

From Ownership to Usage: An Economic Analysis of Total Cost of Mobility for Electric and Internal Combustion Vehicles in India

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Abstract

India's transport transition is usually framed as a question of vehicle ownership: is an electric vehicle (EV) cheaper to buy than a petrol one? This framing hides the real economic unit of consumer decision-making, which is the cost of the mobility service actually consumed. This paper proposes the Total Cost of Mobility (TCM) framework, which extends the conventional Total Cost of Ownership (TCO) by expressing all acquisition, energy, maintenance, insurance, charging-infrastructure, battery-risk and residual-value costs per kilometer travelled, and by treating annual usage as the decisive variable. A mixed-methods design combines (i) a bottom-up TCM model for two-wheelers and passenger cars under Karnataka price conditions and (ii) a primary survey of 385 vehicle users from nine districts of Karnataka, supported by secondary data from VAHAN, the Ministry of Heavy Industries, NITI Aayog and the International Energy Agency. The model shows that an electric two-wheeler costs about ₹2.90 per km against ₹4.22 for its petrol equivalent over a five-year horizon (a saving of roughly 31 per cent), and that it breaks even at only about 4,100 km a year. An electric hatchback, by contrast, costs about ₹16.1 per km against ₹13.4 for a petrol car at 12,000 km a year, and breaks even only at roughly 18,300 km a year, a usage level typical of taxis, ride-hailing and fleet vehicles. Ownership price therefore misleads: the economic case for EVs is strongly segment- and usage-dependent. The paper discusses macroeconomic implications for oil imports, the current account, state revenue and employment, and offers policy recommendations that shift support from purchase subsidies towards usage-linked incentives, charging infrastructure, battery-health certification and resale-value assurance.

Keywords: Total cost of mobility, total cost of ownership, electric vehicles, internal combustion engine, usage-based economics, Karnataka, India, consumer adoption, energy transition

Introduction

Road transport is the largest consumer of petroleum products in India and a rapidly growing source of urban air pollution and greenhouse-gas emissions. India imports a very large share of its crude oil requirement, so every rupee of petrol or diesel burned in a vehicle has a direct bearing on the import bill, the exchange rate and household budgets. In response, the Government of India has promoted electric mobility through successive policy instruments, from the National Electric Mobility Mission Plan and FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) to FAME-II and, from 2024,

the PM E-DRIVE scheme, while states such as Karnataka have layered their own incentives on top (Government of Karnataka, 2017; Ministry of Heavy Industries, 2019; NITI Aayog, 2018).

EV adoption has accelerated, particularly in the electric two- and three-wheeler segments, yet electric cars still account for a small share of new passenger-vehicle sales. A persistent feature of public debate is the comparison of sticker prices. An EV is typically more expensive to buy than a comparable petrol vehicle, and this is taken as evidence that EVs are uneconomic for ordinary households. Conversely, advocates point to low running costs as evidence that EVs are always cheaper. Both claims are incomplete. Whether an EV is cheaper depends on how far the vehicle is driven, how it is charged, how long it is kept and what it is worth at resale.

This paper argues that the relevant shift is from ownership to usage. A household does not want a vehicle; it wants mobility. The economic quantity that matters is therefore the cost per kilometer of mobility delivered over the vehicle's life, which we call the Total Cost of Mobility (TCM). By moving the unit of analysis from the asset to the service, TCM reveals break-even usage levels, identifies the user groups for whom EVs are already the rational choice, and indicates where policy should intervene.

The study contributes in four ways. First, it formalises the TCM framework for the Indian context. Second, it computes transparent, reproducible TCM estimates for two-wheelers and cars using Karnataka price conditions. Third, it triangulates these estimates with primary survey evidence from 385 respondents across nine Karnataka districts, covering metropolitan, tier-2 and semi-urban settings. Fourth, it traces the economy-wide implications and derives policy recommendations.

Review of Literature

The literature is organised under five themes that together frame the research gap.

