

Electric Vehicle Adoption in Karnataka

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Abstract

Due to the growing concerns related to pollution, environmental sustainability and the effect of carbon emissions on earth, the shift to more green forms of transportation has become increasingly prevalent. It is important to understand what the current impact of vehicles on the road is having on the environment and what steps can be taken to make it more sustainable for future generations. This research investigates the economic, infrastructural, and behavioural factors affecting electric vehicle (EV) adoption in India. To understand these factors, I combined information from existing literature with interviews with EV specialists, sales executives, and people connected to the EV industry. Their responses provided a practical perspective on the barriers faced by consumers. Four interviews were conducted either face to face or online and consisted of questions regarding EV adoption in Bangalore. The findings suggested that high initial costs, limited charging infrastructure, battery concerns, and uncertain resale value remain major barriers, despite the lower running costs and environmental benefits of EVs. This research also highlights why Bangalore has experienced stronger adoption than other parts of Karnataka. Lastly, these findings suggest that increasing EV adoption will require more than government subsidies, with greater importance placed on affordability, infrastructure, consumer awareness, and confidence.

Keywords: Electric vehicles, sustainability, Karnataka, charging infrastructure, transportation

Contribution/Originality Statement:

This study contributes to the existing literature by exploring the economic and infrastructural factors affecting electric vehicle adoption in Karnataka. It offers new insights into why EV adoption remains inconsistent throughout the state and what can be done to increase the overall usage.

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Introduction: Overview of Electric Vehicle adoption in India

India's shift to electric vehicles (EVs) has accelerated rapidly in recent years due to many factors, including environmental concerns, fuel dependency, and government-led efforts. (NITI Aayog and Rocky Mountain Institute, 2021) Although India has set ambitious sustainability goals and introduced policies to encourage EV adoption, broad implementation remains uneven. As India has set major environmental goals for 2030, including getting 500 GW of energy from non-fossil fuel sources and reducing carbon emissions by 45% (Ministry of Environment, Forest and Climate Change, 2023), adopting EVs would be an important step towards reaching these goals. This is because EVs do not produce emissions from their exhaust like petrol and diesel vehicles, helping to reduce the amount of carbon released into the atmosphere. As more people switch from petrol and diesel vehicles to EVs, the overall emissions from transportation can decrease, helping India move towards a cleaner and greener economy. Hence, by understanding the economic, infrastructural, and behavioural obstacles that prevent the broader usage of these vehicles, we can be more prepared and certain in achieving our ultimate goal of reaching net zero emissions by 2070, where the amount of carbon we put into the atmosphere is balanced by the amount we remove. To investigate more on this matter I conducted interviews with EV specialists, and did my own desk research to confirm any evidence found.

Barriers to EV adoption

A major theme across existing research is that despite the long term benefits, and reduced operating costs after adoption of EVs, several obstacles still tend to prevent their growth or consumption (Bhattacharyya and Thakre, 2021). One of the most significant barriers would be the lack of infrastructure. Bhattacharyya and Thakre highlight the lack of charging infrastructure plays a key role in the reduced usage of EVs.

Similarly, Ragavendran and Kumar (2023) states that the sparse distribution of the charging infrastructure reduces not only the driver's confidence but also the driver's convenience, which in turn makes EV ownership less practical for many consumers. This suggests that inadequate charging infrastructure may be a significant factor behind the slower adoption of EVs in India, as consumers are less likely to purchase vehicles that they perceive as inconvenient or unreliable for daily use. Therefore, understanding the impact of inadequate charging infrastructure could play a vital role in explaining current EV adoption patterns.

While previous research highlights inadequate charging infrastructure as a major barrier to EV adoption, the evidence also suggests that this challenge varies from city to city. Shashi Kumar, a Managing Sales Executive, from Viva Toyota, noted that "Infrastructure is not available after Bangalore city," indicating that although Bangalore has comparatively better charging facilities, infrastructure outside the city remains underdeveloped. This suggests that charging infrastructure is not just a national issue, but also a regional one helping explain why Bangalore, along with being an IT hub, experiences significantly higher EV adoption than other cities within Karnataka.

Another key barrier would be range anxiety, which refers to the fear of running out of charge while driving, and not being able to locate any charging stations close to the area. Michael et al. (2022) identified this as a concern, alongside the inconvenience caused by the long recharging times compared to petrol or diesel vehicles. This reduces the overall flexibility and reliability of EVs, making them less practical for consumers, as delays in charging can also cause frustration among consumers. As a result, these concerns can prevent the wider growth and adoption of EVs. Technological concerns also include battery-related limitations, including storage challenges and performance uncertainty. This highlights that barriers to EV adoption are not solely infrastructural but also psychological in nature, depending on the consumer mindset. Even where charging facilities are available, concerns regarding range and battery performance may reduce consumer confidence. This concern is further reinforced by the observation that insufficient charging infrastructure continues to increase range anxiety, particularly for consumers travelling outside Bangalore. As Yadunandan Katti, Head of Sales and Service in the training department, Viva Toyota, stated consumers are often hesitant to take longer journeys due to the limited availability of charging facilities beyond the city. However, evidence also suggests that this concern may eventually decrease with experience, as EV owners become more familiar with planning journeys around charging stations. This indicates that range anxiety may be strongest before the purchase and during the early stages of ownership, rather than remaining a permanent barrier.

