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Bridging the Forward–Reverse Logistics Gap in Electric Vehicle Sustainability: A Systematic Review of Battery End-of-Life Integration and a Research Agenda for Circular Economy Alignment

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Abstract
This research is grounded in a Systematic Literature Review (SLR) designed and executed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The study employs a convergent mixed-methods approach, integrating both quantitative bibliometric and qualitative thematic analyses to provide a comprehensive examination of scholarly work on electric vehicles (EVs) and sustainable transportation published between 2015 and 2025. A particular emphasis is placed on identifying research gaps pertaining to reverse logistics, including battery recovery, end-of-life vehicle management, and circular economy practices within EV operations. The review framework was selected for its methodological rigor, transparency, and reproducibility, aligning with established best practices in evidence synthesis.
The literature search was conducted using the Web of Science (WoS) Core Collection and Scopus databases, employing core keywords such as "electric vehicle,""sustainable," and "transportation." The search was restricted to English-language articles published between January 2015 and December 2025, resulting in an initial yield of 787 records. After applying a publication year filter, 768 records remained, and the exclusion of conference proceedings and other non-peer-reviewed sources further refined the pool to 765 articles.
Inclusion criteria required that studies be published in peer-reviewed journals indexed in both WoS and Scopus under the Social Sciences Citation Index (SSCI), with a direct focus on EVs and sustainable transportation within the domains of transportation studies, economics, or management. Articles also needed to address relevant themes such as power systems, EV logistics, or transport policy. Studies falling outside these parameters—including those beyond the thematic or geographic scope, published in languages other than English, or from excluded publishers—were omitted. Application of these criteria reduced the dataset to 63 articles.
A dual-indexing verification was then performed to confirm the presence of each study in both WoS and Scopus, resulting in a final corpus of 27 articles that underwent general analysis. To specifically address reverse logistics, a targeted post-filtering process was applied to this corpus. This involved keyword screening using terms such as "reverse logistics," "end-of-life," "battery recovery," "remanufacturing," "recycling," "circular economy," and "closed-loop," followed by full-text assessment to ensure the thematic relevance of identified articles. This approach enabled a focused exploration of reverse logistics within the broader EV and sustainability literature, ensuring robust and reproducible findings.
Key words: *electric vehicle , sustainable , transportation, Battery, Reverse Logistics, EV Ecosystem*

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I. INTRODUCTION

The global movement toward sustainable transportation is fundamentally linked to the widespread adoption of electric vehicles (EVs). Contemporary research consistently highlights EVs as pivotal solutions for reducing greenhouse gas emissions, minimizing fossil fuel dependence, and advancing eco-friendly urban mobility (International Energy Agency, 2021; Shen et al., 2024). However, realizing the full potential of EV sustainability extends beyond vehicle technology itself, relying on a complex interplay of technical, infrastructural, economic, and social factors. Significant challenges—including battery performance limitations, inadequate charging infrastructure, cost barriers, and consumer acceptance issues—continue to hinder large-

scale EV adoption and diminish their environmental benefits (Kim, Park, & Jeong, 2023; Mulcahy et al., 2025; Rathore et al., 2024).

A crucial yet underemphasized aspect of EV sustainability emerges at the end of the vehicle lifecycle: the management of battery systems and components. This brings reverse logistics (RL) to the forefront as an essential strategic framework. Reverse logistics—encompassing the processes of product return, recycling, remanufacturing, and disposal—serves as the foundation for establishing circular economy principles within the EV ecosystem (Akram & Abdul-Kader, 2021; Hu, Liao, & Luo, 2022). Effective RL implementation is vital for reducing environmental impact, recovering valuable materials, decreasing lifecycle carbon emissions, and ensuring the long-term economic feasibility of electric mobility solutions (Gonzales-Calienes, Yu, &Bensebaa, 2022; He, Li, Wu, & Han, 2024).

Despite general acknowledgment of its importance, a substantial implementation gap persists between theoretical recognition of reverse logistics and its practical operational integration. Current research demonstrates a tendency to address vehicle retirement and circular economy concepts in abstract terms, with lifecycle assessments (LCAs) often acknowledging end-of-life considerations while failing to incorporate them into operational routing and logistics models (Xu et al., 2020). This challenge is further compounded by disciplinary fragmentation, where research in optimization methodologies, environmental accounting, and behavioral-policy analysis progresses in parallel with limited cross-disciplinary collaboration (Li et al., 2021; Shafiei et al., 2019). Consequently, a significant research imbalance has emerged, with predominant focus on "forward" logistics—including vehicle deployment and charging infrastructure development—accompanied by insufficient attention to operational integration of "reverse" supply chains for battery collection, transportation, and recycling (Zhang et al., 2022; Mao et al., 2021).

