Journal of Information Systems Engineering and Management
2025, 10(19s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Circular Economy and its Relationship with Competitive Advantage in an Animal Health Enterprise from Lima

Roxana Mariella Céspedes Estela
Universidad Nacional Mayor de San Marcos
Lima, Perú
ORCID: https://orcid.org/0009-0009-3161-2134
mcegac@gmail.com

ARTICLE INFO

Received: 22 Dec 2024
Revised: 30 Jan 2025
Accepted: 10 Feb 2025

ABSTRACT

Objective: Determine the relationship between Circular Economy activities implemented in an organization in the animal health sector and obtaining competitive advantages. Methods: The study was correlational in scope and non-experimental cross-sectional design, quantitative methodology. The data analyzed corresponded to different sustainable initiatives that were converted into management indicators, applied by the aforementioned company between the years 2020 and 2023. The statistical test used was linear regression, complemented by the trend analysis of the management indicators over time. throughout these years. Results: The statistical correlation was found between the Circular Economy measured through the sale of waste and the estimated savings from recycled waste, and the competitive advantage measured through the cost of production for the year 2021. Conclusion: Yes, a relationship existed. statistically significant between the Circular Economy actions and the competitive advantage of the company in the animal health sector of Lima in 2021 and not for the other years analyzed given that the sustainability actions that are not aligned with the general strategy of the organization They tend to be short-lived and are ultimately destined to disappear.

Keywords: linear economy, recycling, reuse, costs, sustainability, strategy.

Indexing Terms Unesco Thesaurus: economic system, waste treatment, costs, environment, strategic planning.

INTRODUCTION

The move from a linear to a circular economy is essential for business continuity, as addressed in this research. Specifically, it analyzes how the implementation of circular economy principles influenced the competitive advantage of an animal health company between 2020 and 2023, considering that it is an organization with more than thirty years in the market.

One way in which organizations can innovate today is by adopting the circular economic paradigm as an alternative to the linear economy, as it allows them to act in a preventive and non-reactive way in environmental matters with policies that, instead of seeking inefficient solutions to the damage, often irreversible, caused by the high generation of waste and waste, are aimed at guaranteeing a minimum of sustainability over time of the resources they use in their production processes.

The topic of this research is important because it links two indispensable criteria in organizations, generating value in customers to obtain competitive advantages and conserving the environment through the application of circular economy principles; Demonstrating their relationship and that they can coexist is the novel part.

Geissdoerfer et al. (2020) highlight that the circular economy (CE) has become a vital strategy to face sustainability challenges, being an alternative to the linear model of 'take, make and dispose', i.e. it constitutes the appropriate business response to preserve the environment for future generations. This circular model proposes a closed resource loop in which products and materials are kept in use for as long as possible, maximizing their value before being regenerated at the end of their useful life (Tura et al., 2019). To achieve this, companies must optimize their

production processes. In this sense, organizations require economic investment to incorporate, for example, "reused" inputs in production processes.

The circular economy (CE) is based on fundamental principles such as design for longevity, reuse, remanufacturing, and recycling, all focused on minimizing resource use and waste generation (Suárez-Eiroa et al., 2019). The above is explained by the fact that the principles not only promote greater efficiency in the use of materials, but also foster a mentality of shared responsibility between producers and consumers. By adopting these approaches, companies can not only reduce their environmental footprint but also boost customer loyalty by offering more sustainable and long-lasting products.

According to Geissdoerfer et al. (2020), CE can be considered a regenerative system that seeks to decouple economic growth from the consumption of finite resources. In other words, this approach is crucial in a world where the scarcity of resources is increasingly evident. By decoupling economic growth from resource consumption, companies can not only ensure their long-term viability, but can also contribute to a more sustainable and equitable economic model.

Adopting the circular economy (CE) provides companies with a competitive advantage by reducing operating costs by optimizing resource use and minimizing waste. This approach makes it possible to reduce raw material costs and waste disposal, improving profit margins (García-Quevedo et al., 2020). From this point of view, this advantage not only translates into immediate economic benefits, but also positions companies as leaders in sustainability, which can attract consumers who value responsible practices. Thus, the integration of CE not only improves profitability, but also strengthens reputation and long-term competitiveness in an increasingly sustainability-conscious market.

Although there are still doubts about how to move towards a circular economy, there are several organizations around the world, such as the Ellen MacArthur Foundation, that have the necessary tools to lead the standardization process (Ellen MacArthur foundation, 2023). In this sense, industrial history offers numerous examples of companies that achieved advantages by anticipating these major trends, as well as those that missed opportunities by reacting late.

