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REVERSE LOGISTICS: A VIEW FROM THE CIRCULAR ECONOMY AND THE BUSINESS ENVIRONMENT

LOGÍSTICA INVERSA: UNA VISIÓN DESDE LA ECONOMÍA CIRCULAR Y EL ENTORNO EMPRESARIAL

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Abstract
Electronical waste has become an important issue given the global environmental impact that represents; this research aims to examinate the main effects of a diversity of factors bearing the implementation of reverse logistics in electronic companies located in Mexico. The analysis is carried out using a forgotten effects methodology. Thus, the research problem is approached from the perspective of the elements that are included in theory and academic research as factors that should be considered for a successful implementation. The results showed that not considering formalization has a significative effect in the reverse logistics implementation process. This article contributes to the understanding of the way that using expert valuations can represent a useful approach to identify the factors that affect the implementation of reverse logistics in electronic companies.
Keywords: Reverse Logistics, Circular Economy, Sustainable Development, Electronic Companies

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Resumen

Este artículo examina el impacto de diversos factores que inciden directamente en la implementación de logística inversa en diferentes empresas del sector electrónico en México. El análisis se desarrolla desde la perspectiva de la lógica difusa y de manera más específica utilizando la teoría de objetos olvidados, los cuales muestran de manera significativa aquellos factores que no han sido considerables. El problema se abarca desde la perspectiva de los académicos y la teoría los cuales indican cuales son aquellos factores que suponen éxito a la hora de implementar la logística inversa. Los resultados muestran aquellos factores que no fueron considerados desde el principio pero que en efecto afectan y limitan de manera significativa la implementación de la logística inversa en las empresas del sector electrónico en México.

Palabras clave: Logística inversa, Economía circular, Desarrollo sustentable, Compañías electrónicas.

1. Introduction

In the realm of supply chain management, there has been a recent surge of interest in the recovery processes for products that reach the end of their useful life or are discarded by consumers. These products, however, still contain value that can be reclaimed through practices such as reuse, recycling, or remanufacturing. Thus, a line of research has been developed on these product recovery processes, which can be found within the concept of reverse logistics or closed supply chain management (Dekker et al., 2004; Flapper et al., 2005). Historically, companies have shown a tendency to focus on product, economies of scale were centralized, because profits were mainly a reflection of market share. The outcome of this heightened focus is evident in the deteriorating environment and the emergence of new theories, such as the circular economy, along with strategies like reverse logistics. These approaches aim to not only alleviate existing pollution but also alter the current trajectory.

Therefore, the importance of having a different process globalized has emerged. This is where the circular economy and reverse logistics converge on focusing on creating a new process or a new way of doing logistics and consequently a new tendency for today´s economy scenario. Reverse logistics processes have increasingly become more popular due to several reasons. With growing concerns about environmental sustainability, businesses are under increasing pressure to minimize their waste and reduce their carbon footprint. By implementing reverse logistics into the product cycle, this allows for businesses to recover and recycle materials and products that might otherwise go to waste. In turn, this helps to reduce costs by optimizing inventory management and streamlining product disposition (Huang Y., 2012)

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When reverse logistics is managed efficiently in the companies, several positive results are obtained and competitiveness is maintained in each sector by reducing the use of resources and redistributing the resources used to maximize their use (Phoosawad P., 2019). Once an analysis of economic performance has been carried out, it has been competently demonstrated that the implementation of reverse logistics has had a positive results in the matter of economic performance, so it is possible to affirm that by implementing reverse logistics, the impact of the company in society is positive and significant, both, in the economic and environmental branch (Huang Y., 2012).

This article is organized as follows. After the introductory section, the theoretical foundations of reverse logistics and circular economy are presented, as well as their conceptual evolution. In the following section, the selection, analysis criteria and methodological techniques employed are exposed, followed by an analysis and discussion of results in the last part and conclusions, highlighting the most significant contributions of this study.

2. Theoretical and conceptual framework

2.1 Sustainable business practices and reverse logistics

With the rapid growth of the global economy, there is a focus on resources and their relationship with the environment, which have become the main obstacle to the development. How to solve the conflicts between economic growth and high energy consumption, as well as environmental degradation, has become a challenge for the world (Juan, 2011). The theory based on sustainability focuses on a multidimensional transformation for the modification of processes to promote sustainable consumption and production (Markard, Raven, & Truffer, 2012,).

One of the goals in developing new technologies and innovations applied to logistics is to contribute positively to the preservation of the environment, (reducing ecological carbon foot and ecological footprint). Carrion-Flores and Innes, mention that it can reduce waste and environmental damage on the planet, as well as provide better goods and services at a better cost, as well as create jobs for people (Garrette, Justin, Long, & Marcel, 2009, 1); (Carrión-Flores, 2010). The circular economy represents a means of achieving the implementation of closed supply chain or reverse logistics in material flows in the economic system.

