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Critical Enablers of Battery Leasing in Indian Electric Vehicle Battery Infrastructure

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Abstract

Battery leasing, which allows electric vehicle (EV) users to lease batteries independently of vehicle ownership, has emerged as a promising strategy to reduce upfront costs and accelerate EV adoption, particularly in emerging economies. This study seeks to identify and validate the critical enablers that can facilitate the implementation of battery leasing models within India's evolving EV ecosystem. An initial pool of 48 enablers was derived through a comprehensive literature review and subsequently refined to 29 through frequency mapping. To systematically validate these enablers under expert uncertainty, the Fuzzy Delphi Method (FDM) was employed, engaging a panel of experts from both academia and industry with domain-specific knowledge in EV battery systems, energy policy, and mobility solutions. Based on consensus thresholds and defuzzification, nine enablers were confirmed as most influential, including targeted leasing policies, optimized charging modes, integrated leasing platforms, and circularity integration. The findings offer strategic insights for policymakers, EV manufacturers, and infrastructure developers. The study also outlines key limitations and suggests future research directions focused on empirical validation and implementation modeling.

Keywords
Enabling Factors, Battery Leasing Models, Electric Vehicle Battery Infrastructure in India, Delphi Method and Battery-as-a-Service (BaaS) Business Models

1. Introduction
In the battery leasing model, electric vehicle (EV) owners either purchase or lease the vehicle while leasing the battery separately from a Battery Leasing Operator (BLO). The BLO is responsible for the procurement, maintenance, and overall management of the battery system (Gonzalez-Salazar et al. 2023; Picatoste et al. 2022). This model provides several key advantages, including reduced upfront vehicle costs, increased accessibility for occasional users, greater flexibility, and standardization in battery production and charging infrastructure (Li and Ouyang 2011; Sadek 2012). It also aligns with the principles of a Circular Business Model (CBM), promoting resource efficiency, extended battery usage across multiple users, and responsible end-of-life management (Böckin et al. 2022; Gonzalez-Salazar et al. 2023).

An illustrative case is the Chinese EV startup NIO, which adopted a swappable battery architecture along with a battery leasing strategy. NIO vehicles are designed to accommodate interchangeable batteries that can be swapped in under three minutes at designated stations (NIO 2021a). By the end of 2021, NIO had established 700 swapping stations in China and projected a global expansion to 4,000 stations by 2025 (NIO 2021b). Customers can opt to buy a vehicle without a battery and pay a monthly subscription fee for battery leasing. They can either recharge the battery themselves or swap it for a fully charged one, paying only for the difference in energy usage. This model is referred to as Battery-as-a-Service (BaaS) (NIO 2020).

In the Indian context, battery leasing is not entirely new. Mahindra Reva introduced a subscription model for its EV in 2014, which reduced the upfront cost by approximately ₹1.7 lakh, bringing the base price down to ₹4.99 lakh from ₹6.5 lakh (ex-showroom). Under this scheme, customers paid ₹2,599 per month over five years for battery usage, covering 50,000 km or 800 km per month (Bhargava 2024). However, high vehicle costs and inadequate charging infrastructure at the time hindered broader adoption. Despite this early foray, battery leasing in India remains underdeveloped and requires significant policy support and industry participation to achieve widespread implementation (Varghese and Pradhan 2025).

1.1 Objectives

The specific objectives of the study are:

1. To identify factors that enable the battery leasing in EV infrastructure through a review of academic literature.
2. To shortlist these factors based on their frequency of occurrence.
3. To determine the key factors influencing battery leasing within India's EV battery infrastructure.

2. Literature Review

The existing research predominantly emphasizes the design of leasing models, their economic feasibility, and the comparative advantages of different ownership or service modes. However, there remains a significant gap in understanding the critical enablers, from the perspectives of both battery leasing operators and end-users, that facilitate the large-scale operationalization of these models, especially within the Indian context.

