IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Bibliometric Analysis of Environmental Impacts of Electric Vehicles

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Abstract

The automotive industry expansion at a quick pace established major economic development together with technological progress. The growing number of automobiles on the roads has resulted in intensified environmental problems alongside the increase of emissions from vehicles. Large-scale promotion of electric vehicles occurs as a sustainable option to replace traditional cars powered by fossil fuels. The public sees electric vehicles as environmentally beneficial but this research studies their significant negative effects on the environment. The analysis evaluates several major environmental issues involving EV production emissions as well as Earth Element extraction requirements and factory operation energy use and end-of-life battery management obstacles. The report also analyzes EV electricity dependence on existing standard power systems that operate with fossil fuels thus questioning EV technology's actual sustainability. This research examines critical production elements to present a well-rounded evaluation about EV environmental impact distribution within manufacturing's stages along with energy supplying systems.

Keywords: Bibliometric, Electric Vehicles, Environment, Sustainability, Emissions, and Analysis

1. Introduction

The automotive industry, a cornerstone of global economic and technological progress, has embraced electric vehicles (EVs) as a sustainable alternative to fossil fuel-dependent transportation. With 40 million EVs on roads globally and record-breaking sales—14 million new registrations in 2023 alone—EVs now represent 18% of global car sales, driven by aggressive policies in China, Europe, and the U.S. (IEA, 2024). While EVs are lauded for reducing tailpipe emissions, noise pollution, and urban heat (Li et al., 2015; NRDC, 2023), their environmental footprint extends far beyond operational benefits. Emerging research reveals a paradox: the very solutions designed to mitigate climate change may exacerbate ecological harm through resource-intensive production, mining-related degradation, and endof-life waste challenges.

1.1 Environmental Benefits: A Narrow Lens

EVs undeniably offer localized advantages. Unlike internal combustion engine vehicles (ICEVs), they produce zero tailpipe emissions, cutting urban air pollutants like NOx and PM. Their energy efficiency (60–80% versus 20–30% for ICEVs) and regenerative braking systems further reduce energy waste (U.S. DOE, 2021). Noise reduction, particularly at low speeds, addresses chronic urban sound pollution, while studies in cities like Beijing highlight their potential to lower heat emissions by 90% (Li et al., 2015). These benefits position EVs as critical to decarbonizing transportation, the largest source of U.S. greenhouse gases.

1.2 The Hidden Environmental Costs of EVs

Beneath the surface, EVs face significant sustainability critiques:

1. **Resource-Intensive Production**: EV batteries require lithium, cobalt, and nickel— metals linked to ecologically destructive mining. Lithium extraction, for instance, depletes water in arid regions like South America's Lithium Triangle, threatening ecosystems and indigenous communities (Petavratzi et al., 2022). Producing a single EV battery emits nearly twice the greenhouse gases of manufacturing an ICEV, primarily due to energy-intensive mining and refining (Hawkins et al., 2012).

2. **Toxicity and Waste**: Informal recycling of lithium-ion batteries releases heavy metals (cobalt, nickel) into soil and water, raising human toxicity risks (Mrozik et al., 2021). Less than 5% of EV batteries are recycled globally, exacerbating e-waste challenges.
3. **Grid Dependency**: EVs' net emissions depend on the energy grid. In coal-dependent regions (e.g., parts of China, India), EVs can emit more CO_2 than diesel vehicles over their lifecycle (Sun et al., 2020).
4. **Battery Lifespan and Disposal**: While EV batteries last 150,000–300,000 km, their replacement generates waste. Current recycling infrastructure remains inadequate, risking toxic leakage and undercutting long-term sustainability (Hannan et al., 2018).

1.3 The Need for a Holistic Assessment

Despite growing EV adoption, research on their environmental impact remains fragmented across engineering, environmental science, and policy disciplines. Studies often overlook systemic issues:

- **Geographic Disparities**: Coal-reliant regions face higher emissions trade-offs, while mining impacts disproportionately affect developing nations.
- **Supply Chain Governance**: Weak regulations in mineral extraction and recycling perpetuate ecological harm.

- **Technological Gaps**: Advances in solid-state batteries and circular economy models are nascent but critical to reducing resource dependency.

A consolidated, interdisciplinary analysis is urgently needed to inform policies that balance EV adoption with ecological preservation.