Continuing with the argument of these authors, Tetiana Ivanova, Robert Rogaczewski, and Iryna Lutsenko (2019) highlights the importance of reverse logistics in promoting sustainable business practices and its impact on various stakeholders, including economic, environmental, and societal benefits. Reverse logistics contributes to environmental sustainability as it can significantly reduce waste by recovering and recycling materials and

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products that might otherwise be discarded. This contributes to a more sustainable business model and helps companies meet their environmental commitments (Ivanova, 2019)

Several authors, such as Srivastava (2019), Lai et al (2021), draw attention to the possible harm that reverse logistics could do to the environment. While it is generally considered to be a sustainable practice, there is still a lot of potential damage that it could cause to the environment. In some cases, the remanufacturing or refurbishment of returned products may require more resources than producing a new product, resulting in inefficient resource use, and potentially increasing the environmental impact. If reverse logistics processes are not properly managed, it could result in improper disposal of products, leading to environmental harm, and pollution. Inefficient or improper reverse logistics practices could lead to biodiversity loss due to the damage to natural habitats. For this reason, it is of utmost importance to be able to properly identify all the factors that contribute to the proper implementation of reverse logistics.

Regarding this, the incorporation of circular economy concepts is particularly important. The concept of the circular economy has become a trending topic among various interest groups, including numerous companies, governments, and academics. Its appeal lies in the potential to contribute to sustainable development (Geissdoerfer, 2017) through a set of activities known as circular strategies, which have been proven to be efficient and productive (Ghisellini, 2016). One notable strategy is industrial symbiosis, wherein a company utilizes waste, fluids, or emissions generated by another, incorporating them into its own production process.

Lastly, several authors discuss the possible social effects of reverse logistics. In practice this tool, can have both positive and negative effects on the economy. On the one hand, it can lead to increased resource efficiency and cost savings, which can benefit businesses and consumers (Guide and Van Wassenhove, 2009). On the other hand, it can also result in the loss of value and revenue for businesses and increased costs for consumers (Rogers and Tibben-Lembke, 1998). In addition, the implementation of reverse logistics practices can lead to job creation and economic growth (de Brito et al., 2003). Reverse logistics can also have social effects, particularly in terms of consumer behavior and customer satisfaction. By providing hassle-free return processes and reducing waste, reverse logistics can help improve customer satisfaction and loyalty (Fleischmann et al., 1997). It can also contribute to more sustainable consumption patterns by promoting the reuse and recycling of products (Tibben-Lembke, 2002).

According to the strong sustainable development approach, which states that the structure and characteristics of the earth's ecological systems, life-supporting functions or the stock of natural capital should be sustained (Ghisellini, 2016). This ecological sustainability

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should be represented through the concepts of stability and resilience, the former being the ability of species populations to return to equilibrium after a disturbance, and the latter being sustainable development and its indicators, which measures the propensity of the ecosystem to return to its main structure after a disturbance or modification (Ivanova, 2019). In this case, what is considered as the main disturbance to ecosystems are the impacts of human activities and the argument for achieving sustainability is to avoid impacts that reduce these two properties of ecological systems (Daly, 1989). Clearly, under this approach, it is essential to integrate impact factors into the equation, so that those factors that influence ecosystem well-being no longer have a negative impact on the environment.

In view of this statement, it will be necessary to integrate or create a new corporate sustainability index based on existing indexes, thus, the most used components and indices of environmental sustainability are shown in table 1.

Table 1

Components and indicators of the environmental sustainability index

Component	Index
Environmental systems	Air Quality Biodiversity Water Quality Water Quantity
Environmental stress	Air pollution Stress on ecosystems Waste and consumption pressures Water stress Natural resource management
Human vulnerability	Environmental health Basic human sustenance Vulnerability to natural disasters environmentally related
Institutional capacity	Environmental governance

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	Eco-efficiency Private sector responsiveness Science and Technology
Global Management	Participation in collaborative environmental efforts Greenhouse gas emissions Reduction of transboundary environmental pressures

Source: Yale Center for Environmental Law and Policy et. al. (2005).

As table 1 suggest, every component represents a construct measured by a set of variables that includes the quality of the environmental systems that represents essential factors for human life and well-being, as well as highlights the importance of institutional backup to provide support to sustainable practices; thus, it is possible to take some of these indicators as a reference and apply them directly to the companies, as well as part of the rest of the indexes in order to build a sustainability index allowing the potential for implementation of sustainable practices, including reverse logistics, to engage these companies into a circular economy model of competitiveness.

2.2 Forgotten effects theory regarding reverse logistics

The forgotten effects theory is rooted in a mathematical model applied across various knowledge areas, emphasizing reliable decision-making outcomes through a rational selection of variables and expert opinions on the subject under investigation. This theory is centered on the concept of incidence, a subjective notion linked to reasoned action, explored within a network of links that may omit certain stages and overlook conclusions. The notion of incidence is associated with processes of a sequential nature, wherein incidents are transmitted in chains (Vizuete, Gil-Lafuente, García, & Boria-Reverter, 2013).

