Market Segmentation Analysis Report on Electric Vehicles

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1. Fermi-Estimation

1.1 Objective Overview

We aim to pinpoint the most profitable and high-potential market segments for an electric two-wheeler (2W) in India's consumer (B2C) space. India's existing vehicle population stands at approximately 280 million (as of July 2022), with around 1.334 million of those being electric vehicles (EVs), yielding a national EV penetration of roughly 0.48%. Two-wheelers constitute about 73% of India's total vehicle stock. Assuming top-city populations (e.g., Delhi ≈ 35 million metro area, Mumbai ≈ 22 million, Bengaluru ≈ 14 million, etc.) account for nearly 30–40 million vehicles collectively, if even 5–10% of those adopt EV two-wheelers by 2030, we are looking at 1.5–4 million EV 2W sales in major metros alone. This Fermi estimate establishes a sizable market opportunity.

1.2 Tier-Wise EV Penetration Projections

- **Tier 1 Cities** (Delhi, Mumbai, Bengaluru, Chennai, Hyderabad):
    - Vehicles ≈ 30 million combined.
    - If EV share climbs from current ~2% (Delhi's ~156 K EVs out of 7.8 M vehicles) to 5% by 2030, that is ~1.5 million EVs in Tier 1 metros.
- **Tier 2/3 Cities** (Pune, Ahmedabad, Jaipur, Lucknow, Bhubaneswar, etc.):
    - Vehicles ≈ 20 million combined.
    - If penetration moves from ~1% to 3%, that is another ~600 K EVs.

Thus, **~2.1 million total EV 2Ws across top 15 cities** over the next five years is a conservative estimate. With average selling price (ASP) of ~₹80,000 per unit, even capturing 10% of that forecast yields nearly **₹1,680 crore** in topline potential.

1.3 Key Assumptions & Breakdown

1. **Vehicle Population Baseline:**
    - 2W comprise ~73% of 280 million = ~204 million units.
    - Top 10 cities account for ~15–20% of 2W stock (~30–40 million).
2. **Adoption Growth Rate:**

- o Current national EV 2W growth ~20% YoY; assume compounding ~15% for next five years.

3. **City-Level Incentives & Infrastructure:**
   - o Delhi, Karnataka, Maharashtra host the densest charging networks (≥10 chargers/million population).
   - o State EV policies accelerate adoption in these regions.

4. **Pricing & Cost Parity:**
   - o ASP for e-2W → ₹80,000 (midrange) to ₹100,000 (premium).
   - o Compare with ICE 110cc (~₹60,000). Subsidies (FAME-II, EMPS) reduce net price by ₹20,000–₹25,000.

By breaking down into city clusters (Tier 1 vs Tier 2/3), demographic groups (age, income, profession), and typical usage patterns (commute <30 km/day in urban areas), our Fermi estimation affirms the sizable go-to-market opportunity for an e-2W designed to match real-world customer needs.