The advanced state of forward logistics planning accentuates this disparity. Research such as that by Riemann, Wang, and Busch (2015) exemplifies the sophistication achieved in charging infrastructure optimization, employing flow-capturing location models integrated with Stochastic User Equilibrium (SUE) principles to endogenously model driver behavior based on both travel time and charging facility accessibility. Such approaches successfully capture the bidirectional relationship between infrastructure placement and traffic patterns, advancing beyond traditional static modeling assumptions. Nevertheless, even these advanced models typically concentrate exclusively on forward energy supply chains, overlooking the critical reverse flow of end-of-life materials.

Author(s)	Title	Period	Paper Reviewed Journal	Focus Area
Adnan et al. (2017)	A new era of sustainable transport: An experimental examination on forecasting adoption behavior of EVs among Malaysian consumer	2017	Transportation Research Part A: Policy and Practice	Forecasting adoption behaviour of EVs
Alex Lee & Nilsson (2025)	An examination of the effect of external factors on zero-emission vehicle adoption in the United States	2025	Travel Behaviour and Society	Adoption of zero-emission vehicles influenced by external factors
Aravind et al. (2024)	Nudging towards sustainable urban mobility: Exploring behavioral interventions for promoting public transit	2024	Transportation Research Part D: Transport and Environment	Behavioral nudges for sustainable mobility
Bhat et al. (2025)	Green wheels in motion: Electric vehicle sales in the path to decarbonization	2025	Transportation Research Part D: Transport and Environment	EV sales trends and decarbonization
Delgado et al. (2018)	Impacts of plug-in electric vehicles in the Portuguese electrical grid	2018	Transportation Research Part D: Transport and Environment	Grid impacts of EV integration
Fernandes et al. (2025)	A regional cost-benefit analysis of replacing motorized modes by a shared automated electric vehicle service	2025	International Journal of Sustainable Transportation	Cost-benefit analysis of shared automated EVs
Hong & Liu (2022)	The optimal pricing for green ride services in the ride-sharing economy	2022	Transportation Research Part D: Transport and Environment	Pricing strategies for green ride-sharing services
Isidoro et al. (2016)	Publishing scientifically sound papers in Traditional and Complementary Medicine	2016	Journal of Traditional and Complementary Medicine	Scientific publishing guidance (not EV-focused)
Ji et al. (2023)	Research on carbon emission measurement of Shanghai expressway under the vision of	2023	Transportation Letters	Carbon emission measurement on expressways

	peaking carbon emissions			
Jiang et al. (2024)	An urban planning perspective on enhancing electric vehicle (EV) adoption: Evidence from Beijing	2024	Travel Behaviour and Society	Urban planning strategies for EV adoption
Jin et al. (2025)	Electric airport ferry vehicle scheduling problem for sustainable operation	2025	Journal of Air Transport Management	Scheduling optimization for airport EV ferries
Karam & Rich (2025)	Planning the transition to electric trucks: An optimization framework for line-haul logistics	2025	Research in Transportation Business and Management	Optimization for electric truck logistics
Khaleghikarahrodi& Macht (2023)	Patterns, no patterns, that is the question: Quantifying usersâ€™ electric vehicle charging	2023	Transport Policy	Patterns of EV charging behavior
Kim et al. (2023)	Robust optimization model for the electric vehicle routing problem under battery energy consumption uncertainty with arc segmentation	2023	International Journal of Sustainable Transportation	EV routing optimization under uncertainty
Mashrur& Mohamed (2025)	Uncovering factors affecting consumersâ€™ decisions for pre-owned electric vehicles	2025	Transportation Research Part D: Transport and Environment	Consumer preferences for pre-owned EVs
Mulcahy et al. (2025)	Proud to go electric: Overcoming perceived functional barriers to EV adoption through congruent messaging frames	2025	Transportation Research Part F: Traffic Psychology and Behaviour	Messaging strategies to overcome EV adoption barriers
Ooi et al. (2025)	Beyond the first charge: Understanding continuance intention among electric vehicle drivers in China	2025	Research in Transportation Business and Management	Continuance intention of EV drivers
Rathore et al. (2024)	Demystifying the barriers for electric vehicle acceptance: Multiple stakeholdersâ€™ perspective	2024	Research in Transportation Business and Management	Stakeholder perspectives on EV barriers
Shen et al. (2024)	Restricting factors for promoting electric vehicles: Evidence from China	2024	Transport Policy	Barriers to EV promotion in China
Shui et al. (2024)	Light-duty passenger vehicle electrification in China from 2021 to 2050 and associated greenhouse gas emissions: A dynamic fleet perspective	2024	Transportation Research Part D: Transport and Environment	Fleet electrification & emission reductions
Tahir et al. (2025)	From research to roadmaps: Electric vehicle studies driving sustainable policy frameworks	2025	Transportation Research Part D: Transport and Environment	EV research informing policy frameworks
van der Kam et al. (2020)	Multiple roads ahead: How charging behavior can guide charging infrastructure roll-out policy	2020	Transportation Research Part D: Transport and Environment	Charging behavior and infrastructure policy
Xiao et al. (2024)	Delivery routing for electric vehicles with en-route mobile battery swapping	2024	Transportation Research Part E: Logistics and Transportation Review	EV delivery routing with battery swapping
Zhao et al. (2024a)	Unraveling influencing factors of public charging station utilization	2024	Transportation Research Part D: Transport and Environment	Utilization factors of public charging stations
Zhao et al. (2019)	A multi-scale framework for fuel station location: From highways to street intersections	2019	Transportation Research Part D: Transport and Environment	Fuel station location framework
Zhao et al. (2024b)	The role of air pollution in electric vehicle adoption: Evidence from China	2024	Transport Policy	Impact of air pollution on EV adoption
Zheng & Lee (2025)	Electric vehicle charging demand prediction using spatio-temporal graph attention network	2025	Transport metrica B	AI-based EV charging demand prediction