In this context, the theory incorporates experts' opinions regarding direct and indirect relationships of effects on a given variable or construct. It has found application in Social Sciences fields, with researchers utilizing it over the last 50 years (González-Morcillo, Horrach-Rosselló, Valero-Sierra, & Mulet-Forteza, 2023).

Due to its specific characteristics, the forgotten effects theory has been extensively employed in social contexts to investigate the causes and effects of various economic phenomena. These include studies on entrepreneurship, tourism, innovation, international trade networks, the value of exports, economic relationships, trade interdependence

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evolution, policy implications, and other industry-related inquiries (Chávez-Bustamante, F., Mardones-Arias, E., Rojas-Mora, J., & Tijmes-Ihl, 2023).

Considering the development of the theoretical framework, the following parts of the present research explain the methodology followed by the researchers, including the operationalization of the variables explaining dimensions considered in the index of implementation of reverse logistics for the selected sample of companies identifying those related to causes based on the ESI model, and those related to effects in terms of environmental stress reduction, reducing human vulnerability, as well as consumption and production patterns, as it is included in the methodological development as follows.

3. Methodology

The literature about strategic management decision making is very varied, however one of the noblest theories in the social sciences is undoubtedly the forgotten effects theory, proposal by Kauffman and Gil Aluja (1988). The main focus is the function and incidence in the work process as a chain. The use of this methodology makes it possible to obtain qualitative information derived from the appreciation of experts group, whose knowledge comes from experience in the field. The aim of article is to analyze the factors that influence the implementation of reverse logistics and that are ignored or forgotten in electronic companies in Mexico. The problem is approached from the perspective of the elements required by the companies for the implementation of reverse logistics on a daily basis.

According to forgotten effects theory, the events happened around us are part of a system or subsystem. Therefore, it is only logical that any activity is subject to a cause- effect relationship. However, even though there are certain activities with a viable control system, there is always the risk of omitting, either voluntarily or involuntarily, some causal relationships that are not always evident or visible. Therefore, the forgotten effects theory is in fact an innovative and effective approach that considers all the relationships of a phenomenon minimizing errors that can occur in modeling (Gil-Lafuente A. M., 2011).

3.1 Methodological Development

At the beginning of the methodological approach, an occurrence of Ai over Bj is taken into account if the value of the membership functions of the pair of features (AiBj) is estimated between [0,1] (the value of each cell of the matrix cannot be less than 0 nor greater than 1, as if we had valued from 0 to 10, but in decimals); that is. e. $\forall(aibj) \Longrightarrow \mu(aibj) \in [0,1]$ (Kauffman & Gil Aluja, 1988).

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The set of evaluated elements defines the "direct relationship matrix", which for the purposes of this paper is called matrix M, which shows the cause-effect relationships that occur between the joint elements of set A and the joint elements of set B. So, the representation of the sets is shown like this:

$A = \{ai\ /i = 1,2,....,n\}$: Reverse logistics implementation results.

$B = \{bj\ /j = 1,2, \ldots . , m\}$: Sustainability variables

From these data sets it can then be stated that the effects are cumulative, then a third set of elements is required that differs from the first two (Kauffman & Gil Aluja, 1988). This third set starts from the effects of set *B*, which will define the causal relationships on set a., thus creating set *C.*

The mathematical operator that will determine the intensity of the effects of set *A* on set *C* is the Max-Min composition:

$$M \subset A \times B\ ,\ N \subset B \times C \text{ and } P \subset A \times C$$

and the Kaufmann and Henry-Labordère (1977) equation is invoked to:

$$M \circ N = P$$

Therefore, it can be stated that the impact relation P defines the causal relations between the elements of set A and set C in the intensity or degree of the elements belonging to set B (Kauffman & Gil Aluja, 1988). To have a clear view of the criteria used for the evaluation, the table of causes, the table of effects, as well as the semantic evaluation scale shown to the experts, are shown below in table 2.

Table 2

Causes of implementation of reverse logistics

Dimensions	Index of Implementation of RL
Company	C1 Reverse logistics formalization C2 Certifications C3 Infrastructure C4 Costs

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Client	C5 Participation C6 Service C7 Communication
Supplier	C8 Eco-efficiency C9 Corporate Responsibility
Product	C10 Design C11 Quality C12 Classification

Source: Own elaboration based on the ESI Model 2022.

In table 2 the dimensions related to the main causes of the implementation of reverse logistics are included, based on the ESI Model, these dimensions include some relevant indicators related to the company, such as formalization, certification, infrastructure and cost; those measurements are not only related to reverse logistics, but also represent essential factors of competitiveness; also, dimensions related to clients and suppliers, that are essential stakeholders for every organization and some characteristics of the product as well, which are related to the main features that a good must present to be considered of something of value for the market.