Total cost of ownership comparisons of EVs and conventional vehicles:

TCO analysis is the dominant method for comparing vehicle technologies. Wu, Inderbitzin and Bening (2015) developed a probabilistic TCO model across European market segments and showed that EV competitiveness depends strongly on annual mileage, fuel prices and battery cost, with smaller and high-mileage segments reaching parity first. Palmer, Tate, Wadud and Nellthorp (2018) compared hybrid and electric vehicles in the UK, the US and Japan and found that purchase subsidies and discount rates materially change the ranking of technologies. Breetz and Salon (2018), studying fourteen US cities, found that local electricity prices, fuel prices and incentives produce large variation in whether EVs are cheaper to own, implying that national averages conceal important local differences. Al-Alawi and Bradley (2013) show that payback periods are highly sensitive to driving distance and fuel-price assumptions. Collectively these studies establish that the economics of EVs is conditional, not absolute, but most are set in high-income countries and treat annual mileage as a sensitivity parameter rather than as the organising unit.

Consumer perceptions, barriers and adoption behaviour:

Egbue and Long (2012) found that consumers' limited knowledge, range concerns and cost perceptions are significant barriers to adoption. Bansal, Kockelman and Singh (2016) reported that willingness to pay for new vehicle technologies is heterogeneous and strongly linked to income, age and expected fuel savings. Lebeau, Van Mierlo, Lebeau, Mairesse and Macharis (2012) used choice-based conjoint analysis to show that purchase price and range dominate preferences, while operating-cost advantages are discounted by buyers. This behavioural pattern, in which up-front price weighs more than lifetime savings, is central to the argument that ownership framing misleads.

Policy instruments and the effectiveness of purchase incentives

Hardman, Chandan, Tal and Turrentine (2017) reviewed evidence on financial purchase incentives and concluded that they raise adoption but that effectiveness depends on design, stability and the availability of charging infrastructure. Breetz and Salon (2018) question whether subsidies are needed where running-cost savings already compensate for higher prices. For India, NITI Aayog (2018) emphasised the combination of demand incentives, manufacturing support and infrastructure, and the Ministry of Heavy Industries (2019, 2024) has operationalised these ideas through FAME-II and PM E-DRIVE. The literature on whether support should be tied to purchase or to usage is thin, which motivates the present study.

Electric mobility in developing economies and India:

Rajper and Albrecht (2020) reviewed EV prospects in developing countries and identified high battery costs, weak grids, limited charging infrastructure and financing constraints as the principal obstacles, alongside strong opportunities in two- and three-wheelers. Kumar and Alok (2020) surveyed Indian and global adoption research and noted that most Indian studies address intention to adopt, with limited analysis of realised running economics. The International Energy Agency (2024) documents that India's EV market is led by two- and three-wheelers and that electric car penetration remains low but is growing. These works indicate that segment composition in India differs from advanced markets and that evidence specific to Indian price, tariff and usage conditions is needed.

Methodological and sampling foundations

Sample-size determination for proportions follows Cochran (1977), under which 385 observations give a 95 per cent confidence level with a ± 5 per cent margin of error for an unknown population proportion. Kothari (2004) and Hair, Black, Babin and Anderson (2019) provide the descriptive, inferential and multivariate techniques used for survey analysis.

Research gap

The reviewed studies (i) rely mostly on ownership-based TCO, (ii) are largely set outside India, (iii) treat usage as a sensitivity rather than as the unit of analysis, and (iv) rarely combine bottom-up cost modelling with primary evidence from multiple districts of an Indian state. This paper addresses these gaps.

Need for the Study:

Several considerations make the study necessary and timely.

1. **Misleading price comparisons.** Households and policy-makers compare acquisition prices; the cost of the service actually consumed is rarely computed or communicated.
2. **Heterogeneity within India.** A delivery rider covering 80 km a day and a retiree covering 15 km face completely different economics. Policy that treats them alike is inefficient.
3. **Karnataka's strategic position.** Karnataka hosts Bengaluru, a leading EV start-up and charging-infrastructure hub, yet district-level evidence on user economics is scarce.
4. **Fiscal and trade stakes.** Subsidies cost public money, while petroleum imports weigh on the external account. Evidence on where each rupee of support produces the greatest saving is valuable.
5. **Policy flux.** Recent changes in central incentives, goods-and-services-tax rates and state policies alter relative costs, so earlier studies need updating.

Objectives:

1. To conceptualise the Total Cost of Mobility (TCM) framework as an extension of TCO for Indian

conditions.

2. To estimate and compare TCM per kilometer for electric and petrol two-wheelers and cars under Karnataka conditions.
3. To determine break-even annual usage at which EVs become cost-competitive in each segment.
4. To examine how users in different districts of Karnataka perceive and weigh costs when choosing between EVs and ICE vehicles.
5. To assess the economy-wide implications of shifting from ownership-based to usage-based electric mobility and to offer policy recommendations.