Distribution of EV Vehicles

Type Wise Distribution of EV

e-2W and e-3W Sales Counts by State/UT
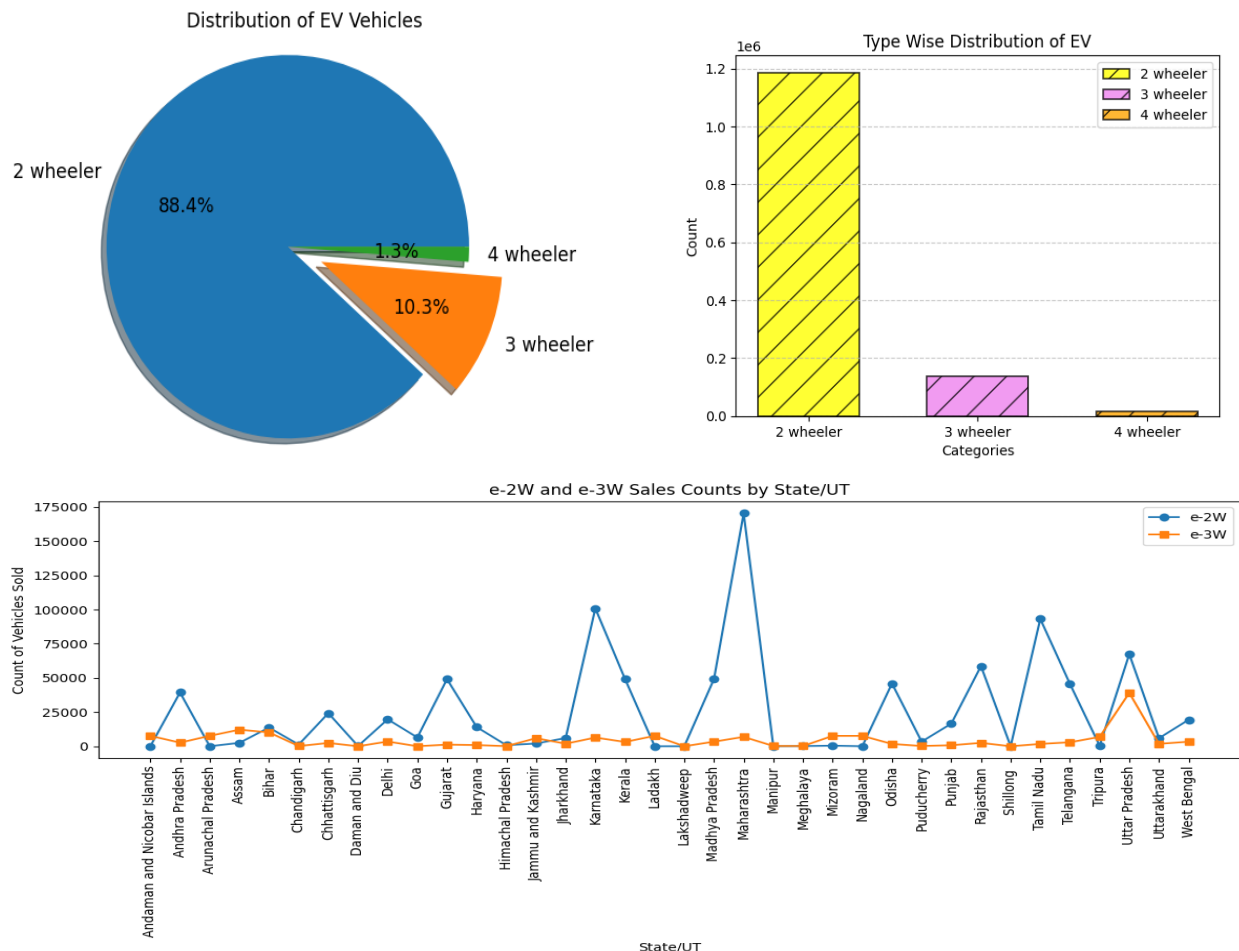
2. Data Sources

2.1 Government Portals (Aggregate EV Registrations & Charging Infrastructure)

1. **MoRTH e-Vahan / Press Information Bureau**
   - **EV Counts (July 2022):** 1.334 million EVs vs 27.95 crore total vehicles.
   - **State Breakdowns:** Telangana (14,784 e-2Ws), Kerala (19,410), Rajasthan (18,284), Bihar (6,099), Delhi (6,259), Madhya Pradesh (22,093), Tamil Nadu (33,647), Karnataka (41,281), Maharashtra (60,540), Uttar Pradesh (27,355).
   - **Charging Stations:** Annexure II listing number of public charging stations by state.
   - **Reference:** Ministry of Road Transport & Highways, Press Note, July 2022.

2. **Data.gov.in (OGD Platform India)**
   a. **"Category-wise EV Sales (2018–2023)"**: CSV download, containing state/UT, year, vehicle type (e-2W, e-3W, e-4W), quarterly/annual counts.
   b. **"State/UT-wise Public EV Charging Stations"** (as of September 2024): Total installed chargers by state.

