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ESTABLISHING AN ECOSYSTEM OF PREPARATION FOR REUSE CENTRES IN ITALY

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Abstract

In 2022, 90% of Italians contributed to product reuse, and 70% recognized the importance of considering the Life Cycle Assessment (LCA) to extend product lifespan and reduce waste, according to Fragilitalia Report by ISPOS & Area Studi Legacoop. The European 'waste hierarchy' has the dual aim of minimizing production impacts (e.g., CO₂ emissions) and improving resource efficiency, and a key element is Preparation for Reuse (PfR), now further promoted through the creation of Preparation for Reuse Centres (PfRCs). These Preparation for Reuse Centres (PfRCs) can operate in the following areas: (i) Preparation for Reuse - i.e., recovery operations aimed at inspection, cleaning, or repair, (ii) Prevention - Reduction - Promotion and resale of used products. This paper aims to: (1) provide a graphical representation of PfRC waste management activities and investigate the following questions: (2) can the process be optimized while complying with current regulations? (3) Can the benefits of these activities be quantified? For the first time in Italy, the reuse preparation process has been translated into a graphic model fully compliant with the MASE Decree No. 119/2023 and immediately integrated into the "Go2Life" management software, ensuring traceability and regulatory compliance at every operational stage. This study presents an innovative methodological approach that combines process mapping and digital implementation to optimize the environmental and economic performance of preparation for reuse centers. The proposed analysis is designed to be evaluated also through a Life Cycle Assessment (LCA), to quantify the avoided environmental impacts and the net benefits resulting from reuse compared to the disposal scenario. This document described represents a first pilot cycle, preparatory to subsequent development phases already planned. Innovating and refining the Preparation for Reuse activity is desirable and achievable by creating an Ecosystem for PfRCs. Digitalizing processes can ensure regulatory compliance, operational certainty, efficient product, inflow and outflow waste tracking to support the ecological transition.

Key words: preparation for reuse (PfR), preparation for reuse centre (PfRC), reuse, waste

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1. Introduction

In the context of growing awareness about the importance of material recovery and sustainable practices, product reuse and Life Cycle Assessment (LCA) have become essential to reducing waste and extending the life of goods (Risso and Toci, 2023). European legislation has long recognized the importance of these practices. The EC Directive (2008) sets a priority order in waste prevention and management legislation and policy (EU, 2021), intending to minimize the negative impacts of

production and waste management while improving resource efficiency (EEA, 2024). Within this "waste hierarchy," preparation for reuse plays a central role, promoting product recovery and reuse without further treatment.

In Italy, the establishment of PfRCs represents a significant step towards circular economy. Decree No. 119 of July 10, 2023, issued by the Ministry of Environment and Energy Security (or MASE), establishes the conditions for the exercise of preparations for reuse under Article 214-ter of Legislative Decree No. 152/2006 (GD, 2006).

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Effective since September 16, 2023, this regulation simplifies the process for opening PfRCs, enabling better recovery of reparable waste that can regain market value.

According to the "6th Report on the Circular Economy in Italy" (MASE, 2024), PfRCs have the potential to operate in two main areas:

- preparation for reuse, which includes inspection, cleaning, and repair of products;
- prevention, which focuses on the promotion and resale of used products (Cappellaro et al., 2020).

The MASE Decree (2023) introduces stringent criteria for the traceability and compliance of reuse preparation processes, with two main critical issues identified: the lack of shared digital standards and the fragmentation of operating procedures. This work fits into this context, proposing an operational model that fully incorporates these legislative provisions, translating them into a flowchart functional to the digital management of the process.

Creating an ecosystem for PfRCs, integrating public-private partnerships, process digitalization, and promoting green purchasing, is essential to ensure the economic and environmental sustainability of these operations (Andretta et al., 2018). Therefore, implementing specific management software for PfRCs can optimize internal processes, ensure the traceability of products and waste, and promote the creation of green jobs and circular communities (Martini and Ferraro, 2022). Only through an integrated and innovative approach will it be possible to respond effectively to the challenges of the ecological transition challenges and foster new sustainable purchasing and consumption patterns.

