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PROPOSAL FOR A THEORETICAL-OPERATIONAL MODEL FOR A COMPUTER RECOVERY CENTER LINKED TO THE PRINCIPLES OF THE CIRCULAR ECONOMY FOR DIGITAL INCLUSION AND INNOVATION IN PUBLIC MANAGEMENT

PROPOSTA DE MODELO TEÓRICO-OPERACIONAL DE CENTRO DE RECUPERAÇÃO DE COMPUTADORES ATRELADO AOS PRINCÍPIOS DA ECONOMIA CIRCULAR PARA INCLUSÃO DIGITAL E INOVAÇÃO NA GESTÃO PÚBLICA

PROPUESTA DE UN MODELO TEÓRICO-OPERATIVO PARA UN CENTRO DE RECUPERACIÓN DE INFORMÁTICA VINCULADO A LOS PRINCIPIOS DE LA ECONOMÍA CIRCULAR PARA LA INCLUSIÓN DIGITAL Y LA INNOVACIÓN EN LA GESTIÓN PÚBLICA

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Abstract

The circular economy has been a challenge for all types of organizations worldwide, particularly for those involved in public administration, aiming to maximize the reuse of as many components as possible from the numerous products discarded every day, especially electronic waste. In this sense, this study aimed to propose a theoretical-operational model for a computer recovery center linked to the principles of the circular economy for digital inclusion and innovation in public administration. The conceptual bibliographic method was used in its four stages (formulation of questions, data collection

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from digital scientific databases, data analysis and organization, and generation of answers to the formulated questions). The results obtained allowed us to: 1) map the stages of the computer recovery process, 2) identify the possible components of a theoretical-operational model for a computer recovery center, 3) list the contributions of a possible theoretical-operational model applied to computer recovery centers for the circular economy, and 4) identify the relationship between the proposed theoretical-operational model for computer recovery centers and the circular economy. The conclusion shows that the proposed model meets the study's objective by structuring an integrated, sustainable solution that consolidates the CRC as a robust technical-operational instrument for the practice of the circular economy in public management.
Keywords: Computer recovery center; Waste electronic equipment; Theoretical-operational model; Circular Economy; Public management.

Resumo

A economia circular tem sido um desafio para todos os tipos de organizações em todo o mundo, com especial atenção às que compõem a gestão pública, para que se faça o reaproveitamento máximo do maior número possível de componentes dos inúmeros produtos descartados todos os dias, especialmente os eletroeletrônicos. Neste sentido, este estudo teve como objetivo propor um modelo teórico-operacional de centro de recuperação de computadores, alinhado aos princípios da economia circular, para a inclusão digital e a inovação na gestão pública. Foi utilizado o método bibliográfico conceitual em suas quatro etapas: formulação de questões, coleta de dados em bases de dados científicas digitais, análise e organização dos dados e geração de respostas às questões formuladas. Os resultados obtidos permitiram: 1) mapear as etapas do processo de recuperação de computadores; 2) identificar os possíveis componentes de um modelo teórico-operacional para centros de recuperação de computadores; 3) listar as contribuições de um possível modelo teórico-operacional aplicado a centros de recuperação de computadores para a economia circular; e 4) identificar a relação entre a proposta de modelo teórico-operacional para centros de recuperação de computadores e a economia circular. A conclusão mostra que o modelo proposto atende ao objetivo do estudo ao estruturar uma solução integrada e sustentável, consolidando o CRC como um instrumento técnico-operacional robusto para a prática da economia circular na gestão pública.
Palavras-chave: Centro de recuperação de computadores; Resíduos de equipamentos eletrônicos; Modelo teórico-operacional; Economia Circular; Gestão pública.

Resumen

La economía circular ha representado un desafío para todo tipo de organizaciones a nivel mundial, con especial atención a las del sector público, con el fin de maximizar la reutilización del mayor número posible de componentes provenientes de los numerosos productos desechados a diario, en especial de los residuos electrónicos. En este sentido, este estudio tuvo como objetivo proponer un

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modelo teórico-operativo para un centro de recuperación de equipos informáticos, vinculado a los principios de la economía circular para la inclusión digital y la innovación en la administración pública. Se empleó el método bibliográfico conceptual en sus cuatro etapas: formulación de preguntas, recopilación de datos en bases de datos científicas digitales, análisis y organización de los datos y generación de respuestas a las preguntas formuladas. Los resultados obtenidos permitieron: 1) mapear las etapas del proceso de recuperación de equipos informáticos; 2) identificar los posibles componentes de un modelo teórico-operativo para un centro de recuperación de equipos informáticos; 3) enumerar las contribuciones de un posible modelo teórico-operativo aplicado a los centros de recuperación de equipos informáticos para la economía circular; y 4) identificar la relación entre el modelo teórico-operativo propuesto para los centros de recuperación de equipos informáticos y la economía circular. La conclusión demuestra que el modelo propuesto cumple con el objetivo del estudio al estructurar una solución integrada y sostenible, consolidando el CRC como un instrumento técnico-operativo sólido para la práctica de la economía circular en la gestión pública.

Palabras clave: Centro de recuperación informática; Residuos de aparatos electrónicos; Modelo teórico-operativo; Economía circular; Gestión pública.

1. Introduction

International scientific literature has made significant progress in understanding the circular economy applied to waste electrical and electronic equipment (WEEE), with an emphasis on strategies for reuse, remanufacturing, and extending the product lifecycle. Recent studies highlight that organized equipment refurbishment and redistribution systems, analogous to Computer Recovery Centers (CRCs), play a relevant role in reducing waste and expanding access to digital technologies, especially when integrated with public policies and reverse logistics mechanisms (Somerville; Nagy, 2025; Roelfsema, 2026; Kumar et al., 2025). Systematic reviews have also indicated that the circular economy has evolved into more complex models, incorporating digital innovation, multilevel governance, and public value creation, which reinforces the importance of socio-technical infrastructures focused on the reuse of technological assets (Campos et al., 2025; Quinto et al., 2025; Gaur et al., 2024). In this scenario, initiatives similar to CRCs emerge as strategic instruments that articulate environmental sustainability, social inclusion, and innovation in the public sector.

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Recent studies in Brazil have analyzed advances in the management of electronic waste and the promotion of the circular economy, highlighting the role of public policies and institutional arrangements in structuring reuse and recycling practices. Research indicates that implementing the National Solid Waste Policy has boosted shared responsibility for the life cycle of products and fostered initiatives to recondition and redistribute computer equipment (Silva et al., 2025; Lupe; Zaganelli, 2022; Silva et al., 2024). Several other studies have found that technological reuse initiatives contribute not only to mitigating environmental impacts but also to digital inclusion and professional empowerment, especially in contexts of social vulnerability (Bensefia, 2026; Chugh, 2026; Aruleba; Esenogho, 2026). The enactment of Law No. 14,479/2022 reinforces this movement by prioritizing the allocation of equipment for refurbishment, consolidating the role of initiatives such as CRCs within the scope of public innovation and sustainable governance.

Despite these advances, the literature still presents a significant gap in developing an integrated theoretical architecture that articulates CRCs with the dimensions of the circular economy, digital inclusion, and public innovation within the Brazilian regulatory framework. Most studies focus on sectoral analyses or fragmented empirical assessments, without advancing to theoretical models capable of explaining how these initiatives operate as institutional infrastructures that generate public value. Furthermore, there is a scarcity of research that explicitly integrates Brazilian regulatory instruments, such as the National Solid Waste Policy and Law No. 14,479/2022, with contemporary approaches to governance, state capacities, and public sector-oriented innovation, limiting the understanding of the transformative potential of CRCs in the context of the circular economy.

Given this scenario, the present study proposes a theoretical-operational model for Computer Recovery Centers grounded in the principles of the circular economy, aiming at digital inclusion and innovation in public management. It seeks to integrate environmental, social, technological, and institutional dimensions into an analytical model that explains how CRCs can contribute to the

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implementation of public policies and the generation of public value. From a scientific point of view, it is expected that the results will advance the literature by proposing an innovative and interdisciplinary theoretical approach, offering subsidies for future research and for the improvement of public policies focused on sustainability, digital transformation, and innovation in the public sector.