Several studies have explored the structural and strategic foundations of battery leasing. For example, Shi and Hu (2024) investigated flexible battery leasing models and found that such arrangements deliver multifaceted benefits to key stakeholders, including manufacturers, consumers, and the environment. Their study highlighted the role of leasing flexibility in adapting to dynamic driving needs and varying usage intensities, which is critical in countries with diverse urban–rural mobility patterns like India.

Similarly, Hildebrandt et al. (2016) proposed a dynamic battery leasing model wherein car manufacturers incentivize users to adopt optimized charging strategies to extend battery life and enhance residual value. Their work emphasized the operational relevance of real-time battery monitoring, which enables data-driven decision-making regarding battery utilization, resale, and secondary market applications. The integration of digital technologies, such as Internet of Things (IoT) platforms and AI-based battery health prediction, emerged as a central enabler for such models.

The comparative analysis by Zhou, Pang, and Tang (2025) added further nuance by examining how service-based supply models (e.g., leasing, swapping) differ from product-based models in terms of cost structures, consumer acceptance, and value proposition. Their findings suggest that battery leasing significantly lowers upfront costs and promotes quicker diffusion of EVs, particularly in developing markets, but hinges on the presence of supporting infrastructure and regulatory clarity.

Gong, Zheng, and Shu (2024) extended the application of battery leasing to hydrogen fuel cell vehicles (HFCVs) and revealed that service-based models can shift the cost burden away from consumers while ensuring stable cash flow for manufacturers. They emphasized the influence of market conditions and supply chain integration on the viability of leasing models, offering important analogs for the EV domain.

From an operational lens, Wu and Li (2024) examined two contrasting EV leasing strategies, unit-based and fixed-rate models, to determine the optimal pricing and service structure for maximizing manufacturer profits while maintaining customer satisfaction. Their results underline the importance of tailored strategies for different customer segments and vehicle categories.

Cheng and Liu (2016) analyzed the adoption of EVs in urban logistics, finding that battery leasing is often the most cost-effective model in high-usage scenarios. However, they cautioned that due to modest profit margins, the financial viability of leasing models may require policy support and long-term strategic planning. This is especially relevant in Indian cities, where last-mile logistics are gaining momentum under e-commerce and hyperlocal delivery models.

Li and Ouyang (2011) delved into the economic feasibility of BLOs. They observed that profitability is constrained by several factors, including high battery costs, the dominance of heavy EVs in certain markets, volatile energy prices, and rigid subsidy structures. Their work concluded that the risk-adjusted survival of BLOs depends not only on pricing strategy but also on battery performance guarantees, maintenance support, and operational scale.

In parallel, several studies have emphasized the consumer perspective in EV adoption and leasing. Huang et al. (2021) conducted a large-scale stated preference (SP) experiment in China and found that consumer preferences for non-ownership models (leasing, sharing) are shaped by both rational and psychological factors, such as cost sensitivity, environmental concern, and the need for uniqueness. These findings indicate that user-centric design of battery leasing models is essential for improving adoption rates.

Miao et al. (2022) developed a Mileage-Based Pricing (MBP) model for EV leasing that incorporates both economic and service value perceptions. By modeling the interaction between perceived quality, price, and satisfaction, they offered a comprehensive framework for understanding profitability while maintaining customer loyalty. This highlights the need for data-driven customization in battery leasing service delivery.

Despite these rich contributions, the current literature is still fragmented in its treatment of enablers. Most studies focus on model design, cost-benefit analysis, or policy impacts in isolation. Few take a holistic view to identify and validate the interdependent enablers, such as regulatory incentives, standardization of leasing platforms, real-time digital monitoring, consumer awareness, risk-sharing mechanisms, and after-sales service infrastructure, that are essential for scaling battery leasing in diverse markets.

Furthermore, there is a conspicuous absence of studies applying consensus-based methods like the Delphi technique to systematically validate such enablers in the context of emerging economies. In India, where EV adoption is growing but infrastructure remains uneven, understanding these strategic enablers is vital for ensuring the long-term success of battery leasing.