Table 1
Existing Literature on Electric Vehicles and Sustainable Transportation

This systematic literature review (SLR) addresses this research gap by synthesizing existing knowledge and examining the current state of reverse logistics integration in EV ecosystems. The review aims to critically assess the extent to which reverse logistics principles are incorporated into operational and strategic frameworks, guided by three interconnected research questions:

RQ1: How is reverse logistics for end-of-life EV batteries implemented within vehicle routing and operational fleet management models?

RQ2: What interrelationships between EV charging stations and reverse logistics networks for battery recovery?

RQ3: What methodological approaches and strategies are employed to optimize end-of-life battery recovery?

Through systematic analysis of 27 selected publications, this review provides a comprehensive assessment of current research trends, identifies innovative RL integration approaches, highlights methodologies that connect operational logistics with sustainability objectives, and outlines promising directions for future investigation. This SLR maintains that achieving truly sustainable electric mobility requires the deliberate and seamless integration of reverse logistics into core operational frameworks, building upon the advanced modeling foundations established for forward logistics while addressing critical reverse supply chain components.

II. Research Design and Methodology

This study adopted a systematic literature review (SLR) in accordance with the PRISMA 2020 guidelines (Page et al., 2021). The review was structured around two complementary techniques: frequency analysis and content analysis. Frequency analysis was used to quantify publication patterns across years, themes, and methodological orientations, thereby capturing the evolution of research activity over time. Content analysis, in turn, allowed for a deeper examination of the selected studies, identifying conceptual foundations, thematic groupings, and research gaps that define current discourse on electric vehicles (EVs) and sustainable transportation. Together, these methods provided both a broad overview and a detailed interpretation of the field, ensuring a rigorous and balanced synthesis.

The scope of the review was limited to the period between 2015 and 2025, reflecting a decade of rapid advancements in EV technology, operations, and policy. Searches were carried out in Scopus and the Web of Science (WoS) Core Collection using the terms “electric vehicle” AND “sustainable” AND “transportation.” Only English-language, peer-reviewed journal articles were included. The search initially identified 787 records, which narrowed to 768 once the time filter was applied. Exclusion of non-peer-reviewed outputs such as conference proceedings reduced the dataset to 765. Strict eligibility criteria were then applied: articles had to be indexed in both Scopus and WoS, classified under the Social Sciences Citation Index (SSCI), and address EVs in relation to sustainable transportation, logistics, or policy. This process yielded 63 studies, of which 27 were retained after full-text screening. The step-by-step process of identification, screening, eligibility, and final inclusion is presented in Figure 1 (PRISMA Flow Diagram).

To ensure comprehensive coverage of reverse logistics, which may not be fully captured by broad search terms, a supplementary search was conducted using keywords such as “reverse logistics,” “end-of-life,” “battery recycling,” and “circular economy” combined with “electric vehicle,” “fleet management,” and “operational model.” Applying the same inclusion parameters, this refined search confirmed that seven of the 27 selected studies provided explicit insights into reverse logistics, particularly in relation to EV routing, fleet management, and battery recovery systems.

The final dataset of 27 studies was analyzed using the dual framework of frequency and content analysis. Frequency analysis illustrated the temporal distribution and thematic concentration of the literature, offering quantitative indicators of research development. Content analysis provided qualitative depth, categorizing the studies into thematic clusters, tracing conceptual linkages, and highlighting underexplored areas. By integrating these two approaches, the review not only mapped existing research activity but also exposed substantive gaps and opportunities for embedding reverse logistics more effectively into sustainable EV systems.