2. CRC and the Circular Economy

The circular economy has established itself as an alternative paradigm to the linear model of production and consumption by proposing the closing of material cycles through reuse, remanufacturing, and recycling, reducing pressure on natural resources and waste generation, as evidenced in the study by Aquino, Pantoja, and Luz (2023), which highlights the centrality of this model in transforming waste into productive inputs. In this sense, Computer Recovery Centers (CRCs) represent concrete applications of this paradigm by promoting the reintroduction of electronic equipment into the production cycle and preventing premature disposal. The operation of these centers depends directly on reverse logistics, which enables the return flow of post-consumer products for reuse and is considered a structuring element of the circular economy (Pereira; Moreira, 2024; Serejo; Rodrigues, 2025). Furthermore, by structuring collection, sorting, and reconditioning chains, CRCs incorporate practices typical of urban mining, recovering valuable components and materials from WEEE and adding economic and environmental value to these flows. This dynamic underscores the relevance of these centers as mechanisms for transitioning to more sustainable production models, while increasing resource efficiency and reducing environmental impacts associated with improper disposal of technological waste.

CRCs can be understood as instruments of innovation in the public sector, since they articulate environmental policies, digital inclusion, and efficient waste management in an integrated approach, aligning with contemporary guidelines for sustainable governance (Okojie et al., 2025; Alvarenga; Rocha, 2023). They promote the reuse of equipment, technological capacity building, and generate public value by expanding access to technology and stimulating innovative

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practices in public administration. From a regulatory perspective, CRCs (Reverse Logistics Centers) can be interpreted as a practical implementation of Law No. 14.479/2022, operationalizing principles such as shared responsibility for the product lifecycle and incentives for the circular economy. This means that the integration between reverse logistics, urban mining, and public innovation proves that CRCs not only contribute to the sustainable management of electronic waste but also constitute an institutional response to contemporary legal and socio-environmental demands. These centers are consolidating themselves as strategic organizational arrangements that connect sustainability, innovation, and public policies, reinforcing their role in building circular systems in the Brazilian context.

2.1 Circular Economy Applied to the Objective of the Study

The circular economy is an alternative to the linear model of production and consumption, especially in resource-intensive sectors such as electrical and electronic equipment. Studies show that circularity is not limited to recycling but involves integrated strategies of redesign, life extension, reuse, and remanufacturing, aiming to maximize the value of materials across multiple production cycles (Bonato; Moudoub, 2026; Alfnes et al., 2025; Patel et al., 2025). In this context, the incorporation of CRCs (Corrected Recycling Centers) can be understood as an operational practice aligned with the logic of value retention processes, in which discarded products are reintroduced into the economy with added value. Recent research indicates that the application of the circular economy in the public sector has significant potential to reduce operational costs and carbon emissions, while promoting social inclusion (Reddy; Zondo, 2025; Wei et al., 2025), since they represent a practical interface between theory and implementation, enabling the concrete operationalization of circular principles. The literature also analyzes the circular economy from a systemic perspective, involving multiple actors and institutional levels, including government, the private sector, and civil society. Collaborative governance is a critical factor for the success of circular initiatives, especially in the context of electronic waste management (Park; Tamaki, 20265; Parmar; Murari, 2026). Circular Waste

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Collection Centers (CRCs) can be interpreted as institutional hubs that articulate material and social flows, connecting public disposal, technical training, and digital inclusion. The integration of these elements directly contributes to achieving the Sustainable Development Goals, especially SDG 12 and SDG 13, by reducing waste generation and promoting sustainable consumption patterns. Analyzing CRCs from a circular-economy perspective helps us understand their role as instruments for transitioning to more sustainable production models.

Advances in measuring circularity reinforce the importance of specific indicators to evaluate the performance of initiatives such as CRCs. Research indicates that metrics such as extended lifespan, material recovery rate, and emission reduction are fundamental for empirically validating the benefits of the circular economy (Volodzkiene; Streimikis, 2026; Lozano-Oviedo, 2026). The performance of CRCs (Corporate Recovery Centers) can be quantified in terms of environmental, economic, and social impact, contributing to the legitimization of these structures within public administration, as well as the digitization and use of tracking technologies, which can increase the efficiency of circular systems, allowing greater control over material flows (Pererva et al., 2026; Streimikiene; Streimikis, 2026). The inclusion of CRCs in this context represents a practical application of the circular economy and a fertile ground for innovation and evaluation of sustainable public policies.

2.2 Reverse Logistics and Operationalization of CRCs

Reverse logistics is also an alternative to the global increase in electronic waste generation, as it has ceased to be merely an operational instrument and has become a strategic component of organizational sustainability (Rana et al., 2025; Ardra et al., 2025). In the context of CRCs, this approach enables the efficient structuring of flows for the collection, transportation, sorting, and reconditioning of discarded equipment. Studies indicate that well-structured reverse logistics systems can significantly reduce the costs of acquiring new equipment while mitigating environmental impacts associated with improper

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disposal (Ali, 2025; Mahmud, 2025). CRCs are operational units that enable the practical implementation of these flows, especially in the public sector.

The integration between forward and reverse logistics forms closed-loop supply chains, as can be seen in the studies by Akram (2026) and Habibi et al. (2026), in which products return to the production cycle after use, allowing for value recovery and reduced dependence on virgin raw materials (Sarkar; Pal, 2026; Lozano-Oviedo, 2026). In the case of CRCs, this integration manifests as the ability to transform obsolete equipment into functional assets that can be redistributed for educational or social purposes. Studies indicate that the efficiency of reverse logistics depends on factors such as infrastructure, regulation, and institutional engagement (Mbago et al., 2026; Jardim, 2026), which reinforces the need for structured public policies to support initiatives such as CRCs (Garcia et al., 2025; Souza et al., 2026). These findings show that reverse logistics provides the conceptual basis for understanding the operational flows that underpin the proposed technical-operational model.

It should also be considered that technological advancements have played a fundamental role in optimizing reverse logistics, especially using information and tracking systems. Research indicates that technologies such as the Internet of Things (IoT) and blockchain can increase the transparency and traceability of waste flows, reduce losses, and improve operational efficiency (Ibitoye et al., 2026; Ahmed et al., 2026), so that the adoption of these technologies can contribute to the monitoring of equipment from disposal to its reintegration into use. The literature also notes that human resource training is a critical factor in the success of reverse logistics, highlighting CRCs as spaces for technical training (Faradillah et al., 2025; Yu et al., 2025). The integration of technology, management, and training reinforces CRCs' potential as effective reverse logistics instruments in the public sector.

2.3 CRCs as Instruments of Public Innovation

Public innovation is a challenge whose overcoming can increase the efficiency and effectiveness of government policies. The reason for this is that

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innovation in the public sector involves not only the introduction of new technologies but also the creation of new institutional arrangements and governance models (Rosa et al., 2025; Todisco et al., 2025; Lundstedt), so that CRCs can be understood as innovative initiatives that combine waste management, digital inclusion, and professional training. These studies also suggest the hypothesis that integrated solutions tend to generate greater public value, especially when they address multiple problems simultaneously. In this way, CRCs stand out as examples of systemic innovation, capable of producing social, economic, and environmental impacts in an articulated manner.

Science emphasizes the importance of mission-driven innovation, in which public policies are structured to address complex challenges such as sustainability and social inclusion (Fava, 2025; Sanderink et al., 2026; Klerkx et al., 2025), which allows CRCs to be included as instruments of public policies aimed at transitioning to a more sustainable and inclusive economy. Collaboration among different actors, including educational institutions, government agencies, and society, is fundamental to the success of these initiatives. If CRCs integrate teaching, outreach, and asset management, they can exemplify this collaborative approach and broaden the reach and effectiveness of public policies.

The importance of impact assessment as a central component of public innovation underscores the need to measure results to ensure the sustainability and scalability of innovative initiatives (Todorova et al., 2025; Van Lunenburg, 2025; Muftugil-Yalcin; Klas, 2025). Indicators such as the number of recovered pieces of equipment, trained personnel, and avoided emissions can be used to evaluate CRC performance. Replicability is a key factor in the diffusion of innovations in the public sector, underscoring the relevance of structured models such as the one proposed in this study. This means that CRCs not only represent an innovation in themselves, but also a potentially replicable model in different institutional contexts.

2.4 Interpretation of Law No. 14.479/2022 from the Perspective of Public Management

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Analysis of legal frameworks shows that legislation plays a central role in enabling innovative practices in public administration. The creation of specific regulatory instruments for the reconditioning and reuse of public assets contributes to the institutionalization of sustainable practices (Ibrahim et al., 2025; Kim, 2025), so that Law No. 14,479/2022 can be interpreted as a significant advance in asset management, by establishing guidelines for the disposal and reuse of movable assets. The legislation also emphasizes that regulatory clarity is fundamental to reducing institutional barriers and encouraging the adoption of innovative practices. Thus, the laws create a favorable environment for implementing CRCs within the scope of public administration.