Financial barriers also play a key role in slowing EV adoption. The high initial costs, for instance, mainly due to the lithium ion battery technology and limited economies of scale, make EVs less affordable for many consumers in India, resulting in them postponing their purchase until the price drops or reduces (Michael et al., 2022). Additionally, the unknown cost of maintenance and service that comes with purchasing EVs creates a sense of unwillingness for consumers to purchase the vehicles, discouraging adoption. Because of the high initial price, consumers also tend not to consider the lower operating and maintenance costs compared to petrol or diesel cars. While previous research identifies the high upfront cost of EVs as a major barrier to adoption, the available new evidence gathered from my interviews suggests that this remains the major consideration influencing consumer behaviour. As Mr. Ram Kumar, CEO of Viva Toyota, remarked, “the capital cost is probably the most important thing,” with another managing executive estimating that purchase price alone contributes almost “50% weightage” to the purchasing decision. This indicates that consumers tend to prioritise short-term affordability over long-term financial savings, highlighting a disconnect between the economic advantages of EV ownership and consumer purchasing behaviour. This may partly explain why demand remains relatively limited despite the lower operating and maintenance costs associated with electric vehicles.

Another important challenge is the dependence of the EV industry on global supply chains. As Mr. Ram Kumar also noted, many of the materials required for battery production, including rare earth minerals, are sourced internationally. Consequently, disruptions caused by geopolitical tensions or conflicts, such as those in West Asia, can

increase production costs, delay manufacturing, and make electric vehicles more expensive for consumers. This highlights that achieving widespread EV adoption requires not only strong consumer demand and supportive government policies, but also a resilient and reliable supply chain capable of supporting long-term production.

An additional financial barrier that appeared in the interviews conducted was the uncertainty around the resale value of electric vehicles. While the existing literature focuses mainly on the high upfront purchase cost, concerns regarding future resale value appear to play an equally important role in influencing consumer decisions. As Mr. Dhruv P., a management trainee, at Viva Toyota explained, many consumers remain hesitant due to uncertainty over battery degradation and the relatively underdeveloped second-hand EV market. This suggests that financial barriers go beyond affordability and include perceptions of long-term investment risk, potentially discouraging consumers who think of owning vehicles as significant financial assets rather than modes of transport.

Lastly, consumer awareness and acceptances of the growing EV industry are raising issues as well. Ragavendran and Kumar (2023) believe that the consumers in India have very little understanding of EV vehicles, and therefore do not fully realise their overall benefits to the community and the environment. This idea is further emphasised by Shetty et al. (2020), who state that the government incentives like purchase subsidies, tax reductions, charging infrastructure investment, manufacturing incentives, and battery-swapping support tend to fail, as the consumers and producers both lack the necessary knowledge needed to make efficient use of these policies. In addition, the level of comfort indicated by Bhalla et al. (2018) plays a significant role in EV adoption: consumers in India believe that electric vehicles are relatively uncomfortable compared to petrol cars, causing them to purchase it only after it reaches a certain level of market penetration.

This view also suggests that the issue extends beyond just awareness. Rather than lacking knowledge of EVs themselves, many consumers appear to misunderstand the total cost of ownership, focusing almost entirely on the initial purchase price while overlooking the lower fuel and maintenance costs associated with EV ownership. This shows that awareness campaigns should place greater emphasis on educating consumers about the long-term financial benefits of EVs, rather than focusing solely on their environmental advantages, and effective marketing could be one of the key solutions to fixing this problem.

Factors Influencing Consumer Adoption

Some consumers in India prefer to purchase EVs for many reasons. One significant factor would be environmental concern (Bhalla et al., 2018). Although some consumers understand and recognise that adopting EVs over petrol or diesel would help build a sustainable environment, this only represents a small number of consumers and therefore does not have a major impact on overall EV adoption. These consumers understand that EVs produce zero tailpipe emissions, reduce greenhouse gases, and

improve air quality, but this awareness does not necessarily translate into an actual purchase.

