper	29.80	81.71	2.82	18.70	16.78	1.99	25.07
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Quantity of inorganic household waste per month

With respect to the amount of inorganic solid waste per month that is observed in table 3, it shows that in January paper and cardboard materials, styrofoam, hazardous waste, plastic, metal and glass increased by a total of 1106.33 kg, more of 13.51% in relation to the month of November. Therefore, it is interpreted that at the end of the year and the beginning of 2021, this waste increased compared to previous years and that these materials can be used to obtain an economic resource. Therefore, it is analyzed that the increase in inorganic waste in the pandemic is viable to create a job and thus obtain economic resources. This result can be compared with research by Huamaní et. to the. (2020), who determined results referring to the generation, classification and sale of compost and inorganic waste inputs, induced positive profitability for the year 2017, as a consequence of the generation of 75,000 tons of municipal solid waste per year; of which 72% were usable and 28% were not.

Table 3. Quantity of inorganic waste (Kg/50 houses/month)

Waste classification	2020		2021
	November	December	January
Glasses	188.70	195.96	203.65
Metal	152.20	165.96	178.62
Plastic	222.30	252.30	275.96
Dangerous residues Peligrosos	31.25	38.25	42.63
Tecnopor	26.80	29.60	31.62
Cardboard paper	335.63	350.63	373.85
Total	956.88	1032.70	1106.33

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In relation to the amount of inorganic waste, the percentages per month that can be seen in figure 3 were obtained, which indicates in January 2021 the highest percentage of paper and cardboard was obtained with 33.79%, plastic with 24.94%, metal with 16.15% and others. Therefore, the increase is evident and stands out compared to the other months, which would be a favorable indicator for recycling, classification, commercialization and in this way obtain economic resources.

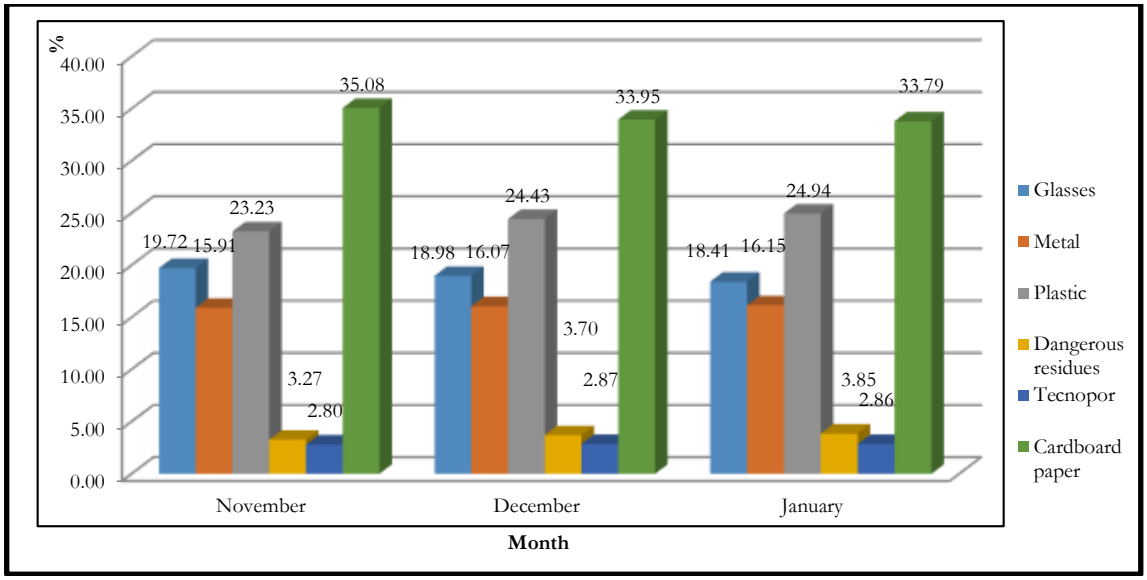

Figure 3: Percentage of inorganic household waste per month

Quantity of inorganic waste for marketing

Regarding the amount of marketable inorganic waste, it is detailed in table 4, which in January obtained a greater amount of cardboard paper with 373.85 kg, plastic with 275.96 kg, glass with 203.65 kg and metal with 178.62 kg of a total of 1032.08. Therefore, it is interpreted that at the end of the year and January 2021, a greater amount of waste was obtained in relation to the previous months, due to the fact that they went to the markets and shopping centers to stock up on basic necessities and other products. Therefore, this result indicates that the increase in this waste is usable to obtain an economic resource, at the same time it can create a job and reduce pollution. This analysis is based on Cajamarca et. to the. (2019) who conclude that recycling has attractive economic benefits to create an inclusive business and intermediaries are the main beneficiaries within this activity.

Table 4. Amount of usable inorganic waste (kg/50 houses/month)

Waste classification	2020		2021
	November	December	January
Glasses	188.7	195.96	203.65
Metal	152.2	165.96	178.62
Plastic	222.3	252.3	275.96
Cardboard paper	335.63	350.63	373.85
Total	898.83	964.85	1032.08

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Valuation, utility and profitability of inorganic waste per month

Regarding the valuation of marketable inorganic household waste that is detailed in table 5, it can be seen that in January it obtained 186.9 Soles, plastic with 165.6 Soles, glass with 122.2 Soles and metal with 89.3 Soles. This result explains that as the year 2021 ends and begins, the inorganic waste increased, which, valued in soles, obtained a gross income of 564 Soles, which stands out in relation to previous months; This result being favorable in generating jobs. Mentioned this analysis is supported by Sangay (2017), he concludes that the research is viable where by applying the 3R (reduce, recycle and reuse) using household solid waste they generate an economic, social and environmental benefit.

Table 5. Valuation of marketable inorganic waste (S/. /50 houses/month)

Waste classification	2020		2021
	November	December	January
Glasses	113.2	117.6	122.2
Metal	76.1	83.0	89.3
Plastic	133.4	151.4	165.6
Cardboard paper	167.8	175.3	186.9
Total	490.5	527.3	564.0

Note: 1 kg of glass, metal, plastic and cardboard paper its value is S/0.6, S/. 0.5, S/.0.6 and S/ 0.5 Soles respectively.

In the economic analysis of utility and profitability of inorganic waste per month shown in table 6, it is noted that the highest utility was obtained in January with S/. 264 Soles and higher profitability with 25.60%, which is interpreted that during the pandemic in January a greater economic gain was obtained; this result being viable to generate jobs.

Table 6. Utility and profitability of inorganic solid waste per month (S/.)

Waste classification	2020		2021
	November	December	January
Gross income (S/.)	490.52	527.25	564.00
Mobility and transportation (S/.)	250.00	250.00	250.00
Utility (S/.)	240.52	277.25	314.00
Cost effectiveness (%)	-3.79	10.90	25.60

4. Conclusions

- It was determined that in January the largest amount of usable inorganic waste was obtained with 1032.08 kg/50 houses/month, which differs by 12.91% from the month of November. Therefore, this result indicates that the amount of these residues increases at the end and beginning of the year.
- It was also determined that in the month of January of the year 2021 the highest profit was obtained with S/ 314 Soles, differing from the month with the least amount, which is

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November of the year 2020 with S/. 240.52 soles, obtained more than 23,401% of economic profit, which is beneficial.

- It is concluded that on Friday, inorganic waste per capita stood out with 0.423 Kg/person/day and in the classification of inorganic waste per day, glass materials stood out with 40.43%. Therefore, these indicators are favorable for commercialization and thus generate economic resources.

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