Recent research highlights that contemporary public management has incorporated principles of efficiency, transparency, and sustainability, aligning itself with global agendas such as the objectivist approach to sustainable development (Agustinho; Herbst, 2023; Gattang; Chong, 2026). Law No. 14,479/2022 can be understood as an instrument that operationalizes these principles by encouraging the reuse of assets and reducing waste, since the integration of legislation and innovation is essential to promote structural changes in the public sector. By relying on this regulatory framework, the CRCs become concrete mechanisms for implementing these guidelines, contributing to the modernization of public management.

The effectiveness of public policies depends on the existence of norms and their practical implementation, so that factors such as institutional capacity, available resources and engagement of managers directly influence the results of policies (Muzakki; Munif, 2025; Matlala, 2025), which, in the case of the CRCs, means that the operationalization of Law No. 14,479/2022 creates adequate organizational structures and the training of technical teams. These studies suggest that intergovernmental coordination can improve the outcomes of these initiatives. Analyzing legislation from a public management perspective helps us understand the challenges and opportunities of implementing CRCs (Collection and Recycling Centers) as an alternative for WEEE management.

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2.5 Urban Mining and Adding Value to WEEE

Urban mining has gained prominence as a key strategy for recovering critical materials from WEEE, which represents one of the richest sources of valuable metals, including gold, copper, and rare earths (Ormuž et al., 2026; Strong et al., 2025), often in concentrations and with advantages superior to those found in natural deposits (Sideris et al., 2025). Urban mining offers a sustainable alternative to traditional mining, reducing environmental impacts and advancing the circular economy. CRCs, by performing equipment sorting and reconditioning, can serve as initial steps in this process, contributing to the valorization of electronic waste.

Urban mining should be integrated into broader waste management systems, involving public policies, infrastructure, and technological innovation. Research indicates that the efficiency of material recovery depends on factors such as product design, collection systems, and processing technologies (Poulose, 2025; Soubache et al., 2026; Brunnenkant et al., 2025), showing that CRCs can play a strategic role by separating reusable equipment from that intended for recycling, increasing the efficiency of the system. These studies also indicate that the economic valorization of WEEE can generate new business and employment opportunities, especially in urban contexts.

Technological advances have expanded the potential of urban mining by enabling the recovery of materials with greater efficiency and lower environmental impact. The use of hydrometallurgical and biotechnological processes for extracting metals from electronic waste (Kalupahana et al., 2025; Haile et al., 2025; López-Martínez et al., 2025; Martinez-Rodriguez et al., 2025) allows the integration of CRCs (Combustible Recycling Centers) with advanced recycling chains, which can enhance the economic and environmental benefits of these initiatives. Public awareness and environmental education are fundamental to increasing WEEE collection rates, enabling urban mining to complement the CRC model and expand its contribution to sustainability and the circular economy.

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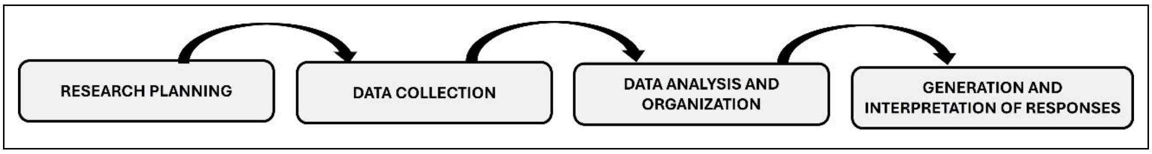
3. Research Methodology

This is a qualitative study based on a literature review that used the conceptual bibliographic method developed by Nascimento-e-Silva (2020; 2021a; 2021b). The unit of analysis consisted of individual concepts, whose level of analysis encompassed the theoretical context in which they are embedded, with a synchronic or transversal (cross-sectional) perspective. The main research question was divided into four guiding questions, which sought to: a) identify the stages of the computer recovery process, b) identify the components of a theoretical-operational CRC model, c) identify the possible contributions of the model to the circular economy, and d) examine the relationship of the technical-operational model with the circular economy.

3.1 Study Design

The study results were generated using the conceptual bibliographic method, a process comprising four stages. The first was research planning, a stage in which the scope of the investigation, the main and guiding research questions, the transformation of the questions into general and specific objectives, the response patterns, the creation and testing of the data collection instrument, and the elaboration of the study protocol were defined. The second stage consisted of data collection, a procedure that began with the translation of the response patterns (strings) into English, the application of the patterns to the search systems of the data platforms (Google Scholar, Scopus, Web of Science, Wiley, MDPI, IEEE, and Taylor & Francis), obtaining the desired data, and filling the instrument with the data set. The result of the second stage was four distinct tables with the collected data, one for each guiding question (Nascimento-e-Silva, 2021c). Figure 1 summarizes the stages of the procedures adopted.

Figure 1. Study design.



Source: prepared by the authors.

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The third stage was the analysis and organization of the data, which began by separating the data (analysis) into the right-hand column and their respective bibliographic sources in the left-hand column, so that the alphabetical cataloging tools of word processors could then be applied, allowing the data to be viewed from this perspective. Next, the data were organized again, first by citation frequency and then by semantic proximity, culminating in a table that allowed the responses to be visualized and transformed into drawings. The fourth and final stage consisted of generating the responses shown in the figures, followed by a comparison of these responses with the study's theoretical framework (presented in the results discussion section).

3.2 Populations and Samples

The population for this research consisted of all published scientific studies available in Google Scholar, Scopus, Web of Science, Wiley, MDPI, IEEE, and Taylor & Francis databases related to each guiding question. This resulted in the creation of several different populations and sample sizes. The guiding question regarding the steps in the computer recovery process yielded 171 qualified studies, of which 32 met the inclusion and exclusion criteria stipulated in the research protocol and were published between 2025 and 2026. All other guiding questions had publication periods from 2020 to 2026, since the number of studies with high-quality data in shorter periods was very small, which could compromise the research results. Table 1 shows these specifications.

Table 1. Specifications of the research population and sample

Unit of analysis	**Scope**	**Population**	**Sample**
Steps in the computer recovery process	2025-2026	171	32
Components of the theoretical-operational model	2020-2026	7	7
Contributions of the model to the circular economy	2020-2026	102	16
Relationship of the model to the circular economy	2020-2026	76	13

Source: prepared by the authors.

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3.3 Data: Instruments and Collection Strategy

The data were collected using four different datasets, one for each guiding question (Nascimento-e-Silva, 2023). Each dataset consisted of a double-entry table, in which the complete bibliographic references of the data sources were listed in the left column and the collected data in the right column, each set representing a different structure. For the computer recovery process steps, the data structure had to present a logical sequence in which the first and last steps could be identified. For the guiding question that sought to identify the components of the theoretical-operational model, the collected data consisted of a list of each component as a piece of a puzzle.

Table 2. Strings Used in the Collection of Bibliographic Data.

Unit of analysis	String used
Steps in the computer recovery process	("computer refurbishment" OR "computer recovery" OR "computer remanufacturing") AND (process OR stages OR steps OR methodology)
	("IT equipment reuse" OR "electronics reuse") AND (procedures OR workflow OR "process chain")
	("e-waste management") AND (recovery AND stages)
Theoretical-operational model components for CRC	("theoretical-operational model" OR framework OR model) AND ("computer refurbishment center" OR "IT recovery center") AND (components OR structure)
	("management model" AND "e-waste") AND (structure OR elements OR dimensions)
	("reverse logistics" AND electronics) AND (model OR framework)
Contributions of the model to the circular economy	("circular economy") AND ("computer refurbishment" OR "IT recovery") AND (impact OR contribution OR benefits)
	("electronics reuse") AND ("circular economy") AND (sustainability OR innovation)
	("e-waste") AND ("circular economy") AND (reduction OR reuse OR recycling)
Relationship between the theoretical-operational model and the circular economy	("theoretical-operational model") AND ("circular economy") AND ("e-waste" OR IT)
	("framework") AND ("circular economy") AND ("reverse logistics" OR "electronic recycling")
	("sustainable management model") AND ("information technology") AND ("circular economy")

Source: prepared by the authors.

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Data collection began with the response pattern formulated for each unit of analysis. For the "steps in the computer recovery process," the pattern consisted of "computer recovery," "computer reconditioning," and "computer remanufacturing," and other aspects that denote the use of these devices, plus "process," "steps," "phases," or "methodology," and similar terms, as specified in the research protocol. This procedure was used for each unit of analysis. Then, each response pattern was transformed into a string, which was then translated into English, as shown in Table 2.