Now, in what comes to the dimensions that are related to the effects of sustainable development that must be considered as part of the value proposition of the companies, the next table 3 shows the indicators that must be considered to measure dimensions related to environment, human vulnerability, as well as consumption, as it is included as follows.

Table 3

Effects of Sustainable Development

Dimensions	Indicators
environmental stress reduction	E1 Waste reduction and consumption E2 Natural resource management
Reducing human vulnerability	E3 Basic human sustenance
Consumption and production patterns	E4 Material consumption E5 Generation and management of waste

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Source: Own elaboration (2023).

As it is possible to see, table 3 shows that every dimension considered in the effects of sustainable development must be measured with specific and definite indicators, so it is also clear how this dimensions can be measured to understand the sustainable development of the companies considered in an objective and unbiased analysis, including measurements related to waste reduction and natural resource management for environmental stress reduction, basic human sustenance for human vulnerability and indicators related to consumption and production patterns.

Having these sets of dimensions clearly identified, the next step is to define the semantic scale including the levels that will be considered in the measurements of the present research, as well as the semantic label related to the selected scale, that goes from 0.0 to 1.0 in terms of influence; the table 4 presents such information as follows.

Table 4

Semantic Scale

Level	Semantic Label
0.0	No influence
0.1	Very weak influence
0.2	Weak influence
0.3	Low influence
0.4	Moderated influence
0.5	Medium influence
0.6	Considerate influence
0.7	High influence
0.8	Strong influence
0.9	Very strong influence
1.0	Total influence

*Source***:** Gil-Lafuente & Santoyo (2015).

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Table 4 shows a semantic scale based on the work of Gil-Lafuente & Santoyo (2015), which proposes a measurement that includes different levels of influence, ranging from "No influence" (0 in the scale) to "Total influence" (1.0 in the scale); this range of levels allow to identify a difference in the intensity of influence that help to identify the relevance of a given variable to understand the problematic situation.

Following that idea, the impact or influence of effect-cause, cause-cause and effect-effect was estimated by 10 experts in sustainability, competitiveness, reverse logistics, infrastructure, and supply chain management. By being aware of possible intermediate impacts or influences, greater internal consistency can be achieved, according to Gento et al (2001). The results are shown below in table 5.

Table 5

Cause and effects Matrix

	E1	E2	E3	E4	E5
C1	0.6	0.5	0.8	0.2	0.5
C2	0.6	0.5	0.8	0.3	0.6
C3	0.5	0.5	0.8	0.4	0.4
C4	0.7	0.6	0.6	0.3	0.4
C5	0.8	0.7	0.7	0.3	0.4
C6	0.7	0.5	0.5	0.8	0.3
C7	0.7	0.7	0.8	0.5	0.5
C8	0.6	0.5	0.5	0.4	0.5
C9	0.6	0.7	0.7	0.4	0.4
C10	0.6	0.5	0.5	0.5	0.4
C11	0.6	0.6	0.6	0.4	0.4
C12	0.8	0.8	0.6	0.6	0.6

Source: Own elaboration (2023).

Table 5 shows the level of impact of effect-cause in first place, considering that the estimation was considered with the contribution of expert knowledge, it is possible to

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observe that the table shows most of the consideration of the experts that varies from "Medium influence" (level of 0.5, with a total of 15 results, that represents a 25% of the total considerations) to "Considerate influence" (level of 0.6, with a total of 14 results, that represents a 23% of the total considerations); lesser common results were "Moderated influence" (level of 0.4, with a total of 10 results, that represents a 17% of the total considerations), "High influence" and "Strong influence" (level of 0.7 and 0.8 respectively, with 8 results each, that represents a total of 13% each); the resting results presented a lower quantity, which can show that the experts were not judging those cause and effects using any extremes levels of interpreted degree of influence.

In what it comes to the matrix causes-causes, table 6 shows a matrix of 132 combinations, that are represented as follows.

Table 6

Matrix Causes-Causes

↱	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
C1	1	0.4	0.4	0.5	0.9	0.3	0.7	0.5	0.2	0.3	0.2	0.5
C2	0.8	1	0.6	0.5	0.5	0.3	0.8	0.8	0.4	0.4	0.3	0.5
C3	0.3	0.5	1	0.6	0.5	0.5	0.6	0.6	0.5	0.4	0.3	0.4
C4	0.2	0.3	0.2	1	0.4	0.4	0.5	0.3	0.6	0.6	0.6	0.5
C5	0.7	0.4	0.5	0.4	1	0.5	0.6	0.5	0.5	0.5	0.6	0.8
C6	0.2	0.3	0.5	0.5	0.6	1	0.5	0.5	0.5	0.5	0.5	0.7
C7	0.7	0.6	0.5	0.5	0.7	0.4	1	0.4	0.5	0.5	0.4	0.5
C8	0.7	0.7	0.6	0.3	0.4	0.4	0.7	1	0.4	0.4	0.4	0.3
C9	0.3	0.3	0.5	0.7	0.7	0.6	0.5	0.5	1	0.8	0.8	0.7
C10	0.5	0.3	0.5	0.6	0.7	0.6	0.5	0.3	0.7	1	0.7	0.7
C11	0.7	0.8	0.3	0.5	0.7	0.4	0.4	0.3	0.7	0.7	1	0.6
C12	0.5	0.5	0.5	0.6	0.7	0.6	0.5	0.3	0.7	0.6	0.6	1

Source: Own elaboration (2023).