This study addresses that gap by applying the Delphi method to identify and validate key enablers for the adoption of battery leasing in India's Electric Vehicle Battery (EVB) infrastructure. The findings will support decision-makers, ranging from BLOs and OEMs to policymakers and investors, in developing targeted interventions that accelerate the sustainable growth of battery leasing ecosystems.

3. Methodology

This study employs the Fuzzy Delphi Method (FDM) to identify and validate the enablers that facilitate the adoption of battery leasing in India's EV battery infrastructure. The FDM combines the systematic consensus-building approach of the traditional Delphi method with the uncertainty-handling capability of fuzzy set theory. This hybrid technique is particularly effective when expert judgments are expressed in linguistic terms and involve subjective evaluations, as is common in the early-stage adoption of emerging technologies.

Based on an extensive literature review and preliminary expert discussions, an initial list of **29 enablers** were generated. These were included in a structured survey, where participants were asked to assess each enabler's importance on a **5-point linguistic scale**. Each linguistic response was translated into a **Triangular Fuzzy Number (TFN)** to capture uncertainty and imprecision in expert perceptions. The fuzzy scale used is shown in Table 1:

Table 1. Linguistic Variables and Corresponding TFNs

Linguistic Variable	**Rating**	**Corresponding TFN**
Extremely unimportant	1	(0.1, 0.1, 0.3)
Unimportant	2	(0.1, 0.3, 0.5)
Normal	3	(0.3, 0.5, 0.7)
Important	4	(0.5, 0.7, 0.9)
Extremely important	5	(0.7, 0.9, 0.9)

Each expert's response for the j_{th} enabler was thus encoded as a TFN:

$\tilde{A}_{ij} = (l_{ij}, m_{ij}, u_{ij})$ **(Equation 1)**

To derive a collective assessment for each enabler, the individual TFNs from all N=26 experts were aggregated using the arithmetic mean:

$l_j = \frac{1}{N}\sum_{i=1}^{N} lij$, $m_j = \frac{1}{N}\sum_{i=1}^{N} lij$, $u_j = \frac{1}{N}\sum_{i=1}^{N} lij$ **(Equation 2)**

This resulted in an aggregated TFN for each enabler $\tilde{A}_{ij} = (l_j, m_j, u_j)$

The aggregated fuzzy scores were defuzzified using the **Centroid Method**, which calculates a crisp value representing the overall importance of each enabler:

$D_j = \frac{lj,mj,uj}{3}$ **(Equation 3)**

4. Data Collection

The data collection phase lasted for a month period started from April to May 2025. The initial part of the data collection; identification of the academicians and industry experts were done on the basis of their experience, area of research and EV battery expertise. The 50 shortlisted experts were reached with emails, phone calls, and in-person visits. Within this time frame, 33 experts were contacted with direct, in-person interactions, and 26 of them participated in the study and completed the questionnaires.

The profile of these respondents varies from technical side of EV batteries to advanced digital technologies. Many of their research labs focused on energy storage systems, electric powertrains, sustainable transportation systems, and lifecycle assessments; topics that closely connected with battery leasing technologies. Policy and industry level experts are mainly working in EV based industries like battery manufacturing, research and development departments and non-governmental organizations (NGOs).

The academician's depth of knowledge in the EV related areas spread across on any levels, large and small. Mechanical engineering professor's proficiency varies from the thermal management of Li-ion batteries, a core requirement for battery life optimization, passively cooled EV battery packs, lithium-ion battery degradation models, lifecycle extension and predictive maintenance of batteries. Electrical engineering experts focuses on the subjects like in battery management systems and EV powertrain optimization. Industry-relevant work on fast charging, wireless charging, and V2G (vehicle-to-grid) integration aligned with the battery leasing ecosystems. There are also experts working in the areas like AI-driven cloud platform for EV batteries and diagnostics for EV motors; a key enabler for leasing models. Many others are also there as their key areas with developing sustainable charging systems and fast-charging stations for EVs.