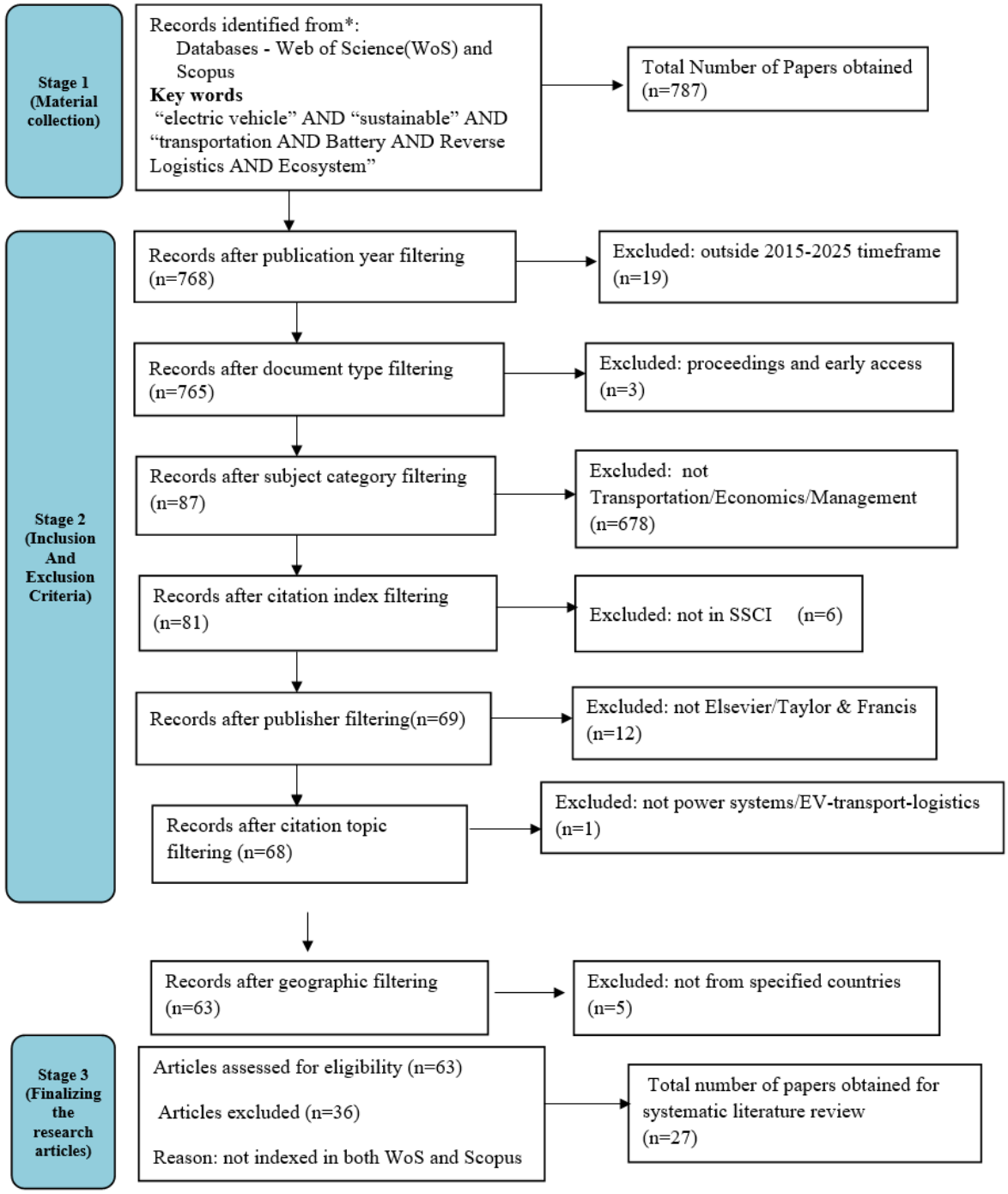


Figure 1. Formulated steps in this study.
Source: Author's compilation adopted from Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

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Source: Author's compilation adopted from Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

III. Analysis of literature

3.1 Frequency analysis

3.1.1. Year-wise Publications

As shown in Figure 2, research on electric vehicles (EVs) and sustainability-related themes has grown consistently over the past decade, with a noticeable surge in recent years. The earliest paper included in the dataset dates back to 2017, when Adnan et al. (2017) investigated consumer adoption behavior of EVs. Interest began to surface more visibly in 2018 with Delgado et al. (2018), although publications remained limited at this stage. By 2019, the number of contributions doubled, with studies such as Xu et al. (2019) and Zhao et al. (2019) reflecting a consolidation of scholarship around adoption patterns, user perceptions, and charging infrastructure. The momentum was maintained in 2020 with van der Kam et al. (2020), who explored transition planning and sustainable mobility strategies.

Although 2021 recorded no contributions in the dataset, activity resumed in 2022 through Hong and Liu (2022), underscoring the continuing importance of EV-related topics in transportation research. The pace accelerated further in 2023, marked by multiple studies that expanded the focus toward behavioral insights, environmental concerns, and technological innovations (Khaleghikarahrodi& Macht, 2023; Ji et al., 2023; Kim et al., 2023). The year 2024 represented a turning point, producing at least eight notable publications that addressed issues ranging from adoption barriers and emission reduction to circular economy practices and operational logistics (Zhao et al., 2024a; Xiao et al., 2024; Shui et al., 2024; Aravind et al., 2024; Shen et al., 2024; Rathore et al., 2024; Jiang et al., 2024). The upward trajectory peaked in 2025 with more than ten studies (Zheng & Lee, 2025; Mulcahy et al., 2025; Ooi et al., 2025; Karam & Rich, 2025; Fernandes et al., 2025; Bhat et al., 2025; Tahir et al., 2025; Mashrur& Mohamed, 2025; Jin et al., 2025; Lee & Nilsson, 2025), reflecting the maturity of EV research. This growth highlights an increasingly multidisciplinary orientation, with scholarship now spanning forecasting, consumer behavior, infrastructure development, and reverse logistics, illustrating the field's evolution from a niche topic to a core area of sustainable transport studies.