2. Literature Review

Electric vehicles (EVs) are widely promoted as a sustainable alternative to internal combustion engine (ICE) vehicles due to their potential to reduce greenhouse gas emissions. However, their environmental footprint extends beyond zero tailpipe emissions, encompassing resource intensive production, energy consumption, and end-of-life management. This review synthesizes research on the ecological challenges of EVs, focusing on battery production, energy demands, recycling, infrastructure, and ethical concerns, while identifying gaps in current knowledge.

2.1 Battery Production and Resource Extraction

The production of lithium-ion batteries, essential for EVs, relies heavily on materials such as lithium, cobalt, and nickel. The extraction of these materials carries significant environmental and social costs. Lithium mining, for instance, often involves water-intensive brine evaporation or energy-demanding hard-rock mining, leading to groundwater depletion and ecosystem contamination in regions like South America's "Lithium Triangle." Similarly, cobalt extraction, predominantly in the Democratic Republic of Congo, is linked to toxic waste, habitat destruction, and human rights violations, including child labor in artisanal mines. Nickel refining, concentrated in countries like Russia and Indonesia, contributes to air and water pollution through sulfur dioxide emissions and heavy metal runoff. These processes underscore the urgent need for sustainable mining practices and alternatives to reduce reliance on ecologically and socially damaging materials.

2.2 Energy Consumption and Carbon Footprint

While EVs eliminate tailpipe emissions, their overall carbon footprint is heavily influenced by the energy sources used for electricity generation. In regions dependent on coal-fired power plants, such as parts of China and India, EVs may emit 20–50% more CO_2 over their lifecycle compared to ICE vehicles. Conversely, in areas with renewable-rich grids, such as Scandinavia, EVs can reduce emissions by up to 70%. The carbon payback period—the time required for an EV to offset emissions from its manufacturing—varies from 1 to 3 years, contingent on the adoption of clean energy. Without a global transition to decarbonized grids, the environmental benefits of EVs risk being undermined by continued reliance on fossil fuels.

2.3 Recycling and End of Life Challenges

End-of-life management of EV batteries remains a critical challenge. Less than 5% of lithium ion batteries are recycled globally, largely due to technical inefficiencies and economic barriers. Current recycling methods, such as pyrometallurgy, are energy-intensive and recover only 30–40% of materials. Hydrometallurgy, though more efficient, relies on hazardous chemicals that pose environmental risks. Repurposing used batteries for secondary applications, such as energy storage systems, offers a promising solution to extend their utility. However, this approach faces hurdles, including lack of standardization, infrastructure gaps, and regulatory support. Without scalable recycling systems, improper disposal of batteries could lead to toxic chemical leakage, contaminating soil and water systems for decades.

2.4 Infrastructure and Manufacturing Impacts

The expansion of EV infrastructure and manufacturing also raises sustainability concerns. Producing an EV generates 30–40% more emissions than manufacturing a conventional vehicle, primarily due to the energy-intensive process of battery production. Additionally, the development of charging networks and grid upgrades demands significant land use and raw materials, such as copper, which is associated with deforestation and mining waste. As EV adoption grows, concerns about grid instability and power demand spikes during peak charging times have emerged. Addressing these challenges requires investments in smart grid technologies, renewable energy integration, and adaptive infrastructure to ensure reliability and sustainability.

2.5 Social and Ethical Concerns

Beyond environmental impacts, the EV industry faces ethical dilemmas tied to its supply chains. Cobalt mining in the Democratic Republic of Congo has been repeatedly linked to exploitative labor practices, including child labor in informal mining operations. Lithium extraction in regions like South America's Atacama Desert and Australia has sparked conflicts over indigenous land rights and water access, as mining operations divert scarce water resources and disrupt local ecosystems. These social and ethical issues highlight the need for stricter regulations, transparent supply chains, and corporate accountability to ensure the shift to electric mobility does not perpetuate harm to vulnerable communities.

Current research consistently emphasizes that the sustainability of EVs hinges on three interconnected factors: the adoption of renewable energy, advancements in battery recycling, and ethical material sourcing. Regional energy mixes play a pivotal role in determining the lifecycle emissions of EVs, underscoring the importance of global efforts to phase out coal and fossil fuels. Recycling technologies, while improving, remain inadequate for large-scale deployment, necessitating innovation and policy incentives to close the loop on battery waste. Ethical concerns, particularly around cobalt and lithium extraction, demand urgent attention through international frameworks and responsible sourcing initiatives.

