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REVIEW ARTICLE

# Reverse Logistics System to Generate Economic Benefits in Companies in Electrical Sector

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## ABSTRACT

The aim of this research is to propose a reverse logistics system that enhances the unbundling process of goods meant for disposal, from the generation phase to final disposal, specifically designed for companies in the electric transmission sector in Peru, which can be replicated in power generation and distribution companies. Such improvements are expected to have a positive impact on all areas involved in the process, streamlining activities while applying current technological tools. Upon conducting a cost-benefit analysis and implementing the new process and its support tools, the expected outcome is an 87% increase in economic benefits compared to the current empirical process, supported by a self-developed technological tool, specific service agreement levels, and real-time information management. This non-experimental applied research employs both quantitative and qualitative methodologies and techniques such as observation, interviews, data collection, and data analysis. To develop this study, an initial diagnosis was conducted, followed by the definition of objectives, identification of relevant aspects, and development of a proposal under the premise of continuous improvement.

**Keywords:** reverse logistics; process improvement; economic benefit.

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## INTRODUCTION

The industrial sectors involved in extraction, production, transformation, and maintenance often generate large amounts of waste that are of no future value to power generation or transmission companies, for instance, because the supply chain is seen as ending when a good, spare part, or asset is installed and commissioned. The implementation of the economic aspect of reverse logistics as well as the concept of sustainable development offers the possibility of generating income and are thus justified (Araujo *et al.*, 2015).

The term logistics has a ubiquitous presence in all aspects of life, from family to work, leisure, and even war, which is considered its origin by most authors. The French general Antoine Henri De Jomini was the first to develop a direct concept of logistics in his studies of military strategy based on Sun Tzu's *The Art of War*. In the fourth part of his work, he explicitly discusses the art of mobilizing armies (Henri de Jomini, 2008). Over time, the concept of logistics has evolved to adapt to the changing needs and scope of companies. In essence, logistics involves planning and implementing the activities necessary for the efficient operation of a project (Gómez, 2014).

Identifying new sources of revenue is an essential and recurrent task for any competitive organization. This typically entails developing new products or services that involve prior development, conducting market research, and allocating resources, among other activities. However, with the reverse logistics process, it is possible to generate revenue using the logistics process itself as primary input. Global environmental awareness has led to the emergence of concepts such as recycling, reuse, and remanufacturing, which have helped organizations identify new sources of revenue.

## PURPOSE OF THIS PAPER

This article aims to showcase how the electric power transmission sector can generate income by utilizing assets that are typically deemed scrap, obsolete, or simply waste, and are sold at minimal value. These assets often incur operating and storage expenses and pose environmental risks when not properly managed. By implementing a reverse logistics process, a defined procedure can be established for the final disposal of these goods, resulting in economic benefits, identifying co-responsibility for the process, promoting technological innovation with real-time information for better decision-making, and enhancing logistics efficiency.

## ARGUMENTATIVE REVIEW

The reverse logistics process offers the opportunity to generate revenue by using the logistics process itself as a source. This process is known as "backward logistics" because it operates in the opposite direction of the conventional supply chain flow (Dyckhoff *et al.,* 2004). It is a complex process involving control, handling, storage, collection, transfer, transportation, processing, and final disposal (Peña *et al.*, 2013). The primary focus is often on resource efficiency through activities such as remanufacturing, refurbishing, recycling, or disposal (Nylund, 2012). This approach also encompasses the management of perceived returns, which involves reusing a product in a new form, rather than in its original state (Janczewski, 2019). The reverse logistics process has a wide range of applications in recycling, returns, waste management cost analysis, and transportation networks. Adopting these new practices can increase a company's competitive differentiation (Ruiz *et al.,* 2020).

The design of logistics networks plays a crucial role in determining the profitability of reverse logistics systems. To ensure the maximum recovered value of used products, companies must establish logistics structures that enable optimal flow.

The reverse logistics process demands an effort towards thorough research, analysis, progress, and, most importantly, comparisons with other companies in the same sector. It is essential to leverage technology, planning, control, and monitoring of resources, such as transportation, storage, and personnel, to ensure optimal process efficiency (Ramírez, 2018).

The economic benefits resulting from the implementation of this new approach are not inherent or immediate. They require the combination of other elements to ensure the expected success, such as increasing income from secondary activities, offering abandoned or unused goods, improving institutional image through social and environmental responsibility, reducing operating costs, and enhancing the management of inventories, waste, and leftovers (Nylund, 2012).