Although many companies have partially adopted the principles of CE, fragmented implementation makes it difficult to visualize benefits, such as competitive advantage. The full adoption of CE requires profound transformations in business models, which implies high initial costs and a change in organizational mindset (Parida et al., 2019). This means that the economic issue and the lack of knowledge represent barriers in the implementation of CE.

Companies should also work closely with governments and non-governmental organizations to influence the creation of policies and regulations that support the circular economy. These policies, aimed at encouraging the reuse of materials, recycling and waste reduction, facilitate the adoption of circular practices (Schroeder et al., 2019). Therefore, the participation of private companies in the development and analysis of new environmental standards and legal requirements is an important criterion.

Some examples of companies that apply CE, according to Gallego (2020), include: The Chinese company GEM Co. Ltd. of a public nature specializes in the recycling of materials and the recycling of waste electrical and electronic equipment. Another example in Peru and globally, H&M, a company in the fashion retail sector, implements circularity in its business model under the premise that "customers can be fashionable while taking care of the planet" (Gallego, 2020, p. 118). Their approach seeks to balance the enjoyment of dressing fashionably with affordable prices while minimizing negative environmental impacts.

Based on the above, the following question arises: Does the circular economy have a relationship with the competitive advantage of a company in the animal health sector? The hypothesis of this study holds that the circular economy, measured through waste management and savings in recycling costs, is related to the competitive advantage of a company in the animal health sector between 2020 and 2023.

Therefore, the objective of the research is to determine the relationship between the Circular Economy activities implemented in an organization in the animal health sector and the obtaining of competitive advantages, between 2020 and 2023.

METHOD

The research had a correlational scope and a cross-sectional non-experimental design, since the required data were measured at a specific time, without analyzing the changes that could occur after collection. This made it possible to

clearly identify the common characteristics of the sample, as well as to determine the relationship between the Circular Economy and Competitive Advantage variables.

As the unit of analysis of this project, the operational processes carried out by the company in the animal health sector in the years 2020, 2021, 2022 and 2023 were considered. The technique used was documentary review based on data and management indicators. The study population was the circularity-related operations of the company in the animal health sector of the city of Lima in the years 2020, 2021, 2022 and 2023.

The sample in this study was census-like, being equal to the population: operations related to circularity of the company in the animal health sector of the city of Lima in the years 2020, 2021, 2022 and 2023 (see Table 1).

Board 1

Normality Test

Dependent variable	Independent variable	Year	Normality test Kolmogorov_Smirnov
Total Production Cost	Final sale of traded waste (in dollars)	2020	0,161
		2021	0,149
		2022	0,159
		2023	0,215

Note. Prepared with data taken from the organization's indicators.

On the other hand, the statistical test used was based on the simple linear regression test, which was chosen because it offers a first understandable and direct approximation to explore whether two variables have some kind of relationship before considering more complex or nonlinear models. To this end, the normality test was performed for the dependent random variable through the residuals of the model, shown with the Kolmogorov Smirnov test given the small sample size.

The initial analysis of the study was the normality test for the dependent random variable using the standardized errors of the regression model (significance level: 0.05). When data is said to have a normal distribution, it means that the data is distributed in the form of a symmetrical bell around its mean. This implies that most of the values are grouped close to the mean, and as they move away from it, the frequency of the values decreases gradually and symmetrically on both sides.

Forecast analysis was also carried out in Excel, which is a common practice in data management and trend analysis, since it allows projections and planning for the future based on historical data.

The research variables were the following:

- Independent variable: circular economy, measured as the commercial management of waste materials and total savings from recycling.
- Dependent variable: competitive advantage, measured through cost management (production costs).

The preliminary analysis of the study consists of the evaluation of the normality of the dependent variable by means of the standardized residuals generated by the regression model, formulating the following hypotheses:

Ho: The cost of production follows a normal distribution.

H1: The cost of production does not follow a normal distribution.

The result was a p value of 0.161; 0,149; 0,159; and 0.215 respectively for each period of time, higher than the level of significance considered (0.05). Therefore, the null hypothesis (Ho) is not rejected. It is determined that the cost of production follows a normal distribution.

Subsequently, the simple linear regression statistical test was carried out. For the independent variable, Circular economy, measured through the commercial management of waste materials, the classification of waste was taken into account (see Table 2). Data were collected in Excel tables in which the quantities in kilograms and weights were recorded.