Despite progress, critical knowledge gaps persist. Alternative battery technologies, such as sodium-ion or solid-state batteries, show potential to reduce reliance on lithium and cobalt but require further research to achieve commercial viability. The long-term impacts of mass EV adoption on energy grids—including demand fluctuations, storage needs, and infrastructure resilience—are still poorly understood. Additionally, the effectiveness of policies aimed at promoting recycling or enforcing ethical mining practices remains understudied, limiting evidence-based decision-making. Addressing these gaps is essential to developing a holistic strategy for sustainable EV integration.

In conclusion, while EVs represent a significant step toward reducing transportation emissions, their environmental and social costs cannot be overlooked. Maximizing their benefits demands systemic changes, including rapid decarbonization of energy grids, breakthroughs in recycling infrastructure, and stringent ethical safeguards across supply chains. Policymakers, industries, and researchers must collaborate to ensure that the transition to electric mobility aligns with broader sustainability goals, avoiding the pitfalls of simply shifting ecological burdens from one sector to another. Only through such a comprehensive approach can EVs fulfill their promise as a cornerstone of sustainable transportation.

2.6 Research Questions

This study employs bibliometric analysis to map the evolving discourse on EVs' environmental impacts, addressing two core questions:

RQ1: What are the publication trends, influential journals, and key contributors in this field?
RQ2: What conceptual themes (e.g., battery recycling, lifecycle emissions) dominate the literature, and where are the research gaps?

Using PRISMA guidelines, we analyzed 1,870 Scopus-indexed documents (2010–2023), refining to 681 studies for thematic evaluation. Tools like Biblioshiny and VOSviewer visualized citation networks, co-occurrence keywords, and emerging trends.

2.7 Toward Informed Solutions

By synthesizing fragmented research, this study aims to guide policymakers in crafting EV incentives tied to renewable energy adoption, stringent recycling mandates, and ethical mining practices. For industry stakeholders, it underscores the need for innovation in battery technology and circular supply chains. Only through a transparent, holistic lens can EVs fulfill their promise as a sustainable mobility solution.

3. Research Methodology

This study employed a bibliometric analysis to systematically evaluate scholarly literature on the negative environmental impacts of electric vehicles (EVs). The objective was to uncover publication trends, influential contributors, thematic structures, and research gaps within this domain.

3.1 Data Source and Search Strategy

The Scopus database served as the primary source due to its comprehensive indexing of peer reviewed literature. A targeted Boolean search string was developed, combining EV-related terms (*e.g., "electric car," "electric vehicle," "EV"*) and keywords reflecting environmental concerns (*e.g., "ecological footprint," "battery disposal," "lithium mining"*). The search, applied to titles, abstracts, and keywords, retrieved 1,870 records as of February 12, 2025.

3.2 Screening Process

The PRISMA framework guided the screening process. After removing 36 duplicates, 1,834 records underwent initial screening. Titles and abstracts of these records were reviewed, leading to the exclusion of 938 irrelevant studies. The remaining 896 articles progressed to full-text assessment, where 215 were excluded due to incompleteness, off-topic focus, or non-English language. Ultimately, 681 studies met the inclusion criteria and were retained for analysis.

3.3 Inclusion and Exclusion Criteria

The inclusion criteria comprised peer-reviewed articles and conference proceedings that explicitly addressed environmental concerns associated with EVs, such as ecological implications or lifecycle assessments. Studies were required to be published in English. Exclusion criteria eliminated non-peer-reviewed materials (*e.g., editorials, notes*), articles focusing solely on positive environmental impacts without critical discussion of negative aspects, and studies unrelated to environmental analysis (*e.g., economic models, policy reviews lacking ecological focus*).

3.4 Bibliometric Analysis Tools

Selected records were exported in Bib Tex and CSV formats and analyzed using Biblioshiny (an R-based interface) and VOS viewer. These tools enabled the mapping of co-authorship networks, citation patterns, keyword co-occurrences, and thematic clusters. They also facilitated the identification of annual publication trends, top authors and journals, citation impact metrics, and emerging research clusters.