3.4 Data Analysis and Organization Techniques

After collection, the data were first separated into references, with complete information placed at the end of the report under "bibliographic references," and only the information in the Author (Year) format left in the source column. On the right side, the data were separated into lists of steps (for the process analysis unit), components, contributions, and relationships, each corresponding to a level of analysis. After separation, the data were reorganized according to the guiding question: the list of steps gave rise to a sequence diagram; the list of components resulted in the elaboration of the theoretical-operational model proposal; the list of contributions was organized into analytical dimensions of the model, constituting a double-entry table; and the list of relationships was transformed into a diagram representing the different relationships of the model with the circular economy.

3.5 Generation and Interpretation of Results

The results are the answers to the guiding research questions, specifically, and to the main question, in general, in accordance with the specific and general objectives, respectively. In this sense, the result consisted of a description of the logic underlying each figure or table generated during the data analysis and organization stage, meaning that these representations function as a kind of snapshot of the logic of the answers sought, marking their theoretical and empirical contours (level of analysis). The results appear in two stages: the first

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being a description of what is fundamental to see in the figure or table, followed by the second, which is the overall logic of what the set of fundamental aspects indicates. For example, in the computer recovery process steps, the figure shows what each step entails, and the paragraph below explains the logic it represents. This procedure was applied to generate each result for each guiding question. The interpretation of the results, in turn, consisted of comparing the underlying logic of each guiding question with the study's theoretical framework (presented in the results discussion section), culminating in the research conclusion.

4. Results and Discussion

This section presents the study's findings, organized according to the guiding questions. First, the proposed steps for the computer recovery process will be presented, followed by the component elements of the proposed technical-operational model. The third part presents the model's main contributions to the circular economy, and the fourth shows its relationships with the circular economy. The section concludes with a discussion of the results.

4.1 Steps in the Computer Recovery Process

The Technical-Operational Model of Computer Recovery Centers (CRC) can be understood as a circular economy system for the management of electronic equipment in public administration, aligned with the National Policy for the Disposal and Refurbishment of Electronic Equipment, established by Law No. 14,479/2022. This model organizes the flow of equipment into six macro-stages. The first stage is entry into the system, which begins when computer equipment becomes obsolete in the public sector due to technological updates, equipment replacement, operational failures, and changes in institutional infrastructure. This equipment then becomes part of the asset disposal process and can be sent to CRCs. The main sources are federal public bodies, educational institutions, autonomous agencies and foundations, and public companies, which begin the

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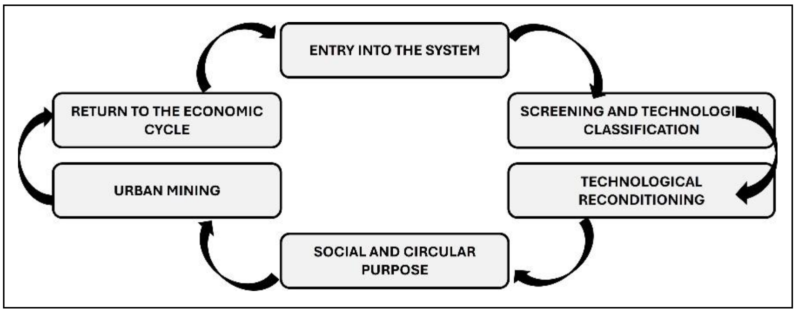
next stage. The second stage is screening and technological classification, which begins upon receipt, when the equipment undergoes technical screening. This step defines three categories: 1) recoverable equipment, which can be reconditioned and reused; 2) partially recoverable equipment, which can provide reusable components; and 3) unrecoverable equipment, which must be sent for specialized recycling. This step is fundamental to reducing waste and increasing technological reuse. Figure 2 shows the process steps.

Figure 2. Steps of the computer recovery process.



Source: Prepared by the authors.

The third stage is technological reconditioning, during which equipment classified as recoverable undergoes technical cleaning, component replacement, software updates, and operational testing. After the process, the equipment becomes reconditioned computers, ready for reuse. This stage constitutes the technical core of the CRC and prepares the equipment for the next stage. The fourth stage is social and circular destination, which is when the reconditioned equipment is destined for: a) digital inclusion in public schools, educational laboratories, libraries, and communities in social vulnerability, and b) professional training, which is when the CRCs function as spaces for technical training, computer maintenance training, and technological education.

The fifth stage is urban mining, which focuses on non-recoverable equipment that enters the process and recovers valuable materials from electronic waste. Among the recoverable materials are copper, gold, silver, aluminum, and rare earths. This stage contributes to reducing environmental impacts, increasing the economic value of technological waste, and preparing it for the next stage.

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The sixth and final stage is the return to the economic cycle, as the CRC model enables equipment and materials to be reintroduced into the production cycle through technological reuse, component recycling, and material repurposing, serving as a strategic node of the circular economy in the public sector. The model presents the flow of equipment from public administration, passing through the asset disposal process, technological sorting, and recovery at the CRC. Recoverable equipment is reconditioned and destined for digital inclusion, while unrecoverable equipment is sent for recycling and urban mining.

4.2 Components of a Technical-Operational CRC Model

Figure 2 presents the Technical-Operational Model of CRC, structured as an integrated system in which components are articulated sequentially and interdependently. The flow begins with equipment originating in public administration, which enters the system through the asset disposal process. Next, the technological sorting and classification module is observed, which identifies the equipment's condition and directs it based on its technical viability. The figure highlights the division of equipment into recoverable, partially recoverable, and unrecoverable categories, establishing distinct paths within the system. Recoverable equipment goes to the technological reconditioning center, where it undergoes maintenance, parts replacement, and software updates. Simultaneously, partially recoverable equipment feeds the component bank, reinforcing the internal reuse aspect. Unrecoverable equipment is destined for urban mining and specialized recycling. The model also highlights the social destination stage, which shows the redistribution of reconditioned equipment for digital inclusion and professional training. Finally, the figure demonstrates the return of materials and equipment to the economic cycle, closing the circular flow. Figure 3 visually synthesizes the CRC's systemic, integrated, and circular logic.

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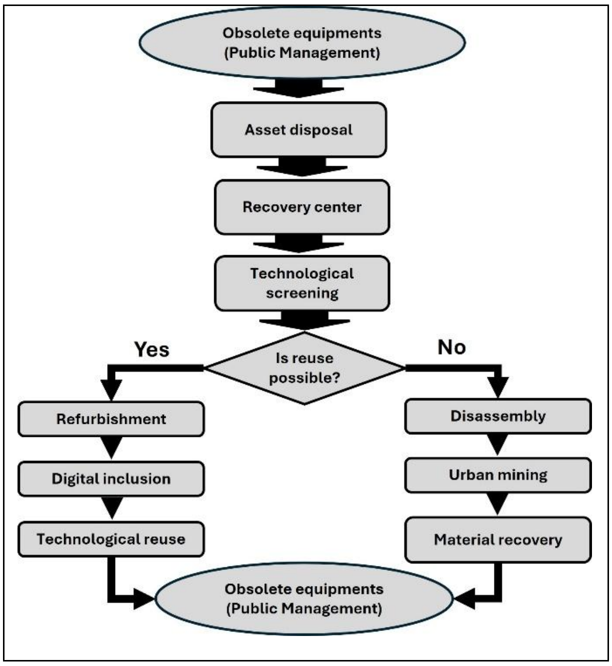
Figure 3. Technical Operational Model of the CRC.



Source: prepared by the authors.

The interpretation of Figure 3 reveals that the CRC Technical-Operational Model materializes, in practice, the principles of the circular economy applied to the management of electronic waste in the public sector. The illustrated system shows that CRC is not limited to a technical maintenance process but is configured as a strategic arrangement that articulates environmental, social, and economic dimensions. By prioritizing reconditioning and reuse, the model shifts the focus from simple recycling to higher value-added strategies, extending the life cycle of equipment. This is directly aligned with the National Policy for Disposal and Reconditioning of Electronic Equipment (Law No. 14,479/2022), which encourages sustainable practices in public administration. Figure 1 also explains the role of CRC as a link between institutional disposal and the productive and social reintegration of equipment, contributing to digital inclusion and technical training; by incorporating urban mining, the model expands the recovery of value from waste, reducing environmental impacts. Thus, the challenge of the technical-operational model is to integrate logistical efficiency, technical feasibility, and social impact into a single system, demonstrating that this integration is possible

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through well-defined, interconnected flows. This consolidates the CRC as a concrete instrument for operationalizing the circular economy in the public sector.