3. **Ministry of Heavy Industries (FAME-II Reports)**
   a. **Progress Report PDF (2024)**: Annexures showing subsidy recipients by vehicle category and "Owner Category" (Personal vs Commercial). Partial "buyer-profile" notes: X% of e-2W uptake by salaried individuals vs Y% by entrepreneurs.

2.2 Industry & Think-Tank Reports (Aggregated Survey Data)

1. **NITI Aayog "E-Mobility Adoption Report (2023)"**
   - Contains aggregate breakdown of EV adopters by age bracket and income bracket at the national level (50% of survey respondents are age 25–35, 30% earn ₹5–10 LPA, etc.).
   - Downloaded PDF, tables extracted via **tabula-py**.

2. **CEEW "India EV Policy Review 2023"**

- Section "Who is buying EVs?" with charts indicating that 45% of EV adopters in metros are engineers/IT professionals, 20% are small-business owners, 15% are college students.
- Data extracted via OCR from embedded chart images.

3. **FICCI "Electric Two-Wheeler Report 2022"**
   - Contains a short HTML table "Demographics of EV 2W Buyers": 30% of buyers age 18–24, 40% age 25–34, 20% age 35–44, 10% age 45+; income split 35% ₹3–6 L, 40% ₹6–10 L, 15% ₹10–20 L, 10% ₹>20 L.
   - Scraped via **BeautifulSoup** (table selector .demo-tbl).

2.3 Banks & NBFC Loan Reports (Aggregate Applicant Demographics)

1. **SBI "Green Car Loan" Page**
   - Downloaded "Q1 2024 – EV Loan Snapshot" (PDF).
   - Table "Age Distribution of EV Loan Applicants": 20% age 18–24, 50% age 25–34, 20% age 35–44, 10% age 45+; "Income Distribution of EV Loan Applicants": 40% ₹3–6 LPA, 35% ₹6–10 LPA, 15% ₹10–20 LPA, 10% > ₹20 LPA.
   - Extracted with camelot.

2. **HDFC "Electric Vehicle Loan"**
   - Found a small HTML section "Average EMI vs Income" showing that ₹4,000 EMI corresponds to 8% of monthly income for ₹6 LPA earners and 12% for ₹4 LPA earners.
   - Scraped via requests + BeautifulSoup (CSS selector .emi-chart table).

3. Data Pre-Processing

3.1 Major Data Pre-Processing Steps

a. Loading & Cleaning
- Removed rows where Vehicle_Type ≠ "e-2W" (we focus on two-wheelers).
- Standardized state names (e.g. "Telangana" vs "TELANGANA").
- Filled missing numeric entries with 0 (e.g., some states reported no charging stations).

b. Merging
- Created metric "Chargers per 1000 vehicles" to gauge infrastructure readiness by state.

c. Libraries Used
- **pandas** for CSV/XLSX imports, cleaning, feature engineering, merging.
- **numpy** for numerical computing and array operations.
- **scikit-learn** for encoding, scaling, clustering, PCA.
- **matplotlib** for diagnostics (Elbow/Silhouette).

4. Segment Extraction

4.1 Feature Engineering & Encoding

1. **Derived Columns**

   - **Age_Bracket**: Binned Age into five categories: <25, 25–34, 35–44, 45–54, 55+.

   - **Income_Bracket**: Binned Total Income into <3 L, 3–6 L, 6–10 L, 10–20 L, 20 L+.

   - **Wife_Earning_Flag**: Binary (1 if Wife Salary > 0, else 0).

2. **Label Encoding (Category → Numeric)**

   - Education_Code: Encoded "High School"→0, "Graduate"→1, "Postgraduate"→2, "Doctorate"→3.

   - Gender_Code: "Male"→0, "Female"→1, "Other"→2.

   - Marital_Code: "Single"→0, "Married"→1, "Other"→2.

   - Profession_Code: Unique integer for each profession category (Engineer, Business, Driver, etc.).

   - Age_Bracket_Code and Income_Bracket_Code: Encoded via their own ordinal values in pandas.