3.5 Outcome

The analysis highlighted key research themes, including battery lifecycle impacts, rare earth extraction, and e-waste management, while underscoring gaps in long-term ecological assessments of EVs. By adhering to a structured methodology, the study provided a comprehensive overview of the evolving discourse on EVs' environmental challenges, offering insights for future research and policy development.

4: Finding & Discussions

4.1 Performance Analysis

4.1.1 Most Influential Publications

The most influential publications in the domain of electric vehicle (EV) environmental impact reveal a strong focus on battery sustainability, lifecycle emissions, and hybrid system efficiency (Table 1). The top-cited paper, *"A review on the state-of-the-art technologies of electric vehicle, its impacts and prospects"* (793 citations), provides a comprehensive overview of EV technologies, including battery systems, motor design, and charging infrastructure. It critically evaluates the environmental burden of battery production and disposal, establishing a foundation for sustainable EV scaling debates.

Hannan et al.'s 2017 review (733 citations) addresses battery degradation and environmental risks tied to improper disposal, advocating for integrating ecological metrics into battery management systems (BMS). Their 2018 follow-up (660 citations) highlights resourceintensive lithium-ion battery production and thermal instability, emphasizing ecological hazards from poor end-of-life management.

Wirasingha and Emadi's 2011 work (613 citations) critiques inefficient EV control strategies that exacerbate energy waste and upstream emissions. Ovshinsky et al.'s 1993 paper (610 citations), though dated, remains pivotal for identifying toxicological risks in battery chemistry, foreshadowing modern concerns over heavy metals and non-biodegradable waste. Collectively, these studies underscore the ecological trade-offs of EV adoption, spanning technical design, lifecycle analysis, and policy gaps.

4.1.2 Most Relevant Authors

Hannan M.A. emerges as the most influential author (h-index: 3, 1,648 citations), with seminal work on battery toxicity and lifecycle inefficiencies (Table 2). Collaborators Hoque M.M. and Ayob A. co-authored key papers on lithium-ion battery challenges, linking technical performance to sustainability. Mithulananthan N. and Ramachandaramurthy V.K. (2015) explored grid integration challenges and rare-earth material impacts, while Yong J.Y. highlighted well-to-wheel emissions disparities.

Productive authors like Wang J. (h-index: 4) and Wen F. (h-index: 7) focus on grid interactions and energy management (Table 3). Emadi A. (h-index: 3) pioneered early control strategy research, indirectly addressing energy waste and material usage. These authors collectively bridge technical innovation with environmental accountability, emphasizing systemic inefficiencies and policy misalignments.

4.1.3 Most Relevant Journals

Renewable and Sustainable Energy Reviews leads in influence (2,622 citations), publishing meta-analyses on EV lifecycle emissions and policy trade-offs (Table 4). *Energies* dominates productivity (29 articles), focusing on grid impacts and battery degradation. *IEEE Access* (1,376 citations) emphasizes engineering solutions to environmental burdens, while *Applied Energy* (680 citations) employs lifecycle assessments (LCA) to evaluate clean energy coupling.

Journal of Cleaner Production (508 citations) targets manufacturing waste and recycling, whereas *Energy* (391 citations) models renewable integration scenarios. *Sustainability* (365 citations) highlights socio-economic drivers of EV environmental outcomes. These journals reflect interdisciplinary convergence, blending environmental science, engineering, and policy studies.