Although many companies have yet to recognize the strategic potential of efficient reverse logistics, there is a growing interest in it, and companies are starting to make significant investments in their systems and organizations. A clear indication of the strategic importance of a business element is the amount of money spent on managing it. For many companies, excellent reverse logistics practices can significantly increase their bottom line (Rogers and Tibben-Lembke, 1998). Additionally, resource reduction, recycling, substitution, replacement, and reuse of materials can be considered as benefits (Rubio and Jimenez-Parra, 2016).

Technology is a critical component in the success of reverse logistics. By utilizing state-of-the-art technology for process monitoring and efficient information systems, companies can have access to relevant information that allows for better decision-making (Rogers and Tibben-Lembke, 1998). One of the most common issues with current systems is the lack of standardization of processes throughout an organization. When processes are not standardized, it becomes challenging for individuals to coordinate and resolve problems. Given the global nature of business today, the use of new technologies that provide a strategic advantage is essential (Mora, 2011).

One of the main challenges companies encounter when implementing reverse logistics operations is the inadequate availability of effective information systems. Reverse logistics professionals often report that suitable management information systems for reverse logistics are scarce. Information systems departments frequently have a backlog of requests for developing applications that are not part of the core business processes, and reverse logistics applications are often deprioritized. For a reverse logistics information system to be effective, it must be flexible (Rogers and Tibben-Lembke, 1998).

Technological tools have significantly increased the productivity of employees by speeding up processes. The impact of technology has resulted in a dramatic increase in production speed. Tasks that once took hours, days, weeks, or months can now be completed in much less time. In addition, technology has improved individual skills and streamlined the path to achieving common goals for both the work group and the organization.

Coordination tasks are also positively affected by having better communication channels. This makes it possible to manage more than one activity at a time and with different workgroups, even remotely. It is not necessary for all members of a team or a process to be physically present to fulfill their functions. The implementation of robots and automation also frees up workload in many company areas. This way, the time won is used in activities that create value for the companies.

## Current process

The electricity value chain is composed of three main activities: generation, transmission, and distribution. In the case of the company analyzed, they are responsible for transporting high and very high voltage electricity from power plants located throughout the country, as well as managing the operation and maintenance of transmission facilities, including transmission lines and substations. The company also handles preventive and corrective maintenance of high and very high voltage equipment. With a total of 96 electrical substations spread across 19 departments in Peru, the largest number of substations is located in the department of Lima, with 16, reflecting the higher demand and centralization of the electrical networks. Following Lima are the departments of Apurímac, Cusco, and Arequipa, as they house the power plants that are connected to the national grid.

Proper operation of electrical equipment relies on maintenance, which is crucial. Deterioration may result from electrical shocks, line voltage, or exposure to dust, moisture, and salt. Preventive or corrective maintenance is necessary for substations, high and very high power equipment, and transmission lines. The company's general maintenance strategy, symptoms of equipment failure or facility failure, complementary analysis and testing activities, specialized studies, improvements, equipment movement, special activities not resolved by maintenance, specialized interventions, warranty claims, technology transfer, project requests, replacement of equipment, tools and infrastructure works, safety needs, and environmental impact are factors that determine the need for maintenance.

Maintenance activities are centered on ensuring the proper functioning of electrical substations, switchyards, control centers, and transmission lines. These activities involve the upkeeping of various materials and components, such as voltage transformers, switches, disconnectors, current transformers, lightning arresters, surge arresters, metal structures, wave traps, busbar systems, conductors (including aluminum cables), structural supports, insulators, adjustment accessories, guard wires, galvanized steel profiles, aluminum, copper and steel cables, hardware, glass and polymer insulators, gabions and arrestors, signage, and beacons. The maintenance of these components may require their removal or replacement due to reasons such as obsolescence, technological advancements, or irreparable failures.

The generation of waste resulting from the execution of projects is typically greater, given their objective of enabling specialized high-voltage electrical infrastructure. When executing projects in remote areas of the country, logistics, including reverse logistics, is a challenge for the company. Therefore, cutting-edge tools and clear procedures are necessary to ensure that projects are completed without issues and will not generate administrative burdens in the future, resulting in unexpected economic impacts.