Experts from the Advanced Technology Development Centre are well versed with indigenous motor drive systems and energy management; crucial element of EV technology. Material science faculties are doing research on innovation in electrode materials, battery health estimation, and life-cycle prediction, supporting battery reuse and second-life applications. Industrial Engineering professors are experts in reverse logistics and scrappage policy modelling, laying policy groundwork essential for battery retrieval in a leasing system. All these expert's industrial, and government-supported project experience supported all sections of EV battery leasing as a practical solution to India's emerging EV eco-system.

Responses on the questionnaire was largely positive from many of the respondents. The clarity, accuracy, and relevance of the questions, aligning the questionnaire with existing policy and technology debates were appreciated by many of them. At the same time, accessibility and availability of these experts to give time for the data collection process was one of the main challenges faced by the research team. Many experts were busy with their work commitments, travel, organisational meetings and out of station issues. Many of them neither accessed by frequent phone calls or emails and hence dropped out from the list.

5. Results and Discussion

This research applied FDM in identifying and confirming the key factors that facilitate the mass adoption of battery swapping in the Indian EVB supply chain. FDM is an integration of the traditional Delphi method and fuzzy set theory to handle expert uncertainty and word vagueness properly (Ishikawa et al. 1993; Kaufmann and Gupta 1988). FDM is most effective in new technology research, where there is scarce data and expert consensus is the key factor.

A preliminary set of 29 enablers was created through a broad scanning of academic research, policy reports, and industry analysis. These enablers cut across themes, technology, economy, rules, behaviour, and operations, to illustrate the multifaceted social and technical character of battery leasing adoption in India.

Table 2. List of 29 Enablers for Battery Leasing Adoption

S. No	Enabler	Dimension	Description	Key References
1	Targeted Leasing Policies	Policy & Regulatory	Government support mechanisms and subsidies to promote battery leasing models.	Hou et al. (2010); González-Salazar et al. (2023)
2	Optimized Charging Modes	Technological	Charging protocols optimized for battery health and operational efficiency.	Hildebrandt et al. (2016); Lim et al. (2015)
3	Strategic Charging Frequency	Technological	Strategically planned charging cycles to align with grid and demand.	Gschwendtner (2024); Hildebrandt et al. (2016); Lim et al. (2015)
4	Competitive Leasing Rates	Economic	Affordable leasing schemes to make EVs financially accessible.	Hildebrandt et al. (2016); Williams (2012)
5	Engaged Lessee Participation	Behavioral	Active involvement of lessees in battery-related decision-making.	J.D. Power (2021); Hildebrandt et al. (2016)