4.3 Contributions of the Technical-Operational Model to the Circular Economy

Table 3 summarizes the main contributions of the CRC Technical-Operational Model to the circular economy, organized into four fundamental dimensions: environmental, social, economic, and institutional. In the environmental dimension, reducing electronic waste and decreasing pressure on natural resources stand out, highlighting the positive impact of technological reuse. In the social sphere, the table highlights the promotion of digital inclusion and professional training, demonstrating that the model transcends the technical dimension by delivering direct benefits to society. In the economic dimension, the reuse of technological assets and the recovery of valuable materials are observed, generating value from equipment previously considered obsolete.

Table 3. Contributions of the model to the circular economy

Dimension	Contribution
Environmental	Reduction of electronic waste and less pressure on natural resources
Social	Digital inclusion and professional training
Professional	Reuse of technological assets and recovery of valuable materials
Institutional	Strengthening of public policies and improvement of asset management

Source: data collected by the authors.

In turn, the institutional dimension emphasizes strengthening public policies and improving asset management, indicating organizational gains in the public sector. The table, therefore, shows that the model operates in an integrated, multidimensional manner. Each dimension reinforces a strategic aspect of the circular economy. The data demonstrate that CRC is not limited to waste management; rather, it structures a system that generates sustainable value across different fronts.

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The analysis of these contributions shows that the CRC Technical-Operational Model constitutes a concrete response to the challenge of implementing the circular economy in the public management of electronic and electrical equipment. The data show that the model is fully aligned with the National Policy for Disposal and Reconditioning of Electronic and Electrical Equipment, established by Law No. 14,479/2022, by integrating practices of reuse, recycling, and repurposing of materials. The convergence among the environmental, social, economic, and institutional dimensions demonstrates that the CRC operates as a complex, strategic system capable of transforming technological liabilities into valuable assets. In this context, the model extends the equipment's life cycle, reducing waste and promoting the efficient use of public resources. By fostering digital inclusion and professional training, it reinforces its role as a public policy instrument with a relevant social impact. The economic dimension demonstrates the model's viability in recovering value from materials and equipment. The institutional dimension reveals its capacity to structure more efficient processes aligned with legal guidelines. The data reinforce the finding that the CRC is not just an operational solution but a mechanism for integrating sustainability, innovation, and public management into an effective strategic framework for operationalizing the circular economy in the public sector.

4 Relationship between the Technical-Operational Model and the Circular Economy

Figure 4 presents a logical scheme of the circular economy cycle applied to CRCs (Collective Recycling Centers), depicting a continuous, self-reinforcing flow of materials and equipment. The diagram begins with the institutional disposal of electronic and electrical equipment from public administration, which enters the system through asset disposal processes. Next, this equipment is directed to the CRC, where it undergoes sorting and technical classification, defining its reuse possibilities. The figure shows that suitable equipment proceeds to reconditioning, a stage in which it is restored for new use. After this, redistribution occurs for digital inclusion and social use, closing a first reuse cycle. Simultaneously, non-

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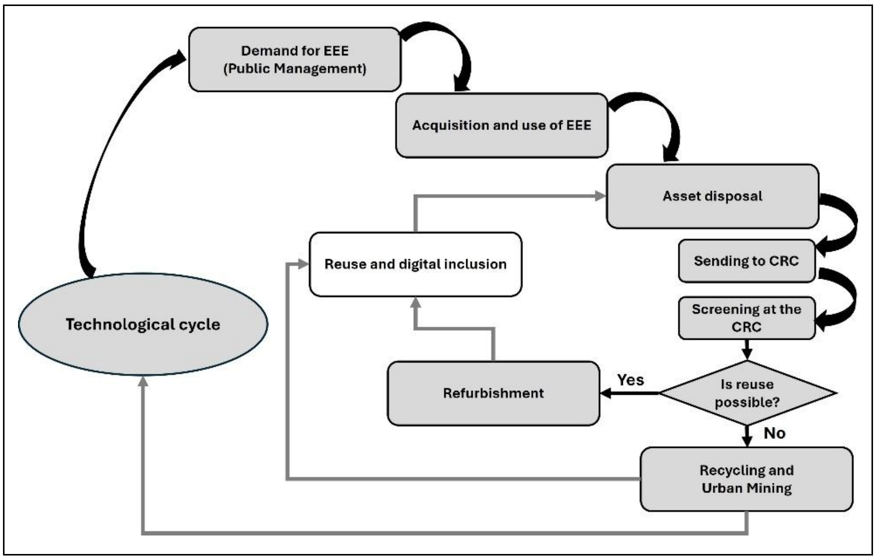
recoverable equipment is sent for recycling and urban mining, enabling the recovery of raw materials. The scheme highlights return arrows indicating the reinsertion of these materials into the production cycle. Thus, the model does not present a linear flow but rather a circular, continuous one, reinforcing the idea of maximizing resource value over time.

Figure 4. Circular economy applied to CRCs.



Source: Prepared by the authors.

The interpretation of the logical scheme shows that the CRC Technical-Operational Model practically materializes the principles of the circular economy in the management of electronic and electrical equipment in the public sector. The data and flows presented indicate that the model aligns with the National Policy for Disposal and Reconditioning of Electronic and Electrical Equipment, established by Law No. 14,479/2022, by prioritizing strategies that extend the life cycles of public goods. Instead of adopting a linear logic of disposal, the model promotes the reintegration of equipment and materials into the productive and social system. This demonstrates a paradigm shift in public management, with practices now incorporating sustainability and efficiency. Furthermore, the emphasis on reuse as a priority step demonstrates the adoption of higher-value-added strategies within the circular economy hierarchy. The presence of urban

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mining reinforces the commitment to resource recovery and to reducing environmental impacts. The model also serves a social function by reintegrating equipment into digital inclusion contexts, acting as a link between the different stages of the economic and social cycle. The proposed challenge is overcome by integrating multiple dimensions into a single operating system. The model is thus established as a structured solution aligned with legal and sustainable guidelines.

4.5 Discussion of the Results

The results regarding the stages of the computer recovery process align closely with the literature on circular economy and reverse logistics, particularly by highlighting a structured flow from equipment entry to its return to the economic cycle. The organization into stages, such as sorting, reconditioning, and disposal, is aligned with the understanding that the circular economy depends on closing material cycles through integrated reuse and recycling strategies (Aquino et al., 2023). The centrality of technical sorting as a value-maximizing mechanism also aligns with studies that highlight the importance of efficient waste separation for optimizing material recovery (Soubache et al., 2026). Furthermore, the inclusion of urban mining in the model confirms findings indicating that electronic waste is a relevant source of valuable materials (Ormuž et al., 2026). The presented structure also reflects principles of reverse logistics, considered a structuring element of the circular economy (Pereira; Moreira, 2024). Thus, the results not only confirm the literature but also operationalize it in the context of public administration. The integration of the technical and social dimensions reinforces contemporary approaches, highlighting the practical applicability of theoretical concepts and consolidating itself as an empirical translation of theory.

Regarding the components of the CRC technical-operational model, the results align closely with the literature on the circular economy from a systemic and integrated perspective. The model presented highlights the interdependence among operational modules, which aligns with the idea of circular systems composed of multiple actors and flows (Park; Tamaki, 2025). The segmentation of recoverable, partially recoverable, and unrecoverable equipment aligns with best

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practices for maximizing the efficiency of reuse systems (Lozano-Oviedo, 2026). In addition, the presence of parallel flows and component banks reinforces the logic of value retention throughout the product lifecycle (Bonato; Moudoub, 2026). The literature also highlights the importance of governance and institutional integration, aspects evidenced in the proposed model (Parmar; Murari, 2026). Another point of convergence is the articulation between technical and social function, characteristic of systemic public innovations (Rosa et al., 2025). The model advances by contextualizing these practices in the Brazilian public sector. This broadens its applied relevance, confirms and expands the theoretical foundations of the model, and its contributions to the advancement of the field of circular economy.

The model's contributions to the circular economy, organized into environmental, social, economic, and institutional dimensions, are highly coherent with contemporary literature on sustainability and public innovation. The environmental dimension, focused on waste reduction, is aligned with studies that highlight the benefits of circularity in mitigating environmental impacts (Wei et al., 2025). The social dimension, focused on digital inclusion and capacity building, converges with approaches that emphasize the generation of public value through integrated solutions (Okojie et al., 2025). The economic dimension reinforces the idea of creating value from waste, a central element of the circular economy (Patel et al., 2025). The institutional dimension, in turn, confirms the importance of legal frameworks and governance for enabling sustainable practices (Ibrahim et al., 2025). The study advances by integrating these four dimensions into a single operational model, whose multidimensional approach is recommended in the literature but not always applied. However, the results demonstrate the practical viability of this integration, highlight the simultaneous impacts in different spheres, and strengthen the applicability of the circular economy in the public sector. This expands the model's theoretical and empirical contributions.