Board 2
Waste sorting

Classification	Waste Material	Proceeding process	Area
Marketed	Packaging paper	Office Waste Material	Warehouse/Production
Marketed	Cardboard	Materials/Supplies Reception Process	Warehouse
Marketed	Strech Film	Materials/Supplies Reception Process	Warehouse
Marketed	Big bag bags	Calcium Carbonate Reception Process	Warehouse
Marketed	Plastic Cylinder	Production Process	Production
Marketed	Cardboard drums	Production Process	Production
Marketed	Metal Cylinder	Production Process	Production
Marketed	Wooden pallet	Materials/Supplies Reception Process	Warehouse
Marketed	Metal scrap	Production Process	Production
Recycled	Cardboard boxes	Reagent Receiving Processes	Quality Control
Recycled	Safety Shoes in disuse	Operational processes	Warehouse & Quality Control
Recycled	Cell phones and unused PCs	Operational processes	Production, Warehouse & Quality Control
Recycled	Bond paper	Laboratory processes	Quality Control
Recycled	Plastic packaging	Laboratory processes	Quality Control
Dangerous	Plastic bags, paper and raffia	Production Process	Production
Dangerous	Flammable liquids	Laboratory processes	Quality Control
Non-Hazardous	Calcium Carbonate Cleaning	Production Process	Production
Common	Waste from sshh, dining room	General Services	Production, Warehouse & Quality Control

Note. Prepared with data taken from the organization's indicators

For the independent variable, Circular Economy, measured by the indicator "savings generated by the implementation of recycling measures and commercial waste management", data collection was carried out in Excel. The calculation of the corresponding savings for each of the months of the years under study is detailed below (see Table 3).

Board 3
Indicator "Total savings from the implementation of recycling measures and commercial waste management"

Calculation: Savings generated ($) by the implementation of recycling measures and commercial waste management.
to. The cost of disposing of recycled waste (they fall into the hazardous category) is $99.3/ton (this includes freight plus final disposal by a specialized EORS waste company).
b. The amount of waste recycled in kg x $ 99.3/1000 is the estimated savings in recycled waste expenditure, that is, what was not paid for having recycled (recycling carried out by an external company).
c. The sale of marketable waste generates income from the sale *per se*.
d. Savings in expenditure generated by the change in the process, including the reduction in the consumption of calcium carbonate input whose cost is $ 57.9/ton, plus the savings of not discarding calcium carbonate which is $ 15.4 / ton. So the savings in $ generated by process change is the sum of the amount equivalent to the calcium

carbonate that was not purchased (at $ 54.9 /ton) plus the amount saved by not discarding calcium carbonate ($ 15.4 / ton)

and. Total savings is the sum of the three items described.

Note. Prepared with data taken from the organization's indicators

For the dependent variable, the Competitive Advantage, the measurement was made through production costs. The monthly values detailed by the operations management per month were considered and the annual cost value was considered as the result of: $/ton produced multiplied by the total quantity produced.

In addition, annual measurements were obtained of the operational areas related to waste recycling and reuse activities. Thus, the trend is calculated and the following years are forecast using the "Trend" function of Excel. This data allows us to evaluate the performance of the organization and its changes in the years 2020, 2021, 2022 and 2023. Although they do not show a specific correlation, important data have been considered for discussion and conclusions.

RESULTS

A simple linear regression statistical analysis was performed on the independent variables: Circular Economy (sale of commercialized waste) and the dependent variable: Competitive Advantage (cost of production). To evaluate the relationship between these variables, the following hypotheses are proposed:

Ho: B1 = 0 (there is no relationship between the variables).

H1: B1 ≠ 0 (there is a relationship between the variables).

In the time periods, the significance for the period 2021 and 2023 is observed (see Table 4), given that the p-value yields a value of 0.019 and 0.048 respectively, being lower than the significance level (0.05). Therefore, Ho is rejected, determining that the cost of production is related to the sale of waste marketed in the years 2021 and 2023.

Table 4 *Analysis of variables 1*

Dependent variable	Independent variable	Year	P value	Coefficient of determination R2
Total Production Cost	Final sale of traded waste (in dollars)	2020	0,101	24,60 %
		2021	0,019	43,69 %
		2022	0,581	3,16 %
		2023	0,048	33,70 %

Note. Prepared with data taken from the organization's indicators.

In addition, for these periods it is stated that the total cost of production is being explained as follows:

- Year 2021: the total cost of production is being explained in 43.69% by the sales of final waste.
- Year 2023: the total cost of production is being explained by 33.7% of the sales of final waste.

In the same way, the simple linear regression statistical analysis of the variables Circular Economy (savings in estimated expenditure of recycled waste) and competitive advantage (cost of production) was carried out. To evaluate the relationship between these variables, these hypotheses arise:

Ho: B1 = 0 (there is no relationship between the variables).

H1: B1 ≠ 0 (there is a relationship between the variables).