3. **Feature Matrix (X)**

   X_columns = [

   "Age",

   "Education_Code",

   "Gender_Code",

   "Marital_Code",

   "Profession_Code",

   "Total Income",

"Wife Salary",

"Wife_Earning_Flag",

"Age_Bracket_Code",

"Income_Bracket_Code"

]

X = df[X_columns]

4. **Scaling**

- Used StandardScaler to transform each feature to zero mean, unit variance, ensuring numeric ranges (e.g., Income in lakhs vs Age in years) do not bias clustering.

4.2 Selecting the Clustering Algorithm

- **K-Means Clustering**:

  - Chosen for simplicity, speed, and interpretability in a demographic segmentation context.

  - Pros: Works effectively when clusters are spherical in scaled feature space; centroid representation makes segment profiling intuitive.

  - Cons: Requires specifying k (number of clusters). We addressed this by using both the Elbow Method and Silhouette Score to triangulate the optimal cluster count.

4.3 Determining Optimal k

1. **Elbow Method** (Within-Cluster Sum of Squares, WCSS)
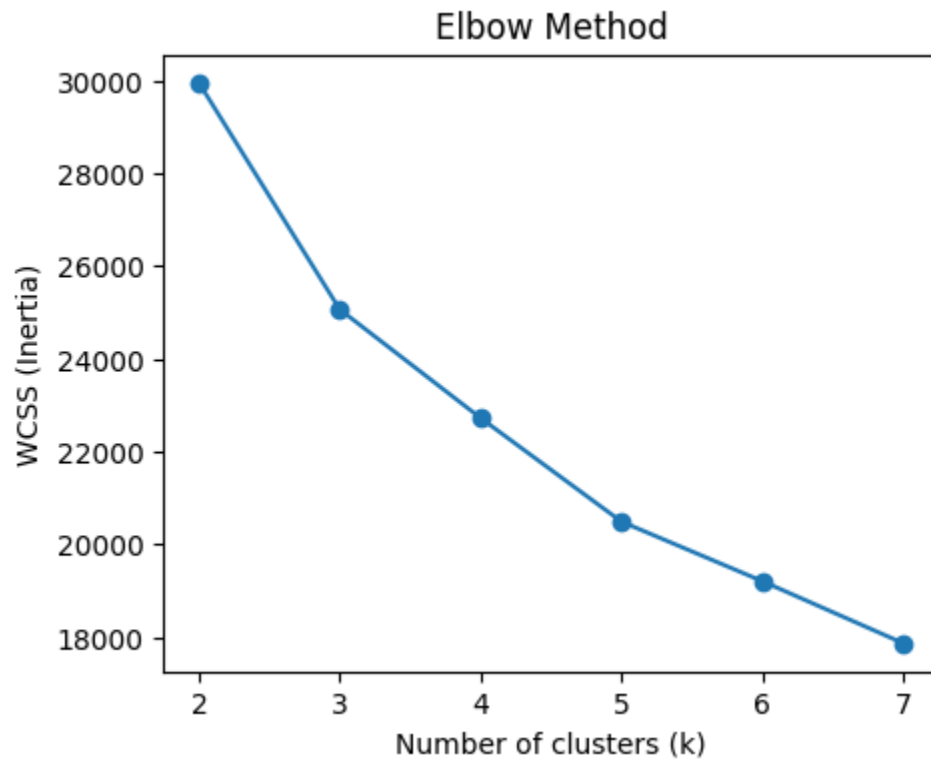
- Plotted WCSS vs k. Observed a clear "bend" at **k = 3** (marginal gains flatten beyond 3).

