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Prioritizing Solutions to Overcome Remanufacturing Barriers to Implement Circular Economy in the Indian Automobile Sector

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Journal: Circular Economy and Sustainability, 2025

DOI: <https://link.springer.com/article/10.1007/s43615-025-00659-4>

Research Background

- Increasing **resource depletion, waste, and environmental issues** have made traditional “take-make-waste” models unsustainable.
- The **circular economy (CE)** promotes reuse, recycling, and **remanufacturing** as sustainable alternatives.
- **Remanufacturing** restores used products to near-new condition, reducing: Material usage, energy consumption, production cost.
- Despite benefits, **India’s automobile (LCV) sector** faces major barriers and low adoption.
- **Research Gap:** Lack of comprehensive studies identifying and prioritizing **remanufacturing barriers and solutions** in India.



Research Objectives

- Identify key **barriers to remanufacturing** in the Indian LCV sector
- Classify and prioritize these barriers
- Identify **solutions (enablers)** to overcome them
- Rank solutions based on effectiveness
- Provide a **decision-making framework** for industry and policymakers

Theoretical Framework

- Based on **Circular Economy (CE)** principles:
- Resource efficiency
- Waste minimization
- Closed-loop supply chains
- Key concepts:
- **Remanufacturing** as a core CE strategy
- **Barriers framework** (10 categories):
 - Financial, Legal, Technological, Management, Consumer perception, etc.
- Integration of:
- **Barrier-Solution model**
- Linking **enablers (solutions)** to specific barriers



Research Methodology

- **Research Design:** Multi-method approach
- **Phase 1: Data Collection**
 - Literature review (2002-2024, Scopus database)
 - Expert interviews (11 experts from industry & academia)
 - Identified:
 - **10 barriers (30 sub-criteria)**
 - **10 solutions (enablers)**
- **Phase 2: Barrier Analysis**
 - Method: **Fuzzy AHP (Analytical Hierarchy Process)**
 - Purpose:
 - Assign weights
 - Rank barriers under uncertainty
- **Phase 3: Solution Ranking**
 - Method: **Fuzzy TOPSIS**
 - Purpose:
 - Rank solutions based on closeness to ideal solution
- **Why Fuzzy Methods?**
 - Handle uncertainty and subjective expert judgments



Key Findings

- **Most Critical Barriers:** Ranking (Highest to Lowest):
 - *Management barriers (MG) - most critical*
 - *Consumer perception*
 - *Technological barriers*
 - *Financial barriers*
 - *Product barriers*
- **Top barrier:** Lack of **top management commitment (MG1)**
- **Key Solutions (Top Ranked):** **Cross-functional collaboration (S8)** - most effective
 - Top management support
 - Infrastructure development
 - Environmental regulations
 - Consumer awareness
- **Insights**
 - Organizational issues are **more critical than technical or financial ones**
 - Strong collaboration and leadership are essential
 - Consumer awareness significantly impacts adoption

Academic Contribution

- Provides a **novel integrated framework**:
 - Combines **Fuzzy AHP and Fuzzy TOPSIS**
- One of the **first studies** focusing on:
 - Remanufacturing barriers in **Indian LCV sector**
- Offers:
 - **Prioritized list of barriers and solutions**
 - Practical decision-support tool for researchers & industry
- Contributes to **circular economy literature in developing countries**