As it can be seen in table 6, the table shows most of the consideration of the experts that varies from "Medium influence" (level of 0.5, with a total of 40 results, that represents a 28% of the total considerations) to "Strong influence" (level of 0.7, with a total of 21 results, that represents a 15% of the total considerations); lesser common results were "Considered influence" (level of 0.6, with a total of 20 results, that represents a 14% of the

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total considerations), which is the same case for "Moderated influence" (level of 0.4). Next, in relation to the effects-effects matrix, the Table 7 shows the following results.

Table 7

Matrix Effects-Effects

	E1	E2	E3	E4	E5
E1	1	0.9	0.8	0.7	0.6
E2	0.8	1	0.9	0.6	0.6
E3	0.7	0.6	1	0.5	0.7
E4	0.8	0.6	0.6	1	0.5
E5	0.6	0.5	0.6	0.5	1

Source: Own elaboration (2023).

These results are produced by subjecting to evaluation the possible direct influence on the components of the implementation of reverse logistics on the sustainable development of Mexico. As mentioned above, expressing the development phenomenon with this evaluation is not enough, so it must be analyzed more deeply in order to explain the effects on sustainability (not only for its direct causes but also for the cross effects). Thus, it is necessary to develop two other cross-relationship matrices that present the influence of indicators on sustainable development and how they are pursued in an interrelated manner.

According to the explained model, from the max-min composition of the three previous matrices, we run the matrix convolution according to the matrices observed in tables 5, 6 and 7, obtaining the matrix that collects the forgotten effects (Table 8), that is, the global incidence that each one of the components of the implementation of reverse logistics has on its sustainable development.

Table 8

Accumulation of forgotten effects

	E1	E2	E3	E4	E5
C1	0.1	0.2	0.0	0.7	0.2
C2	0.1	0.2	0.0	0.6	0.1

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C3	0.2	0.1	0.0	0.2	0.3
C4	0.0	0.1	0.1	0.5	0.2
C5	0.0	0.1	0.1	0.5	0.3
C6	0.1	0.2	0.2	0.0	0.3
C7	0.0	0.0	0.0	0.2	0.2
C8	0.1	0.2	0.2	0.3	0.2
C9	0.1	0.0	0.0	0.3	0.3
C10	0.1	0.2	0.2	0.2	0.3
C11	0.1	0.1	0.2	0.3	0.3
C12	0.0	0.0	0.2	0.1	0.1

Source: Own elaboration (2023).

Table 8 shows the accumulation of forgotten effects, which are highlighted in the case of the indicator E4 (Material consumption), which is part of the dimension related to "consumption and production patterns"; such result is evidently superior compared to the remaining dimensions and variables, which ranges from 0.3 to 0.0, providing the evidence that supports the idea of material consumptions having an important effect on sustainable development.

4. Results and discussion

The results show those variables that turn out to be not fully considered when implementing a reverse logistics process; in that sense, they represent the current state of reverse logistics in electronic enterprises in Mexico. These results can help at the national level—the departments of spatial planning and the environment in higher territorial units in México in the formation and creation of tools and strategies of environmental activities.

It is important to mention that the theory of forgotten effects allows the researcher to analyze the direct and indirect impacts of the results of the implementation of reverse logistics in companies of the electronic sector in Mexico within the framework of sustainable development indicators. With this model it is possible to observe the secondary effects (forgotten effects) that are not directly considered when seeking to implement reverse logistics, as can be seen in table 9.

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Table 9

Major influence of forgotten effects

Implementation reverse logistics	Sustainable development	M 1 C-C	M2 C-E	M 3 E-E	M-M
C1 Reverse logistic formalization	E4 Material Consumption	0.2	0.9	0.7	0.7
C2 Certifications	E4 Material Consumption	0.3	0.5	0.7	0.6
C4 Costs	E4 Material Consumption	0.3	0.5	0.7	0.5
C5 Participation	E4 Material Consumption	0.3	0.6	0.7	0.5

Source: Own elaboration (2023).

In relation to these results, in table 9 it can be observed that the estimated value of the influence of actions for the formalization of reverse logistics and material consumption had a score of 0.2. However, the formalization of reverse logistics has a strong average influence on customer participation, and in turn participation has a strong influence on the reduction of waste and consumption. Therefore, there are two effects that modified the direct influence value on material consumption, giving rise to a secondary (forgotten) effect of the mean influence on the formalization of reverse logistics on material consumption. With these results, it can be observed that if the reverse logistics implementation process is formalized in companies, a significant improvement of material consumption indicators can be expected indirectly. This moderate influence can be seen below in Figure 1.