6	User-Centric Communication	Behavioral	Communication platforms tailored to lessee needs and preferences.	Hildebrandt et al., (2016); Liao et al. (2017)
7	Integrated Leasing Platforms	Technological	Digital infrastructure enabling end-to-end leasing operations.	Oracle (2023); Hildebrandt et al., 2016)
8	Dynamic Revenue Models	Economic	Revenue streams adaptable to usage patterns and business scalability.	Remane et al. (2016); Hildebrandt et al. (2016)
9	Optimized Battery Lifecycle	Technological	Maximizing performance and longevity of leased batteries.	Geotab, (2025); Yuan et al. (2023)
10	Resale Anxiety Mitigation	Behavioral	Reducing buyer anxiety around battery resale value and degradation.	Yuan et al. (2023; Lim et al. (2015); Liao et al. (2017)
11	Recycled Battery Standards	Policy & Regulatory	Regulations for recycling and reuse of EV batteries.	Alliance for Automotive Innovation (2023); Yuan et al. (2023)
12	Grid Storage Maximization	Environmental	Utilizing batteries for energy storage during off-peak hours.	Eco-Stor, (2024); Williams (2012)
13	Reduced Battery Costs	Economic	Lower battery costs enhancing affordability of swapping solutions.	Hou et al. (2010); Zhou et al. (2025); Cheng and Liu (2016)
14	Contract Flexibility Balance	Policy & Regulatory	Flexibility in contracts to match user and operator preferences.	Forvis Mazars (2024); Zhang and Rao (2016); Williams (2012)
15	Leasing Firms' Pricing	Economic	Pricing strategies from leasing firms based on usage and tenure.	Wu and Li (2024); Lim et al. (2014)
16	Diverse Leasing Models	Economic	Offering multiple models of leasing to meet varied market needs.	Huang et al. (2021); Lim et al. (2014)
17	Flexible Leasing Strategies	Economic	Adjustable leasing models to cater to different use-cases.	Remane et al. (2016); Zhang and Rao (2016)
18	Circularity Integration	Policy & Regulatory	Designing leasing models aligned with circular economy principles.	Ellen MacArthur Foundation (2020)
19	Supply Chain Collaboration	Operational	Coordination among supply chain players for leasing ecosystem efficiency.	Yuan et al. (2023); Cheng and Liu (2016)
20	Battery Raw Materials	Economic	Availability and pricing of key raw materials affecting battery leasing.	Reuters (2025); Hou et al. (2010)
21	Recharged Battery Viability	Technological	Battery reliability post-recharging and performance after multiple swaps.	Geotab (2025); Zhou et al. (2025)
22	High Fossil Fuel Costs	Environmental	High fuel prices pushing transition to EVs and battery swapping.	International Energy Agency (2022); Zhou et al. (2025); Li and Ouyang (2011)
23	Battery Leasing Economies	Economic	Economies of scale reducing per-unit battery leasing cost.	Hou et al. (2010); Li et al. (2018)
24	Leasing Risk Behavior	Behavioral	Consumer risk perception around long-term leasing commitments.	J.D. Power (2021); Williams (2012)
25	Vehicle Type Impact	Behavioral	Effect of EV type (2W/3W/4W) on swapping adoption likelihood.	Williams (2012) ; Li et al. (2018)