The relationship between the technical-operational model and the circular economy, as evidenced by the results, aligns with the literature advocating a transition from linear models to circular systems based on closed material cycles.

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The logical scheme presented reflects the concept of circular supply chains, in which products return to the production cycle after use (Akram, 2026). The prioritization of reuse over recycling aligns with the circular economy hierarchy and the maximization of resource value (Alfnes et al., 2025). The presence of urban mining reinforces recent trends in the recovery of critical materials from electronic waste (Kalupahana et al., 2025). Furthermore, the model highlights the role of CRCs (Critical Recycling Centers) as strategic nodes within circular systems, connecting different material and social flows (Pereira; Moreira, 2024). The literature also emphasizes the importance of collaborative governance, reflected in the articulation between different actors in the model (Klerkx et al., 2025). It goes further by demonstrating the operationalization of these principles in the public sector. This reinforces its practical relevance and confirms and expands the theory, consolidating the model as a concrete application of the circular economy.

The study demonstrates that integrating circular economy, reverse logistics, and public innovation is viable and strategic in the context of public administration. The results show that CRCs can act as structured systems capable of transforming electronic waste into assets of social, economic, and environmental value. The comparative analysis with the literature confirms the theoretical consistency of the model while highlighting its innovation in proposing a practical, integrated application. The model contributes to closing the material cycles, aligning with the guidelines of the circular economy (Aquino et al., 2023); reinforces the role of reverse logistics as a structuring element of these systems (Rana et al., 2025); expands its social impact with digital inclusion and professional training; and strengthens its institutional viability through adherence to Law No. 14,479/2022. These results also make the model potentially replicable, consolidating it as an innovative and sustainable solution, and it can significantly contribute to the modernization of public management.

5. Conclusion

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This study proposed a technical-operational model of CRCs as a structured, coherent, and viable system for operationalizing the principles of the circular economy in the management of electronic and electrical equipment in the public sector. The findings showed that the model organizes the stages of disposal, sorting, reconditioning, social destination, urban mining, and return to the economic cycle in an integrated way, forming a continuous circular flow. The results demonstrated that the components of the model act in an interdependent manner, enabling the maximization of the equipment's value throughout its life cycle. The contributions identified across the environmental, social, economic, and institutional dimensions reinforce the model's multidimensional character. The analysis also showed that the CRC functions as a link between institutional disposal and productive and social reintegration, and that its central strategy is prioritizing reuse, in alignment with the circular economy hierarchy. The systemic relationship among the model's elements confirms its adherence to the theoretical and normative foundations, and it can be concluded that the proposed model meets the study's objective by structuring an integrated and sustainable solution and consolidating the CRC as a robust technical-operational instrument.

The implications of these findings for public management and the circular economy are significant, especially in the context of administrative modernization and sustainability. The model offers a concrete alternative for the efficient management of electronic waste, reducing operational costs and promoting the reuse of public assets through refurbishment and redistribution practices, thereby directly contributing to digital inclusion and reducing social inequalities. The model strengthens the implementation of the National Policy for the Disposal and Refurbishment of Electronic Equipment by integrating it with the circular economy, thereby reducing pressure on natural resources and minimizing environmental impacts. Another relevant outcome is the strengthening of public governance through more efficient and transparent processes, which stimulate innovation in the public sector by articulating different dimensions into a single solution, and create opportunities for technical training and knowledge generation. These

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results indicate that the CRC can act as a strategic instrument of public policy and contribute to the transition to more sustainable and inclusive models.

In the scientific field, the study makes relevant contributions by advancing the articulation between theory and practice in the context of the circular economy applied to the public sector. The main contribution lies in the proposition of a structured technical-operational model, capable of integrating concepts such as reverse logistics, urban mining, public innovation, and asset management. Unlike predominantly theoretical approaches, the study offers an applied systematization, with the potential for replicability across different institutional contexts and for broadening understanding of CRCs as complex and multidimensional systems rather than isolated refurbishment initiatives. The model also highlights the interdependence among the environmental, social, economic, and institutional dimensions, and incorporates the legal framework as a structuring element. The research also reinforces the importance of a systemic approach to analyzing the circular economy, contributing to the field of public innovation by presenting an integrated organizational arrangement. Thus, the study broadens the scientific debate on sustainability in public management and consolidates itself as a reference for future research.

Despite the contributions, the study presents limitations that should be considered. The main limitation concerns the model's theoretical and propositional nature, which has not yet been empirically validated at scale. Furthermore, the analysis focused on the context of public administration, and variations may exist in other institutional contexts. Another limitation concerns the lack of quantitative data to measure the model's impact in terms of operational and environmental performance, as well as its dependence on factors such as infrastructure, institutional capacity, and the engagement of the actors involved. In this sense, it is recommended that future studies carry out empirical applications of the model in different regions and levels of government; the development of specific indicators for evaluating the circularity and performance of CRCs is also suggested; future research could explore the use of digital technologies to improve the traceability of flows; and comparative investigations between different

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CRC models could broaden the understanding of the topic. This new research could validate, refine, and expand the proposed model, thereby advancing the continuous development of scientific fields related to public management and the circular economy.

References

AGUSTINHO, E. O.; HERBST, K. K. Public administration ensuring sustainable companies by leveraging ESG criteria. In: LEAL FILHO, W.; FRANKENBERGER, F.; TORTATO, U. (Eds.). **Sustainability in practice:** Addressing challenges and creating opportunities in Latin America. Cham: Springer Nature, 2023. p. 497-509. https://doi.org/10.1007/978-3-031-34436-7_29.

AHMED, M.; AL AMAREEN, O. S.; ARAFAT, Y. Harnessing big data for reverse logistics and waste management: Pathways to sustainable supply chains. In: HASAN, M. K. et al. (Eds.). **Enhancing sustainability in global supply chains with big data analytics**. Hershey: IGI Global, 2026. p. 175-210. https://doi.org/10.4018/979-8-3373-6896-2.ch006.

AKRAM, H. W. Closed-loop and circular supply chains: a meta-review of reverse logistics, product lifecycle and zero-waste strategies. **International Journal of Industrial Engineering and Operations Management**, p. 1-19, 2026. https://doi.org/10.1108/IJIEOM-10-2025-0257.

ALFNES, E. et al. Critical success factors for remanufacturing and reuse of equipment in the engineer-to-order shipbuilding industry. **International Journal of Production Economics**, v. 287, p. 109697, 2025. https://doi.org/10.1016/j.ijpe.2025.109697.

ALI, W. Optimizing the e-waste management in India: A sustainable mathematical modeling approach to circular economy. **Quality & Quantity**, v. 59, n. 5, p. 4647-4678, 2025. https://doi.org/10.1007/s11135-025-02176-w.

ALVARENGA, C.; ROCHA, D. J. Logística reversa e reciclagem como forma de mitigar o excesso de resíduos sólidos em aterros sanitários e seus impactos ambientais. **Revista de Direito, Globalização e Responsabilidade nas**

REMUNOM
ISSN 2178-6925
Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

Relações de Consumo, v. 9, n. 2, p. 35-55, 2023. https://doi.org/10.26668/IndexLawJournals/2526-0030/2023.v9i2.10017.

AQUINO, M.; PANTOJA, M.; LUZ, K. Economia circular: uma revisão sistemática da literatura e análise bibliométrica. **Revista Da UI_IPSantarém**, v. 11, n. 2, p. 259-271, 2023. https://doi.org/10.25746/ruiips.v11.i2.32802.

ARDRA, T. B.; SREE SAI, V. G.; HARIKRISHNAN, R. Sustainability in reverse logistics: Enhancing customer satisfaction and loyalty in e-commerce. In: KUMAR, S. et al. (Eds.). **International Conference on Communication and Computational Technologies**. Singapore: Springer Nature, 2025. p. 79-91. https://doi.org/10.1007/978-981-95-3486-9_7.

ARULEBA, K.; ESENOGHO, E. Sustainable computing education in African higher education: A critical synthesis and context-aware framework for practice. **Sustainability**, v. 18, n. 7, p. 3170, 2026. https://doi.org/10.3390/su18073170.

BENSEFIA, S. Refurbished IT as a driver of sustainable community development in France. **Asian Education and Development Studies**, p. 1-13, 2026. https://doi.org/10.1108/AEDS-10-2025-0564.

BONATO, M.; MOUDOUB, A. Circular economy and reliability: Extended lifespan requirements in automotive. In: **2026 Annual Reliability and Maintainability Symposium (RAMS)**. IEEE 2026, Miramar Beach, FL, USA, 26-29 January 2026, p. 1-6. https://doi.org/10.1109/RAMS50514.2026.11424483.