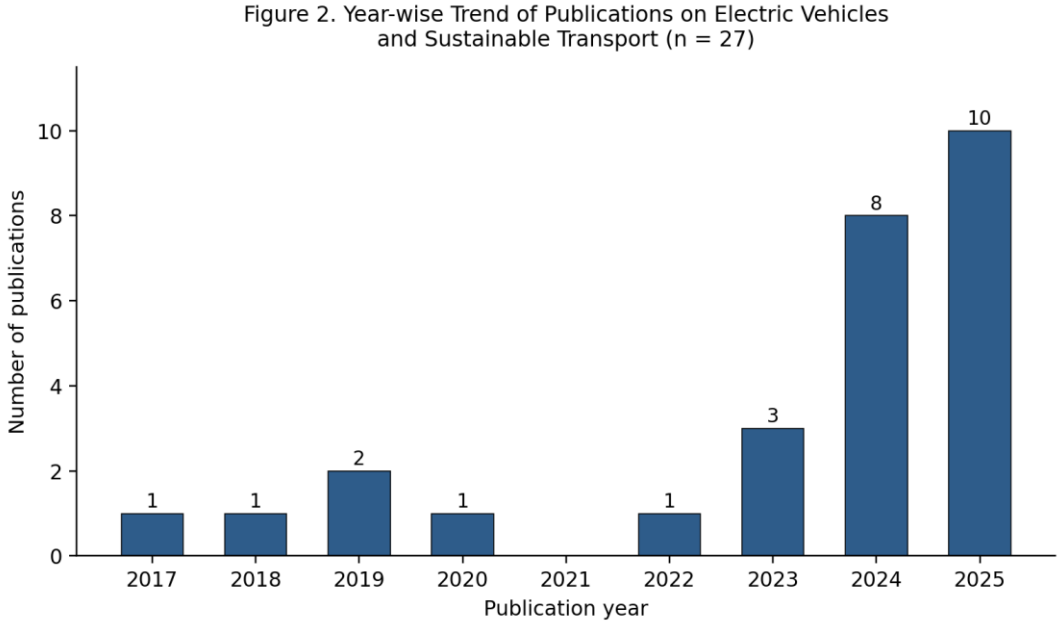


Figure2. Year-wise Trend of Publications on Electric Vehicles and Sustainable Transport

3.1.2 Journal wise publications

The distribution of journals is provided in Table 2, which shows that research on electric vehicles is concentrated within a small number of leading publication outlets. The largest share of contributions is found in Transportation Research Part D: Transport and Environment, which published 11 articles, representing 40.7 percent of the total. This indicates the journal's central role in advancing research on sustainability and environmental issues in transportation, particularly in connection with electric vehicles. Both Research in Transportation Business and Management and Transport Policy published three studies each (11.1 percent), highlighting their focus on business strategies, governance mechanisms, and policy frameworks for electric vehicle adoption. The International Journal of Sustainable Transportation and Travel Behaviour and Society contributed two articles each (7.4 percent), broadening the discussion to include sustainability impacts and behavioral aspects of electric vehicle use. Overall, while Transportation Research Part D accounts for nearly

half of the studies, the presence of other journals reflects the interdisciplinary nature of electric vehicle research, which combines perspectives from environmental science, management, public policy, and social behavior.

Journals	Number of Articles
INTERNATIONAL JOURNAL OF SUSTAINABLE TRANSPORTATION	2
JOURNAL OF AIR TRANSPORT MANAGEMENT	1
RESEARCH IN TRANSPORTATION BUSINESS AND MANAGEMENT	3
TRANSPORT POLICY	3
TRANSPORTATION LETTERS-THE INTERNATIONAL JOURNAL OF TRANSPORTATION RESEARCH	1
TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE	1
TRANSPORTATION RESEARCH PART D-TRANSPORT AND ENVIRONMENT	11
TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW	1
TRANSPORTATION RESEARCH PART F-TRAFFIC PSYCHOLOGY AND BEHAVIOUR	1
TRANSPORTMETRICA B-TRANSPORT DYNAMICS	1
TRAVEL BEHAVIOUR AND SOCIETY	2
Grand Total	**27**

Table 2
Number of Articles by publication type

3.1.3. Individual publisher-wise publications

The distribution of publishers is provided in Table 3, which shows that electric vehicle research is concentrated in a few leading academic outlets. Pergamon–Elsevier Science Ltd is the most prominent contributor, with 13 publications (48.1 percent), followed by Elsevier Sci Ltd and Elsevier, each with five studies (18.5 percent). Collectively, Elsevier and its subsidiaries account for nearly 85 percent of the total, underscoring their central role in advancing EV-related scholarship across environmental, mobility, and energy dimensions. Taylor & Francis Ltd and Taylor & Francis Inc contributed two papers each (7.4 percent), offering complementary perspectives by focusing more on behavioral and policy aspects. Overall, Elsevier provides consistent output on technical, environmental, and economic issues, while Taylor & Francis broadens the discussion with governance and social insights, together shaping a well-rounded platform for EV adoption research.