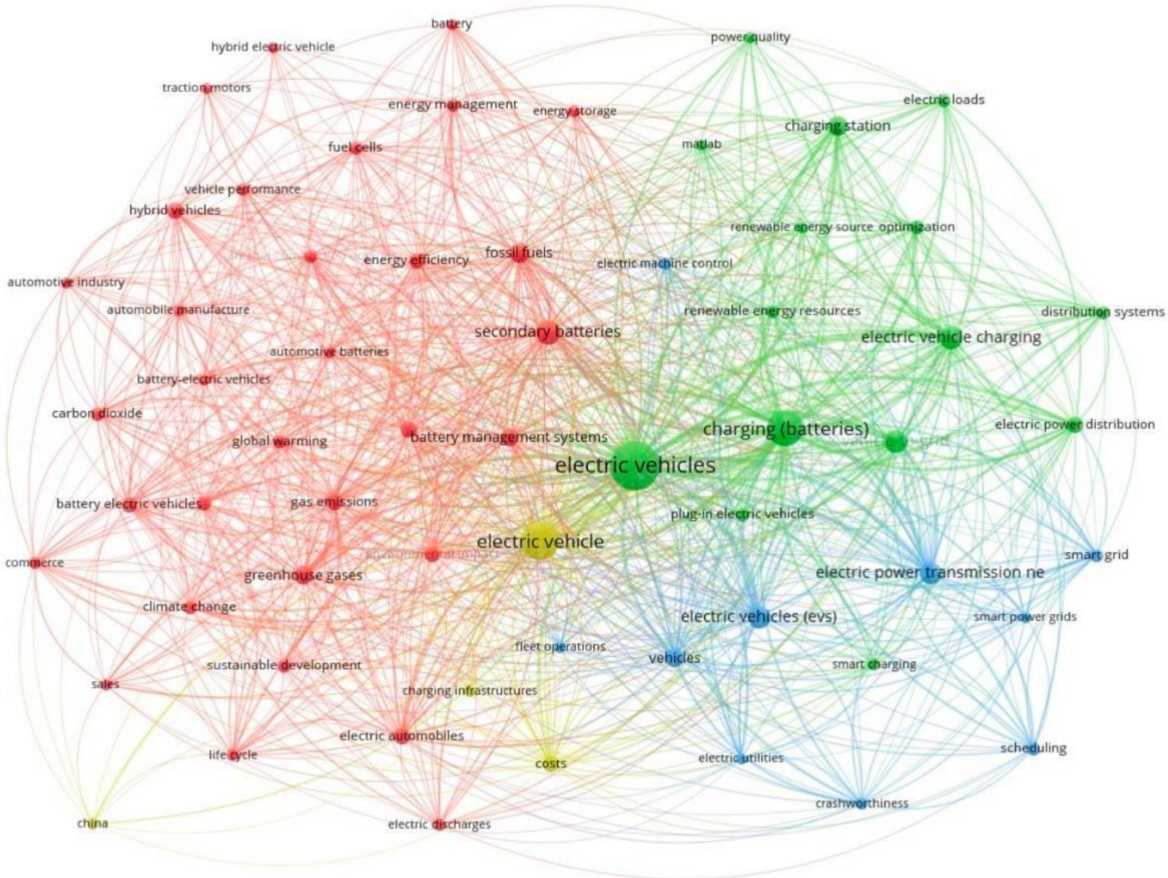
4.1.4 Most Authoritative Countries

Malaysia leads in citation impact (3,544 citations), driven by collaborative studies on battery safety and toxicity (Table 6). China dominates productivity (137 articles, 20.1% share), addressing supply chain emissions and rare-earth mining (Table 7). The U.S. (2,455 citations) focuses on policy frameworks and grid modernization, while India (636 citations) examines coal-dependent grid emissions.

Germany's single-country publications (21 articles) emphasize circular economy models, whereas the U.K. (43.8% international collaboration) explores transboundary pollution. Australia and Canada (54.5% collaboration) model climate impacts and Indigenous land concerns. These patterns mirror national EV stakes, linking research output to industrial and ecological priorities.