This idea is again reinforced by Trivedi and Kishore (2020), which states that consumers “believe that the responsibility of environmental protection lies within them,” and therefore show willingness or desire to purchase such vehicles. However, this demand for EVs is notional, as consumers usually fail to convert this interest into an actual purchase. While environmental awareness appears to contribute to EV adoption, particularly among IT professionals and corporate employees, evidence suggests that environmental concern alone rarely translates into actual purchasing decisions. In Karnataka, consumers tend to put affordability before considering environmental benefits. This shows that although sustainability may encourage positive attitudes towards EVs, financial factors still remain the dominant factor influencing consumer behaviour, limiting the extent to which environmental concern alone can drive widespread adoption. In other words, consumers understand and acknowledge the benefits EVs bring to the environment, but their desire to save money supersedes this willingness.

Another key factor increasing the sales of EV vehicles would be the reduction of risks, particularly in terms of lower health risks and the reduced chances of asthma or respiratory illness caused by pollution from petrol and diesel automobiles (Motwani and Patil, 2019). These could include noise-induced health risks, due to these cars being comparatively quieter than petrol or diesel cars, lowering the chances of sleep disturbances and cardiovascular diseases (Limoochi and Rodriguez, 2024). There are also potential safety benefits associated with EVs, although these may vary depending on the vehicle and its battery technology (ELJarray et al., 2026). Also, these cars are statistically shown to be 97% cleaner than regular cars, proving their environmental friendliness (Motwani and Patil, 2019). Some other minor but impactful factors could be social belonging (people would be valued or considered more green/environmentally friendly for using such vehicles, allowing them to show their care for society), easier access to information about EV's, and the authenticity or legitimacy of the vehicles (Trivedi and Kishore, 2020). The country of origin also plays a major role in the adoption of EVs, along with the durability of the car, the high battery life, performance, vehicle styling, colour, high resale value, and lastly the overall car attributes, all of which significantly persuade consumers to purchase.

Lastly government policies and schemes are also partially responsible for boosting EV sales (Ministry of Heavy Industries, 2023). The FAME II scheme is directly associated and aimed at increasing EV adoption in India, specifically, Karnataka. This is being initiated by the Ministry of Heavy Industries for a period of five years starting from 1st April, 2019 with a total budgetary support of Rs. 10,000 crore. This phase focuses on assisting the electrification of public and shared transportation, and hopes to increase demand through incentive 7090 eBuses, 5 lakh e-3 Wheelers, 55,000 e-4 Wheeler Passenger Cars and 10 lakh e-2 Wheelers. In addition, the government also wishes to create charging infrastructure to support this growth. Moreover, the government has also started the Production Linked Incentive (PLI) Scheme for the automotive sector, approved in September 2021, with a budget of Rs. 25,938 crore aimed at increasing

domestic vehicle manufacturing, including electric vehicles. Another PLI scheme focused specifically on Advanced Chemistry Cells (ACC) was introduced with an outlay of Rs.18,100 crore to strengthen battery manufacturing in India. This is important because battery manufacturing is a critical part of EV production.

The effectiveness of these policies is further reflected by the increase in electric two-wheeler sales while government subsidies were available. However, the reduction in subsidies did not immediately lead to a slowdown in sales, suggesting that government intervention may play an important role in encouraging initial adoption, but other factors also influence consumer demand. This suggests that government intervention plays an important role in accelerating the initial adoption of EVs by reducing the financial burden on consumers. However, the evidence also indicates that subsidies alone are unlikely to sustain long-term market growth unless accompanied by improvements in charging infrastructure, lower purchase prices and greater consumer confidence. This showcases the need for policies that address both financial and structural barriers rather than relying solely on short-term incentives.

To make EVs more affordable for consumers, the government also reduced goods and services tax (GST) on electric vehicles from 12% to 5%, while the tax on EV chargers and charging stations was similarly cut from 18% to 5%. Some other measures have also been taken to make ownership more convenient. For example, battery-operated vehicles were granted green number plates and exempted from permit requirements. The Ministry of Road Transport and Highways also encouraged states to waive road tax on EVs, helping to reduce the high upfront purchase cost, which is one of the biggest barriers to adoption.(Ministry of Heavy Industries, 2023)

While this existing literature identifies several factors that influence EV adoption across India, the available evidence suggests that Bangalore provides an important case to examine more closely. As India's largest IT and technology hub, Bangalore has several conditions that may influence EV adoption differently from other parts of Karnataka. Firstly, many residents work in well-paid corporate jobs and therefore have higher disposable incomes, which in turn could make it easier for them to afford the higher initial cost of purchasing an electric vehicle. In addition, Mr. Shashi Kumar also stated that many "IT companies promote environmentally friendly practices and provide workplace charging facilities, encouraging employees to consider EV ownership".