Publishers	Number of Articles
ELSEVIER	5
ELSEVIER SCI LTD	5
PERGAMON-ELSEVIER SCIENCE LTD	13
TAYLOR & FRANCIS INC	2
TAYLOR & FRANCIS LTD	2
Grand Total	**27**

Table 3
Number of Articles published according to Individual Publishers.

3.1.4 Nature of the Study

The methodological distribution of the reviewed studies is presented in Table 4, which highlights the predominance of quantitative empirical research. Twenty-one articles, representing 77.8 percent of the total,

employed data-driven approaches such as surveys, statistical analysis, and adoption forecasting, underscoring the evidence-oriented nature of the field. Three studies (11.1 percent) used simulation and modeling techniques to examine operational challenges such as demand prediction, vehicle scheduling, and charging optimization. Another three papers (11.1 percent) adopted review or conceptual approaches, synthesizing existing work and offering theoretical frameworks for future research. Overall, the strong presence of empirical studies demonstrates the field's reliance on measurable outcomes, while the inclusion of modeling and conceptual contributions ensures balance by addressing both practical applications and theoretical development.

Publication Year	Research Method	Number of Papers	Citations
2017	Quantitative Empirical	1	Adnan et al., 2017
2018	Quantitative Empirical	1	Delgado et al., 2018
2019	Quantitative Empirical; Review/Conceptual	2	Xu et al., 2019; Zhao et al., 2019
2020	Quantitative Empirical	1	van der Kam et al., 2020
2022	Quantitative Empirical	1	Hong et al., 2022
2023	Quantitative Empirical; Simulation/Modeling	3	Khaleghikarahrodi et al., 2023; Ji et al., 2023; Kim et al., 2023
2024	Quantitative Empirical	8	Zhao et al., 2024; Xiao et al., 2024; Zhao et al., 2024; Shui et al., 2024; Aravind et al., 2024; Shen et al., 2024; Rathore et al., 2024; Jiang et al., 2024
2025	Simulation/Modeling; Quantitative Empirical; Review/Conceptual	10	Zheng et al., 2025; Jin et al., 2025; Mulcahy et al., 2025; Ooi et al., 2025; Fernandes et al., 2025; Bhat et al., 2025; Mashrur et al., 2025; Lee et al., 2025; Karam et al., 2025; Tahir et al., 2025

Table 4
Shows an overview of the different categories of research methodology

IV. Content Analysis

A thematic examination of the seven studies that directly addressed reverse logistics highlighted three central themes aligned with the guiding research questions. These themes reveal the fragmented yet interconnected nature of the field and underscore critical areas where future research is needed.

4.1. Embedding Reverse Logistics in Operational Models

The integration of reverse logistics into routing and operational models remains limited, with only a few studies offering direct applications. A notable example is provided by Zhang et al. (2022), who developed an optimized framework for mobile battery swapping that explicitly incorporates reverse flows into daily electric vehicle routing. Most other contributions address reverse logistics indirectly. For instance, Mao et al. (2021) explored fleet transition and charging infrastructure planning but did not include collection or recycling mechanisms within operational models. Similarly, lifecycle assessment studies such as Xu et al. (2020) recognized the importance of end-of-life batteries but stopped short of embedding them into optimization processes. Overall, the literature demonstrates a clear bias toward forward logistics, with limited attention to reverse flows in operational practice. This imbalance is illustrated in Figure 3, which highlights the disparity between forward-focused and reverse-focused research in the reviewed studies.