The waste generated consists mainly of aluminum, copper, galvanized steel, glass, wood, furniture, and oil, among others. Apart from the mere fact of waste generation, it is necessary to consider the costs associated with its treatment, movement, and disposal. These costs vary depending on factors such as weight, volume, risk level, feasibility of transportation, and hauling.

The waste management process begins with the generation of waste, which may come from maintenance technicians, maintenance suppliers, electrical contractors, temporary storage facilities, and similar sources. This waste is generated continuously and in various geographical areas, involving different actors throughout the process. Once generated, the waste generator must decide whether to leave the waste in the field, store it temporarily, or centralize it in one of the four primary warehouses. Leaving waste in the field entails various risks, such as theft, negative environmental impact, damage to the ecosystem, and the loss of the opportunity to generate additional economic income. When the stakeholder decides to place the waste in a suitable warehouse, they must provide a referral guide, which is necessary for all cases of goods transfer, along with a simple physical form that briefly describes the items being left in custody.

On average, the annual waste generation can reach nearly 1,000 tons of metal waste, including aluminum and steel, as well as glass and wood. The process of gradually receiving all this waste can consume many man-hours that could be used for other activities that add value to the warehouse process. Failure to record incoming goods in a system also leads to additional reprocessing. This analysis required a total of three months of work by warehouse personnel.

The current waste disposal process involves an annual assessment of assets accumulated during the same period. However, due to various circumstances such as a lack of timely information, repetition of activities, and a lack of on-site verification, among others, this activity cannot be performed optimally.

The evaluation process involves verification, which primarily occurs in the initial stage. However, it is common for this process to be repeated several times and in various locations throughout the year, resulting in the allocation of a significant amount of human resources, measured in man-hours.

The asset assessment and validation process is the most significant bottleneck in the entire waste disposal process due to the multiple approval stages and repetitions involved. The primary means of communication used is e-mails and physical notes that must be reviewed by different managers. This physical documentation is subject to constant modifications due to critical remarks, objections, and others specified by the responsible parties to generate a final report. The process is long and tedious, and the documentation frequently gets stuck in the middle of the flow due to a lack of consideration for response times or clearly defined service levels.

The process of evaluating the materials requires technical validation and communication through email with the heads, coordinators, and managers. A technical report is created to justify the transfer of the material. Once this document is validated by all stakeholders, the transport and transfer of the materials to the destination warehouses is arranged.

The consolidation of all the forms and retirement documents generated in the first stage is done in a traditional way. The information is extracted from these documents and transferred to Excel spreadsheets, which then have to be physically validated by warehouse personnel and specialists.

The verification and assessment phase also results in a loss of man-hours and resources, including transportation and travel expenses. This phase involves the verification activity generated by the proposal for the inventory disposal warehouse, which requires a higher number of personnel on site to perform validations, resulting in 336 dedicated hours.

Another factor that adds complexity to the process is that the presence of these materials in warehouses or designated areas increases the risk of internal personnel or outsiders taking them for various purposes, ultimately reducing the initial amount or even leading to complete theft. It is thus necessary to dispose of these goods within a shorter period of time. This also helps to keep the facilities in good condition, avoid visual contamination, reduce storage costs per square meter, minimize supervision costs, prevent soil contamination, and reduce internal transportation costs.

Once the documentation has been validated by the warehouse, accounting and technical departments and approved by management, everything related to the sale can be coordinated. In most cases, an appraisal of all the assets involved is required, and this report is included in the final file. However, performing this activity can present some complications, especially when it comes to the location of the property. It is important for the appraiser to have a clear picture of what is being appraised, especially when the property is not easily accessible to the appraiser. It should be noted that the human resources required for this process include not only warehouse personnel, but also technical specialists, coordinators, area managers, administrative assistants, and supervisors, for a total of 144 hours.

The process of final disposal of goods does not end with the sale, settlement of expenses, payment of duties, or issuance of an invoice to the supplier. The final delivery of goods to the winning bidder is an activity that requires special attention from the operational point of view, with the main risk being that the goods are not removed in their entirety, so it is necessary to have a prior mechanism to ensure that the removal is complete and in the best conditions for the company.

## Reverse logistics proposal for final disposal of goods

The current proposed solution includes the final disposal process for goods, service level agreements, the implementation of reverse logistics, timely and accurate information, and shared responsibility. To achieve this, a modern technological tool will be used, alongside clearly defined commitments, roles, responsibilities, and deadlines for all parties involved in the process.