2. Material and methods

2.1. Case study: The Preparation for Reuse Centre (PfRC) digital platform

The main idea consists of adopting management software specifically tailored to the requirements of Decree No. 119 of July 10, 2023, issued by the Italian Ministry of Environment and Energy Security. This specialized software, designed for both operational and administrative management, offers significant opportunities to improve efficiency and ensure traceability at PfRCs. To achieve this, the Pomili Demolizioni Speciali Srl's R&D Department, in collaboration with the programmers of Giunko Srl Gruppo Terranova, developed a Preparation for web-based management software for PfRCs. This development was grounded in regulatory analysis and graphical transposition (Figs. 3-5). The software underwent a two-month trial (June - July 2024) by administrative staff at at Pomili Demolizioni Speciali's headquarters and a dedicated operator at a chosen operational site.

Input and output flows were mapped using a simplified LCA approach, excluding WEEE from this study for specific regulatory reasons (CENELEC, 2020) and the need for a dedicated analysis.

LCA approach addresses the following steps:

1. Goal and scope: define the system's objectives and boundaries, including both the preparation for reuse process and the reference scenario.
2. Life Cycle Inventory (LCI): collect data on inputs and outputs (reused products, residual waste, emissions).
3. Life Cycle Impact Assessment (LCIA): calculate environmental impacts using recognized methods.
4. Interpretation: analyze results to identify critical points and opportunities for improvement.

The workflow was represented using flowcharts compliant with BPMN (Business Process Model and Notation) symbology, which were subsequently implemented in the Go2Life software.

In this first phase the test site, located in the used products warehouse of Pomili Demolizioni Speciali (Fig. 1) in Capena, Roma Capitale Metropolitan Area (Via Traversa del Grillo No. 11 Km 0.200), was chosen for its commercial and operational relevance. The site was also identified as a potential "Equipped Preparation for Reuse Centre" (Pomili, 2021) in an action project for the European Week for Waste Reduction (EWWR), a key event for waste prevention at the national and European levels, focusing on building "circular communities".

Pomili Demolizioni Speciali Srl participated in the 2021 EWWR with "Go2Life" project that delved on the following:

- waste prevention and reduction through the collection of durable goods for reconditioning or reuse;
- resale of used products either as-is or after repair and compliance.



Fig. 1. Used products warehouse – Pomili Demolizioni Speciali Srl Via Traversa del Grillo no. 11 Km 0.200, 00060 Capena (Roma)

Go2Life was designed to establish a PfRC tailored to the local community, as outlined in Legislative Decree No. 205/2010 (GD, 2001). The project was carried out as per Article 156 of the Budget Law that just landed in the Italian Senate. It took place in a facility equipped with adequate tools and personnel responsible for monitoring the structure's functioning and managing operations such

as cleaning, dismantling, and repairing items delivered by citizens, businesses, and public entities, following a "circular community" approach. To support this, the authors reviewed current European and Italian regulations to create a logical, coherent flow of operational and administrative activities, and evaluated the results and benefits of the preparation for reuse process.

Following this trial, the following additional phases are planned:

- Phase 2 – twelve months, authorization from the PfRC, with two/five operators, environmental and economic data collection.
- Phase 3 – replication in another area to assess the adaptability and comparability of the results.

2.2. Overview of the European Regulatory Framework

The EC Directive (2008) also known as the Waste Framework Directive, establishes a legal framework for waste management in the European Union. Amended by EU Directive (2018), it strengthens waste management regulations and promotes the circular economy.

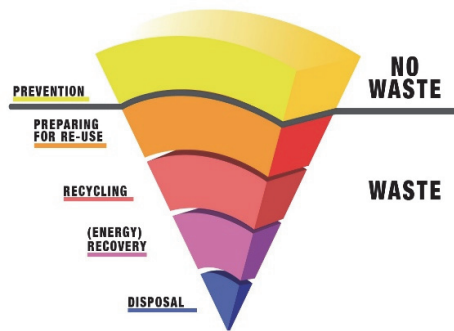


Fig. 2. "Waste hierarchy"

The EC Directive (2008) defines the waste hierarchy, establishing priorities for waste management that include prevention, preparation for reuse, recycling, energy recovery, and disposal, which guide waste management policies across the EU and promote practices that minimize environmental impact. The European waste management framework is structured around several key principles and measures designed to promote sustainability and resource efficiency. These include extended producer responsibility, recycling and recovery targets, the promotion of a circular economy, and waste prevention measures, all of which contribute to reducing environmental impact and fostering more sustainable production and consumption patterns.