4.2 Science Mapping

4.2.1 Keyword Co-occurrence Analysis

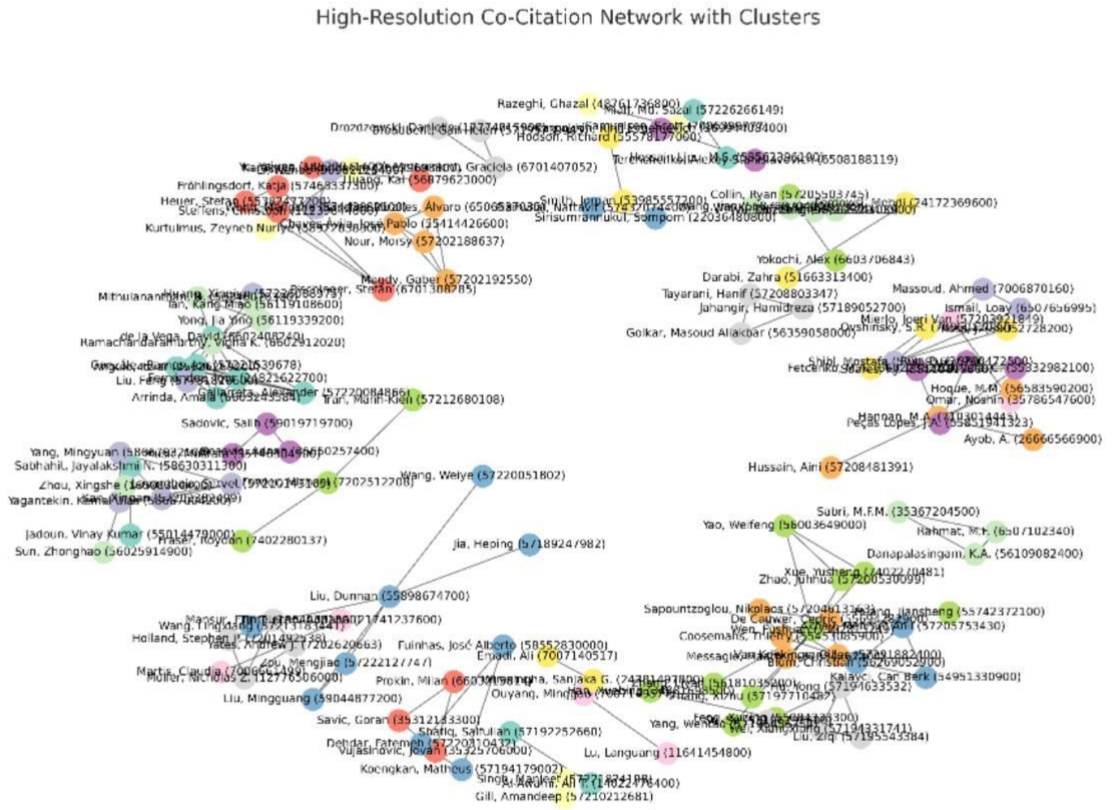


Keyword clusters reveal four thematic domains :

1. **Environmental Lifecycle**: Terms like *greenhouse gases* and *battery electric vehicles* dominate, critiquing indirect emissions from production and disposal.
2. **Charging Infrastructure**: *Renewable energy resources* and *power quality* highlight grid integration challenges.
3. **Smart Grid Optimization**: *Demand-side management* and *electric utilities* explore decarbonization via intelligent systems.
4. **Economic-Policy Dimensions**: *Costs* and *China* stress market forces and regulatory gaps.

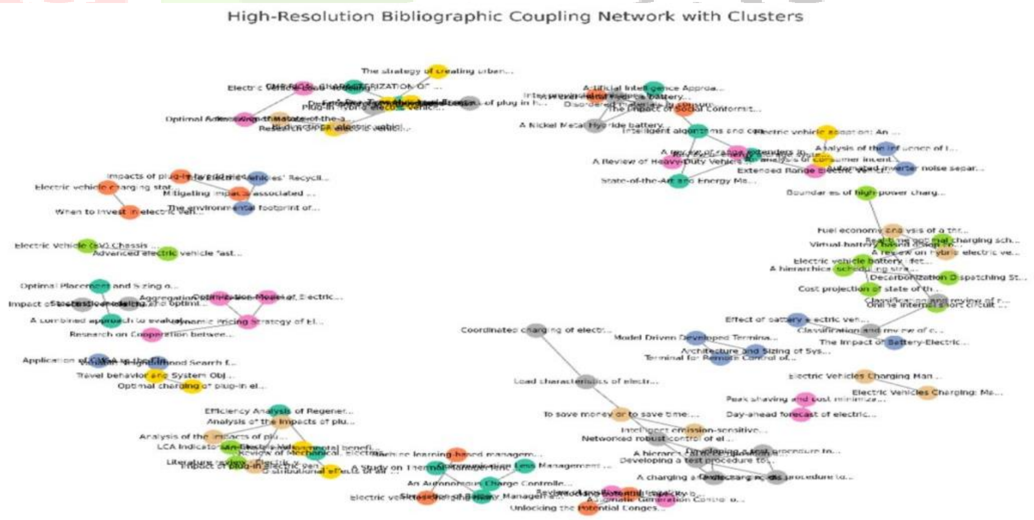
Central nodes (*electric vehicle*, *charging*) anchor cross-cluster linkages, reflecting mature, interdisciplinary discourse.