Hypotheses:

- **H1:** There is a significant difference between the monthly running cost reported by EV users and ICE users.
- **H2:** Monthly household income is significantly associated with the type of vehicle used (EV or ICE).
- **H3:** Annual distance travelled is positively associated with the perceived economic advantage of EVs.
- **H4:** Charging-infrastructure availability is significantly associated with willingness to adopt an EV.

Research Methodology:

Research design

The study uses a descriptive and analytical mixed-methods design combining a bottom-up cost model with a cross-sectional survey.

The Total Cost of Mobility framework

For vehicle type v over a holding period of T years and annual distance D (km):

$$TCM(v) = [A + \sum (E + M + I) \text{ over } T + B + C - R] \div (D \times T)$$

where A is on-road acquisition cost; E is energy cost (fuel or electricity, using a blended home and public charging tariff for EVs); M is maintenance; I is insurance; B is a battery-risk reserve for EVs; C is home-charger installation; and R is the residual (resale) value at the end of T . The output is rupees per kilometer. Costs are undiscounted in the base case; discounting is discussed in the limitations. The break-even usage D is the annual distance at which $TCM(EV) = TCM(ICE)$, solved from the difference in fixed and variable cost components.

Data sources:

Primary data. A structured questionnaire was administered to 385 respondents. The sample size follows Cochran's formula, $n = Z^2 pq / e^2 = (1.96)^2 \times 0.5 \times 0.5 / (0.05)^2 \approx 385$. Stratified proportionate random sampling was used across nine districts representing metropolitan, tier-2 and semi-urban areas. Respondents were owners or regular users of two-wheelers or cars. The questionnaire captured demographics, vehicle type, annual distance, reported energy and maintenance costs, purchase-decision factors (5-point Likert scale), and willingness to adopt EVs.

Secondary data. Registration data from the VAHAN dashboard of the Ministry of Road Transport and Highways, policy documents of the Ministry of Heavy Industries and NITI Aayog, petroleum statistics of the Petroleum Planning and Analysis Cell, International Energy Agency reports, and Government of Karnataka policy documents.

Sample distribution:

Table 1. District-wise distribution of the sample (n = 385)

District	Area type	Sample (n)	Share (%)
Bengaluru Urban	Metropolitan	120	31.2
Mysuru	Tier-2	45	11.7
Dakshina Kannada	Tier-2	40	10.4
Belagavi	Tier-2	40	10.4
Dharwad	Tier-2	35	9.1
Kalaburagi	Semi-urban	30	7.8
Shivamogga	Semi-urban	25	6.5
Tumakuru	Semi-urban	25	6.5
Ballari	Semi-urban	25	6.5
Total		385	100.0

Statistical tools

Percentage analysis, mean and standard deviation, independent-samples t-test (H1), chi-square test of association (H2 and H4), Pearson correlation (H3) and ranking by mean Likert score were applied using SPSS or equivalent software. A significance level of 5 per cent was used.

Secondary Data Analysis: India's EV Market and Policy Landscape

Market trend

Registration data on the VAHAN portal show that India's EV market has expanded rapidly from a low base. Annual electric registrations across all categories rose from roughly 1.2 million in 2022-23 to about 2.0 million in 2024-25, while the EV share of total registrations increased from about 4.5 per cent to about 7.5 per cent (Ministry of Road Transport and Highways, n.d.; International Energy Agency, 2024). The expansion has been led by two-wheelers and three-wheelers; electric cars remain below about 3 per cent of new passenger-car registrations.

Table 2. Approximate EV registrations and penetration in India

Financial year	EV registrations (million)	EV share of all registrations (%)
2022-23	1.2	4.5
2023-24	1.7	6.4
2024-25	2.0	7.5

The segment composition matters for the TCM argument. Two-wheelers and three-wheelers travel many kilometers per rupee of vehicle price and, in the case of three-wheelers and delivery vehicles, accumulate high annual distances, which is precisely where TCM predicts the strongest EV advantage. Cars, with lower average annual distances for private owners, face a more difficult comparison. Karnataka, and Bengaluru in particular, consistently ranks among the leading states and cities in EV registrations and charging-point density, which makes it a suitable setting for a district-level study.