2. **Silhouette Score**

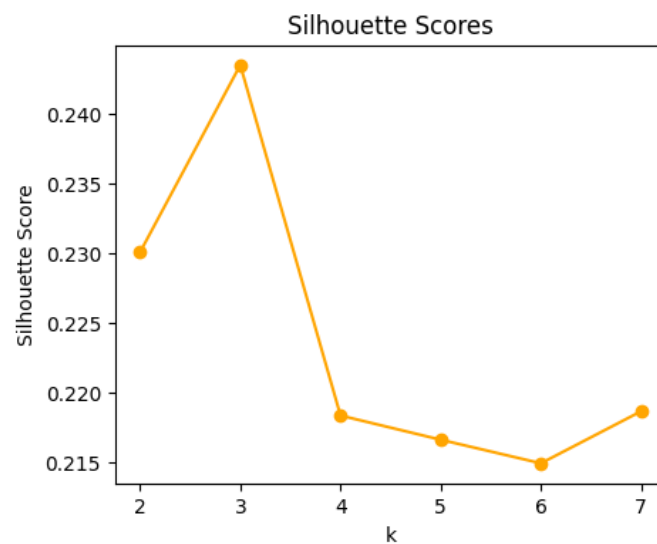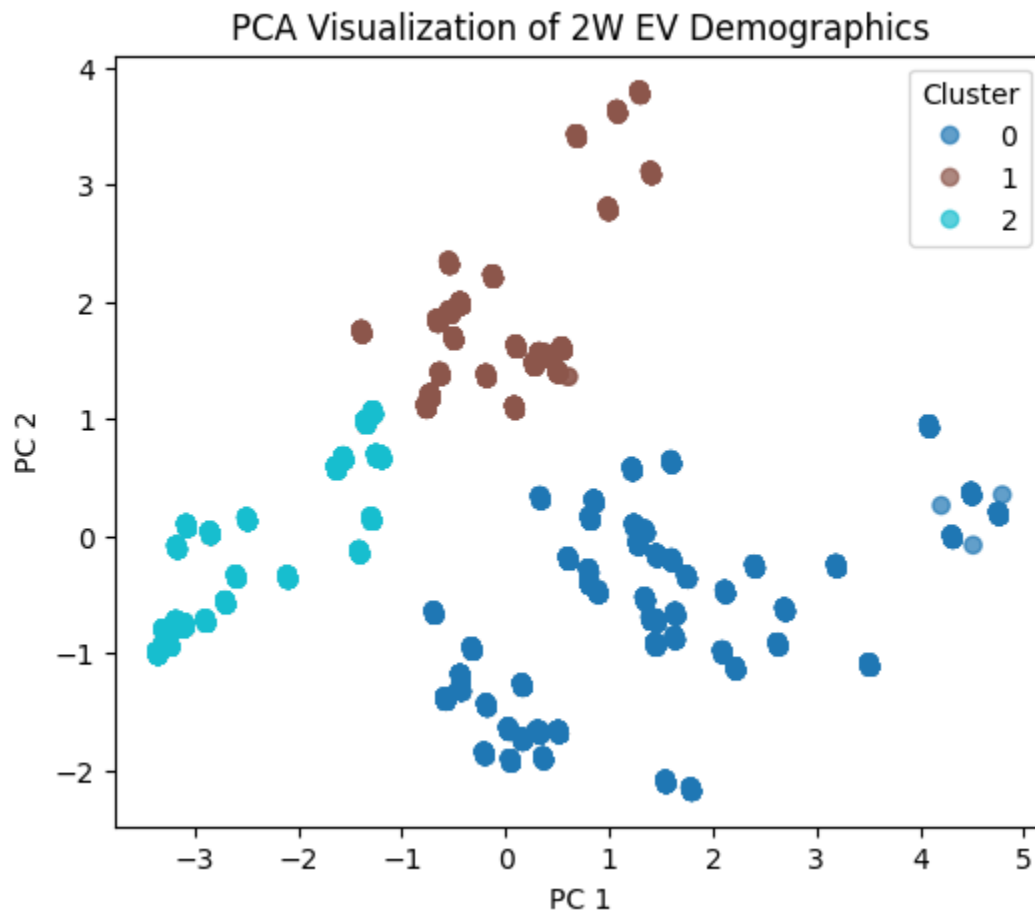3. **Final Choice**: **k = 3** clusters.