1. Extended Producer Responsibility: the Directive introduces extended producer responsibility, requiring producers to manage the waste generated by their products. This includes both organizational and financial responsibility for waste collection, treatment, and recycling.

2. Recycling and Recovery Targets: the EU Directive (2018) sets ambitious recycling and

recovery targets. By 2020, EU member states must achieve a 50% recycling rate for household waste and 70% for construction and demolition waste.

3. Promotion of the Circular Economy introduces measures to improve resource efficiency, reduce dependence on imported raw materials, and create new economic opportunities. The text also emphasizes the relevance of the full life cycle (ISO, 2006) of products to preserve resources and reduce greenhouse gas emissions.

4. Waste Prevention Measures: Member States are encouraged to adopt measures supporting sustainable production and consumption, reducing waste generation, and promoting product reuse and recycling (EC Directive, 2008). This includes incentives for eco-friendly design and sustainable consumption practices (EU Directive, 2018).

Therefore, the EU Waste Management directives and the recent MASE Decree (2023), are fundamental tools for promoting preparation for reuse and the circular economy in Italy. These regulations provide a clear legal framework and incentivize sustainable practices that can significantly reduce the environmental impact of waste management.

2.3. Analysis of the MASE Decree 10 July 2023, No. 119

MASE Decree No. 119 of July 10, 2023, represents a major regulatory step for PfR operations in Italy. In force since September 16, 2023, it simplifies preparation for reuse operations under Article 214-ter of Legislative Decree No. 152/2006 (GD, 2006).

The Decree includes key elements:

1. Operational methods: the Decree defines the operational methods for preparation for reuse operations, specifying the necessary technical and structural equipment. These include minimum qualification requirements for operators and maximum quantities of waste that can be treated.

2. Origin and type of waste: specific conditions are established for the origin, types, and characteristics of waste eligible for reuse operations. These conditions are essential to ensure that only suitable waste is treated, thus reducing the risk of contamination and improving process efficiency.

3. Conditions of use: the Decree specifies the conditions of use for products or components of products that have become waste. These include the necessary control, cleaning, and repair operations to prepare the products for reuse without further treatments.

4. Simplified procedures: one of the most significant innovations introduced by the Decree is simplified procedures for opening and managing Preparation for Reuse Centres (PfRCs). This set of measures makes it easier for companies to start and manage Preparation for Reuse Centres (PfRCs), promoting greater interception of waste flows and facilitating the reuse of products that would otherwise be disposed of.

This Decree is a significant step toward a circular economy in Italy, promoting product reuse and reducing landfill waste through the establishment of PfRCs.

2.4. Definition and relevance of Preparation for Reuse Centres (PfRCs)

Preparation for Reuse Centres (PfRCs) are facilities intended for collecting, selecting, inspecting, cleaning, and repairing products or product components that have become waste to prepare them for a new cycle of use without further treatment. These centers play a crucial role in the waste hierarchy by promoting reuse over disposal, in alignment with both European and Italian regulations. The importance of PfRCs lies in their ability to intercept waste streams that, through repair and maintenance operations, can regain market value and be reused with the same functions and safety guarantees as the original product. This process not only reduces landfill waste but also preserves resources, lowers CO₂ emissions, and fosters a circular economy.

The main objectives of PfRCs can be summarized as follows:

1. Waste reduction: intercept and treat waste to reduce the volume of materials destined for landfills and incinerators. This objective aligns with the waste hierarchy established by Directive 2008/98/EC, which prioritizes prevention and preparation for reuse.

2. Value recovery: repair and reintroduce products and components that would otherwise be disposed of to recover their economic and functional value. This process helps create a market for used and

repaired products, promoting economic sustainability (Rossi and Bianchi, 2023).

