LARANA, INC.

FUTURE OF AUTOMOBILE INDUSTRY

SUMMER PROJECT

CONSULTING AND ANALYTICS CLUB IIT GUWAHATI

CONTENT

PROBLEM STATEMENT

A growing need for sustainable solutions and growing environmental concerns have put the world and Indian automotive industries at a crossroads. The transportation industry, which is one of the major sources of greenhouse gas emissions, is under increasing pressure to innovate and lessen its environmental impact as the globe struggles with the effects of climate change. In the pursuit of a more sustainable future, this case study aims to discuss the relative benefits and difficulties of hybrid vehicles, compressed natural gas, or CNG, and battery electric vehicles (BEVs).

GOALS AND OBJECTIVES

Study

Analyze the electric vehicle market, focusing on vehicle autonomy, refueling time, costs, carbon emissions, safety, and lifespan. Evaluate the costs and logistics of building new refueling infrastructure.

Analysis

Identify barriers to adoption, particularly the high costs and strategic placement of refueling stations. Assess the impact on consumer behavior and traffic patterns.

Solution

Propose cost-effective strategies for developing refueling infrastructure, optimizing charging station locations, and recommending policies to support sustainable transportation.

COMPARISON OF BATTERY ELECTRIC VEHICLES AND FUEL CELL VEHICLES

Fuel Cell Vehicles

Since the diesel scandal, many European cities have committed to phasing out diesel and petrol cars from their centers. Paris aims to eliminate diesel cars by 2024 and petrol cars by 2030. Brussels plans to remove diesel cars by 2030. The EU mandates that all new cars must be CO2-free by 2035 to achieve carbon neutrality by 2050. The UK will ban the sale of new diesel and petrol cars by 2040 due to their significant contribution to air pollution and climate change.

Two main alternatives are Fuel Cell Electric Vehicles (FCEVs) and Battery Electric Vehicles (BEVs). The electric car market has seen rapid growth, with sales soaring. In 2022, China led with 60% of global electric car sales, followed by Europe (20%) and the U.S. (8%). The International Energy Agency projects that nearly one in five new cars sold in 2023 will be electric.

For widespread adoption of electric vehicles (FCEVs and BEVs), convenient access to refueling stations is crucial due to their limited range, and it is essential to compare their vehicle autonomy, refueling time, usage cost, purchase cost, carbon emissions, safety, and lifespan, while considering the high cost of building this infrastructure and the need for well-located charging stations to reduce range anxiety and optimize traffic flow, minimizing additional CO2 emissions.

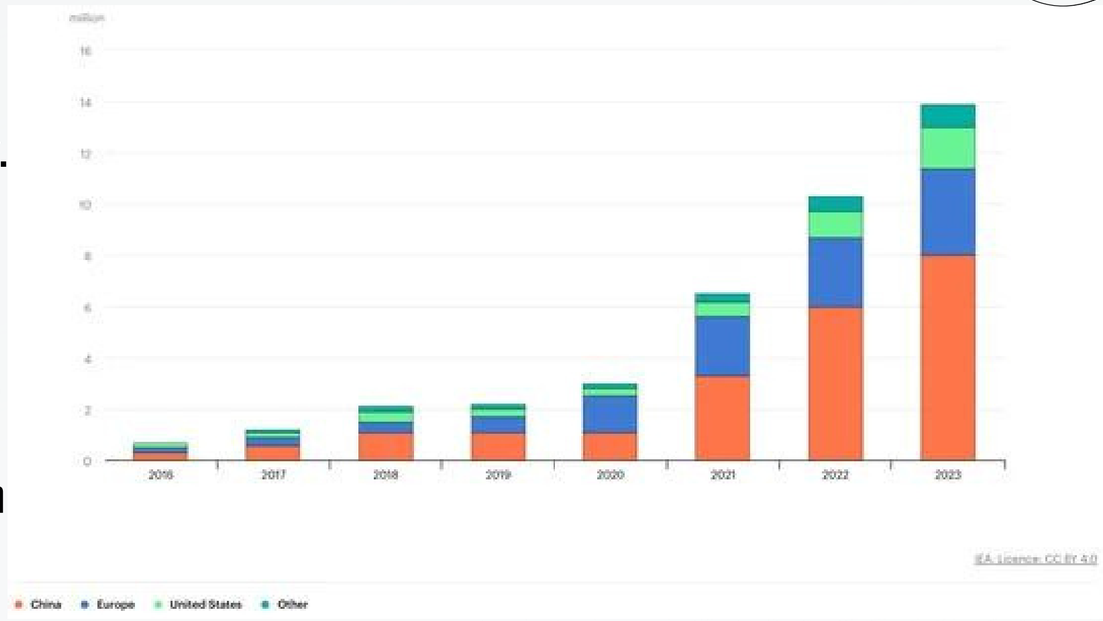


Figure 1. World electric car sales 2016–2023 (source: IEA 2023 report [4]).

COMPARISON OF BATTERY ELECTRIC VEHICLES AND FUEL CELL VEHICLES

Advantages and Obstacles of Hydrogen Cars

Advantages:

- Charging Time and Autonomy: Hydrogen cars, like the Toyota Mirai, have a refueling time of 3 minutes and an autonomy of up to 600 km, comparable to conventional diesel cars. In contrast, BEVs take hours to charge at home and have lower real-world autonomy.

Obstacles:

- Cost: The high price of hydrogen cars, such as €79,200 for the Toyota Mirai, contrasts wi the average €25,000 spent on new cars in France.
- Infrastructure: There are only 22 hydrogen refueling stations in France and 40 in Germar limiting accessibility.
- Production: Currently, hydrogen is mainly produced from fossil fuels, which is not sustainable.

Hydrogen Production Methods:

- Steam Methane Reforming (SMR):Produces hydrogen from natural gas, accounting for 48 of global supply but emits significant CO2.
- Partial Oxidation of Oil (POX): Uses hydrocarbons at high temperatures, contributing 30 of hydrogen production.
- Coal Gasification (CG): Uses coal at high temperatures, contributing 18% of hydrogen production.
- Electrolysis:Splits water into hydrogen and oxygen using electricity, ideally from renewal sources, but currently accounts for only 4% of production due to higher costs

Table 1. Existing models on european market.