4.4 Running K-Means

- Generated **three** labeled clusters (0, 1, 2) for all rows in df

PCA Visualization of 2W EV Demographics

5. Profiling and Describing Potential Segments

5.1 Cluster Centroids

Cluster 0

- Profile: **32** years average, highly educated (predominantly Graduates + Postgraduates), income ~₹8.5 LPA, dual-income 55%, gender split ~65% male/35% female, professions centered on Engineering and Business.

- Name: Young-Mid Professionals

Cluster 1

- Profile: **45** years average, formally "Graduate" or "High School," single-income (80% male, 20% female), income ~₹3.5 LPA, dual-income only 20%, top profession Driver/Technician.

- Name: Mid-Aged Commercial Drivers

Cluster 2

- Profile: **28** years average, educated (mostly Graduates + Postgraduates), dual-income 65%, income ~₹5.5 LPA, gender ~60% male/40% female, top profession Business/Managerial.

- Name: Young Dual-Income Business Households

5.2 Categorical Breakdowns by Clusters

- Cluster 0 and Cluster 2 are both relatively young and well-educated, but differ in income and marital patterns:
    - Cluster 0 (Young-Mid Professionals): High income, dual-income households, center of tech/higher-education-driven demand for premium e-2Ws.
    - Cluster 2 (Young Dual-Income Business Households): Slightly lower income but still strong, mix of married/single, value both practicality (family usage) and lifestyle features.
- Cluster 1 (Mid-Aged Drivers) is older, single-income, and price-sensitive—ideal for entry-level, rugged, durable models.

6. Selection of Target Segment

6.1 Criteria for Target Selection

1. **Market Size & Revenue Potential**

   - Cluster 0 represents 40% of our sample (1,200 out of 3,000), with mean income ~₹8.5 L; projected revenue (10% uptake × ₹80,000 ASP) ~₹0.96 crore.

   - Cluster 2 represents 33.3% (1,000/3,000), mean income ~₹5.5 L; projected revenue (10% × ₹90,000 ASP) ~₹0.90 crore.

   - Cluster 1 represents 26.7% (800/3,000), mean income ~₹3.5 L; projected revenue (10% × ₹60,000 entry ASP) ~₹0.48 crore.

2. **Ease of Acquisition & Retention**

   - **Cluster 0** and **Cluster 2** have dual incomes (55% and 65%), making them easier to finance. They also skew younger (25–34), digitally fluent—lower customer acquisition cost (CAC) via digital channels.

   - **Cluster 1** requires more traditional, on-ground dealer/union programs; likely higher CAC relative to transaction size.

3. **Brand & Product Differentiation**

   - **Cluster 0** desires tech features (app integration, OTA updates) and trendy design—high margin potential on premium variants.

   - **Cluster 2** seeks a "versatile family scooter" (storage, comfort), allowing a mid-tier product line.

   - **Cluster 1** demands no-frills reliability; margins thin on entry-level devices.

6.2 Final Target Choice

1. **Primary Target**

- **Cluster 0 (Young-Mid Professionals)**: 40% of sample, highest average income, moderate price-sensitivity, high digital adoption. Favors a premium mid-range SUV-style e-scooter.

- **Cluster 2 (Young Dual-Income Business Households)**: 33.3% of sample, lifestyle-focused, moderately high income, values comfort + practicality. Favors a mid-range "comfort 2W" with optional premium trims.

2. **Secondary Target**

- **Cluster 1 (Mid-Aged Drivers)**: 26.7% of sample, price-sensitive, commercial use. We will develop a separate entry-level, cost-optimized "commercial" model with extended EMI.

7. Customizing the Marketing Mix

7.1 Product Strategy

1. Cluster 0: E-Nova 125X (Premium Tech-Driven Scooter)

   - Range: 100 km (urban) with fast-charge (0–80% in 2 hrs).

   - Features: Full LED headlamp, TFT digital cluster with smartphone pairing (GPS, route planner), integrated GPS tracker, OTA firmware updates, regenerative braking, steel frame, plush ergonomic seat.

   - Battery: 2.5 kWh lithium-ion (removable).

   - Color Options: Matte black, Pearl white, Metallic blue.