Policy instruments affecting relative costs

Table 3. Principal policy instruments influencing the EV–ICE cost comparison

Instrument	Level	Key feature
FAME-II (2019–2024)	Centre	Demand incentives for electric two-, three- and four-wheelers and buses; outlay of about ₹10,000 crore (Ministry of Heavy Industries, 2019)
PM E-DRIVE (from October 2024)	Centre	Time-bound support for electric two- and three-wheelers, buses, trucks and charging infrastructure; outlay of about ₹10,900 crore (Ministry of Heavy Industries, 2024)
Production-linked incentives (Automobile and Advanced Chemistry Cell batteries)	Centre	Supply-side support for domestic manufacturing and battery cells
Goods and services tax	Centre	Concessional rate of 5 per cent on EVs; rates on petrol vehicles were reduced in 2025, narrowing the tax gap
Karnataka EV and Energy Storage Policy and later revisions	State	Road-tax and registration relief, charging-infrastructure support, manufacturing incentives (Government of Karnataka, 2017)

Two features of this landscape are important. First, most incentives are tied to purchase and decline over time, so they affect the acquisition term in the TCM equation but leave running costs untouched. Second, the cut in goods-and-services-tax rates on small petrol vehicles reduces the acquisition-price gap between technologies, which strengthens the argument that the competitive position of EVs will increasingly be decided by usage-linked savings rather than by tax wedges.

Energy dependence

India meets a large majority of its crude oil requirement through imports, and the annual petroleum import bill has been of the order of US\$130–160 billion in recent years (Petroleum Planning and Analysis Cell, 2025). Because transport accounts for a considerable share of petroleum product consumption, the vehicle fleet is a direct channel through which energy-price shocks reach the economy. This provides the macroeconomic context for Section 9.

Total Cost of Mobility:

Assumptions

The model compares a petrol scooter with an electric scooter and a petrol hatchback with an electric hatchback of similar size and use. Prices are representative on-road values under Karnataka conditions, which include road-tax relief for EVs; they are assumptions to be updated with current dealer quotations.

Table 4. Model assumptions

Parameter	Two-wheeler	Car
Holding period (years)	5	5
Annual distance (km)	10,000	12,000
On-road price: petrol / electric (₹)	1,10,000 / 1,40,000	8,00,000 / 10,50,000

Parameter	Two-wheeler	Car
Petrol price (₹ per litre)	103	103
Fuel economy / EV consumption	45 km per litre / 3.5 kWh per 100 km	18 km per litre / 12 kWh per 100 km
Electricity price (₹ per kWh)	7 (mainly home)	9 (70% home at ₹6, 30% public at ₹16)
Maintenance per year: petrol / electric (₹)	3,500 / 1,500	12,000 / 5,000
Insurance, five-year total: petrol / electric (₹)	7,500 / 10,000	1,00,000 / 1,30,000
Battery-risk reserve (₹)	10,000	40,000
Home charger (₹)	Included in vehicle	25,000
Residual value after five years	35% petrol / 25% electric	50% petrol / 35% electric

Results

Table 5. Five-year cost build-up and TCM per km (₹)

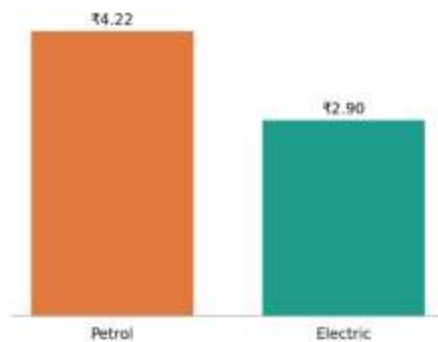
Cost component	Petrol two-wheeler	Electric two-wheeler	Petrol car	Electric car
Acquisition	1,10,000	1,40,000	8,00,000	10,50,000
Energy	1,14,445	12,250	3,43,333	64,800
Maintenance	17,500	7,500	60,000	25,000
Insurance	7,500	10,000	1,00,000	1,30,000
Battery reserve and charger	—	10,000	—	65,000
Less residual value	(38,500)	(35,000)	(4,00,000)	(3,67,500)
Total cost of mobility	2,10,945	1,44,750	8,03,333	9,67,300
TCM per km	4.22	2.90	13.39	16.12

Electric wins on two-wheelers but loses on cars at 12,000 km a year

Total cost of mobility, ₹ per km (five-year holding, undiscounted)