In the time periods, the significance for the period 2021 is observed since the p-value yields a value of 0.025 (see Table 5), being lower than the significance level (0.05). Consequently, Ho is rejected, determining that the total cost of production has a relationship with the sale of waste marketed in the year 2021. And it is pointed out that the total cost of production is explained in 40.83% by the sales of final waste.

Table 5 *Analysis of variables 2*

Dependent variable	Independent variable	Year	P value	Coefficient of determination R2
Total Production Cost	Savings in estimated waste cost of recyclates	2020	0,152	19,04 %
		2021	0,025	40,83 %
		2022	0,186	16,80 %
		2023	0,053	32,40 %

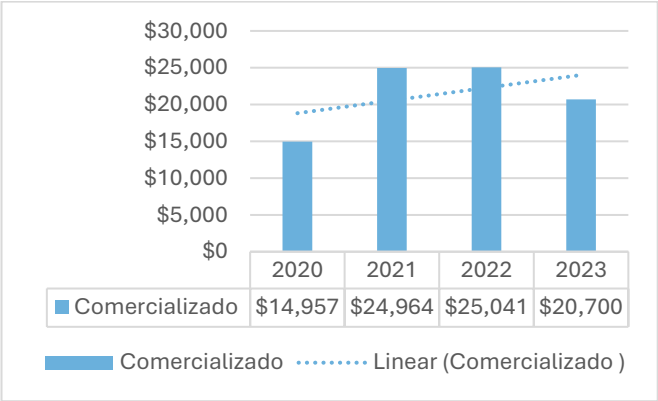
Note. Prepared with data taken from the organization's indicators.

Subsequently, the analysis of the trend of the management indicators was carried out. The company, which is the object of study, maintains management indicators that allow different activities to be measured and trends to be evaluated with this data.

In relation to the waste marketed per year (see Figure 1), an indicator that measures the amount in tons of waste sold, that is, that generated an economic income for the organization, the positive trend allows us to observe that in 2021 there is an increase of approximately $ 10,000 in relation to 2020. The evaluation of the trend, years marked in orange, allows us to predict that, in the following four years, the amount in $ of the waste traded will remain stable, without significant increases.

Figure 1

Commercialized Waste ($) 2020-2023 and its trend. In original language Spanish



Year	Tons	% increase over the previous year
2020	14957	-
2021	24964	67 %
2022	25041	0.3 %
2023	20700	-17 %
2024	25742	24 %
2025	27473	7 %
2026	29203	6 %
2027	30934	6 %

Note. Prepared with data taken from the organization's indicators.

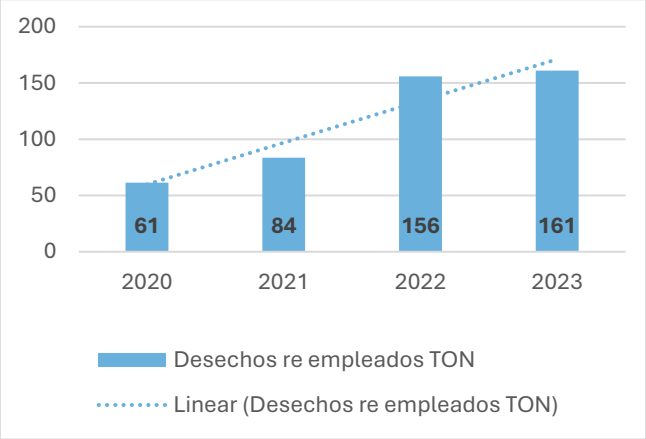
In relation to the Reused waste indicator , measured in tons (see Figure 2), made up of commercialized waste plus recycled waste, the trend shows that, in 2022, waste is generated for reuse in 72 tons more than in 2021 (86%). For 2023, this value was higher than in 2022 (3.3%). The evaluation of the trend allows us to predict that, in the next four years, the organization will increase the amount of reused waste, as long as it maintains the commitment to the application of circular economy principles; although the increase tends to be discreet.