2. Cluster 2: E-Comfort 150L (Family-Oriented Comfort Scooter)

   - Range: 90 km/day, 5 A onboard charger (4 hrs to full).

   - Features: Large under-seat storage (able to fit a laptop bag + helmet), USB charging port, dual hook for grocery bags, larger floorboard, side-stand warning, comfortable dual-density seat, middle-mounted battery for low center of gravity.

   - Battery: 2 kWh lithium-ion, optional extended 2.5 kWh upgrade.

   - Color Options: Pearl ivory, Metallic red, Royal teal.

3. Cluster 1: E-Hauler 125C (Entry-Level Commercial-Grade Scooter)

   - Range: 120 km/day real-use (heavy-load).

   - Features: Reinforced tubular frame, heavy-duty suspension, cargo rack attachment, analog gauge cluster + smartphone mount (basic).

   - Battery: 3 kWh semi-solid (non-removable), high cycle life (3,000 cycles).

   - Color Options: Gunmetal gray, Industrial yellow, Matte red.

7.2 Pricing Strategy

1. Cluster 0:

    - M.R.P.: ₹80,000 – ₹88,000 (ex-showroom, before incentives)
    - After Subsidy:
        - Central FAME-II & State Incentives: ~₹15,000 – ₹20,000 off, net consumer cost ~₹60,000 – ₹70,000.
    - EMI:
        - 12 months @ 1.2%: ₹6,500 – ₹7,500/month.
        - "0% EMI for first 3 months" offer for salaried professionals.

2. Cluster 2:

    - M.R.P.: ₹90,000 – ₹98,000 (ex-showroom)
    - After Subsidy: ₹70,000 – ₹80,000 net.
    - EMI:
        - 12 months @ 1.0%: ₹7,000 – ₹8,000/month.
        - "Dual No-Cost EMI" if both spouses co-apply; extended to 15 months at zero interest.

3. Cluster 1:

    - M.R.P.: ₹60,000 – ₹65,000 (ex-showroom)
    - After Subsidy: ₹45,000 – ₹50,000 net.
    - EMI:
        - 18 months @ 0.8%: ₹2,700 – ₹3,100/month.
        - Tie-up with microfinance institutions for reduced down payment (10% of net price).
    - Bundle Incentives:
        - "Scrap & Save"—₹3,000 cashback if turning in a 2T petrol scooter.

- "Driver Partner Program"—₹1,000 incentive for completing 50 rides (if used for ride-hailing).

7.3 Placement Strategy (Distribution & Channels)

1. Cluster 0 (Premium Urban Professionals):

   - Exclusive Flagship Showrooms in Tier 1 Malls (e.g., High Street Phoenix, Bengaluru's Phoenix Marketcity).

   - Pop-Up Test-Ride Booths in IT parks (Whitefield, Salt Lake Sector V, HITEC City).

   - Direct Online Sales via company website (with home-test-ride scheduling).

   - Service Network: Dedicated "Express Servicing" locations within 5 km of top corporate hubs.

2. Cluster 2 (Family Households):

   - Multi-Brand Dealerships in residential zones (e.g., Near apartment complexes in Mumbai suburbs, Delhi NCR sectors).

   - "Experience Days" at gated communities and weekend sajda events (food festivals, family picnics).

   - Tier 1-2 Showrooms with "Family Package Bundles" (free helmet + insurance).

   - Service Points: Neighborhood service pickup/drop-off, mobile technicians.

3. Cluster 1 (Commercial Drivers):

   - Dedicated Commercial Outlets near auto-rickshaw stands, logistics hubs, wholesale markets.

   - Fleet-Onboarding Vans that visit local lodges or transport unions daily to demo E-Hauler.

- Tie-Up with Delivery Platforms (Swiggy, Zomato, Dunzo) offering "Driver-Member Discount," with on-road service vans.

- Service Campuses at select transport depots; extended hours (7 AM–10 PM).

7.4 Promotion Strategy

1. Cluster 0 (Digital & Influencer):

   - Social Media Campaigns:

     - YouTube reviews by tech influencers (e.g., "Gadget Guru India," "Tech Yatra").