3. Promotion of the circular economy: facilitate the transition towards a circular economy, where products and materials are kept in use for as long as possible, thus reducing the need for new resources and minimizing environmental impact (OECD, 2024).

4. Creation of “Green Jobs”: generate new job opportunities in the repair, maintenance, and waste management sectors, contributing to the development of specific skills and local economic growth (Martini and Ferraro, 2022).

5. Education and awareness: promote citizen awareness and education regarding the importance of reuse and sustainability through informational campaigns and awareness activities.

PfRCS are essential for transitioning to sustainable production and consumption models. They offer practical solutions for extending product life (ISO, 2006), reducing waste, and promoting reuse.

2.5. PfRC workflow

The authors carried out a text and data analysis of the MASE Decree (2023). The analysis led to the creation of a workflow that includes three main phases ("sections") related to the requirements set out in the "Schedario" ("Record Book" or "Register"), provided for by the PIFRCs Decree.

These sections are:

- A) Delivery and Storage (Fig. 2)
- B) Management (Fig. 3)
- C) Storage and Product Transfer (Fig. 4).

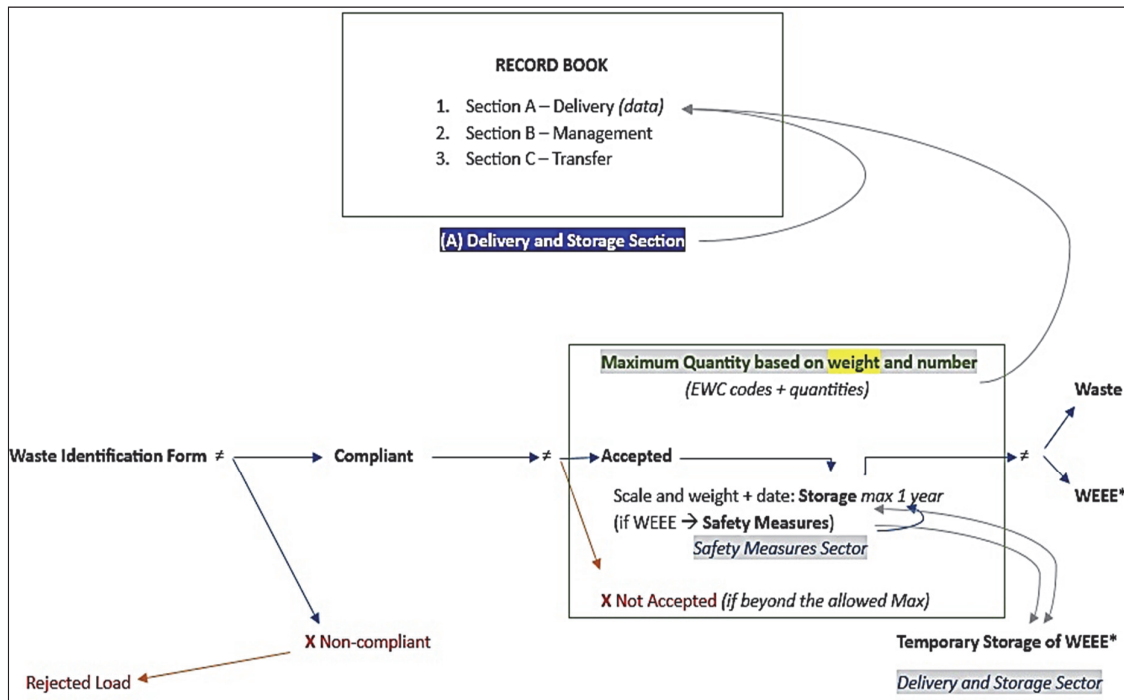


Fig. 3. “Delivery and Storage Section” (A)

(* WEEE managed according to CENELEC EN 50614:2020 standard)