26	Lower Electricity Costs	Economic	Lower energy costs supporting viable business models.	Gong et al. (2024); Li and Ouyang (2011)
27	Battery Weight Economics	Technological	Weight considerations influencing vehicle efficiency and leasing viability.	Li and Ouyang (2011) ; Li et al. (2018)
28	Smart Distribution Patterns	Technological	Routing and logistics strategies for optimal battery delivery/swap.	González-Salazar et al. (2023) ; Wang et al. (2021)
29	Enhanced Leasing Services	Operational	Value-added services provided to enhance lessee satisfaction.	Huang et al. (2023); Wang et al. (2021)

Following established FDM studies (Kaufmann & Gupta, 1988; Murry & Hammons, 1995), a threshold value of **λ ≤ 0.6** was used to determine acceptable agreement among experts. Enablers meeting this threshold were retained for further analysis, while those exceeding it were excluded due to insufficient consensus.

As a result of this screening, **9 enablers (Table 3)** were validated and shortlisted as critical to the adoption of battery leasing within the Indian context. These validated enablers are analyzed in the subsequent sections, including their dimensional distribution and strategic implications.

Table 3. Final Selection of Battery Leasing Enablers Based on Fuzzy Delphi Method

S. No.	**Enablers**	**Fuzzy Weight (p, q, r)**	**Defuzzified Value**	**Decision**
1	Targeted Leasing Policies	(0.3, 0.778, 0.9)	0.659	Accept
2	Optimized Charging Modes	(0.3, 0.727, 0.9)	0.642	Accept
3	Strategic Charging Frequency	(0.1, 0.633, 0.9)	0.544	Reject
4	Competitive Leasing Rates	(0.1, 0.713, 0.9)	0.571	Reject
5	Engaged Lessee Participation	(0.3, 0.700, 0.9)	0.633	Accept
6	User-Centric Communication	(0.1, 0.677, 0.9)	0.559	Reject
7	Integrated Leasing Platforms	(0.3, 0.744, 0.9)	0.648	Accept
8	Dynamic Revenue Models	(0.1, 0.706, 0.9)	0.569	Reject
9	Optimized Battery Lifecycle	(0.1, 0.708, 0.9)	0.569	Reject
10	Resale Anxiety Mitigation	(0.1, 0.666, 0.9)	0.555	Reject
11	Recycled Battery Standards	(0.1, 0.695, 0.9)	0.565	Reject
12	Grid Storage Maximization	(0.1, 0.664, 0.9)	0.555	Reject
13	Reduced Battery Costs	(0.1, 0.730, 0.9)	0.577	Reject
14	Contract Flexibility Balance	(0.1, 0.631, 0.9)	0.544	Reject
15	Leasing Firms' Pricing	(0.1, 0.688, 0.9)	0.563	Reject
16	Diverse Leasing Models	(0.1, 0.652, 0.9)	0.551	Reject
17	Flexible Leasing Strategies	(0.3, 0.665, 0.9)	0.622	Accept
18	Circularity Integration	(0.3, 0.749, 0.9)	0.650	Accept
19	Supply Chain Collaboration	(0.3, 0.739, 0.9)	0.646	Accept
20	Battery Raw Materials	(0.1, 0.651, 0.9)	0.550	Reject
21	Recharged Battery Viability	(0.1, 0.677, 0.9)	0.559	Reject
22	High Fossil Fuel Costs	(0.1, 0.691, 0.9)	0.564	Reject
23	Battery Leasing Economies	(0.3, 0.716, 0.9)	0.639	Accept
24	Leasing Risk Behavior	(0.1, 0.682, 0.9)	0.561	Reject
25	Vehicle Type Impact	(0.1, 0.664, 0.9)	0.555	Reject
26	Lower Electricity Costs	(0.1, 0.671, 0.9)	0.557	Reject
27	Battery Weight Economics	(0.1, 0.677, 0.9)	0.559	Reject
28	Smart Distribution Patterns	(0.1, 0.662, 0.9)	0.554	Reject
29	Enhanced Leasing Services	(0.3, 0.749, 0.9)	0.650	Accept

The final nine enablers, derived using the FDM (as presented in Table 2 and visualized in Figure 1), are the most important drivers influencing the application of battery leasing in the Indian electric vehicle industry. These enablers present a balanced mix of strategic, operational, behavioural, and technological drivers required to create effective models of leasing. At the policy level, Targeted Leasing Policies was an important enabler, presenting the case for supportive regulatory frameworks that connect government objectives with industry incentives. Likewise, Battery Leasing Economies present the case for achieving cost economies and scale advantages to make leasing an economically sound proposition for both providers and consumers.

Operational effectiveness is encapsulated through enablers like Optimized Charging Modes and Integrated Leasing Platforms, both emphasizing infrastructure readiness and connectivity leading to seamless user experience. Flexible Leasing Strategies also enable flexibility through customized leasing terms according to usage patterns, contract duration, and vehicle type – a consideration especially relevant in India's price-conscious and diversified mobility landscape.

User enablers like Engaged Lessee Participation and Leasing Services Enrichment mirror increasing awareness that customer engagement, trust, and support after the lease are key to long-term adoption and satisfaction. Furthermore, enablers like Circularity Integration and Supply Chain Collaboration indicate a proactive approach, with a focus on sustainability through reuse and recycling of batteries, as well as coordination among OEMs, battery manufacturers, and service providers to provide ecosystem resilience. Together, the nine facilitators form a strategic framework to enable battery leasing in India. They provide actionable suggestions to industry stakeholders and regulators who are working towards creating scalable and sustainable leasing frameworks that can drive electric mobility while strengthening the pillars of the circular economy.