Model	Type	Price	Autonomy	Charging Time
BMW I3	BEV	€32,100	200 km	8 h
Citroen C-Zero	BEV	€30,235	150 km	15 h
Hyundai Ioniq	BEV	€35,850	280 km	7 h
Kia Soul EV	BEV	€35,400	200 km	8 h
Nissan Leaf	BEV	€32,640	140–250 km	13 h
Peugeot Ion	BEV	€30,370	150 km	11 h
Renault Zoe	BEV	€25,900	200–350 km	10 h
Tesla S	BEV	€75,700	600 km	38 h
Volkwagen E-Goff	BEV	€39,350	300km	17 h
Average	BEV	€37,505	261 km	13 h
Model	**Type**	**Price**	**Autonomy**	**Charging Time**
Toyota Mirai	FCEV	€79,200	500 km	3 min
Honda Clarity	FCEV	€57,600	650 km	3 min
Hyundai ix 35	FCEV	€66,550	500 km	3 min
Average	FCEV	€62,075	575 km	3 min

COMPARISON OF BATTERY ELECTRIC VEHICLES AND FUEL CELL VEHICLES

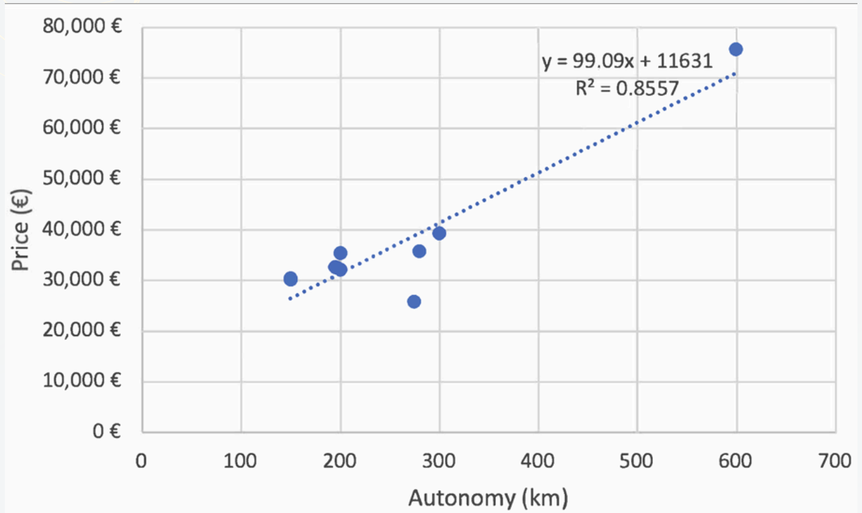


Figure 1

Figure 3. Relationship between autonomy and recharge time.

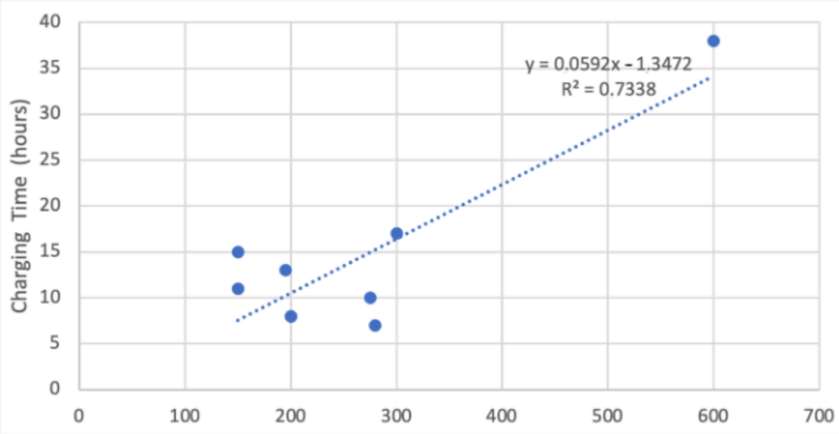


Figure 2

The Battery Electric Vehicles

The main advantages of BEVs are the lower purchase cost of the vehicle and the wide accessibility of the electrical grid to charge the vehicles. BEVs have many advantages: they produce no emissions and can be charged overnight using low-cost electricity produced by any type of power station, including renewables.

The two main disadvantages of BEVs are the real autonomy (no more than 260 km in real traffic conditions for the main existing vehicles) and the long time to charge the battery at home (13 h as an average). Electricity storage is still expensive and battery recharging is time-consuming, which explains why the range of these vehicles is limited.

Another disadvantage of battery-powered vehicles is illustrated in Figure 1. Indeed, we see that autonomy and price are positively correlated with a $r2r2$ coefficient of 85%. This means that if the user is looking for a high level of autonomy (that of an existing diesel car), the price of the car rises rapidly. In fact, a significant weight of additional batteries is required, which makes the vehicle more expensive to purchase (and heavier).

Note, however only 9% of vehicles exceed 160 km in a day. In other words, the autonomy problem only affects a minority of users, as the rest can largely charge at home at night. Finally, the same exercise can be carried out between autonomy and charging time, which also shows a positive correlation (see Figure 2).

COMPARISON OF BATTERY ELECTRIC VEHICLES AND FUEL CELL VEHICLES

Battery electric vehicles (BEVs) have several social and environmental drawbacks. Jenifer Baxter notes two key issues: the environmental and human costs of producing lithium-ion batteries and their low recycling rate (only 5% are recycled). CO2 emissions from BEVs vary by country due to different electricity mixes. For example, in Germany, BEVs produce 20.9 g CO2/km compared to 2.7 g CO2/km for hydrogen vehicles when using excess renewable electricity.

Comparative life cycle assessments, such as those by Bicer et al., show that hydrogen vehicles emit less CO2 (57 g CO2 eq/km) than BEVs (170 g CO2 eq/km). Additionally, the safety of BEVs is a concern due to the fire risks associated with lithium-ion batteries, as illustrated by the 2023 Fremantle Highway incident.

Lithium's rarity and increasing cost push for alternatives like sodium-ion batteries, which offer potential advantages in cost, safety, and lifespan. Sodium-ion batteries, presented at WBE 2023, promise 5–6 times the lifespan of lithium-ion batteries and faster charge times, although they are not yet market-ready.

Fuel cells in hydrogen vehicles also have a longer lifespan than lithium batteries. Fuel cell stacks can last the vehicle's lifetime (about 200,000 miles), whereas lithium batteries are typically guaranteed for only 100,000 miles. Optimizing energy management strategies for hydrogen vehicles can further enhance efficiency and lifespan, reducing hydrogen consumption and degradation of both fuel cells and batteries.

Table 2. CO_2 emissions from use in Germany.

Model	CO_2 per km
BEV	2.7 g
FCEV	20.9 g

Table 3. CO_2 emissions for life cycle assessment.

Model	CO_2 per km
BEV	170 gr
FCEV	57 gr

Table 4. Life cycle CO_2 emissions reduction for BEV in Europe.