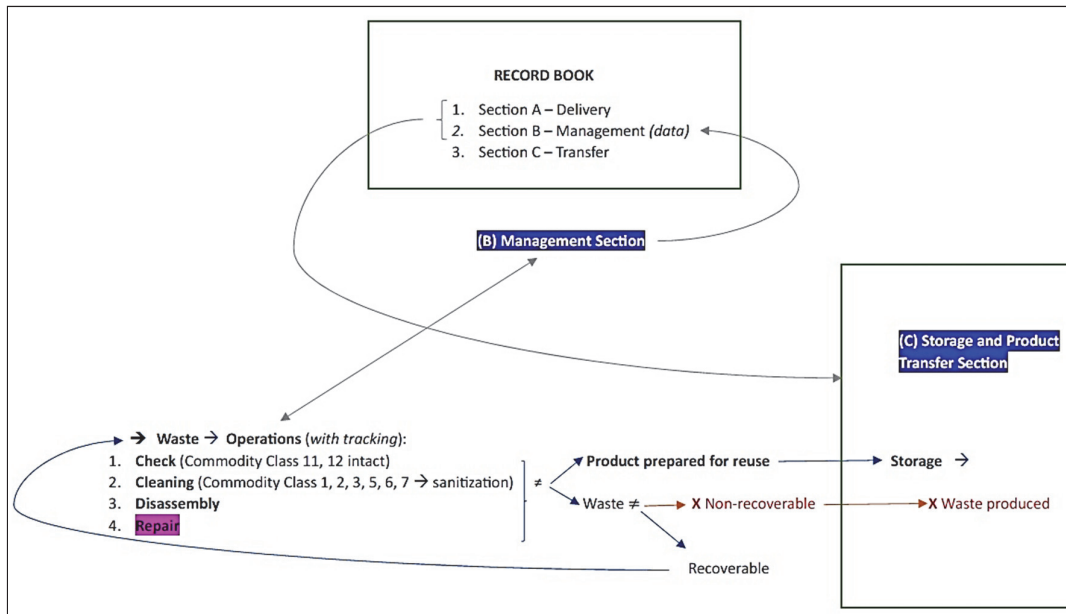


Fig. 4. “Management Section” (B)

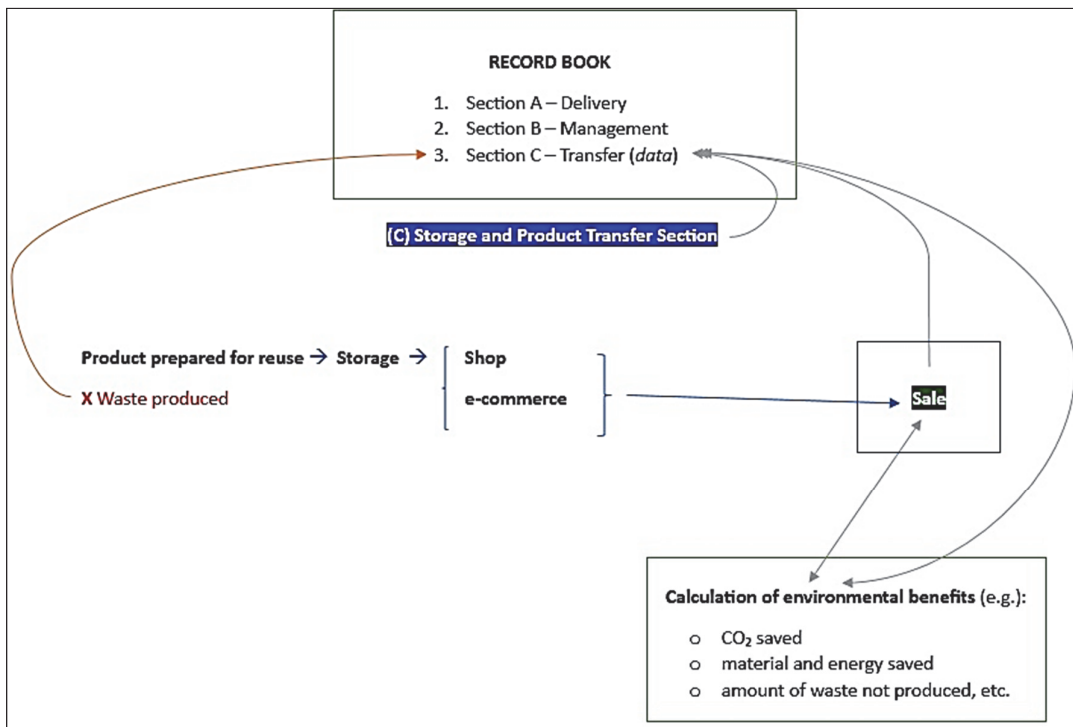


Fig. 5. “Storage and Product Transfer Section” (C)