BRUNNENKANT, F.-A. et al. Combining morphological and techno-economic analysis: evaluating the impact of battery pack design on recycling. **Procedia CIRP**, v. 136, p. 832-837, 2025. https://doi.org/10.1016/j.procir.2025.08.142. Design

CAMPOS, R. A. et al. Recriar project: sustainability, digital inclusion, and pedagogical innovation through the reuse of illicit technological devices. **Aracê**, v. 7, n. 7, p. 36485-36507, 2025. https://doi.org/10.56238/arev7n7-076.

CHUGH, R. The sustainability paradox: rethinking digital technologies in education for a sustainable future. **Humanities and Social Sciences Communications**, v. 13, n. 1, p. 275, 2026. https://doi.org/10.1057/s41599-026-06845-5.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

FARADILLAH, P. et al. Assessing the readiness of Malaysia's recycling industry for sustainable transboundary e-waste management. **Discover Environment**, v. 3, n. 1, p. 1-21, 2025. https://doi.org/10.1007/s44274-025-00395-4.

FAVA, V. Innovation policy and deep transitions: instruments, institutions and implementation in complex contexts. **Innovation: The European Journal of Social Science Research**, v. 38, n. 2, p. 563-569, 2025. https://doi.org/10.1080/13511610.2025.2503643.

GARCIA, A. M. C. et al. Approaches, challenges, and opportunities in humanitarian logistics integrated with reverse logistics and sustainability. **Logistics**, v. 10, n. 1, p. 9, 2025. https://doi.org/10.3390/logistics10010009.

GATTANG, G. S.; CHONG, H.-Y. Enhancing audit quality through research-based practices: a comparative study of China and Indonesia. **Public Money & Management**, p. 1-13, 2026. https://doi.org/10.1080/09540962.2025.2561174.

GAUR, T. S. et al. A systematic review on sustainable E-waste management: challenges, circular economy practices, and a conceptual framework. **Management of Environmental Quality: An International Journal**, v. 35, n. 4, p. 858-884, 2024. https://doi.org/10.1108/MEQ-05-2023-0139.

HABIBI, F. et al. Building resilient closed-loop supply chains: resilience enablers and diversified sourcing under global disruptions. **International Journal of Production Research**, v. 64, n. 1, p. 192-219, 2026. https://doi.org/10.1080/00207543.2025.2546653.

HAILE, M. G. et al. Hydrometallurgical, pyrometallurgical, and electrometallurgical extraction of niobium and tantalum: an overview. **Mineral Processing and Extractive Metallurgy**, v. 134, n. 1, p. 3-12, 2025. https://doi.org/10.1177/25726641241301982.

IBITOYE, S. E. et al. Smart waste, smarter world: exploring waste types, trends, and tech-driven valorization through artificial intelligence, internet of things, and blockchain. **Sustainable Development**, v. 34, p. 132-153, 2026. https://doi.org/10.1002/sd.70345.

IBRAHIM, A.; ABDULKADIR, H.; BABA, S. U. Institutionalization of sustainable practices in the hospitality industry: Evidence from the Kaduna Metropolis,

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

Nigeria. **Kaduna Journal of Geography**, v. 7, n. 1, p. 419-432, 2025. https://doi.org/10.47514/kjg.2025.07.01.045.

JARDIM, G. Circular economy and sustainable entrepreneurship in healthcare in Portugal: Circular business models for rehabilitation equipment. **Journal of Entrepreneurial Researchers**, v. 4, n. 1, 2026. https://doi.org/10.29073/jer.v4i1.62.

KALUPAHANA, R.; DUSHYANTHA, N.; RATNAYAKE, A. S. Circular hydrometallurgy to overcome the limitations of conventional extractive metallurgy. **Journal of Sustainable Metallurgy**, v. 11, n. 4, p. 3322-3342, 2025. https://doi.org/10.1007/s40831-025-01247-4.

KIM, M. A study on the development direction for achieving sustainability in airline in-flight meals: Domestic and international airline cases. **Culinary Science & Hospitality Research**, v. 31, n. 11, p. 239-250, 2025. https://doi.org/10.20878/cshr.2025.31.11.021.

KLERKX, L.; BEGEMANN, S.; JANSSEN, M. Mission cocreation or domination? Explorative and exploitative forces in shaping the Dutch circular agriculture mission. **Science and Public Policy**, v. 52, n. 1, p. 128-145, 2025. https://doi.org/10.1093/scipol/scae061.

KUMAR, A.; GUPTA, D.; MAHAJAN, N. Sustainability through digital twins: a circular economy approach to product lifecycle management. In: **2025 12th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)**. IEEE 2025, Noida NCR, India, 18-19 September 2025, p. 1-6. https://doi.org/10.1109/ICRITO66076.2025.11241834.

LÓPEZ-MARTÍNEZ, A. et al. Acidophilic bacteria for metal extraction: biotechnological characteristics and applications. **Brazilian Journal of Chemical Engineering**, v. 42, n. 1, p. 31-52, 2025. https://doi.org/10.1007/s43153-024-00434-2.

LOZANO-OVIEDO, J. et al. Sustainable closed-loop supply chain of returnable packaging considering circular transition indicators. **Environment, Development and Sustainability**, p. 1-38, 2026. https://doi.org/10.1007/s10668-026-07338-w.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

LUNDSTEDT, A. A.; EK ÖSTERBERG, E.; ZAPATA, P. Mobilizing policy capacity amid rapid green industrialization: peripheral local government in the Northvolt boom-and-bust. **Planning Practice & Research**, p. 1-18, 2026. https://doi.org/10.1080/02697459.2026.2623119.

LUPE, G. Z.; ZAGANELLI, M. V. Universidade sustentável: um estudo sobre a gestão pós-uso de produtos tecnológicos. **Public management**, v. 9, n. 2018, 2022. https://doi.org/10.29327/2183989.26.51-9.

MAHMUD, D. An IOT-Enabled decision support system for circular economy business models: A review of economic efficiency and sustainability outcomes. **American Journal of Scholarly Research and Innovation**, v. 4, n. 01, p. 250-286, 2025. https://doi.org/10.63125/28kdxg31.

MARTÍNEZ-RODRÍGUEZ, G. A. et al. Biotechnological strategies for the recovery of lithium and other metals from a secondary source: the role of microorganisms and metal-binding peptides. **Recycling**, v. 11, n. 1, p. 4, 2025. https://doi.org/10.3390/recycling11010004.

MATLALA, L. S. Factors affecting the use of evidence in public sector programs in South Africa: A systematic review of outcome 8 programs. In: **26th Annual International Conference on Digital Government Research,** Pontifical Catholic University of Rio Grande do Sul, Porto Alegre City, Brazil, 09 – 12 June 2025. https://doi.org/10.59490/dgo.2025.1024.

MBAGO, M. et al. A complex adaptive systems approach to reverse logistics: A holistic implementation framework from developing country context. **Environmental Quality Management**, v. 35, n. 3, p. e70285, 2026. https://doi.org/10.1002/tqem.70285.

MUFTUGIL-YALCIN, S.; KLAS, A. On social impact measurement and social entrepreneurs combating food waste in the Netherlands. **Social Enterprise Journal**, p. 1750-8614, 2025. https://doi.org/10.1108/SEJ-03-2024-0033.

MUZAKKI, H.; MUNIF, M. Evaluating public sector efficiency and its influence on economic development across nations. **International Journal of Economics and Development**, v. 1, n. 1, p. 32-45, 2025. https://doi.org/10.71305/ijed.v1i1.346.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

NASCIMENTO-E-SILVA, D. **Manual do método científico-tecnológico**: edição sintética. Florianópolis: DNS Editor, 2020. https://doi.org/10.5281/zenodo.19035103.

NASCIMENTO-E-SILVA, D. **Handbook of the scientific-technological method**: Synthetic edition. Manaus: DNS Editor, 2021a. https://doi.org/10.5281/zenodo.19035456.

NASCIMENTO-E-SILVA, D. **O método científico-tecnológico**: fundamentos. Manaus: DNS Editor, 2021b. https://doi.org/10.5281/zenodo.19142042.

NASCIMENTO-E-SILVA, D. **O método científico-tecnológico**: questões de pesquisa. Manaus: DNS Editor, 2021c. https://doi.org/10.5281/zenodo.19142187.

NASCIMENTO-E-SILVA, D. **O método científico-tecnológico**: coleta de dados. Manaus: DNS Editor, 2023. https://doi.org/10.5281/zenodo.19570428.