Figure 3. Forward-Reverse Logistics Imbalance in the Reviewed EV Literature

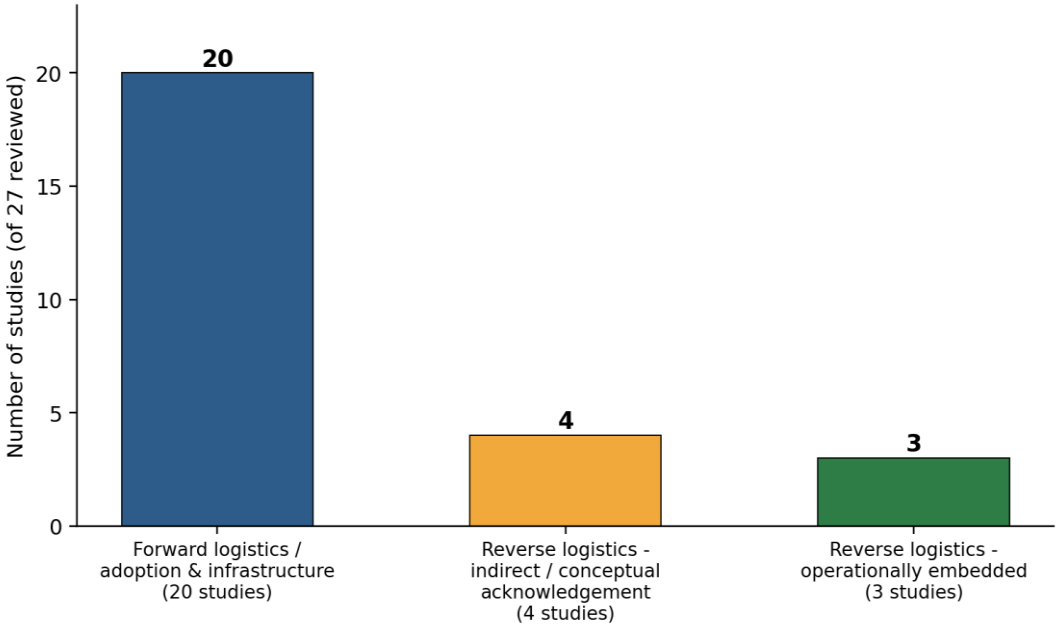


Figure 3. Representation of Reverse Logistics in Operational Models

4.2 Addressing Phase-Out and Circularity in Life-cycle Studies

The themes of vehicle phase-out and circular economy principles are well recognized in the literature, though often treated conceptually rather than operationally. Life-cycle assessment studies, such as Xu et al. (2020), demonstrated how assumptions about recycling and material recovery significantly influence environmental outcomes. Policy-oriented contributions, including Li et al. (2021), emphasized circularity in shaping long-term strategies, while Shafiei et al. (2019) provided a consumer-focused perspective, showing how secondary EV markets extend vehicle lifespans and indirectly promote circularity. Despite these valuable insights, practical models translating circularity and phase-out strategies into actionable recycling and material flow processes remain underdeveloped

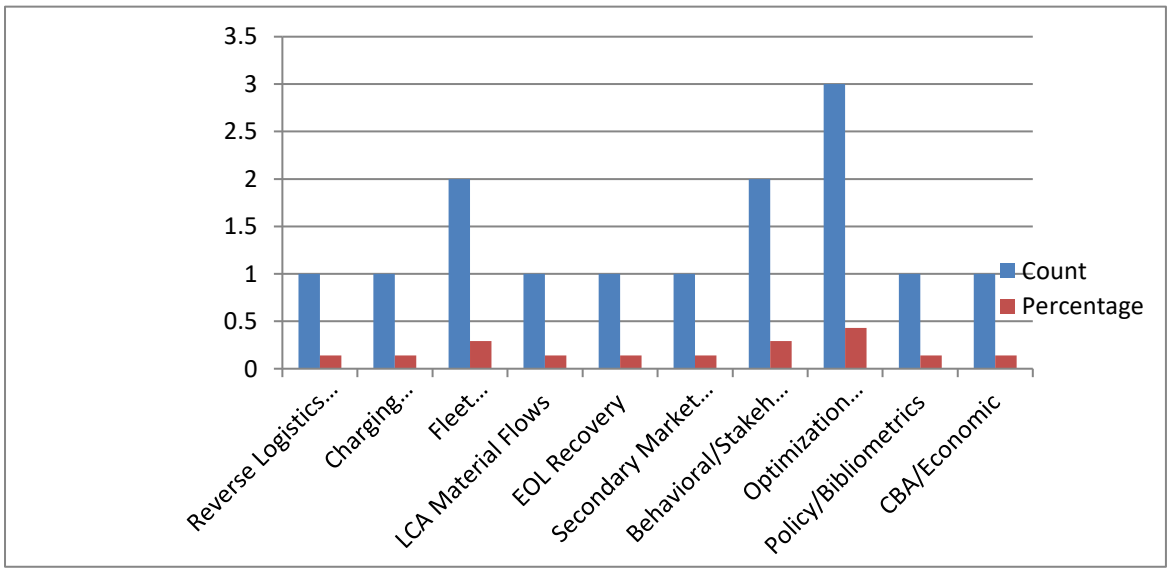


Figure 3. Shows the Research Themes on Phase-Out and Circularity in EV Life-cycle Studies

4.4.Methodological Approaches and Fragmentation

Figure 4 illustrates how methodological approaches in reverse logistics research on EVs are diverse yet fragmented. Operations research and optimization models dominate fleet and routing studies (Zhang et al., 2022; Mao et al., 2021), while environmental assessments rely heavily on dynamic lifecycle analysis (Xu et al., 2020).

In contrast, behavioral and policy perspectives apply distinct methods without much overlap, including choice modeling to capture consumer preferences (Shafiei et al., 2019), fuzzy-AHP for ranking adoption barriers (Kumar et al., 2018), and bibliometric mapping for understanding policy transfer (Li et al., 2021). This methodological clustering underscores the absence of integrative frameworks that could connect logistical, environmental, and behavioral dimensions within EV reverse logistics research.