This analysis does not include the “Management Section” (B) for WEEE (Waste Electrical and Electronic Equipment) or “e-waste” (Avvannavar and Shrihari, 2007), as these are subject to different regulations. WEEE must be managed in accordance with the CENELEC (2020) standard, which outlines specific requirements separate from those for other types of waste.

The data collected in this pilot research phase will be used as the basis for a simplified LCA, with

subsequent extension to a full LCA in phases 2 and 3 of the project.

3. Result and discussions

The Go2Life software, developed starting from the graphic mapping of the MASE Decree (2023), is currently the only Italian management system designed from scratch to ensure full traceability and regulatory compliance at every stage.

The flowcharts (Figs. 3-5) were accompanied by explanatory subheadings describing the operational logic and interactions between related and sequential sections. The exclusion of WEEE was motivated by regulatory constraints and the need for a dedicated analysis underway due to the relevance of the product category, which includes specificities both in terms of their treatment and because they may be composed of critical materials.

Another key result is that the developed software, 'Go2Life,' is integrable with other programs, including the GeA-Caronte24 platform. It has already been implemented in a real operational center: the Capena Warehouse of Pomili Demolizioni Speciali Srl, a small-to-medium-sized depot specializing in furniture and small equipment.

Therefore, the implementation of Go2Life, which took place in June 2024, has ensured traceability and operational management. The software has been integrated with existing systems for seamless workflow management and advanced reporting and data analysis functionalities through hardware devices such as desktop computers, tablets and smartphones (Fig. 6).

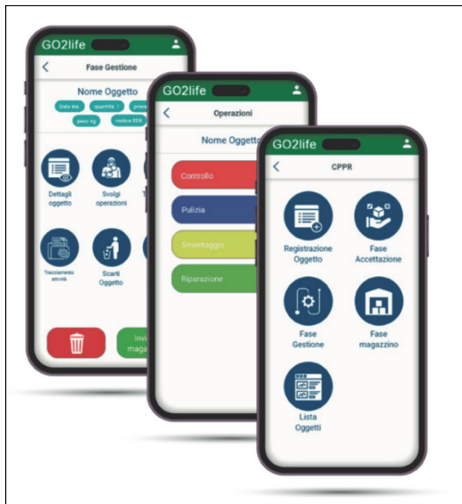


Fig. 6. Go2Life APP – R&S Pomili Demolizioni Speciali Srl with Giunko Srl (Pomili, 2021)

On the operational side, the project focused on functional areas according to the three planned sections. The Capena facility ensured the following operations:

1. Inspection.
2. Cleaning.
3. (Possible) Dismantling.
4. (Possible) Repair.
5. Resale of used products (either in their current state or to be sent for subsequent repair and compliance).

Go2Life proved to be a web platform and management software for initiating the reuse of durable goods in good condition or to be repaired.

Results

The implementation of the system led to several notable results that enhanced both operational and environmental performance. Key outcomes included process optimization and improved data analysis capabilities, enabling rapid identification of bottlenecks and compliance with regulatory requirements. The adoption of the software increased sustainability through greater reuse of products, improved operational efficiency by reducing cataloging and traceability time, and enhanced transparency by allowing real-time verification and remote control of operations. Furthermore, the system ensured full compliance with the MASE Decree (2023) and the GDPR (EU Regulation, 2016), guaranteeing secure and traceable management of all activities.