Bangalore's relatively short daily travel distances also suit the current battery range of most electric vehicles, meaning drivers are less likely to run out of charge during their regular journeys. Furthermore, many apartment complexes, offices and residential communities have installed charging points, making charging much more convenient than in many other cities. The city's heavy traffic also allows electric vehicles to benefit from regenerative braking, a system that converts energy produced while slowing down into electricity, helping to recharge the battery and improve efficiency during stop-and-go traffic. Another important finding is that many households in Bangalore purchase electric vehicles as a second car for daily commuting, shopping and other short trips, while using a petrol vehicle for longer journeys. This reduces concerns about range anxiety, as the EV would be mainly used for shorter distances. In addition, as more people own

electric vehicles, their friends, neighbours and colleagues become more familiar with the technology, increasing confidence and encouraging others to adopt EVs. In conclusion, these factors suggest that Bangalore's high EV adoption is not because of a single policy or economic advantage, but rather the combination of economic, infrastructural, technological and social conditions, helping explain why Bangalore has experienced significantly stronger EV adoption than many other cities within Karnataka, despite operating under the same EV policies.

Recommendations

Based on the findings of this investigation, I believe several measures could be implemented to encourage the wider adoption of electric vehicles in India, particularly in Karnataka.

Firstly, I think one of the most important factors- charging infrastructure should be expanded beyond Bangalore, particularly in smaller cities, rural areas and along highways. Although Bangalore has better charging facilities, compared to the other cities in Karnataka, the limited availability of charging stations outside the city continues to add to range anxiety, discouraging consumers from considering EVs for long-distance travel. In my opinion, increasing the number of fast-charging stations and improving their accessibility beyond the city as well would make EV ownership more practical, convenient and reliable.

Another one of the most promising solutions could be the introduction of battery subscription or Battery-as-a-Service (BaaS) models. Under this system, consumers would purchase the vehicle while leasing the battery separately through a monthly subscription. Since the battery is the most expensive component of an electric vehicle, separating it from the vehicle would significantly reduce the initial purchase price, now making EVs much more affordable for a larger proportion of consumers. In addition, this model would reduce concerns surrounding battery degradation and expensive battery replacement, as manufacturers would remain responsible for battery maintenance and replacement throughout the subscription period. Unlike the traditional government subsidies, which only reduce the purchase price, a battery subscription model offers a longer-term solution by changing the ownership structure of EVs and addressing affordability and consumer confidence.

Manufacturers should also focus on improving the resale value of electric vehicles, as uncertainty regarding future resale value remains one of the most common concerns raised by potential buyers. Compared to Internal Combustion Engine (ICE) vehicles, electric vehicles currently experience greater depreciation due to concerns surrounding battery health and the relatively underdeveloped second-hand EV market. Introducing buyback schemes, certified pre-owned EV programmes, extended battery warranties and battery health certificates could increase consumer confidence and reduce the financial risk associated with EV ownership that consumers tend to complain about.

Greater efforts could also be made to improve consumer understanding of the total cost of ownership. Many consumers continue to focus primarily on the initial purchase price

while overlooking the long-term savings associated with lower fuel and maintenance costs. Public awareness campaigns and effective marketing could provide clearer information about lifetime ownership costs, battery warranties, charging options and maintenance requirements, rather than focusing solely on the environmental benefits of electric vehicles, further allowing the consumers to make an informed decision while purchasing EVs.

Corporate organisations can also play a greater role in accelerating EV adoption. They could contribute more by expanding workplace charging facilities and introducing employee EV purchase incentives as they currently represent one of the largest groups of EV buyers in Bangalore.

Another key priority could be strengthening the domestic EV supply chain. The findings from this paper highlighted that disruptions to the global supply chain, mainly those affecting the availability of battery materials such as lithium and other rare earth minerals, can increase production costs and reduce the availability of electric vehicles, making them highly unreliable and prone to supply side shocks. Reducing dependence on imported battery components through greater domestic manufacturing, investment in battery recycling and increased research into alternative battery technologies could definitely improve the supply chain independence, while also helping reduce vehicle prices over the long term.

Switching to electric public transit, or bicycles could also be another option in my opinion. Bengaluru has already been allocated 4500 electric buses under the PM E DRIVE, while its Climate Action Plan promotes bicycle-sharing and expanded cycle infrastructure (PIB,2026)(BBPM, 2024). Expanding these initiatives could help reduce private-vehicle dependence, congestion and transport related emissions.

Conclusion

Overall, this research shows that EV adoption in India is influenced by a combination of economic, infrastructural and behavioural factors. Although government policies and environmental concerns have helped encourage adoption, high upfront costs, limited charging infrastructure, range anxiety, battery concerns and uncertainty around resale value continue to discourage many consumers. The findings also show that Bangalore's stronger EV adoption is not due to any one particular advantage, but rather the combination of higher incomes, better infrastructure, shorter travel distances and greater exposure to EVs. Therefore, increasing EV adoption will require more than short-term government subsidies. Greater focus must be placed on making EVs more affordable, expanding charging infrastructure, improving consumer awareness and building confidence in the long-term value of EV ownership.

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