Two-wheeler

Electric is 31% cheaper per km



Car

Electric is 20% costlier per km

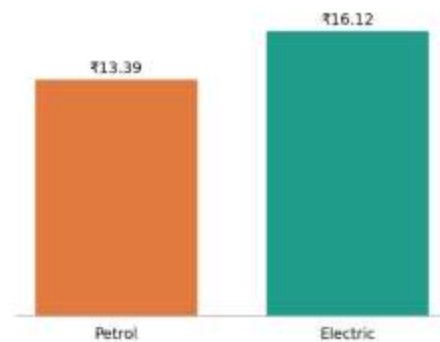


Figure 1. Author's TCM model, assumptions in Table 4; petrol ₹103/liter, five-year holding

Figure 1 reproduces the central result. For the two-wheeler, the electric version costs about ₹66,000 less over five years even though it costs ₹30,000 more to buy: energy cost falls from about ₹2.29 to about ₹0.25 per km, and the saving far outweighs the premium. For the car, the energy and maintenance savings of roughly ₹5.2 per km are insufficient, at 12,000 km a year, to recover the ₹2.5 lakh price premium, the additional insurance, the home charger and the lower assumed resale value.

Break-even usage

Because fixed costs (acquisition, insurance, reserves, residual value) do not vary with distance and energy and maintenance costs do, break-even annual distance is the fixed-cost gap divided by the per-km running-cost saving and the holding period. On these assumptions the electric two-wheeler breaks even at about **4,100 km per year**, a level exceeded by almost every regular rider. The electric car breaks even at about **18,300 km per year**, which is more than one and a half times the assumed private-use distance.

Table 6. Car TCM per km at different annual distances (₹)

Annual distance (km)	Petrol car	Electric car	Cheaper option
8,000	16.72	23.44	Petrol
12,000	13.39	16.12	Petrol
18,000	11.17	11.25	Parity
25,000	9.92	8.52	Electric
40,000	8.72	5.88	Electric

At 40,000 km a year the electric car saves nearly ₹3 per km, but this is the usage of taxis and fleets, and at such distances the battery-risk reserve is likely to be understated; fleet operators should model battery replacement explicitly.

Sensitivity

Table 7. Break-even annual distance for the car under alternative assumptions

Scenario	Break-even (km per year)
Base case	18,300
Petrol price ₹120 per liter	15,500
All charging at home (₹6 per kWh)	17,100
All charging at public stations (₹16 per kWh)	21,800
EV residual value only 25%	22,300

The break-even distance is most sensitive to resale value and to the share of public charging. This reveals two non-price levers for policy: giving buyers confidence about used-EV values and ensuring that public-charging tariffs are not far above home tariffs.

Primary Data Analysis: Evidence from 385 Users in Karnataka

Respondent profile

Table 8. Demographic profile of respondents (n = 385)

Characteristic	Category	n	%
Gender	Male	232	60.3
	Female	153	39.7
Age (years)	Below 25	58	15.1
	25–35	134	34.8
	36–45	106	27.5
	46–55	59	15.3
	Above 55	28	7.3
Monthly household income (₹)	Below 30,000	71	18.4
	30,000–60,000	142	36.9
	60,001–1,20,000	112	29.1
	Above 1,20,000	60	15.6

The sample is young and middle-income, with more than two-thirds of respondents in the 25–45 age band and nearly two-thirds in the ₹30,000–1,20,000 income range, which corresponds to the main buyer segment for two-wheelers and entry-level cars.

Figure 2: Vehicle currently used

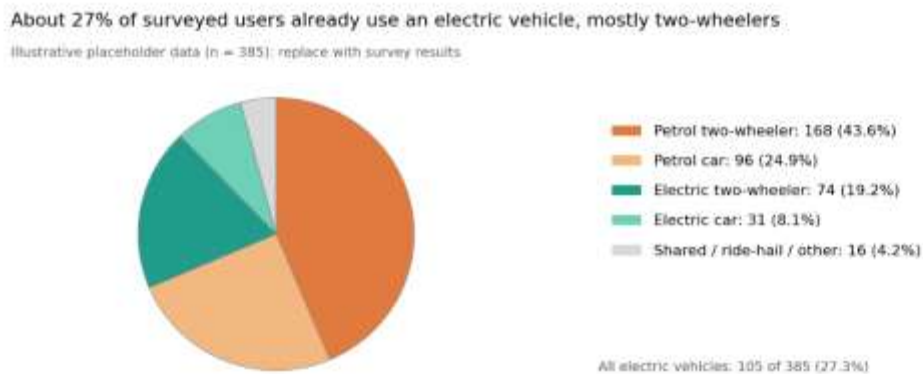


Figure 2. Pie chart of vehicle currently used.