Figure 1

Moderate influence of formalization of reverse logistic in Material consumption

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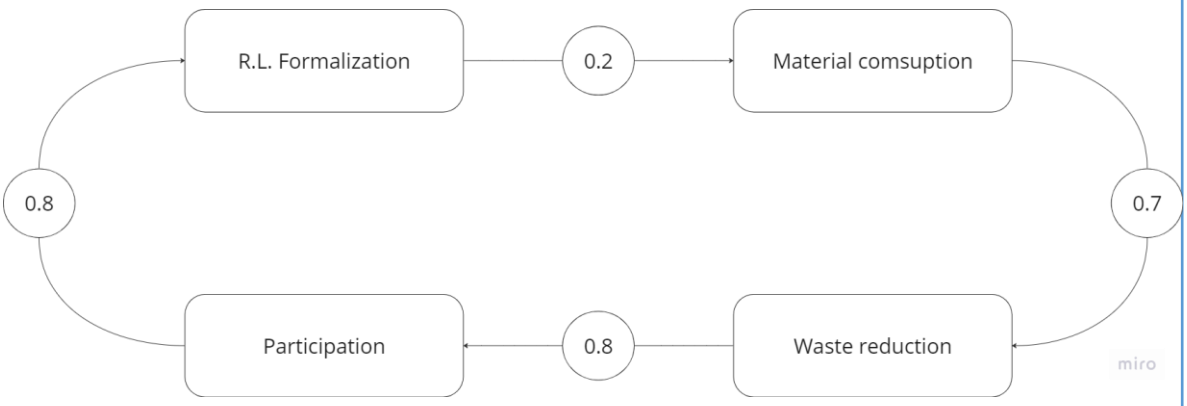

***Source*:** Own elaboration using software MIRO based on the results (2023).

The results of this study show that using expert assessments of sustainable development policies, it is possible to identify the components of reverse logistics implementation that affect Mexico's sustainable development. We were only able to identify maximum neglected effects on the components of formalization, and on certifications, cost and customer participation assistance that according to this study have impacts on the material consumption indicators. If this sustainable development indicator is to be positively impacted, policies aimed at these indicators should be considered to improve the implementation of reverse logistics and thus promote a circular economy that leads to the sustainable development of the country, in this particular area.

These results are consistent with Gonzales & Johansson (2021), who conducted a study regarding reverse logistics in supply chain management, finding that the positive environmental effects that can be achieved through a circular approach and by an increased reverse logistics maturity level, and these products designed for circularity will prolong the product life cycle and reduce the energy consumption.

Also, there is another study made by Abid & Zahra (2021), that mentions how firms are adopting sustainability in their activities, reducing the energy and material consumption during manufacture by using existing components and reducing the level of monetary expenditure of a given company producing or acquiring new components. Additionally, Mbekeka (2021) contributes with some findings that revealed that practicing reverse logistics on a small scale represents an important subject for manufacturers, government agencies, policy makers, managers and researchers.

Another study that shows convergence in results is Piyathanavong, Garza-Reyes, Kumar, Maldonado-Guzmán, & Mangla (2019), finding that the manufacturing sector has served

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as an engine for the economic and social expansion, where several companies have implemented operational environmental sustainability approaches including reverse logistics and circular economy, among others.

For the mentioned studies, the forgotten effects theory allowed to carry out causal relationships studies that allows to analyze direct relationships, helping to alleviate hidden or forgotten relationships that may exist indirectly (Anido & Ancizar, 2021), resulting in a valuable tool to understand complex problems in a comprehensive manner.

5. Conclusions

It is undeniable that the outcomes of diverse sustainable development indexes play a crucial role in shaping public programs and policies aimed at fostering the sustainable development of a country, thereby enhancing the well-being of its citizens, and preserving its resources. Nevertheless, when applying the theory of forgotten effects to the context of an emerging nation like Mexico, it becomes apparent that certain effects have not been fully considered. This is evidenced by the identification of indicators within these indexes that do not align with the observable results in the country's sustainable development.

In that sense, some indicators such as cost, certifications, logistics formalization and customer participation have not been fully considered, since the cumulative effect of other indicators are eliminating positive impacts that should be incorporated to consolidate public policy efforts and programs for sustainable development and circular economy in the country. This work points out the need to conduct a broader study on the influence on sustainable development indicators to develop to propose programs and public policies to promote and improve reverse logistics; thus, it is possible to clearly identify as formalization area of reverse logistics has been an indicator of "forgotten effects" in this area of development.

Likewise, for future lines of research, it is recommended to measure the cause-effect of waste and consumption reduction and design strategies to promote the five “R”, in addition to reverse logistics.

References

Agrawal , S., Singh , R., & Murtaza, Q. (2016). Triple Bottom Line Performance Evaluation of Reverse Logistics. *Competitiveness Review: An International Business Journal*, 3 pp.