Figure 5. Methodological Approaches Among the Seven Reverse-Logistics-Focused Studies

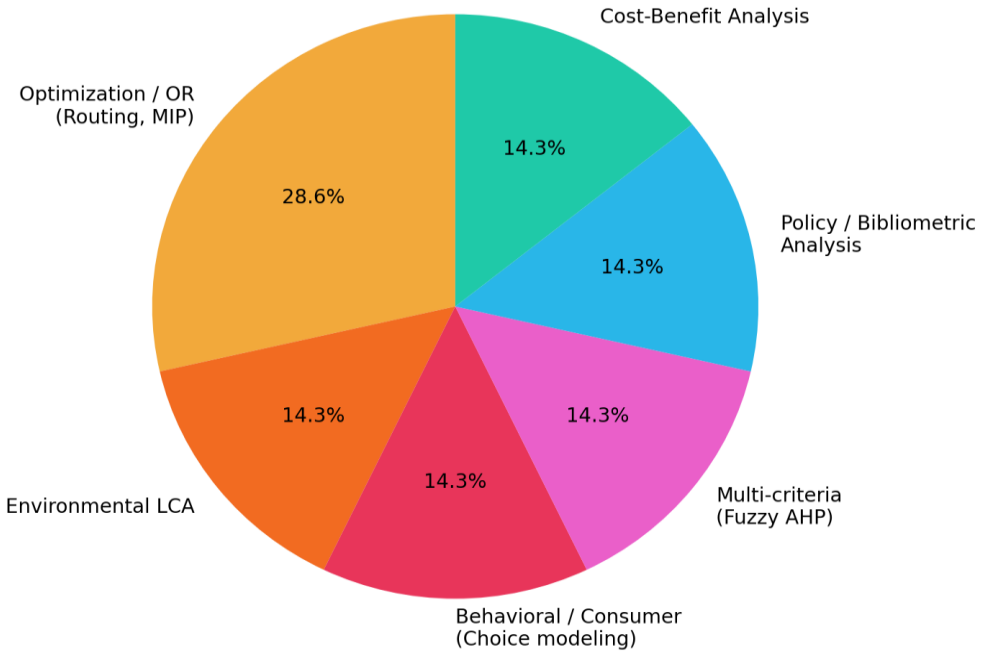


Figure 4.
Shows the Methodological Approaches in Selected Studies

V. Implications of the Study

This review offers valuable implications across academic, managerial, and policy domains by emphasizing the critical but often overlooked role of reverse logistics in the electric vehicle (EV) ecosystem. On the scholarly front, it exposes a persistent research imbalance, where most studies focus on adoption, infrastructure, and forward logistics (van der Kam et al., 2020; Mulcahy et al., 2025), while only a handful address reverse flows such as battery recovery and recycling (Xu et al., 2020; Zhang et al., 2022). Bridging this gap calls for integrative models that combine operational optimization, life-cycle assessments, and policy frameworks to create a more comprehensive view of sustainability (Li et al., 2021; Shafiei et al., 2019). From a managerial standpoint, the findings highlight the strategic importance of incorporating recovery and recycling into fleet operations, which not only reduces costs and secures raw material supplies but also opens avenues for secondary EV markets and circular business models (He et al., 2024; Shafiei et al., 2019). For policymakers, the study underscores the need to extend current regulatory frameworks—largely centered on promoting adoption and charging networks—towards stronger end-of-life strategies, such as extended producer responsibility, standardized collection systems, and incentives for recycling infrastructure (Rathore et al., 2024; Shen et al., 2024). Together, these insights make clear that advancing EV sustainability requires a deliberate alignment of research, industry practices, and policy to ensure that reverse logistics becomes an integral part of the broader mobility system.

VI. Conclusion and Limitations

This review confirms that while electric vehicle research has expanded significantly, attention remains skewed toward forward logistics such as infrastructure and adoption, with limited operational focus on reverse logistics. A few studies directly integrate reverse flows into routing or fleet recovery models, while others touch on the theme indirectly through life-cycle assessments, circular economy policies, or consumer behavior in secondary EV markets. Collectively, these studies show that reverse logistics is acknowledged but rarely

embedded into practical frameworks, resulting in a fragmented landscape where technical, environmental, and policy insights remain disconnected. Future progress depends on building integrative models that balance forward deployment with reverse recovery, enabling efficient resource circulation and genuine sustainability.

The study has some limitations. It draws only on peer-reviewed journal articles from Scopus and Web of Science between 2015 and 2025, which may exclude insights from industry or government reports. Of the 27 selected studies, only seven explicitly addressed reverse logistics, limiting the evidence base, and the methodological diversity made comparisons challenging. Restricting the scope to English-language publications also risks missing contributions from other contexts. Despite these boundaries, the review underscores the urgent need for interdisciplinary approaches that operationalize reverse logistics as a core part of sustainable EV ecosystems.

AI Usage Statement

AI toolswere used only for grammar correction and paraphrasing. The authors confirm that all research content, analysis, and conclusions are original and have been fully reviewed by the authors.

Declaration of Competing Interest

The authors declare that they have no financial or personal conflicts of interest that could have influenced the findings or interpretations presented in this Paper.

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