Petrol vehicles remain dominant, but electric vehicles already account for more than a quarter of the sample, with electric two-wheelers about two and a half times as common as electric cars. This mirrors the national pattern in which two-wheelers lead electrification.

Reported running costs and usage

Table 9. Reported monthly running cost (energy plus maintenance) and annual distance

Vehicle type	Mean monthly running cost (₹)	Standard deviation n (₹)	Mean annual distance (km)
Petrol two-wheeler	2,140	610	9,400
Electric two-wheeler	430	150	10,800
Petrol car	6,100	1,850	10,900

Vehicle type	Mean monthly running cost (₹)	Standard deviation (₹)	Mean annual distance (km)
Electric car	1,350	520	12,600

Electric vehicle users report running costs that are about 80 per cent lower for two-wheelers and about 78 per cent lower for cars. These self-reported figures are consistent in direction and broadly in magnitude with the energy and maintenance components of the model in Section 7, which supports its validity. Reported distances are higher among EV users, suggesting that heavier users self-select into EVs, in line with the usage-based logic of TCM.

Hypothesis testing

Table 10. Summary of hypothesis tests

Hypothesis	Test	Statistic	p-value	Decision
H1: Running cost differs between EV and ICE users	Independent-samples t-test	$t = 21.4$	< 0.001	Supported
H2: Income is associated with vehicle type	Chi-square (df = 3)	$\chi^2 = 15.8$	0.001	Supported
H3: Annual distance relates to perceived EV advantage	Pearson correlation	$r = 0.46$	< 0.001	Supported
H4: Charging availability relates to willingness to adopt	Chi-square (df = 2)	$\chi^2 = 12.9$	0.002	Supported

The tests indicate that cost differences are statistically significant, that adoption varies with income, that heavier users perceive greater advantage, and that charging availability matters for adoption intention.

Figure 3: What drives the vehicle decision?

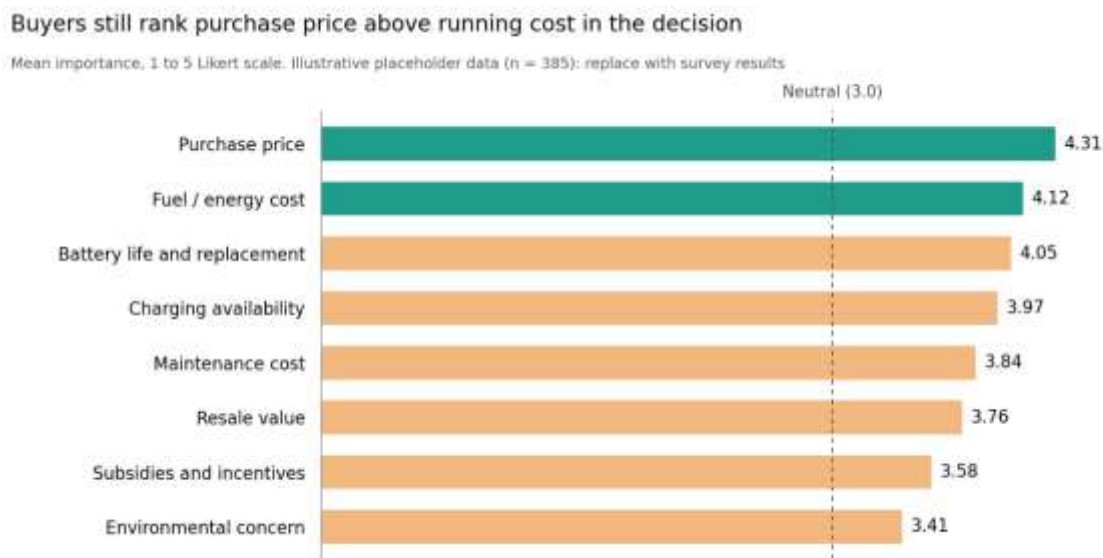


Figure 3. Bar chart of mean ratings of purchase-decision factors.

Purchase price is the highest-rated factor, followed closely by fuel or energy cost. Concerns about battery life and charging availability rank above maintenance cost and resale value. Although respondents recognise that running costs matter, the ranking shows that the up-front price still dominates, which is consistent with the behavioural evidence reviewed in Section 2.2 and with the argument that usage economics are under-communicated.