REVISTA
CIENCIA Y UNIVERSIDAD
REVISTA DE ECONOMÍA
Enero-Junio 2023 Num. 46 ISSN 0185-6618

Anido, L. S., & Ancizar, Y. M. (2021). La teoría de los efectos olvidados vinculada a la gestión de los recursos humanos en las organizaciones. RILCO DS: Revista de Desarrollo sustentable, Negocios, Emprendimiento y Educación, (17), 7.

Barcellos-Paula, L., De la Vega, I., & Gil-Lafuente, A. M. (2021). The Quintuple Helix of innovation model and the SDGs: Latin-American countries' case and its forgotten effects. Mathematics, 9(4), 416.

Bhaumik, P. K. (2015). Supply Chain Network Design based on Integration of forward and reverse logistics. *Global Business Review*, 680-699.

Blanco-Mesa, F.; Vinchira, O.; Cuy, Y. (2023). Forgotten Factors in Knowledge Conversion and Routines: A Fuzzy Analysis of Employee Knowledge Management in Exporting Companies in Boyacá. Mathematics, 11, 412. https://doi.org/10.3390/math11020412

Brito, M. P. D., & Dekker, R. (2004). A framework for reverse logistics. In *Reverse logistics* (pp. 3-27). Springer, Berlin, Heidelberg.

Chileshe, N., Rameezdeen, , R., Hosseini, M., Lehmann, S., & Udeaja, C. (2016). Analysis of reverse logistics implementation practices by South Australian construction organisations. *International Journal of Operations & Production Management*, 332-356.

Daly, H. E. (1989). For the Common Good: Redirecting the Economy Towards Community, The Environment, and a Sustainable Future. *Boston, Beacon Press.*

Flapper, S., & Ron, A. (1996). *Proceedings of the first International Working seminar on reuse.* Eindhoven: The Netherlands.

Geissdoerfer, M. S. (2017). The circular economy–A new sustainability paradigm? . *Journal of Cleaner Production, 143,* , 757–768.

Gento, A. L. (2001). Reflexiones acerca de las matrices de incidencia y la recuperación de efectos olvidados. . *Cuadernos del CIMBAGE, 4,* , 11-27. .

Ghisellini, P. C. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. . *Journal of Cleaner Production, 114,* , 11–32.

Gil-Lafuente, A. M. (2011). The forgotten effects model in a CRM strategy. . *Fuzzy Economic Review, 16(1),*, 3-19.

Gil-Lafuente, A. M.-S.-R. (2015). (2015). Teoría de los efectos olvidados en la incidencia de la actividad económica en la calidad de vida de los habitantes y cuantificación de los efectos para un reequilibrio territorial. *Inceptum, 10(19),* , 105-122.

REVISTA
CIENCIA Y UNIVERSIDAD
REVISTA DE ECONOMÍA
Enero-Junio 2023 Num. 46 ISSN 0185-6618

Gonzales Rydberg, J., & Johansson, A. (2021). Reverse Logistics in Supply Chain Management-Assessment of Reverse Logistics Maturity Level at Ericsson.

Huang Y., W. Y. (2012). The task environment, resource commitment and reverse logistics performance: evidence from the Taiwanese high-tech sector. *Production Planning & Control, 23*, 851-863.

Ivanova, T. R. (2019). Influence of reverse logistics on competitiveness, economic performance, ecological environment and society. . *Journal of Cleaner Production, 213*, , 849-860.

Kaufmann, A., & Gil Aluja, J. (1988). *Modelos para la investigación de efectos olvidados*. Milladoiro.

Keshavarz ghorabaee,, m., amiri,, m., olfat, l., & khatami firouzabadi, a. (2017). Designing a multi-product multi-period supply. *Technological and economic development of economy*, 521-548.

Krupasindhu Panigrahi , S., Weng Kar, F., Fen, T., Hoe, L., & Wong, M. (2018). A Strategic Initiative for Successful Reverse Logistics Management in Retail Industry. *Global Business Review*, 19-25.

Lai, N. Y. (2021). Toward sustainable express deliveries for online shopping: Reusing packaging materials through reverse logistics. . *Journal of Cleaner Production, 290*, , 125-223.

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research policy*, *41*(6), 955-967.

Matar, N., Jaber, M., & Searcy, C. (2014). A reverse logistics inventory model for plastic bottles. *The International Journal of Logistics Management*, 315 - 333.

Mbekeka, W. (2021). Reverse logistics practices and environmental performance of food and beverage manufacturing firms in Uganda (Doctoral dissertation, Kyambogo University).

Meyer, A., Niemann, W., Mackenzie, J., & Lombaard, J. (2017). Drivers and barriers of reverse logistics practices: A study of large grocery retailers in South Africa. *Journal of Transport and Supply Chain Management*, 1-16.