Figure 2

Reused waste by year 2020-2023 and its trend. In original language Spanish

Year	Tons	% increase over the previous year

2020	61.4	-
2021	83.6	36 %
2022	155.9	86 %
2023	161.0	3.3 %
2024	208.2	29 %
2025	245.3	18 %
2026	282.4	15 %
2027	319.5	13 %



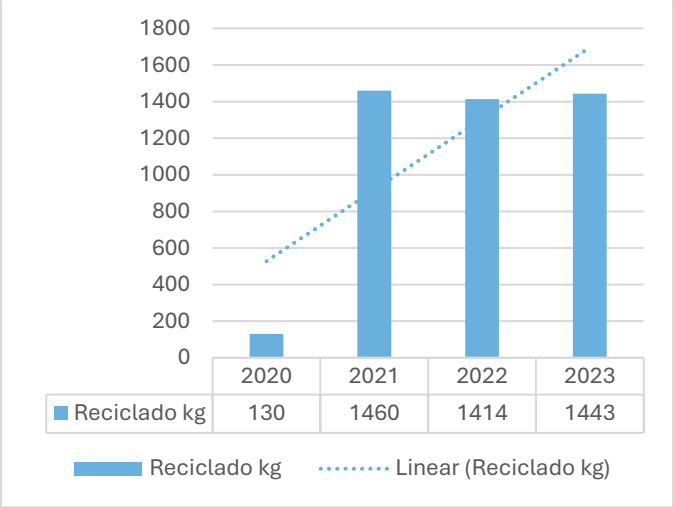
Note. Prepared with data taken from the organization's indicators.

In relation to the Recycled indicator, which reports the amount in tons of waste that is recycled with the collaboration of the Municipality of Ate (see Figure 3), as in the previous indicators, a substantial increase is observed between 2020 and 2021, equivalent to 1300 kg, to then remain stable in quantity during 2022 and 2023. The analysis of the trend, years marked in orange, allows us to predict that in the following years the increases will be discreet.

Figure 3

Recycled (kg) 2020-2023 and its trend. In original language Spanish

Year	Tons	% increase over the previous year
2020	130	
2021	1460	1023 %
2022	1414	-3 %
2023	1443	2 %
2024	2085	44 %
2025	2474	19 %
2026	2864	16 %
2027	3253	14 %



Note. Prepared with data taken from the organization's indicators.

Regarding annual destruction, this indicator shows a marked trend towards a decrease in the amount ($) destroyed, since in 2023 this amount ($) is equivalent to 30% of the value destroyed in 2020. The result of the actions for the recovery of inputs before their expiration date is observed, without affecting the quality of the resulting products.

A final indicator, Percentage of commercialization versus the cost of disposal, which shows that the income ($) from the commercialization of waste allows to recover a percentage of the expense that motivates the final disposal of these (those that cannot be reused). Obviously, in 2021 compared to 2020, a marked difference equivalent to 33% higher is observed. In the following years, the trend is classified as downward, since the amount ($) of marketed decreases.

The statistical analysis of the Circular Economy and Competitive Advantage variables reveals that in 2021 a significant relationship was established between the two, which suggests that circular economy practices positively influenced the company's competitiveness. However, this relationship did not remain constant in 2022 and 2023. This is because the organization has not integrated the principles and criteria of the circular economy into its business strategy, limiting the continuity of the benefits obtained. The efforts made have been siloed, driven primarily by operational management, rather than being a goal shared by the entire company.

DISCUSSION

The novel contribution of this research lies in demonstrating, based on empirical data, that the application of CE principles not only contributes to environmental care, but also generates tangible benefits in business continuity for companies in the animal nutrition sector, translated into competitive advantage. By measuring the impacts of these practices, it is evident that it is possible to achieve significant improvements in economic and environmental terms, which reinforces the commitment to the preservation of the environment for future generations.

The results indicate that, in 2020, the company under study began to be concerned about caring for the environment, reflected in the various actions undertaken such as recycling, reuse and the commercialization of waste. During 2021, these actions reached significant value, helping to identify the relationship between CE and competitive advantage, differing significantly from the results obtained in 2020. However, in the years 2022 and 2023, although initiatives such as recycling and waste commercialization were maintained, no substantial improvement was observed compared to 2021.

There are different causes for the explanation of not having found such positive results for the years 2022 and 2023. One of the explanations is that the principles of CE have not been integrated into the organization's strategy; This inclusion must be systematic because it could, depending on the type of company and the organizational culture, generate strong or weak integration; this coincides with the definition of Tura et al. (2019), which details the important analysis of the environment and environment of organizations to implement CE; also agrees with Puglieri et al. (2022) who detail the importance of including CE criteria in the strategic planning of organizations.

In the integration of CE into the strategy, the role of the organizational leader is important; it is convinced that the most important thing is that the head of the company is fully committed to the implications and benefits of any system

to be implemented, coinciding with what Parida et al. (2019) explained, in which they detail three special characteristics of leaders: standardization, promotion, and negotiation.

On the other hand, the lack of preliminary evaluation of the implementation barriers could also have contributed to a scenario of weak stability in actions; this review, similar to the one defined by Ada et al. (2021), would allow us to anticipate possible failures. Analyzing the barriers in the organization under study, some criteria have been detected, such as: the lack of an effective regulatory framework in our country, the lack of economic and human resources of the organization, the training and underdeveloped experience of the organization's collaborators, and the diminished relationship between innovation and CE. Similar to what García Quevedo et al. (2020) analyzed, obstacles or barriers can only be taken as such when they are correctly evaluated.