Land	BEV's CO_2 Reduction
Poland	−29%
Germany	−56%
Italy	−57%
Netherlands	−58%
UK	−62%
Belgium	−65%
Spain	−67%
France	−77%
Sweden	−79%
EU27	E63%

COMPARISON OF BATTERY ELECTRIC VEHICLES AND FUEL CELL VEHICLES

Infrastructure and Research

In 2017, Robinius et al. analyzed the infrastructure needs for battery and fuel cell electric vehicles (BEVs and FCEVs) in Germany. They considered scenarios ranging from 100,000 to several million vehicles, assuming the use of surplus renewable electricity. Key findings include:

1. At low market penetration, infrastructure costs for hydrogen refueling stations and battery charging networks are similar.
2. Hydrogen infrastructure becomes more expensive during the transition to renewable hydrogen due to electrolysis and storage costs.
3. At 20 million vehicles, battery charging infrastructure costs (€51 billion) exceed hydrogen infrastructure costs (€40 billion).

Initially, hydrogen can be economically transported by road tanker. As demand increases, building a hydrogen pipeline network incurs high initial costs but becomes more cost-effective over time. The study assumes a new hydrogen transport network is needed, though existing natural gas pipelines could be repurposed.

Future research should extend this analysis to other countries to compare CO2 emissions and total infrastructure costs for BEVs and FCEVs. The Belgian Federal Service for Public Transport suggests BEVs are sufficient for daily use, while hydrogen vehicles are better for users needing longer range, such as truck drivers and taxis. Hydrogen's ability to store excess renewable energy is also a significant advantage.

In summary, both BEVs and FCEVs have roles in different market segments, with infrastructure development following demand.

Conclusion

In the near future, both electric charging and hydrogen refueling will reduce greenhouse gas emissions from transport, a major CO2 contributor. BEVs and FCEVs produce zero emissions when using renewable energy. They also effectively use renewable resources: BEVs charge at night during low demand, and hydrogen can store surplus renewable electricity.

Hydrogen can absorb excess renewable energy via electrolysis, storing it in the gas grid. This approach ensures no renewable electricity is wasted. A combination of BEV and FCEV infrastructure will create a sustainable transport system, with BEVs for short distances and hydrogen cars for long-distance and heavy-duty transport.

In Germany, initial infrastructure costs for BEVs and FCEVs are similar. However, hydrogen becomes more expensive during the transition to electrolysis and storage. At higher vehicle penetration (20 million), battery infrastructure costs (€51 billion) exceed hydrogen infrastructure costs (€40 billion).

Future studies should extend this analysis to countries with different electricity mixes, like France, and include total production, transport, and distribution costs for BEVs and FCEVs.

STRATEGIES AND INNOVATIONS

The automotive industry is undergoing a profound transformation driven by sustainability and digitalization. With ESG standards reshaping the landscape and data becoming crucial, the age of electric and connected cars is here. Incumbent OEMs and tier-one suppliers face competition from tech-forward entrants, necessitating adaptation, internal knowledge building, strategic partnerships, and R&D investment.

To stay ahead, organizations must develop foresight capabilities to understand the forces shaping the industry's future. This involves identifying key trends, technologies, and players driving market changes, and recognizing developments with the greatest strategic impact.

Forces Shaping the Future of the Automotive Industry

1. The Ever-Changing Consumer

Consumer preferences are driving new automotive business models like Mobility-as-a-Service (MaaS) and subscription services. Dealerships must balance in-person and virtual showrooms as remote work and a new generation of consumers change perceptions of vehicle ownership and usage. Technologies like Extended Reality (XR) will enable online showrooms and test drives. The shift from ownership to usership, personalized commerce, and redefined luxury are key trends.

Inspiration: Ryder's COOP platform expands nationwide, enabling businesses to list and rent vehicles across the U.S.

2. Sustainability Regulations

The automotive industry faces stricter sustainability regulations, with governments promoting sustainable practices through incentives and penalties. Independent regulators demand higher standards for emissions and fuel economy. Key technologies include Alternative Energy Storage, Smart Grids, and Carbon Capture. Blockchain-Track-and-Trace ensures value chain transparency, highlighting sustainability in corporate strategy.

Inspiration: Automakers launch Cofinity-X, a platform for supply chain transparency, connecting companies for improved traceability and ESG monitoring.

STRATEGIES AND INNOVATIONS

3.Embedded Connectivity

By 2030, 95% of new vehicles will have embedded connectivity, generating vast data and enabling data-driven business models. Technologies like Edge Computing and Predictive Maintenance turn data into insights for improved driver experience and safety. Trends like Diversified Value and Data Ethics emphasize the need for personalized experiences and responsible data use.

Inspiration: Qualcomm unveils 5G and AI robotics solutions for urban air mobility, enhancing commercial applications like delivery robots and industrial drones.

4.Cities of the Future

Future cities will rely on smart mobility infrastructure with IoT, smart sensors, and edge computing. Technologies enable car-sharing, autonomous vehicles, EV charging stations, and real-time analytics. Collaboration between governments and businesses is key.

Inspiration: Saudi Arabia Railways partners with Uber for integrated transport services.

5.Intelligent Manufacturing

Digital supply networks and technologies like industrial IoT, 5G, AI, and digital twins transform manufacturing. Challenges include retrofitting costs, skill shortages, security, and job loss concerns. Benefits include productivity, customization, and cost efficiency.

Inspiration: Hyundai partners with TeamViewer to digitize smart factory processes.

6.Electro-Investment

EV sales are predicted to overtake ICE vehicles by 2030, driven by government incentives, ESG standards, and consumer demands. Investment in alternative energy technologies and infrastructure is crucial. Trends include next-gen batteries and behavior shaping.

Inspiration: Audi plans significant investments in electromobility and hybridization.

MARKET TRENDS & CONSUMER PREFERENCES IN INDIA

- In sharp contrast to global trends, Indian customers prefer hybrid vehicles, which have a blend of combustion engine and electric motors, to pure-play electric cars that are powered entirely by batteries or BEVs.
- Car companies, quick to recognise this trait, have been luring the Indian clientele with 51 new model launches of hybrids compared with just 29 for EVs in 2023.
- Hybrids have become favourites due to their reliability, affordability and lower maintenance cost. Meanwhile, limited range, lack of charging infrastructure and expensive insurance are concerns that the EV ecosystem needs to aggressively address to make its India ride smoother.
- Hybrids are cheaper, too. The average retail price of a hybrid is Rs 16.98 lakh while that of an EV is Rs 17.71 lakh, according to market researcher Jato Dynamics. No wonder hybrids accounted for 12.6% of total passenger vehicle (PV) sales in January-November 2023, while the share of EVs was only 2.3%.
- The Indian EV market has seen an over 100% growth in demand since 2017. In 2023, EV sales doubled to 89,137 units in January-November 2023, from 44,489 in the same period in 2022. However, sales of EVs in India are expected to moderate in 2024 because of a high base, Tata Motors told ET in a report on Friday. The leader in EVs, Tata Motors says annual sales of electric cars will touch 1 million units by 2028, thanks to new launches and expansion of charging infrastructure. EVs, it estimates, will account for 25% of it’s sales by 2027 and 50% by the end of the decade.