Mihi Ramírez, A., & García, V. (2014). Improving organisational performance through reverse logistics. Journal of the Operational Research Society, 954–962.

Niknejad, A., & Petrović, D. (2014). Optimization of integrated reverse logistics networks with different product recovery routes. European Journal of Operational Research, 2-32.

REVISTA
CIENCIA Y UNIVERSIDAD
REVISTA DE ECONOMÍA
Enero-Junio 2023 Num. 46 ISSN 0185-6618

Peretti , U., Tatham , P., Wu , Y., & Sgarbos, F. (2015). Reverse logistics in humanitarian operations: challenges and opportunities. Journal of Humanitarian Logistics and Supply Chain Management, 253-274.

Pires de Lima Simão, M., Hisano Barbosa, D., Sayuri Kurumoto, J., Lapasini Leal, G., Cardoza Galdamez, E., & Lemos Cotrim, S. (2018). Emerging trends and collaborative network patterns on reverse logistics. Independent journal of management & production , 321-339.

Carrión-Flores, C. E. (2010). Environmental innovation and environmental performance. . *Journal of Environmental Economics and Management, 59(1),*, 27-42.

Chávez-Bustamante, F., Mardones-Arias, E., Rojas-Mora, J., & Tijmes-Ihl, J. (2023). A Forgotten Effects Approach to the Analysis of Complex Economic Systems: Identifying Indirect Effects on Trade Networks. Mathematics, 11(3), 531.

Daly, H. E. (1989). For the Common Good: Redirecting the Economy Towards Community, The Environment, and a Sustainable Future. *Boston, Beacon Press.*

Geissdoerfer, M. S. (2017). The circular economy–A new sustainability paradigm? . *Journal of Cleaner Production, 143,* , 757–768.

Gento, A. L. (2001). Reflexiones acerca de las matrices de incidencia y la recuperación de efectos olvidados. . *Cuadernos del CIMBAGE, 4,* , 11-27. .

Ghisellini, P. C. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. . *Journal of Cleaner Production, 114,* , 11–32.

Gil-Lafuente, A. M. (2011). The forgotten effects model in a CRM strategy. . *Fuzzy Economic Review, 16(1),*, 3-19.

Gil-Lafuente, A. M.-S.-R. (2015). (2015). Teoría de los efectos olvidados en la incidencia de la actividad económica en la calidad de vida de los habitantes y cuantificación de los efectos para un reequilibrio territorial. *Inceptum, 10(19),* , 105-122.

González-Morcillo, S., Horrach-Rosselló, P., Valero-Sierra, O., & Mulet-Forteza, C. (2023). Forgotten effects of active tourism activities in Spain on sustainable development dimensions. Environment, Development and Sustainability, 25(10), 10743-10763.

Huang Y., W. Y. (2012). The task environment, resource commitment and reverse logistics performance: evidence from the Taiwanese high-tech sector. *Production Planning & Control, 23*, 851-863.

REVISTA
CIENCIA Y UNIVERSIDAD
REVISTA DE ECONOMÍA
Enero-Junio 2023 Num. 46 ISSN 0185-6618

Ivanova, T. R. (2019). Influence of reverse logistics on competitiveness, economic performance, ecological environment and society. . *Journal of Cleaner Production, 213,* , 849-860.

Lai, N. Y. (2021). Toward sustainable express deliveries for online shopping: Reusing packaging materials through reverse logistics. . *Journal of Cleaner Production, 290,* , 125-223.

Phoosawad P., F. W. (2019). Impacts of collaboration networks, operational performance and reverse logistics determinantson the performance outcomes of the autoparts industry. *Management and Production Engineering Review, 10(3),*, 61-72.

Piyathanavong, V., Garza-Reyes, J. A., Kumar, V., Maldonado-Guzmán, G., & Mangla, S. K. (2019). The adoption of operational environmental sustainability approaches in the Thai manufacturing sector. Journal of Cleaner Production, 220, 507-528.

Salma Abid & Fatima Zahra Mhada (2021) Simulation optimisation methods applied in reverse logistics: a systematic review, International Journal of Sustainable Engineering, 14:6, 1463-1483, DOI: 10.1080/19397038.2021.2003470

Srivastava, S. K. (2019). Reverse logistics: Evolution, revolution, and contemporary research. . *International Journal of Physical Distribution & Logistics Management, 49(5),* , 498-523.

Vizuete Luciano, E., Gil-Lafuente, A.M., García González, A. and Boria-Reverter, S. (2013), "Forgotten effects of corporate social and environmental responsibility: A case study of Catalonian economy", Kybernetes, Vol. 42 No. 5, pp. 736-753. https://doi.org/10.1108/K-04-2013-0065

Yale Center for Environmental Law and Policy, Y. U. (2005). *Environmental Sustainability Index, Benchmarking National Environmental Stewardship".* . Retrieved from Environmental Sustainability Index, Benchmarking National Environmental Stewardship". : http://www.yale.edu/esi/.