In the analysis of the management indicators of the organization under study, one of the main obstacles observed has been identified: the individual and fragmented nature of the actions carried out, which reveals a disconnection with the core of the business. This finding highlights the importance of integrating CE holistically within the business strategy, rather than treating it as an isolated component. In fact, this behavior coincides with what Parida et al. (2019) point out, who state that CE requires a profound transformation in business models, which implies not only the assumption of high initial costs, but also a fundamental change in the organizational mentality.

In addition to the detailed causes, an important characteristic of the organization under study could be considered, such as the resistance to change of human capital and the tension generated by suppliers, when requiring them to comply with certain environmental criteria; coinciding with what was detailed by Tura et al. (2019), in whose analysis they identified the tensions caused by CE in companies from different industries: economic, structural, psychological, and behavioral, and with Piyathanavong et al. (2024), who determines the importance of aligning organizational culture with the development of CE. In this regard, government support contributes to reducing tension in customers and suppliers, in accordance with what Rodríguez et al. (2022) indicated in their assessment of the role of the circular economy and sustainability.

Another possible cause could be not including innovation in the development and optimization of products and processes, considering that "disruptive innovation" is a driver of CE. This study has not addressed important criteria such as digital transformation issues, which have been detailed in other research such as those by Neligan et al. (2023) and Kristoffersen et al. (2021), where they detail the important role of digitalization in circular business models.

Similarly, supply chain issues such as "Sustainable Procurement" have not been addressed, unlike other studies such as that of Despoudi et al. (2021) which addresses how the collaborative implementation of the circular economy within supply chains can generate a sustained competitive advantage.

An important aspect of this research is the analysis of the annual Destruction indicator, which shows a clear decrease in the economic amount to be destroyed between 2020 and 2023, due to the extension of the useful life of the product, which generated advantages for the company under study. This does not coincide with what was researched by Luzzati et al. (2022), who after their evaluation concluded that greater efficiency of materials, by extending the useful life, has not generated the expected benefits. On the other hand, Suárez-Eiroa et al. (2019) define operational principles of CE within the framework of sustainable development, incorporating the principle of "maintaining the value of resources within the system", as in the present research.

It is, therefore, important to carry out the analysis of the life cycle of the product, a topic that has not been addressed in this research, nor is it considered in the company as the subject of study, which does not agree with different studies such as those of Bjornbet et al. (2021), in which they identify the life cycle assessment as a tool to quantify the environmental effects of a product or service.

On the other hand, reducing operating costs through the commercialization of waste represents a key strategy for the organization to achieve competitive advantages, as evidenced by the correlation observed in 2021 between waste minimization and competitive advantage. These actions are considered by the organization as "Good Practices", coinciding with what was detailed by Vásquez et al. (2024): Production design, Use and consumption of resources, waste management, good practices related to educational and social policies.

Given that sustainability has become a key pillar for business success and competitive advantage, the results found could lead to define that the application of CE principles is an important part of achieving sustainable development. Considering that the dimensions of Sustainable Development: Ecological, Economic and Social, the analysis leads to

the conclusion that the results of this research are related to the ecological and economic dimensions, and to a lesser extent to the social dimension. Some other research, such as that of Millar et al. (2019), highlights the need for CE to promote social equity and how it does so while incorporating the other two dimensions.

In line with what was detailed by Bjornbet (2021), the practice of CE is generally approached only from the environmental dimension, neglecting the other two dimensions. On the other hand, Suárez-Eiroa et al. (2019) define operational principles of CE within the framework of sustainable development, incorporating the principle of "maintaining the value of resources within the system", as in the present research.

It is difficult to define how CE affects social change in this research, but it is important to detail that the recycling process with the local municipality has managed to generate work for people in the area, contributing to the social dimension of sustainable development in a fairly basic way; this is largely due to the lack of guidance, coinciding with Gallardo et al. (2024).

In relation to the details, it is important to take into consideration the SDGs and for this research, the relationship with SDG 12: Responsible production and consumption is evident; it is therefore CE a tool for sustainable development, coinciding with what was explained by Schroeder et al (2019), who also explore the synergies that can be created through CE practices and SDG targets.

The use of indicators as management tools: Reused waste, Commercialized waste, Recycled and Annual destruction amount, are an important part for the maintenance and improvement of the implementation of the CE principles and allowed to evaluate the relationship with the competitive advantage in the company under study. This perspective coincides with the one detailed by Kristensen (2019), which includes the review of 30 indicators, most of which focus on recycling, end-of-life management, or remanufacturing.