BRAND STRATEGY

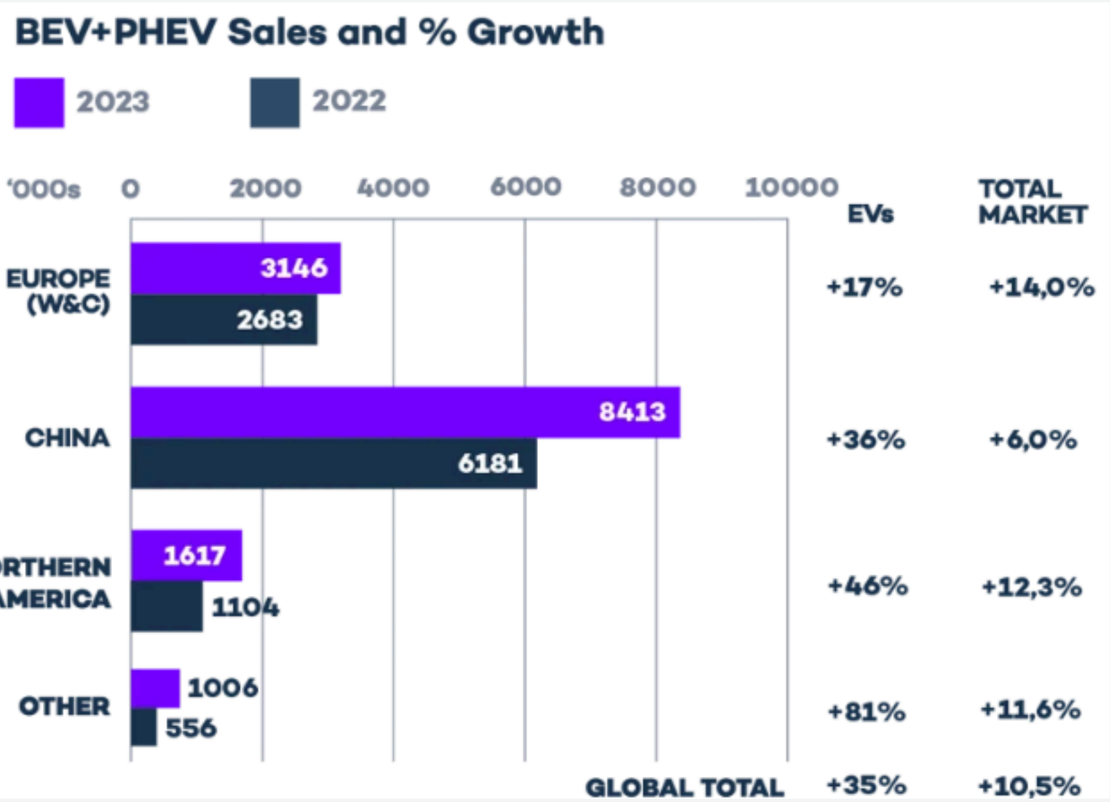
- Automobile majors are adopting various strategies for EVs. Tata Motors, Mahindra and MG Motor have a long-term focus on EVs. Several electric players like US based Tesla and Fisker and Vietnambased VinFast are firming up their plans for India. VW and Skoda are planning EV launches in the next two-three years. Meanwhile, Maruti Suzuki, which is a leader in internal combustion and hybrid cars, and Toyota, which has launched hybrid models as an intermediate step, will eventually launch electric vehicles.
- Hyundai launched the fully electric SUV Kona in India in 2019 and the long-range EV SUV, Ioniq 5, with a range of 631 km, in 2023. The Ioniq5 has sold 1,100 units so far. “We are committed to introducing more EVs as our strategy in India is focused on them in line with government policies,” says Garg. The Korean major plans to invest Rs 20,000 crore in Tamil Nadu towards capacity expansion, new product development and EV battery pack assembly plant.
- MG Motor is the second largest electric passenger vehicle seller in India. “Our flagship EV model, MG ZS, and Comet have received positive response, with over 18,000 units sold till date. Around 30% of our sales comes from EV models,” says Gaurav Gupta, deputy MD, MG Motor India.
- Since an expansion of charging infrastructure is crucial for EVs to become mainstream, MG India partnered with a campaign called Shoonya–Zero Pollution Mobility by NITI Aayog and installed more than 12,000 charging touch points, including public and home chargers, across the country, adds Gupta.
- Hyundai has over 1,100 functional charging stations, and continues to grow this network.