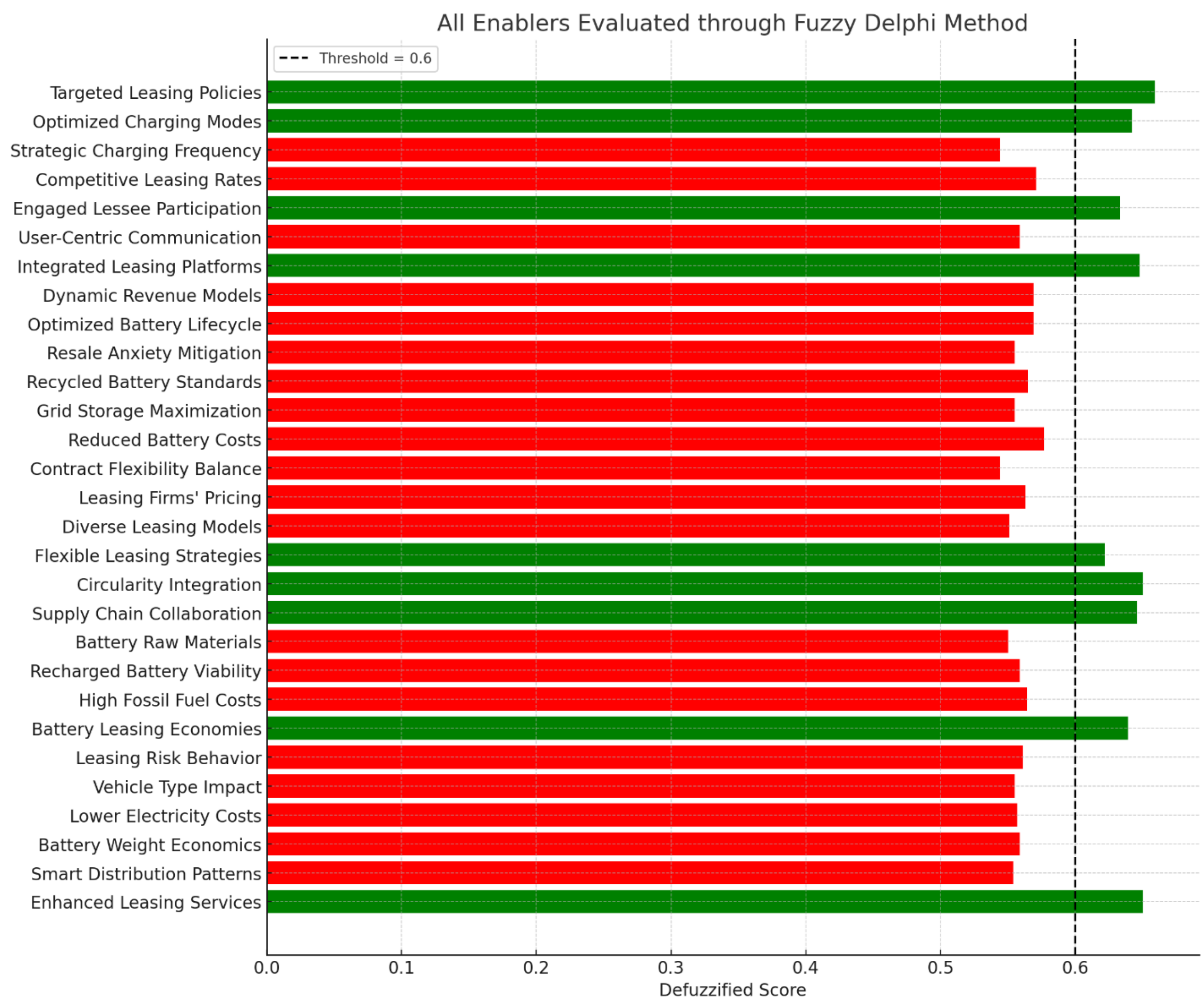

Figure 1. Evaluation of All Battery Leasing Enablers Using Fuzzy Delphi Method

6. Managerial Implications

The findings of this study carry several important implications for managers, policy-makers, and industry stakeholders engaged in the development and scaling of battery leasing systems in India's EV sector. The identification of nine key enablers through the Fuzzy Delphi Method offers strategic direction for facilitating the mass adoption of battery leasing as a viable mobility solution.

First, the prominence of Targeted Leasing Policies underscores the necessity of policy frameworks that promote battery leasing as a mainstream model. Government institutions, including NITI Aayog and the Ministry of Power, are encouraged to establish clear guidelines, fiscal incentives, and compliance mechanisms that decouple battery ownership from vehicle ownership. Such measures can alleviate upfront cost burdens and encourage adoption among value-sensitive consumer segments, especially in the two- and three-wheeler market.