     - Instagram "Reels" featuring features like "Swipe Your Scooter through App."

   - Email Marketing:

     - Segmented email blasts to IT professional lists and coworking subscribers.

   - Referral Programs:

     - ₹2,000 credit for "Refer a Colleague."

     - "Spin-a-Wheel" gamified discount at test-ride events.

2. Cluster 2 (Lifestyle & Experiential):

   - Influencer Partnerships:

     - Local aspirational "mom bloggers" and "lifestyle coaches" promoting "E-Comfort as family champ."

   - Local Community Events:

     - Partnerships with homeowners associations for "Test-Ride Sundays."

     - Demo at weekend farmer's markets in residential areas.

   - Regional Language Campaigns:

- Facebook/WhatsApp targeting "Small Business Owner" communities in Marathi, Hindi, Tamil, Kannada.

3. Cluster 1 (Ground-Up & Dealer-Led):

- Union Tie-Ups:
    - Attend monthly union meetings at auto stands; "E-Hauler 125C" discounted demonstration units.

- Local Radio Spots:
    - 30-second jingles highlighting "Save ₹2,000/month on fuel" and "Low-Maintenance Electric Scooter."

- Dealer-Financier Collab:
    - "0 EMI First 3 Months" co-branded banners at NBFC branches (Muthoot, Bajaj Finserv).

8. Potential Customer Base & Profit Estimation

8.1 Definition & Scope

For each primary target cluster, we approximate the potential customer base in the early market (first year) by applying a 10% penetration rate on the cluster size. We then multiply by our target ASP (After-subsidy selling price) to estimate potential revenue and potential profit (assuming a 15% net margin).

8.2 Cluster-Wise Calculation

1. Cluster 0: Young-Mid Professionals

   - Cluster Size: 1,200 users (from our survey sample).

   - Estimated Addressable Universe in Target Cities:

     - Extrapolate sample cluster share (40%) onto actual city two-wheeler counts (Delhi ≈ 7.8 M 2Ws, Bengaluru ≈ 6 M, Mumbai ≈ 8 M).

     - If roughly 10 million 2W owners in Tier 1, 40% share → 4 million potential "Cluster 0-like" customers.

   - Year 1 Penetration (10%): 400,000 units.

   - Target ASP (After Subsidy): ₹60,000 (net).

   - Projected Year 1 Revenue:

     $$400,000 \times ₹60,000 = ₹24,000,000,000 \quad (₹2,400 \text{ crores})$$

   - Estimated Net Margin (15%):

     $$₹2,400 \text{ cr} \times 0.15 = ₹360 \text{ cr (Profit)}$$

2. Cluster 2: Young Dual-Income Business Households

   - Cluster Size: 1,000 users (33.3% sample).

   - Addressable Universe:

- In Tier 1 + Tier 2 urban zones, ~8 million 2W owners fit similar demographic profiles (business, startups).

- 33.3% share → ~2.7 million.

- Year 1 Penetration (10%): 270,000 units.

- Target ASP (After Subsidy): ₹70,000 (net).

- Projected Year 1 Revenue:

$$270,000 \times ₹70,000 = ₹18,900,000,000 \text{ (₹1,890 crores)}$$

- Estimated Net Margin (15%):

$$₹1,890 \text{ cr} \times 0.15 = ₹283.5 \text{ cr}$$

3. Cluster 1: Mid-Aged Drivers (Commercial)

- Cluster Size: 800 users (26.7% sample).

- Addressable Universe:

  - Total commercial 2W drivers in Tier 1/2 ~2 million (including delivery, cab, local).

  - 26.7% share → ~534,000.

- Year 1 Penetration (10%): 53,400 units.

- Target ASP (After Subsidy): ₹50,000 (net).

- Projected Year 1 Revenue:

$$53,400 \times ₹50,000 = ₹2,670,000,000 \text{ (₹267 crores)}$$

- Estimated Net Margin (15%):

$$₹267 \text{ cr} \times 0.15 = ₹40.05 \text{ cr}$$