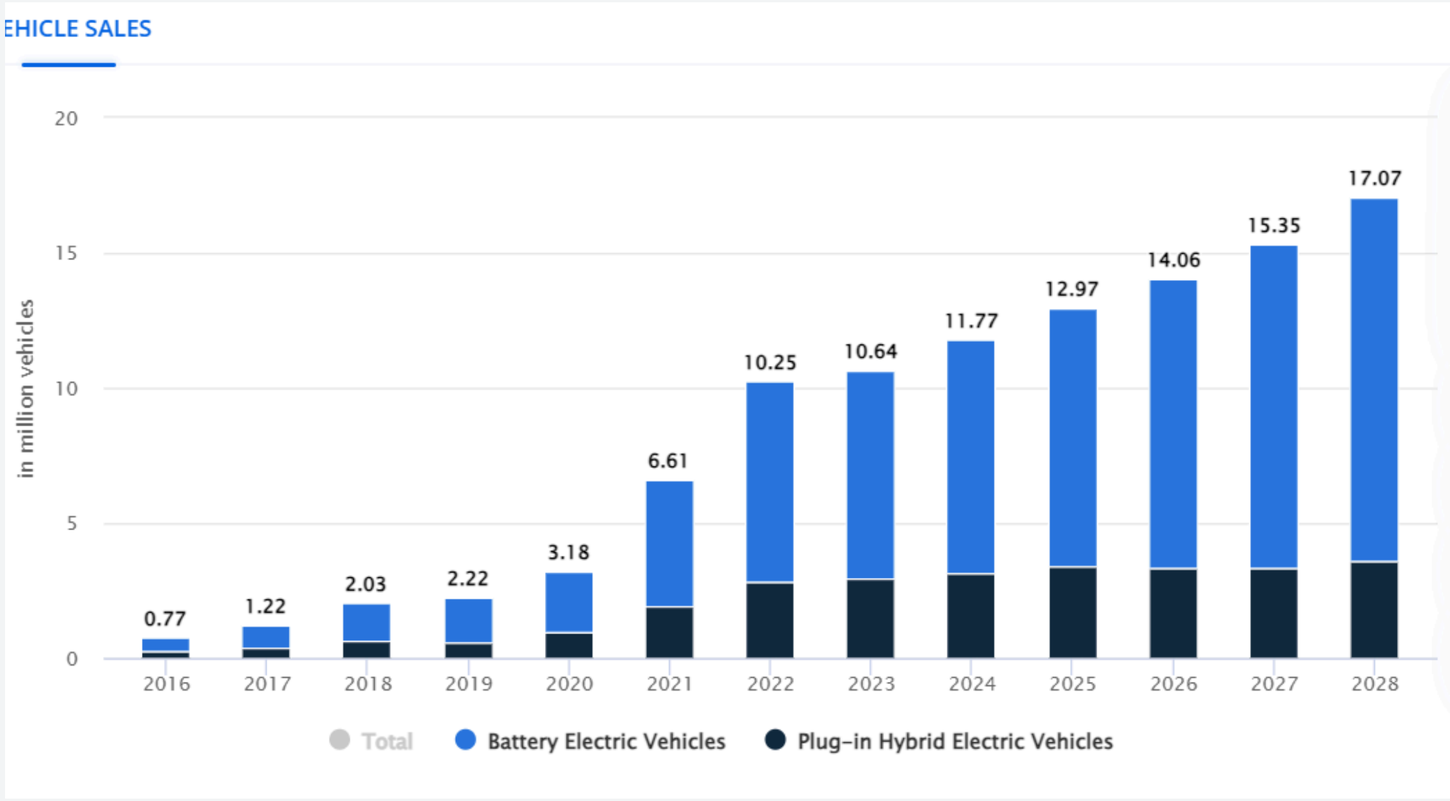
GLOBAL CONSUMER TRENDS & PREFERENCES

- Almost 14 million new electric cars were registered globally in 2023, bringing their total number on the roads to 40 million, closely tracking the sales forecast from the 2023 edition of the Global EV Outlook (GEVO-2023).
- Electric car sales in 2023 were 3.5 million higher than in 2022, a 35% year-on-year increase. This is more than six times higher than in 2018, just 5 years earlier. In 2023, there were over 250 000 new registrations per week, which is more than the annual total in 2013, ten years earlier.
- Electric cars accounted for around 18% of all cars sold in 2023, up from 14% in 2022 and only 2% 5 years earlier, in 2018. These trends indicate that growth remains robust as electric car markets mature. Battery electric cars accounted for 70% of the electric car stock in 2023.

Customer preferences: One of the main reasons for the growing popularity of Electric Vehicles is the increasing concern for the environment and the need to reduce carbon emissions. Customers are becoming more conscious of their ecological footprint and are opting for greener transportation options. Electric Vehicles offer a cleaner and more sustainable alternative to traditional gasoline-powered cars, making them a preferred choice for environmentally conscious consumers. Additionally, the rising cost of fuel and the desire for energy efficiency have also contributed to the increasing demand for Electric Vehicles.

Trends in the market: The Electric Vehicles market is witnessing several trends that are driving its growth. Firstly, there is a growing number of government initiatives and incentives to promote the adoption of Electric Vehicles. Many countries are offering subsidies, tax benefits, and other incentives to encourage consumers to switch to electric cars. These initiatives are not only aimed at reducing carbon emissions but also at boosting the local economy by supporting the development of the Electric Vehicle industry. Another trend in the market is the improvement in battery technology. As battery technology continues to advance, Electric Vehicles are becoming more affordable, efficient, and have longer driving ranges. This has addressed one of the major concerns of consumers - range anxiety. With the development of fast-charging infrastructure, the charging time for Electric Vehicles has significantly reduced, making them more convenient for everyday use.





COST EFFICIENCY ANALYSIS REPORT

Historically, cost-effectiveness policy re- views of regulatory decisions on the automo- bile have been very controversial. Uncer- tainty surrounding the cost estimates of tech- nological changes for the automobile is usu- ally the key reason for the controversy. Be- cause costs are difficult to estimate, cost-effectiveness analysis is deemphasized, and policy decisions often turn on other criteria, such as ease of implementation or political acceptability.

INTRODUCTION

MARKET SIZE

- The automobile industry produced a total of 1,861,849 vehicles including passenger vehicles, commercial vehicles, three-wheelers and two-wheelers in April 2014 as against 1,687,243 in April 2013, registering a growth of 10.35 percent over the corresponding month of 2013.

- Two-wheeler sales registered growth of 11.67 percent in April 2014 over April 2013.

- The cumulative foreign direct investment (FDI) inflows into the Indian automobile industry during the period April 2000 - May 2014 was recorded at US$ 9,885.21 million, according to data published by Department of Industrial Policy and Promotion (DIPP).

GOVERNMENT REGULATIONS

- BOOST TO GST (GENERAL SALES TAX)
- REDUCTION OF EXCISE DUTY TILL DECEMBER 2014
- DEVELOPMENT OF ROADS AND INFRASTRUCTURE
- DEVELOPMENT OF AGRICULTURAL SECTOR

COST STRUCTURE

Segment wise cost structure in the auto-component sector (2013-2014):

	Equipment Parts	Braking Parts	Steering Parts	Electrical Parts	Engine Parts
Raw Material Cost	62%	72%	70%	66%	47%
Power and Fuel Cost	3%	3%	5%	2%	4%
Employee Cost	17%	8%	11%	12%	23%
Consumable Stores	1%	4%	4%	1%	7%
Selling Cost	6%	4%	3%	1%	5%
Others	11%	9%	7%	18%	14%

Cost Structure in the auto-component sector (2013-2014):

Cost Item	%
Material Cost	51.3
Power and Fuel Cost	3.8
Employee Cost	12.5
Other Manufacturing Expenses	6.9
Selling expenses	3.3
Interest & Finance Costs	6.4
Depreciation	15
Tax	10
Operating Profit Margins	15.3
Net Profit Margins	4.2

COST EFFICIENCY ANALYSIS REPORT

REQUIRING technological improvements to the automobile has been a prominent strategy for meeting major public policy objectives. Current fleet fuel economy standards and current vehicle tailpipe emissions standards are the specific policies that deal with past public policy concerns about improving air quality and reducing petroleum use. Higher fuel economy standards and lower allowable vehicle emis- sions are now being considered for the future as dependence on foreign oil continues and states and metropolitan areas continue to have difficulty meeting ambient air quality standards.