- **Process optimization:** the repair and preparation processes for reuse were optimized, ensuring compliance with regulatory requirements.
- **Data analysis:** the ability to analyze operational data enabled the rapid identification and resolution of bottlenecks in the processes (Rossi and Bianchi, 2023).
- **Sustainability:** the adoption of the software contributed to more effective waste management, with an increase in the volume of reused products.
- **Operational efficiency:** the time required for product cataloging and traceability was reduced.
- **Traceability of products and,** most importantly, the planned operations is now verified and can be shared quickly and controlled remotely.
- **Regulatory compliance:** the software facilitated compliance with the MASE Decree (2023), ensuring that all operations are documented and traceable, and it is also compliant with GDPR (General Data Protection Regulation) – EU Regulation, (2016).

Identified critical points

Several critical points were identified during the implementation process, highlighting operational, organizational, and technical challenges that affected system integration and performance.

- The management of variability in incoming flows.
- The analysis was conducted in a Used Products Warehouse and not in an officially authorized PIRRC, with only one dedicated operator at the production site. Nevertheless, the operations were carried out as if the used material was originally classified as “waste” and treated according to regulations.
- The integration of the new software with existing systems required significant time and resources.
- **Change management:** the staff exhibited resistance to adopting the new system, necessitating training sessions and support.
- **Staff training:** an intensive training period for the staff was required, leading to an initial reduction in productivity.

- Initial costs: the software implementation incurred initial costs, which are not significant when considering the overall time frame of just two months.

Three mitigation strategies have been identified:

1. standardization of operating procedures,
2. adoption of incentive systems,
3. creation of territorial (e.g. provincial or regional) networks of interconnected PfRCs.

The results confirm the technical feasibility of the proposed model, while highlighting the need to expand the database to validate environmental and economic performance. To accurately quantify these benefits, it is essential to rely on prior studies that interpret the data in terms of CO₂ savings, such as the "Second Hand Effect" analyzed by the IVL - Swedish Environmental Research Institute in relation to second-hand sales platforms (IVL, 2021). The data must be linked to quantities, both in terms of the number of objects/products processed and their weight. Thus, looking ahead, indicators such as CO₂ avoided (kg.), secondary raw materials recovered (kg.) and economic value generated (€) will be measured. This should encompass both the materials involved and the preparation activities for reuse, including associated tasks such as repair and transportation.

Beyond these, the benefits of a PfR Centre are multifaceted and extend across several domains:

- Economic: creation of a market for used and repaired products, reduction of waste disposal costs, and the generation of new job opportunities, contributing to local economic development.
- Social: promotion of a culture of reuse and sustainability, enhancement of quality of life through waste reduction, and the development of more resilient and environmentally conscious communities (Pergolizzi, 2021).
- Technological: advancement and dissemination of innovative repair and maintenance technologies and practices, fostering sector-wide innovation and competitiveness.

4. Conclusions

This work has produced the first results of creating flowcharts compliant with the MASE Decree (2023) and their implementation in a dedicated management software. The adoption of this digital tool for the operational and administrative management of Preparation for Reuse Centres offers numerous advantages, including increased operational efficiency, improved traceability, and regulatory compliance. However, it is essential to address the challenges related to staff training and system integration.

The proposed model is scalable and replicable in different territorial contexts, with potential application also in B2B supply chains. The "PfRC Ecosystem" refers to a network of local centers, interconnected via a common digital standard, with

full input/output traceability, openness to B2B supply chains, and the objective of territorial control and socio-economic return.

The analysis conducted in this article highlights the crucial importance of PfRCs in the European-Italian context, both from an environmental and regulatory perspective. Through the examination it has emerged that reuse and Life Cycle Assessment are fundamental tools for promoting a circular and sustainable economy.

Integrating LCA into the PfRC model can allow to quantify the environmental benefits of reuse compared to other waste management options. PfR Centres represent an essential component for the realization of a circular economy. They offer a practical and sustainable solution for waste management and with the use of LCA indicators such as Global Warming Potential (GWP) and primary resource consumption can provide a scientific basis for strategic and policy decisions. This is possible, more efficient, and simpler through the digitization of processes and the adoption of an integrated management system that can be integrated into various operational digital platforms. Future directions include the integration of WEEE, the extension of the trial to more sites, and the annual evaluation of the software performance.

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