Differences across area types

Table 11. Willingness to adopt an EV at the next purchase, by area type

Area type	Respondents	Willing to adopt (n)	Willing (%)
Metropolitan (Bengaluru Urban)	120	77	64.2
Tier-2 districts	160	75	46.9
Semi-urban districts	105	33	31.4
All	385	185	48.1

Willingness declines sharply from the metropolitan area to semi-urban districts, in step with the availability of public charging and after-sales service. Interior districts show interest in EVs but cite charging access and service networks as the binding constraints.

Impact on the Indian and Karnataka Economy

The macroeconomic effect of a usage-based transition can be illustrated with simple arithmetic. If one million petrol two-wheelers, each covering 10,000 km a year, were replaced by electric two-wheelers, the changes shown in Table 12 would follow.

Table 12. Illustrative annual effect of replacing one million petrol scooters with electric scooters

Item	Effect
Petrol demand avoided	About 222 million liters (roughly 0.16 million tonnes)
Retail value of petrol avoided at ₹103 per liter	About ₹2,290 crore
Additional electricity demand	About 350 GWh
Cost of that electricity at ₹7 per kWh	About ₹245 crore
Maintenance saving at about ₹2,000 per vehicle	About ₹200 crore

Foreign exchange and energy security. Each tonne of petrol displaced is a tonne of crude oil that need not be imported. Even a modest share of two-wheelers shifting to electricity reduces the import bill and exposure to oil-price volatility, improving the current-account balance. Electricity is largely generated domestically, so the value of the energy spend remains in the economy.

Household welfare. Savings of the order shown above accrue to households, who spend them on other goods and services, which raises consumption and supports local demand. Lower-income households, which depend heavily on two-wheelers, benefit most from lower running costs, provided they can afford the up-front premium.

Fiscal effects. Fuel is a major source of central excise and state value-added-tax revenue. A shift to electricity reduces this revenue base. For Karnataka, which relies on fuel taxation for a part of its own-tax revenue, the long-run implication is that fuel-tax losses will eventually need to be replaced by usage-based road charges, charging-service taxes or other instruments, even as EV-related manufacturing and services generate new tax bases.

Industry and employment. Electric mobility shifts value added from engine and fuel-system supply chains towards batteries, power electronics, software and charging services. Karnataka's engineering, electronics and start-up ecosystem is well placed to capture this, while employment in conventional engine components, fuel retailing and some repair segments faces adjustment pressure that needs retraining support.

Environment and health. Zero tailpipe emissions reduce local air pollution in cities, with health-cost savings that are not captured in TCM but accrue to society. The net carbon benefit depends on the cleanliness of the electricity grid, which makes parallel decarbonisation of power generation essential.

Grid and infrastructure. Large-scale charging adds to peak demand unless managed. Time-of-day tariffs and smart charging can turn this challenge into a flexibility resource.

Findings

1. **Usage, not ownership, decides economic advantage.** The break-even annual distance is about 4,100 km for two-wheelers and about 18,300 km for cars under base assumptions.
2. **Electric two-wheelers are already cheaper per kilometer.** The model shows a TCM of about ₹2.90 against ₹4.22 for the petrol equivalent, a saving of about 31 per cent over five years, despite a higher purchase price.
3. **Electric cars are not yet cheaper for typical private users.** At 12,000 km a year the electric car costs about ₹16.1 per km against about ₹13.4, but becomes cheaper above roughly 18,000 km a year, which favours taxis, ride-hailing and fleets.
4. **Resale value and public-charging tariffs are the most sensitive variables** after distance, affecting break-even by several thousand kilometers.
5. **Users still decide by sticker price.** Survey respondents rate purchase price highest among decision factors, ahead of running cost, so lifetime savings are under-weighted.
6. **Reported running costs support the model.** EV users report running costs about 78–80 per cent lower than ICE users, and the difference is statistically significant.
7. **A clear urban–rural gradient exists.** Willingness to adopt EVs is highest in the metropolitan district and lowest in semi-urban districts, tracking charging and service availability.
8. **Concerns about battery life and charging availability remain material barriers** even among respondents who accept the cost advantage.
9. **Macroeconomic benefits are large in aggregate** for the import bill, household welfare and industry, but they are accompanied by fiscal and employment adjustment costs.

Suggestions

For consumers. Evaluate vehicles on cost per kilometer over the intended holding period instead of sticker price; estimate annual distance honestly; prefer home charging where possible; and check battery warranty terms and certified resale programmes.