4.2.2 Co-citation Analysis



Co-citation pairs like Fetcenko-Ovshinsky (3 counts) and Zhao-Wen (3 counts) signal foundational contributions. While frequencies are modest, recurring authors (e.g., Wencong Su) indicate bridging roles across subfields. This nascent cohesion suggests evolving thematic schools, typical of emerging domains.

4.2.3 Bibliographic Coupling



Documents sharing references reveal collaborative clusters. For example, *Emissions generated by electric vehicles...* and *EMPIRICAL CHARACTERIZATION...* (6 shared authors) reflect institutional synergy in EV charging research. Other pairs focus on grid load management, highlighting systematic development of EV infrastructure studies. These clusters identify research ecosystems for future meta-analyses.

This analysis maps the intellectual landscape of EV environmental impact research, emphasizing lifecycle analysis, grid integration, and policy gaps. Influential works and authors underscore the centrality of battery sustainability, while journals and countries reflect interdisciplinary and geopolitical stakes. Science mapping reveals evolving thematic clusters, guiding future research toward systemic solutions and collaborative frameworks. Addressing ecological trade-offs will require harmonizing technical innovation with circular economy principles and equitable policy design.

The bibliometric analysis of research on the environmental drawbacks of electric vehicles (EVs) reveals a concentrated yet multidimensional scholarly ecosystem. High citation counts and productivity indicators highlight a mature knowledge base, shaped by influential authors, journals, and collaborative networks. The discourse has evolved from early enthusiasm about EV adoption to critical examinations of lifecycle emissions, battery sustainability, and systemic inefficiencies, reflecting a paradigm shift in environmental accounting.

4.3 Citation Density and Thematic Focus

The scholarly maturity of the field is evident in the citation metrics of foundational works.
The top-cited paper by Yong et al. (2015), with 793 citations, and Hannan et al. (2017), with 733 citations, underscore a transition from exploratory research to rigorous environmental evaluations post-2010. Early works like Ovshinsky et al. (1993) remain relevant, signaling longstanding academic awareness of battery-related trade-offs. These trends align with global policy shifts, such as the Paris Agreement, and rising EV adoption, which spurred research into upstream and downstream environmental impacts.

Battery technology emerges as the core concern, with lithium-ion performance, degradation, and disposal dominating the discourse. Studies on toxicological footprints, material extraction, and lifecycle assessments (LCAs) reinforce batteries as the primary source of EV externalities. The repeated emphasis on energy conversion efficiency and recycling challenges highlights the technological and environmental complexities of EV sustainability.

4.4 Author Influence and Regional Collaboration

Hannan M.A. stands out as the most influential author, with 1,648 citations across publications on battery management and lifecycle emissions. Collaborative networks, particularly with Hoque M.M. and Ayob A., reflect South and Southeast Asia's emergence as regional hubs for battery research. These collaborations emphasize scalability and environmental safety, contrasting with Western authors like Emadi A. and Pollet B.G., who focus on electrochemical properties and grid integration. Such geographical diversity underscores global relevance while revealing regional priorities—Asia's emphasis on practical scalability versus Western technocentric approaches to grid stability and hybridization.

4.5 Journal Impact and Interdisciplinary Reach

Renewable and Sustainable Energy Reviews leads as the most impactful journal, bridging environmental science, energy systems, and policy analysis. Its meta-analytical approach synthesizes technical and policy dimensions, reinforcing interdisciplinary dialogue. Journals like *Energies*, *Applied Energy*, and *Journal of Cleaner Production* further illustrate the field's diversity, spanning electrochemistry, mechanical systems, and sustainability governance. This thematic spread signifies a shift from narrow technical analyses to broader questions of industrial ecology, climate outcomes, and environmental governance.

4.6 Temporal Trends and Emerging Gaps

The peak citation period (2011–2018) aligns with decarbonization efforts and scrutiny of mineral sourcing. Citation lag leaves contemporary debates—supply chain ethics, circular economies, grid dependency—underrepresented, necessitating real-time impact studies in regions like Sub-Saharan Africa and Southeast Asia, where infrastructure gaps hinder EV transitions. Structural challenges in recycling scalability, equity, and e-waste policies persist. While lifecycle assessments dominate, holistic frameworks merging urban planning, behavioral shifts, and smart charging are sparse, demanding systems-based research to address implementation barriers.