This research did not include an indicator similar to the one detailed by Huysman et al. (2017), called the CE performance indicator, which is of relevant importance because it includes in its definition the quality criterion, which for the industry in which the company under study develops, is an indispensable factor and generator of competitive advantages.

The implementation of new techniques for measuring the degree of implementation of CE is a criterion not covered in this research, because it is considered that the use of indicators and the effective use of the PHVA cycle (continuous improvement) are sufficient. The above does not agree with Diéguez-Santana et al. (2021), who developed a tool consisting of a checklist with 91 items and 9 study variables, in addition to a neural network method used in a case study to predict the level of circular economy.

In conclusion, the circular economy has a significant relationship with competitive advantage, as long as it is applied as an integral part of the business strategy. It is not enough to implement isolated or superficial actions; The circular economy must be understood as a business model that is deeply incorporated into the environmental management and corporate social responsibility of the organization. This integration is key to ensuring that the efforts made have a sustainable impact on both environmental performance and competitiveness

The present research had no information limitations, due to the adequate Knowledge Management developed by the organization under study and the predisposition to be studied. It is essential to identify key areas for future research to advance knowledge about the relationship between the circular economy and competitive advantage. Below is a research agenda with three open questions that could guide future studies:

1. How does the complete integration of the circular economy influence corporate strategy in different industries, to generate competitive advantage?
2. What are the factors that allow the application of CE as a key tool for sustainable development?
3. What impact does organizational culture have on the adoption of circular economy practices in the long term?

These questions open up avenues to further explore the challenges and opportunities presented by the circular economy, providing a solid foundation for future research that can contribute to competitive advantage and business sustainability.

REFERENCES

[1] Ada, N., Kazancoglu, Y., Sezer, M., & Ede-Senturk, C. (2021). Analyzing barriers of circular food supply chains and proposing Industry 4.0 solutions. *Sustainability, 13*(12), 6812. https://doi.org/10.3390/su13126812

[2] Bjørnbet, M., & Vildåsen, S. (2021). Life cycle assessment to ensure sustainability of circular business models in manufacturing. *Sustainability,* 13(19), 11014. https://doi.org/10.3390/su131911014

[3] Bjornbet, M., Skaar, C., Magerholm, A., & Overbo, K. (2021). Circular economy in manufacturing companies: a review of case study. *Journal of Cleaner Production*, 294, 126268. https://doi.org/10.1016/j.jclepro.2021.126268

[4] Despoudi, S., Sivarajah, U., & Dora, M. (2021). The circular economy advantage and implications on sustainability performance: collaborative advantage and impact of CE implementation. In Palgrave Macmillan (ed.), *From Linear to Circular Food Supply Chains* (pp. 63-66). https://doi.org/10.1007/978-3-030-72673-7_7

[5] Diéguez-Santana, K., Rodríguez, G., Acevedo, A., Muñoz, E., & Sablón-Cossio, N. (2021). An assessment tool for the evaluation of circular economy implementation. *Academia Revista Latinoamericana de Administración*, *34*(2), 316-328. https://doi.org/10.1108/ARLA-08-2020-0188

[6] Ellen MacArthur Foundation. (2023). *Annual Impact Report and Consolidated Accounts: September 2022 to August 2023*. Ellen MacArthur Foundation. https://emf.thirdlight.com/file/24/sjZ_pROsjGmZ60hsjoOCsUf7m3O/SORP%20Report%20K%2012-08-24%20-%20NEW%20August%202024.pdf

[7] Gallego, J. (2020). *Circulating towards a new economy. Companies with a fixed course towards the circular economy*. Editorial Profit España.

[8] Gallardo, D., Scarpellini, S., Aranda, A., & Fernández, C. (2024). How does the circular economy achieve social change? Assessment in terms of sustainable development goals. *Humanities and Social Sciences Communications*, *11*, 692. https://doi.org/10.1057/s41599-024-03217-9.