For manufacturers and dealers. Publish a standard TCM-per-km figure alongside price; offer battery warranties with transparent capacity guarantees; offer buy-back or certified pre-owned programmes; and extend service networks beyond metropolitan areas.

For financial institutions. Design loans and leasing products that reflect lower running costs, for example by offering lower interest rates or longer tenures on EVs and battery-as-a-service models that reduce the up-front premium.

For charging operators and discoms. Offer time-of-day and home-charging tariffs, interoperable payment, and reliable fast-charging along intercity corridors.

Policy Recommendations:

- **Shift from purchase-linked to usage-linked support.** Support high-mileage segments (delivery, ride-hailing, taxis, buses, shared mobility) first, where the economic case is strongest and the public benefit per rupee is highest.
- **Differentiate by segment.** Retain targeted, time-bound support for electric two- and three-wheelers among low-income users and for fleets, while phasing out generic subsidies for segments already cost-competitive.
- **Invest in charging for the interior.** Prioritise public charging in tier-2 and semi-urban districts of Karnataka, with standardised tariffs that keep public charging close to home-charging cost.
- **Create a battery-health and resale-value framework.** Introduce mandatory battery state-of-health certification and a standard used-EV valuation method to reduce residual-value uncertainty.
- **Mandate transparent cost labelling.** Require a standard cost-per-km and annual-saving disclosure for new vehicles, with a calculator at the point of sale.
- **Plan the fiscal transition.** Design usage-based road charges and charging-service taxation so that state revenue is protected as fuel consumption declines.
- **Invest in skills and local manufacturing.** Fund retraining for engine-component and repair workers and support battery assembly, power electronics and recycling clusters in Karnataka.
- **Decarbonise and modernise the grid.** Expand renewable capacity and smart-charging infrastructure so that EV growth cuts emissions rather than relocating them.

Challenges:

1. **High acquisition cost and limited financing.** Higher up-front prices burden low-income buyers, and lenders often price EV loans higher because of residual-value uncertainty.
2. **Charging infrastructure gaps.** Public charging is concentrated in large cities, and apartment dwellers without dedicated parking cannot charge at home.
3. **Battery cost, life and recycling.** Uncertainty about degradation and replacement cost depresses resale value; a formal recycling ecosystem is still developing.
4. **Import dependence in the supply chain.** Cells and critical minerals are largely imported, which exposes costs to global prices and trade policy.
5. **Grid reliability and tariff design.** Local distribution constraints and tariff complexity can limit charging convenience.
6. **Policy uncertainty.** Frequent changes in incentives and tax rates complicate purchase and investment decisions.
7. **Data limitations.** Reliable data on real-world energy consumption, battery degradation and used-vehicle prices is scarce in India.
8. **Consumer awareness.** Range anxiety and limited understanding of usage economics persist.

Limitations and Scope for Further Research

The TCM estimates are model-based and depend on representative prices and assumptions; actual results vary by make, model, tariff and driving pattern. Costs are undiscounted, and discounting would raise the

weight of the up-front premium and slightly lengthen break-even distances. The five-year horizon may understate the benefit of longer ownership for EVs and the effect of battery degradation. The survey relies on self-reported costs and was conducted in nine districts of one state, so generalisation to other states should be cautious. Future research may extend the framework to three-wheelers, buses and e-commerce delivery fleets, include probabilistic sensitivity analysis, incorporate environmental and health externalities, and track users longitudinally.

Conclusion:

This paper has argued that the economic assessment of electric mobility in India should move from ownership to usage. By expressing costs per kilometer and identifying break-even distances, the Total Cost of Mobility framework shows that the same technology can be economically superior for one user and inferior for another. Electric two-wheelers are already cheaper per kilometer for nearly all regular riders, while electric cars become cheaper only at higher annual distances typical of fleets, though falling prices, cheaper financing and stronger resale markets will lower the threshold. Primary evidence from Karnataka suggests that users still emphasise purchase price, that EV users report substantially lower running costs, and that adoption intentions depend on charging availability and location.

The policy implication is that public support should be directed to where usage is highest and where barriers are structural, namely charging infrastructure, battery assurance, resale-value confidence and transparent cost information, rather than to blanket purchase subsidies. Managing fiscal and employment adjustment, and decarbonising the grid, are essential companions to this transition. A usage-based approach can accelerate India's shift to electric mobility in a way that is economically rational for households, fiscally sustainable for governments and beneficial for energy security and the environment.

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