4.7 Science Mapping and Knowledge Networks

Keyword co-occurrence analysis identified four thematic clusters: lifecycle emissions (red), charging infrastructure (green), smart grid optimization (blue), and socio-economic policy (yellow). These clusters reflect the field's multidisciplinary nature, bridging engineering, economics, and environmental science. Co-citation analysis revealed intellectual lineages, with influential pairs like Ovshinsky & Fetcenko bridging battery chemistry and environmental performance. Bibliographic coupling highlighted emerging collaborations, particularly in charging optimization and grid stability, signalling a pragmatic shift toward operational challenges.

This bibliometric study analyzes EV environmental research, highlighting battery challenges, regional networks, and interdisciplinary engagement. While foundational insights exist, gaps persist in systemic approaches, real-world application, and regional inclusivity. Integrating technical, policy, and socio-economic dimensions can foster holistic sustainability frameworks, ensuring EVs advance equitable global environmental outcomes.

5. Conclusion

Electric vehicles (EVs) are widely championed for reducing greenhouse gas emissions and air pollution, yet a data-driven bibliometric analysis reveals nuanced environmental trade-offs. Key concerns include battery production, energy sourcing, and end-of-life management, which challenge the sustainability narrative of EVs. Lithium-ion battery manufacturing, for instance, drives significant upstream emissions, resource depletion (e.g., lithium, cobalt, nickel), and ecological harm in mining-intensive regions. These impacts are exacerbated in regions reliant on fossil fuel-dominated grids, particularly in developing economies with limited renewable energy adoption.

The scholarly landscape is organized into four thematic clusters:

1. **Life Cycle Assessment & Carbon Footprint**: Highlights emissions from production to disposal.
2. **Charging Infrastructure & Grid Stress**: Examines energy demand and grid reliability challenges.
3. **Smart Grid Integration**: Explores renewable energy synergy and load management.
4. **Economic-Political Considerations**: Addresses policy incentives, market dynamics, and subsidies.

Geographically, research is dominated by China, India, the USA, and Malaysia, reflecting varied priorities tied to local EV market maturity, regulations, and energy infrastructure. Emerging hubs in Asia focus on battery safety, thermal management, and efficiency, shaping global discourse.

5.1 Persistent Gaps in Research:

- **Scalability of Recycling Infrastructure**: Limited solutions for efficiently repurposing battery materials.
- **Socio-Environmental Justice**: Inequities in mining communities often overlooked.
- **Second-Life Applications**: Understudied potential for reused batteries in energy storage.
- **Long-Term Ecological Impacts**: Inadequate data on disposal effects, particularly leaching toxins.

The literature remains techno-centric, with minimal integration of governance, ethics, or regional disparities in sustainability outcomes. While EVs mark progress in decarbonizing transport, their long-term viability hinges on systemic innovation: ethical mineral sourcing, robust recycling frameworks, policy coherence, and circular economy principles. Future research must bridge disciplinary divides, prioritize socio-technical perspectives, and ensure EVs are sustainable *across* their lifecycle—not just at the tailpipe.

5.2 Implications

The implication of the research indicates a troubling reality regarding electric vehicles (EVs) and their purported sustainability. While marked as cleaner alternative to traditional vehicles, this study reveals significant environmental drawbacks associated with EVs that are often overlooked.
The production processes for EVs, particularly battery manufacturing, involve extensive carbon emissions and resource extraction, contributing to environmental degradation rather than alleviating it.
Moreover, the reliance on fossil fuels for electricity generation to power these vehicles raises serious questions about their overall sustainability. Despite producing zero tailpipe emissions, the lifecycle

emissions from EVs-including those from manufacturing and energy generation-may negate their perceived benefits. This disconnect reveals a misleading narrative that frames EVs as a panacea for environmental issues.

Furthermore, the challenges related to battery disposal and recycling introduce additional environmental concerns, as improper management can lead to hazardous waste. As such, the promotion of EVs without addressing these critical issues may lead to increased harm to our ecosystems. This research underscores the need for a more nuanced understanding of EV technology, cautioning against its uncritical adoption as a solution to climate change.

Overall, the findings advocate for a re-evaluation of policies and practices surrounding electric vehicles, urging stakeholders to consider the broader environmental implications rather than succumbing to the allure of a quick fix.

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