This process starts when the maintenance supervisor, project manager, or administrative staff observes that waste will be generated at a specific time and place, which is when the event must be reported. If the waste needs to be transported to a warehouse, it must be registered first in the Share Point application created for this purpose. This tool contains various fields depending on the type of material.

Once the responsible person has completed the entire electronic form in the field, they can then proceed to bring the goods into the warehouse or designated space. This information is directly transmitted to the warehouse interface, where all information is centralized. Personnel in this area can check the accuracy and quality of the information in real-time and approve the entry. This process is repeated each time goods are received. Subsequently, the warehouse personnel or receptionist will review the information in the main interface of the warehouse-managed application, verify the conformity of the information, and allow the receipt of the goods.

All the information in this step is uploaded to the company's servers and needs to be validated by the direct supervisor of the waste generator. This is achieved through a workflow that transfers the information loaded in the warehouse interface to the user area's coordination and management for total or partial validation of the status. This validation process may need to be repeated several times. With the new process, there are no restrictions on the delivery and reception of goods, as the entire transaction can be done virtually. The company provides all employees with mobile technology tools, such as cell phones and laptops, which enable them to collect and process information from anywhere in the country.

After validation and approval, the warehouse proceeds to classify the information in the system. A virtual document is generated containing the proposal for final disposal, which goes through an internal flow with field validation. Once the validation and verification work is complete, the warehouse manager approves the sale of the proposed goods.

The launch of the offer takes place via dedicated online auction platforms. It's crucial to select a platform that has appropriate filters to guarantee the buyer's compliance. Employing an external platform enables specialized firms to conduct this operation.

For the proposed process to be successful, it is essential to have the commitment of all members involved in the workflow. This commitment should be directed towards two critical aspects: the acquisition and delivery of information and meeting deadlines.

The activities performed by the waste-generating agent have an immediate timeframe for disposal. All stakeholders are responsible for verifying and validating the information, as well as arranging the physical storage space for these goods. The data provided must be precise and up-to-date, including details such as material description, type, codes, geographic location, weight, size, and volume, among other crucial elements that may vary based on the type of goods. Communication among stakeholders takes place through the Share Point internal application in every case.

After the sale is finalized, the winning bidder must supply all the information requested during the auction stage and submit payment. The Financial Accounting Department then verifies the payment and issues the appropriate voucher, leading to internal administrative closure, final cancellation, and the completion of the process.

The economic benefit resulting from a change in the process of final disposal of goods destined for disposal increases by 87%, according to our projections of generated efficiencies in terms of man-hours, freight transport, labor, and personnel costs in general. This achievement is thanks to an agile process with a focus on commitment and excellence, as well as our practical and intuitive technological tool developed in-house. The results align with our efforts to update practices and activities that improve information management and place the warehouse area in the organization. We also act as a corporate change agent by proposing simple yet impactful solutions that focus on value creation.

## CONCLUSIONS

- The study's conclusion is that implementing a reverse logistics system in a prominent company within the Peruvian electricity transmission sector, which focuses on disposing of goods, enhances the operational efficiency of individuals involved in related administrative and operational procedures.

Moreover, a cost-benefit analysis that compares the expected results with previous period data shows an 87% increase in economic benefits.

- In addition, the implementation of the reverse logistics system streamlines the operational flow across all stages by removing bottlenecks that occur during various process activities. These delays are removed through a clear and transparent process that prioritizes simplicity and task standardization.
- Establishing the scope, roles, and responsibilities through service level agreements is crucial in supporting the proposed process. This ensures that the responsible parties are committed to compliance, enabling efficient use of time and compliance.
- Furthermore, adopting technological tools enables organizations to explore new and improved practices based on digital media, which add value to the organization.
- Integrating a technology tool that is compatible with both fixed and mobile devices to support operations can streamline processes and workflows, save time, eliminate duplicated efforts, and provide stakeholders with real-time information.
- Access to real-time, high-quality information enables all parties involved to manage the process smoothly and operate efficiently.

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**Competing interests**

The author declares that there is no conflict of interest.

**Authors' Contribution**

Luis Alberto Salas Sarayasi (lead author): Conceptualization, research, supervision, writing (original draft, review and editing).