[9] García-Quevedo, J., Jové-Llopis, E., & Martínez-Ros, E. (2020). Barriers to the Circular Economy in European Small and Medium-sized Enterprises. *Business Strategy and the Environment, 29(6),* 2451-2464. https://doi.org/10.1002/bse.2513

[10] Geissdoerfer, M., Pieroni, M., Pigosso, D., & Soufani, K. (2020). Circular business models: a review. *Journal of Cleaner Production, 277,* 123741. https://doi.org/10.1016/j.jclepro.2020.123741

[11] Huysman, S., Schaepmeester, J., Ragaert, K., & Dewulf, J. (2017). Performance indicators for circular economy: a case of study on post-industrial plastic waste. *Resources, Conservation and Recycling, 120,* 46-54. https://doi.org/10.1016/j.resconrec.2017.01.013

[12] Kristensen, H., & Mosgaard, M. (2020). A review of micro level indicators for a circular economy – Moving away from the three dimensions of sustainability? *Journal of Cleaner Production, 243,* 118531. https://doi.org/10.1016/j.jclepro.2019.118531

[13] Kristoffersen, E., Mikalef, P., Blomsma, F., & Li, J. (2021). Towards a business analytics capability for the circular economy. *Technological Forecasting and Social Change*, *171*, 120957. https://doi.org/10.1016/j.techfore.2021.120957

[14] Luzzati, T., Distefano, T., Lalenti, S., & Andreoni, V. (2022). The circular economy and longer product lifetime: framing the effects on working time and waste. *Journal of Cleaner Production*, 380, 134836. https://doi.org/10.1016/j.jclepro.2022.134836

[15] Millar, N., McLaughlin, E., & Börger, T. (2019). The Circular Economy: Swings and Roundabouts? *Ecological Economics, 158*, 11-19. https://doi.org/10.1016/j.ecolecon.2018.12.012

[16] Neligan, A., Baumgartner, R., Geissdoerfer, M., & Schooggl, J. (2022). Circular disruption: digitalisation as a driver of circular economy business models. *Business Strategy and Environment*, 32(3), 1775-1188. https://doi.org/10.1002/bse.3100

[17] Parida, V., Burström, T., Visnjic, I., & Wincent, J. (2019). Orchestrating industrial ecosystem in circular economy: a two-stage transformation model for large manufacturing companies. *Journal of Business Research, 101,* 715-725. https://doi.org/10.1016/j.jbusres.2019.01.006

[18] Piyathanavong, V, Olapiriyakul, S., Garza-Reyes, J., Kumar, V., Huynh, V., & Karnjana, J. (2024). Implementing Industry 4.0 and circular economy through the developmental culture perspective—Driving a competitive advantage in the manufacturing industry. *Business Strategy and Environment*, *33*(5), 4233-4251. https://doi.org/10.1002/bse.3967

[19] Puglieri, F., Salvador, R., Romero-Hernández, O., Escrivao, E., Piekarski, C., De Francisco, A., & Ometto, A. (2022). Strategic planning oriented to circular business models: A decision framework to promote sustainable development. *Business Strategy and Environment, 31*(7), 3254-3273. https://doi.org/10.1002/bse.3074

[20] Rodríguez, O., Cuevas, A., Chowdhury, S, Díaz, N., Alborez, P., Despoudi, S., Malesios, C., & Dey, P. (2022). The role of circular principles and sustainable-oriented innovation to enhance social, economic and environmental performance: Evidence from Mexican SMEs. *International Journal of Production Economics*, *248*, 108495. https://doi.org/10.1016/j.ijpe.2022.108495

[21] Schroeder, P., Anggraeni, K., & Weber, U. (2019). The relevance of circular economy practices to the sustainable development goals. *Journal of Industrial Ecology, 23*(1), 77-95. https://doi.org/10.1111/jiec.12732

[22] Suárez-Eiroa, B., Fernández, E., Méndez-Martínez, G., & Soto-Onate, D. (2019). Operational principles of circular economy for sustainable development: linking theory and practice. *Journal of Cleaner Production, 214,* 952-961. https://doi.org/10.1016/j.jclepro.2018.12.271

[23] Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., & Valkokari, K. (2019). Unlocking circular business: a framework of barriers and drivers. *Journal of Cleaner Production, 212,* 90-98. https://doi.org/10.1016/j.jclepro.2018.11.202

[24] Tura, N., Keränen, J., & Patala, S. (2019). The darker side of sustainability: tensions from sustainable business practices in business networks. *Industrial Marketing Management,* 77, 221-231. https://doi.org/10.1016/j.indmarman.2018.09.002

[25] Vásquez, R, Vidal, L., Miñan, S., Vásquez, A., Pintado, M., Cruzado, Rosa. (2024, July 11-13). Good circular economy practices in agro-export companies in Lambayeque-Peru: a focus on sustainability [conference]. *International Conference in Information Technology and Education*. ICITED 24. Recife, Brazil.

Conflict of interest / Competing interests

The author declares that there is no conflict of interest.

Author contributions

Roxana Mariella Céspedes Estela (main author): conceptualization, formal analysis, research, methodology, project management, validation, writing (original draft, revision and editing).