Second, operational readiness emerged as a critical theme, reflected in the validation of Integrated Leasing Platforms and Optimized Charging Modes. Managers overseeing EV infrastructure should prioritize investments in interoperable digital platforms that enable real-time monitoring, usage tracking, predictive maintenance, and seamless integration with charging infrastructure. These platforms will be instrumental in ensuring system reliability and user trust, both essential for widespread leasing adoption.

Third, the findings highlight the importance of financial scalability. The enablers Flexible Leasing Strategies and Battery Leasing Economies emphasize the need for differentiated leasing models that cater to varying user profiles, such as last-mile delivery operators, fleet aggregators, and private consumers. Managers should design usage-based pricing schemes and dynamic contract options that optimize customer retention while reducing financial risk for service providers.

In addition, behavioural enablers such as Engaged Lessee Participation and Enhanced Leasing Services draw attention to the role of customer experience in driving long-term engagement. Service providers are advised to develop user-centric strategies that include transparent communication, responsive support systems, and personalized leasing plans. Encouraging customer feedback and co-design approaches can also strengthen lessee satisfaction and service loyalty. The study further reinforces the growing significance of sustainability in EV battery management. The enabler Circularity Integration calls for embedding circular economy principles into leasing models, particularly in relation to second-life battery use and recycling frameworks. Managers should pursue cross-sectoral collaborations to ensure material recovery and lifecycle optimization of batteries, thereby enhancing both environmental and economic performance.

Lastly, the validation of Supply Chain Collaboration as a key enabler underscores the necessity of coordinated action among manufacturers, logistics providers, energy suppliers, and platform developers. Establishing partnerships and shared governance models can streamline operational processes, enhance traceability, and reduce systemic inefficiencies. Such ecosystem-level integration is essential for scaling battery leasing systems across diverse geographies and use cases in India.

Taken together, these implications suggest that the future of battery leasing in India hinges not only on technological innovation but also on strategic policy alignment, ecosystem orchestration, and user-centric service design. Managers across the EV value chain must adopt a holistic and collaborative approach to harness the full potential of battery leasing as a driver of clean, efficient, and inclusive mobility.

7. Conclusion

This study applied the Fuzzy Delphi Method to identify and validate the key enablers for battery leasing in India's evolving EVB infrastructure. Drawing on expert insights from both academia and industry, the analysis evaluated 29 candidate enablers and shortlisted 9 critical drivers based on consensus defuzzified scores. These validated enablers offer a comprehensive perspective on the strategic, operational, technological, and behavioural factors necessary to establish a robust battery leasing ecosystem in India. The results reveal that enablers such as **Targeted Leasing Policies**, **Integrated Leasing Platforms**, and **Battery Leasing Economies** play a pivotal role in aligning policy directives with market viability and infrastructure readiness. Operational enablers like **Optimized Charging Modes** and **Flexible Leasing Strategies** highlight the importance of user-centric service design, while behavioural enablers such as **Engaged Lessee Participation** and **Enhanced Leasing Services** reflect the growing emphasis on trust, transparency, and service continuity. Meanwhile, sustainability-oriented enablers like **Circularity Integration** and **Supply Chain Collaboration** emphasize the need to build circular value chains through reverse logistics and cross-stakeholder coordination. The study makes a significant contribution by systematically identifying actionable enablers to support policy-makers, battery service providers, EV manufacturers, and infrastructure developers in creating scalable and sustainable battery leasing models. As India transitions toward a decarbonized and electrified transportation future, battery leasing, if supported by the right strategic levers, can become a cost-effective, inclusive, and environmentally responsible solution. Future research can extend this work by integrating multi-criteria decision-making (MCDM) techniques or system dynamics modelling to examine the interdependencies among these enablers. Additionally, exploring regional pilot studies or consumer behaviour simulations could help validate the practical impact of these enablers on leasing adoption outcomes.

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