In choosing among policies, most public policy analysts today recognize that economics is important and would agree that cost-effectiveness calculations should be considered, i.e., the cost per barrel of petroleum saved or the cost per ton of emissions reduced that result from technological modifications to the automobile should be compared to similar cost ratios for other possible policies. Technology-based options should not be pursued if there are other policy possibilities that deliver the same effectiveness with significantly lower costs.

IMPROVING FUEL ECONOMY

Several years ago, a proposal to increase the corporate average fuel economy (CAFE) from 27.5 to 40 mpg was seriously debated: While no action was taken to change the standard at that time, the issue continues to be discussed, and reconsideration of the proposition is quite possible

COST EFFICIENCY ANALYSIS REPORT

The most difficult problem with cost-effectiveness analysis in the automobile industry is the uncertainty and confusion about the true costs of technology options. Analysts outside the industry are criticized just as strongly for developing conservative and self- serving cost estimates that are unreasonable high. All of this uncertainty has the effect of discrediting cost- effectiveness analysis as a valid approach for policy choice. Decisions are made on the basis of ease of implementation and political acceptability rather than cost-effectiveness grounds. These are not irrelevant criteria but suffer from being difficult to interpret in the absence of accompanying data on the total policy costs. This article reviews cost-effectiveness analysis for both energy savings and lower emissions levels, to illustrate the problems of estimating costs and completing cost-effectiveness analysis in the automobile industry.

COST EFFICIENCY ANALYSIS REPORT

- **Measurement of efficiency and Analytical method:**

Two main types of efficiency modules are used to analysis the efficiency level they are profit efficiency and cost efficiency. The study adopted both methods to measure the efficiency of the automobile companies in India. In cost efficiency measures the how companies minimize their cost where the minimum expenses are determined by the best performance in the dataset. The cost of a firm (C) depends on the output (y), the price of inputs (w), the level of cost inefficiency (u) and a set of random factors (v) which incorporate the effect of errors in the measurements of variables. Thus, the cost function is expressed functionally as:

C= C (y, w, u, v)

The cost efficiency for firm i at time t can be calculated as: Cost efficiency it =$E\left(Ci：u\right.$=0.$W\ Y$)

$E\left(Ci：u\ W\ Y\right)$

Where Ci are total cost incurred i, w and y are the input cost and output of i respectively. The numerator reflects the minimum cost achievable by the companies and denominator shows actual costs of i given the actual level of efficiency.

On the other side, profit efficiency is a broader concept than cost efficiency since it takes into account the effects of the choice of certain vectors of production, both on costs and on revenues. Given the input and output (w) and (p) respectively, the firm maximizes profits by adjusting the amounts of inputs and outputs.

Thus, the profit function can be expressed as:

Profit efficiency: P (w, p, u, v)

COST EFFICIENCY ANALYSIS REPORT

- **CONCLUSION :**

The current study is an attempt to know about the cost-effectiveness of selected automobile companies. For this, researchers used cost-effectiveness analysis by using to important model i.e., cost impact model and profit impact model. The study concludes that the regression analysis of cost effect model evident that all the considered input and output variables were found to have a positive impact on total cost of the firms. Profit model impact on all input and output variables are shows the significantly positive impact on all selected variables. The study contributes to the depth of application of efficiency structure hypothesis to efficiency and performance in automobile companies.

The limitation of this study is the inability to include other external macroeconomic variables which effects the determination of both efficiency and performance. The company's profit may be influenced by not only input and output, but also by its quantity, revenue, the economy scale, or economy of scope. Future studies may sufficiently include control variables to account for firm- level heterogeneities.

Four Big Ways the Automotive Industry Can Save Money

- 1. Consider the impact of employees: Having a highly skilled and trained workforce is essential for cost reduction. Employees that introduce errors, do not adhere to company spend policies, or who are not trained on procedures and practices properly can cause a company to incur significant costs. It's important that employees receive extensive training and are regularly assessed to determine their qualifications, suitability, and competency regarding their day-to-day work activities, especially for jobs with a higher risk of danger. Reducing employee errors, increasing employee satisfaction for automotive jobs, and ensuring your workforce is appropriately skilled will help to reduce costs as well as increase safety and employee retention.

2. Introduce remote software updates: Enabling wireless, over-the-air software updates to telematics and infotainment systems has the potential to save the automotive industry more than USD 30 billion (in America alone) by 2022, according to a study by IHS Automotive. This method of remote software fixes is significantly less expensive than updates done using a cellular network. Over-the-air software updates—which are possible for any vehicle that has built-in Wi-Fi capabilities—will reduce warranty costs, increase convenience for software recalls, and make it easier overall for customers and manufacturers to ensure that their software stays up to date. This will also reduce costs for OEMs and add value to vehicles and related products. Many auto manufacturers are already using over-the-air updates, and the practice will most likely become an industry standard and norm over the next five years.

Four Big Ways the Automotive Industry Can Save Money

- 3. Collaborate and cooperate: Manufacturers should work in close cooperation and collaboration with both suppliers and customers in order to effectively deliver a product that meets customers' needs and wants. This collaboration should begin as early as possible when developing a new vehicle or product so that the customers' demands are clear and integrated into the rest of the development process and the supply chain. This will ensure that manufacturers do not waste time and money developing a product that customers will not find appealing and will help them to make appropriate procurement decisions.

- 4. Cut material costs: The high price of raw materials is one of the biggest cost drivers in the automotive industry, accounting for almost half of the total cost of manufacturing a vehicle. Vehicle manufacturers' dependence on these raw materials—especially steel—leaves them vulnerable to the negative effects resulting from global fluctuations and hikes in prices. To combat this, rather than simply maintaining their traditional supplier relationships, manufacturers should shop around for suppliers who will offer them the best price. As the industry shifts towards the use of aluminum, which is twice as expensive as steel but considerably more lightweight, reducing the cost of materials will become even more important, so auto manufacturers should begin to prioritize, make procurement decisions, and begin negotiations now.

PESTEL ANALYSIS ON AUTOMOTIVE INDUSTRY

PESTEL Analysis of the Automobile Industry

The PESTEL analysis highlights external factors affecting the automobile industry and potential future challenges, enabling companies to develop solutions.

Political Factors

Regulations: Governments mandate safety standards for automobile parts; failure to comply can result in license cancellation and high costs for test runs.

Fossil Fuel Restrictions: Emission regulations require manufacturers to limit pollutants.

Trade Policies: Import/export decisions impact profitability, with lower-cost, high-quality parts being advantageous.

Economic Factors

Income Levels: Rising incomes in stable and emerging economies increase car demand.

Luxury Taxes: High taxes on luxury items can reduce their demand, while affordable cars attract more buyers.

Parts Costs: Increased prices of parts can raise car costs, potentially decreasing demand.

Social Factors

Fashion and Trends: Cars as fashion statements require manufacturers to align with consumer preferences.