OKOJIE, J. S. et al. Circular approaches to the pharmaceutical industry: from waste to resource recovery. **Int. J. Adv. Multidiscip. Res. Stud**, v. 5, p. 594-608, 2025. https://doi.org/10.62225/2583049X.2025.5.5.4966.

ORMUŽ, J. K.; ŽMAK, I.; ĆURKOVIĆ, L. Selective gold recovery from waste electronics: A speciation-based recycling approach—materials, v. 19, n. 3, p. 538, 2026.
https://doi.org/10.3390/ma19030538.

PARK, Y. W.; TAMAKI, K. **Circular economy strategy for SDG business management:** New theories and system techniques. Singapore: Springer Nature Singapore, 2025. p. 155-170. https://doi.org/10.1007/978-981-96-4194-9_9.

PARMAR, H.; MURARI, U. K. Blockchain in electronics and E-Waste management. In: KUMAR, A. et al. (Eds.). **Blockchain Innovations for a Sustainable Circular Economy**. Cham: Springer Nature, 2026. p. 209-225. https://doi.org/10.1007/978-3-032-02428-2_9.

PATEL, S. S. et al. A review on integrating the circular economy in diabetic appliances manufacture and management for sustainable healthcare. **Circular Economy and Sustainability**, v. 5, n. 5, p. 3865-3886, 2025. https://doi.org/10.1007/s43615-025-00611-6.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

PEREIRA, G. G.; MOREIRA, N. R. Economia circular: a importância da logística reversa. **Advances in Global Innovation & Technology**, v. 3, n. 2, p. 1-13, 2024. https://doi.org/10.29327/2384439.3.2-8.

PERERVA, P. et al. Development of an integrated entrepreneurship model based on the principles of circular and sharing economy: theoretical substitution and practical analysis. **Technology audit and production reserves: Economics of enterprises. Macroeconomics**, v. 1, n. 4 (87), p. 34-44, 2026. https://doi.org/10.15587/2706-5448.2026.352859.

POULOSE, N. Advancing sustainability through tire recycling innovations. **International Journal of Automotive Science And Technology**, v. 9, n. 3, p. 325-342, 2025. https://doi.org/10.30939/ijastech..1655579.

QUINTO, S. et al. Exploring the e-waste crisis: Strategies for sustainable recycling and circular economy integration. **Recycling**, v. 10, n. 2, p. 72, 2025. https://doi.org/10.3390/recycling10020072.

RANA, Sidra et al. Toward a sustainable future: enhancing environmental performance through reverse logistics, resource commitment, and organizational learning capability for circular business models. **Journal of Organizational Change Management**, v. 38, n. 5, p. 951-965, 2025. https://doi.org/10.1108/JOCM-01-2025-0075.

REDDY, E.; ZONDO, R. W. D. Influence of digital technology on business operations among manufacturing organisations in the iLembe municipal district in South Africa. **International Journal of Research in Business & Social Science**, v. 14, n. 8, p. 1-14, 2025. https://doi.org/10.20525/ijrbs.v14i8.4530.

ROELFSEMA, H. Circular business models and ecosystems: governance by aligning incentives. **Sustainability**, v. 18, n. 3, p. 1619, 2026. https://doi.org/10.3390/su18031619.

ROSA, R. M.; SOUZA, J. D.; FREITAS, C. N. Development and deployment of sentiment analysis AI on citizens' feedback in Goiás. In: **26th Annual International Conference on Digital Government Research,** Pontifical Catholic University of Rio Grande do Sul, Porto Alegre City, Brazil, 9th to 12th June, 2025. https://doi.org/10.59490/dgo.2025.944.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

SANDERINK, L.; BUYLOVA, A.; FLORES, C. A. C. The EU cities mission: A governance innovation for Stockholm? **Environmental Policy and Governance**, 1-15, 2026. https://doi.org/10.1002/eet.70053.

SARKAR, A.; PAL, B. Sustainability-oriented decision making in dual-channel closed-loop supply chains: The role of green innovation and promotional effort. **Process Integration and Optimization for Sustainability**, p. 1-21, 2026. https://doi.org/10.1007/s41660-026-00704-1.

SEREJO, L. D. F.; RODRIGUES, E. H. C. Logística reversa de resíduos eletrônicos no Brasil: um estudo bibliométrico. **Revista Ceuma Perspectivas**, v. 39, n. 1, p. 12-23, 2023. https://doi.org/10.24863/rcp.v39i1.606.

SIDERIS, Konstantinos M. et al. Integrated Circuits from Lighting Equipment: Presence and Characterisation of Precious Metals (Ag, Au, Pd, and Pt). **Recycling**, v. 10, n. 5, p. 175, 2025. https://doi.org/10.3390/recycling10050175.

SILVA, V. C. P.; FERREIRA FILHO, H. R.; NASCIMENTO-E-SILVA, D. Challenges and opportunities of the circular economy for sustainability based on reverse logistics. **Revista de Gestão Social e Ambiental**, v. 18, n. 11, p. 1-18, 2024. https://doi.org/10.24857/rgsa.v18n11-144.

SILVA, V. C. P.; FERREIRA FILHO, H. R.; NASCIMENTO-E-SILVA, D. National solid waste policy: Principles, objectives and instruments for sustainable management. **Revista de Gestão Social e Ambiental**, v. 19, n. 4, p. 1-19, 2025. https://doi.org/10.24857/rgsa.v19n4-048.

SOMERVILLE, L.; NAGY, L. The refurbishment and redistribution of disability equipment from the UK to low-and middle-income countries: a case study focusing on 2016–2021 redistributions to Romania. **Disability and Rehabilitation: Assistive Technology**, v. 20, n. 3, p. 545-551, 2025. https://doi.org/10.1080/17483107.2024.2367717.

SOUBACHE, I. D.; YADAV, S. S.; GUPTA, S. K. Sustainable electronic waste management: processes, technologies, and impact. In: KULKARNI, S.; TROIS, C. (Eds.). **Sustainable solutions for environmental pollution**. Cham: Elsevier, 2026. p. 175-200. https://doi.org/10.1016/B978-0-443-33145-9.00008-0.

REMUNOM
ISSN 2178-6925
Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

SOUZA, M. J. F. et al. Reverse logistics in the Amazon: A territorialized conceptual model and guidelines for regional public policies. **Fronteira: Journal of Social, Technological and Environmental Science**, v. 15, n. 1, p. 273-294, 2026. https://doi.org/10.21664/2238-8869.2026v15i1.8531.

STREIMIKIENE, D.; STREIMIKIS, J. Circular economy applications in the EU. In: ŠTREIMIKIENĖ, D. (Ed.). **Circular Economy Assessment**. Boca Raton: CRC Press, 2026. p. 51-101.

STRONG, C.; SOKHANVARAN, S.; CANDY, I. New copper smelter: How to select the right technology and configuration? In: **International Copper Conference**. Cham: Springer Nature, 2025. p. 2397-2428. https://doi.org/10.1007/978-3-032-00102-3_216.

TODISCO, L et al. Foreseeing the future: anticipatory governance as a response to the technological and managerial challenges in the public sector. **International Journal of Public Sector Management**, p. 1-17, 2025. https://doi.org/10.1108/IJPSM-03-2025-0109.

TODOROVA, A.; KOSTADINOVA, I.; KIROVA, M. AI-Based plan-strategy for implementing the principles of corporate social responsibility in small family businesses' activities. **European Journal of Sustainable Development**, v. 14, n. 4, p. 257-257, 2025. https://doi.org/10.14207/ejsd.2025.v14n4p257

VAN LUNENBURG, M. Scaling of social initiatives: the role of entrepreneurial skills and positions. **International Journal of Public Sector Management**, v. 38, n. 2, p. 181-195, 2025. https://doi.org/10.1108/IJPSM-12-2023-0374.

VOLODZKIENE, L.; STREIMIKIS, J. Indicators of circular economy. In: ŠTREIMIKIENĖ, D. (Ed.). **Circular economy assessment**. Boca Raton: CRC Press, 2026. p. 136-177.

WEI, Y.; ALI, M. S.; BHAT, M. A. Exploring the impact of digital technology, circular technology and public management on environmental sustainability in emerging economies. **Scientific Reports**, 16, p. 1-18, 2025. https://doi.org/10.1038/s41598-025-34092-2.

YU, X. et al. Sustainable development assessment of household e-waste reverse supply chains from an environmental ethic perspective. **Humanities and Social**

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 01/05/2026
Vol: 13.08
DOI: 10.66104/b9ej1t93
Pages: 1-37

Sciences Communications, v. 12, n. 1, p. 1-17, 2025. https://doi.org/10.1057/s41599-025-05012-6.