Population Distribution: Dense populations and large families boost sales of bigger cars like SUVs.

Public Transport: Well-connected bus services can reduce car ownership, while developed countries tend to have higher car ownership rates.

Technological Factors

Innovation: Companies must use advanced technology to enhance safety and reduce emissions.

Self-Driven Cars: The growing market for self-driven and electric vehicles requires promotion and development.

PESTEL ANALYSIS ON AUTOMOTIVE INDUSTRY

Environmental Factors

Pollution Concerns: Battery-driven and electric cars help reduce emissions.

Environmental Policies: Stricter environmental regulations may impact profit margins.

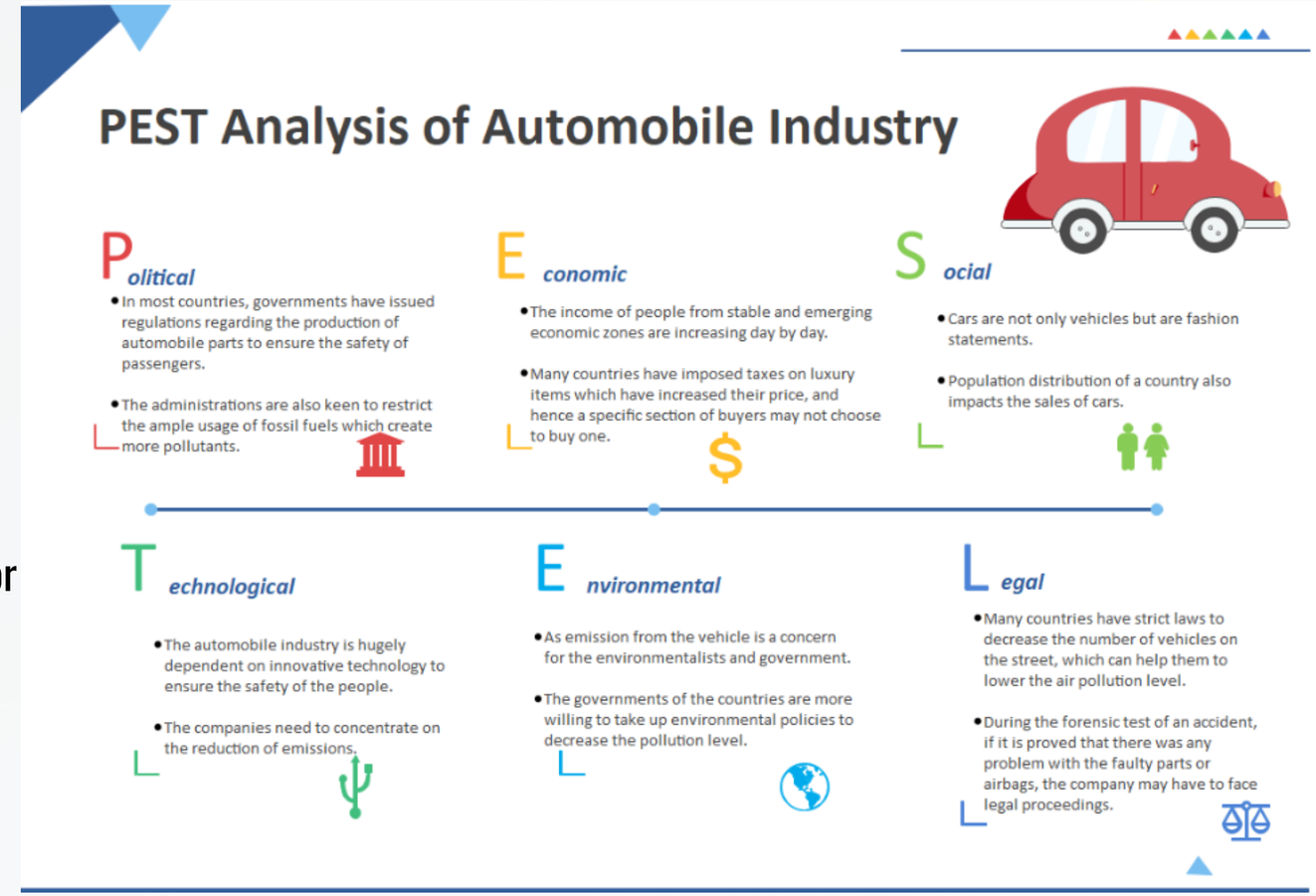
Testing and Compliance: Rigorous testing ensures vehicles meet pollution standards before market debut.

Legal Factors

Vehicle Regulations: Laws to limit the number of vehicles help reduce air pollution.

Forensic Tests: Faulty parts leading to accidents can result in legal action.

International Compliance: Adhering to tax and environmental laws is crucial for operating in global markets, with non-compliance risking bans.



SWOT ANALYSIS ON AUTOMOTIVE INDUSTRY

SWOT Analysis: Automotive Sector

Strengths

Evolving Industry: Continuous growth and improvement in quality of life.

Innovation & Technological Advancement: Investment in e-vehicles and renewable energy sources.

Cost Control: Manufacturing in Asian countries like India and China to reduce costs.

Weaknesses

Consumer Bargaining Power: High competition and numerous options empower consumers.

Government Regulations: Policies and fuel price volatility challenge growth.

High Employee Turnover: Attracting and retaining talent is difficult.

Opportunities

Fuel-Efficient Vehicles: Demand for optimized and cost-efficient engines.

Changing Lifestyles: Shift in consumer demands and regulatory requirements.

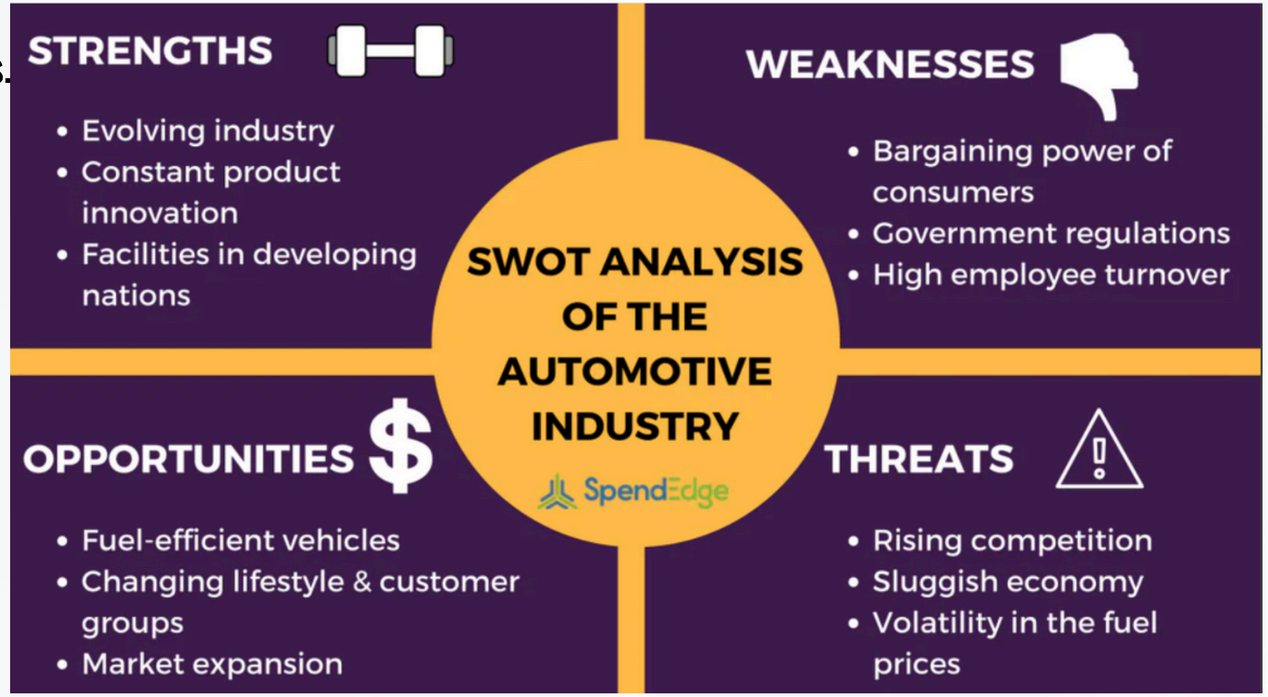
Market Expansion: Growth potential in Asian and BRIC nations.

Threats

Rising Competition: Intense competition limits new player entry.

Sluggish Economy: Economic instability and unemployment impact growth.

Fuel Price Volatility: Fluctuating fuel prices and alternative fuel regulations affect demand.



INVESTMENT ROADMAP

Investing in the automobile sector involves considering various factors such as market trends, technological advancements, regulatory changes, and economic conditions. Here's a structured investment roadmap for the automobile sector:

1. Sector Analysis

- Market Trends: Evaluate current trends such as electric vehicles (EVs), autonomous driving, and sustainability.
- Economic Factors: Consider economic cycles, interest rates, and consumer spending trends.
- Regulatory Environment: Stay updated on emissions regulations, safety standards, and government incentives for EV adoption.

2. Identify Investment Opportunities

- Electric Vehicles (EVs): Companies leading in EV production and infrastructure (e.g., Tesla, Rivian).
- Autonomous Vehicles: Invest in companies developing autonomous driving technology (e.g., Waymo, Nvidia).
- Sustainable Technologies: Companies focusing on eco-friendly solutions like hydrogen fuel cells or improved battery technology.

INVESTMENT ROADMAP

Investing in the automobile sector involves considering various factors such as market trends, technological advancements, regulatory changes, and economic conditions. Here's a structured investment roadmap for the automobile sector:

3. Company Analysis

- Financial Health: Review balance sheets, income statements, and cash flow to assess stability and growth potential.
- Competitive Position: Analyze market share, innovation capabilities, and strategic partnerships.
- Management Quality: Evaluate leadership and their track record in navigating industry challenges.

4. Risk Assessment

- Market Risks: Assess volatility, demand fluctuations, and sensitivity to economic conditions.
- Technological Risks: Evaluate risks associated with new technologies like cybersecurity in connected vehicles.
- Regulatory Risks: Consider potential impacts of changing regulations on operations and profitability.

INVESTMENT ROADMAP

Investing in the automobile sector involves considering various factors such as market trends, technological advancements, regulatory changes, and economic conditions. Here's a structured investment roadmap for the automobile sector:

5. Monitoring and Adjustments

- Regular Review: Monitor industry news, company earnings reports, and macroeconomic indicators.
- Rebalancing: Adjust portfolio allocations based on performance, changes in sector dynamics, and risk tolerance.
- Stay Informed: Continuously update your knowledge base regarding technological advancements and regulatory changes impacting the automobile sector.

Example Portfolio Allocation:

- **Tesla (TSLA):** Leading EV manufacturer with global reach.
- **General Motors (GM):** Established player diversifying into EVs and autonomous vehicles.
- **Nvidia (NVDA):** Technology leader in AI and autonomous driving systems.
- **BorgWarner (BWA):** Supplier of clean technology solutions for combustion, hybrid, and electric vehicles.

INVESTMENTS

To keep up with the growing demand, several auto makers have started investing heavily in various segments of the industry during the last few months. The automobile sector received a cumulative equity FDI inflow of about US$ 35.65 billion between April 2000 - December 2023. India is on track to become the largest EV market by 2030, with a total investment opportunity of more than US$ 200 billion over the next 8-10 years.

Some of the recent/planned investments and developments in the automobile sector in India are as follows:

- Ola Electric IPO to be the first auto company in India to launch an IPO in over two decades (20 years). It has an expected size of US$ 1.01 billion (Rs. 8,500 crore).
- In January 2024, BMW sold 1,340 luxury cars, the highest in the segment, which gave it a market share of 0.34%. Mercedes-Benz sold 1,333 cars in January 2024.
- In January 2024, Hyundai Motor India Limited announced US$ 743.8 million (Rs. 6,180 crore) investment plans in the state of Tamil Nadu including US$ 21.7 million (Rs. 180 crore) towards a dedicated ‘Hydrogen Valley Innovation Hub,’ in association with IIT- Madras.
- In January 2024, Hyundai Motor India Ltd. finalized the acquisition and transfer of specified assets at General Motors India's Talegaon Plant in Maharashtra and inked an MoU with the Government of Maharashtra committing to an investment of US$ 722 million (Rs. 6,000 crore) in the state.
- In January 2024, Mahindra & Mahindra Ltd. and the India-Japan Fund ("IJF"), managed by the National Investment and Infrastructure Fund Limited ("NIIF"), entered into a binding agreement, with IJF committing to invest US$ 48.1 million (Rs. 400 crore) in Mahindra Last Mile Mobility Limited (MLMML).
- In January 2024, at the Vibrant Gujarat Global Summit, Maruti Suzuki announced the investment plans in Gujarat with a New Greenfield plant and a fourth line in SMG.

APPENDIX

- https://www.spendedge.com/blogs/swot-analysis-automobile-industry/t
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- https://economictimes.indiatimes.com/industry/renewables/hybrid-vehicles-have-overtaken-pure-play-electric-cars-in-india-what-is-the-road-ahead-for-evs/articleshow/106238515.cms?from=mdr
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