



## SMART EV INDUSTRY DRIVEN BY DIGITAL INFRASTRUCTURE: IOT, AI, ML, TELEMATICS, DIGITAL PAYMENTS

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### **ABSTRACT:**

*The implementation of Industry 4.0 principle enables digital product development frameworks, allowing for a speedier transition to sustainable e-mobility. Another area where virtual technology has the potential to change the game is EV charging. This study will investigate into the role of digital solutions such as AI, machine learning, IoT, telematics, biometric authorization, and digital payments in transforming the Electric Vehicle (EV) sector into a Smart EV industry in India. The research will look at how these technologies affect EV production function, battery management, powertrain, autonomous driving, charging infrastructure, vehicle design etc.*

**KEYWORDS:** EV Industry, Digital Infrastructure, IoT, Artificial Intelligence, Machine Learning, Telematics, Digital Payments

### **I. INTRODUCTION**

Consumers are seeking greater access, connectivity, legit on-demand services, and deliverability. Consumers have high expectations for the EV sector because the conventional automobile industry has not displayed the most innovative advances. Electric automobiles have zero emissions and are safe for the environment and humans, with huge benefits.

EVs offer green energy options for the transportation industry, but understanding the idea of dirty power is imperatives. An EV requires 25-50 kWh of energy to go 160 kilometers, and overall electric usage is expected to rise by 40% by 2050. The answer for electricity must be coupled with renewable energy, else

greenhouse gas emissions will stay unchanged. If the EV sector employs solar energy, EVs will be the best green transportation alternative.

Although electric vehicles in beginning were not effective in lowering carbon emissions, newer EVs are producing better outcomes with fast decarbonization. Digitalization has aided various sectors in their growth and transition, it will also affect the EV business.

### **FAME I & II and the Digital Revolution**

The FAME-India Scheme (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India) was launched in 2011 as part of the National Mission on Electric Mobility/National Electric Mobility Mission Plan 2020, which was unveiled in 2013. The scheme's purpose is to encourage the progressive deployment of dependable, cost-effective, and efficient electric and hybrid vehicles (xEV). The scheme's First Phase was approved for a two-year duration commencing April 1, 2015.

The Scheme has been extended many times, with the most recent extension extending it through March 31, 2024. It is one of the components of the Demand Incentive Disbursement Mechanism. The incentive amount has been determined for each vehicle type, including Mild Hybrid, Strong Hybrid, Plug-in Hybrid, and Pure Electric technologies, as well as battery specification. The National Automotive Board, which is part of the Department of Heavy Industry, implements and regulates it. It is categorised as an in-kind DBT programme.

The FAME India website was developed as part of the digitalization of activities to increase the efficiency, transparency, and efficiency of our country's EV ecosystem monitoring. It is available at <http://fame-india.gov.in/index.aspx>. The complete scheme's process life cycle has been digitalized thanks to this Web Portal. This programme presently has thirty Original Equipment Manufacturer (OEM) models from all vehicle categories registered.

To far, the total incentive money given amounts to around Rs 359 crores for 2.8 lakh autos. The dashboard shows the most recent state-by-state results. It also symbolises the after-purchase benefit of e-vehicles acquired via the Scheme. Total fuel savings from electrification are estimated to be around 50 million litres, with around 52,700 litres saved every day. The daily CO<sub>2</sub> reduction in Liters is roughly 1.3 Lakh Kg, while the overall CO<sub>2</sub> reduction is approximately 129 million Kg. There are also built-in MIS reports for monitoring and management.

Other reports, such as OEM-specific sanctions, state-specific / manufacturer-specific / month-specific progress, and so on, are also available to limited users. Beneficiaries' online Demographic Aadhaar Authentication is also enabled under DBT compliance. Regardless, digitalization is essential for managing such a large setup.

### Impact of digital solutions on EV production function

The EV sector has a significant advantage over the present car business owing to its digital potential, which includes aid systems, health monitoring, battery management systems, big data analytics, and self-driving mode. These digital technologies are critical for greener solutions, fewer carbon emissions, and enhanced digital prospects.

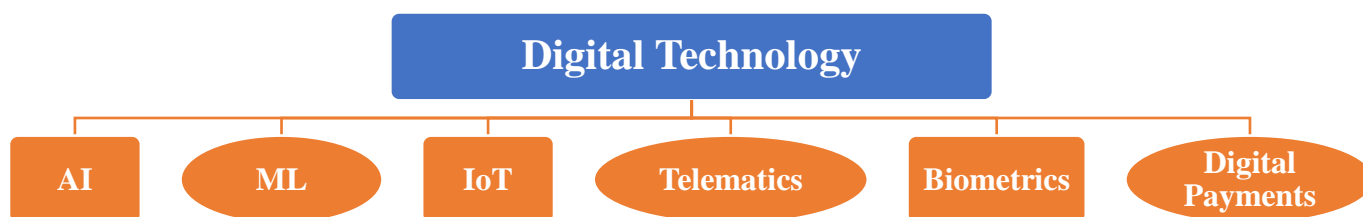
Digitalization improves business insights and efficiency in the EV industry. It also improves the supply chain process, enabling streamlined operations, enhanced management, and boosted visibility. Customers can access EV companies' websites, book service slots, buy equipment, and consult with experts in case of issues.

## II. OBJECTIVES OF THE STUDY:

The research objectives of this study are:

- 1) To state the meaning of digital technology.
- 2) To examine the role of digital solutions- opportunity, benefits & opportunity offered.
- 3) AI, ML, IoT, telematics, biometric authorization, and digital payments in EV Industry.
- 4) To analyze impact of digital solutions on EV production function.

## III. Meaning of digital technology AI, ML, IoT, Telematics, Biometrics, Digital Payments



- ✚ **AI:**Artificial intelligence is the replication of human intellect in computers that have been trained to think and learn in the same way that people do. AI systems may execute activities that would normally need human interaction, such as speech recognition, data interpretation, and decision making.
- ✚ **ML:** Machine Learning is a subset of AI in which computers are trained to make predictions or choices based on data without becoming explicitly programmed to do so. In other words, without human involvement, ML systems may learn from experience and enhance their performance over time.
- ✚ **IoT:**The Internet of Things is an integrated network of physical gadgets, automobiles, household appliances, and other objects that have sensors, software, and connection to share data and interact with one another.
- ✚ **Telematics:**Telematics is a technique that integrates telecommunications and informatics to enable data transmission across great distances. It is frequently used in the automobile sector to monitor and track the location, speed, and other performance data of cars.
- ✚ **Biometrics** is a technology that uses human physiological or behavioral features for identification and authentication.
  - Fingerprints
  - Facial Recognition
  - Voice Recognition
- ✚ **Digital payments:** Digital payments refer to the electronic transactions that take place between buyers and sellers through digital channels, such as mobile devices or computers. These payments can be made using various methods, including credit/debit cards, e-wallets, and cryptocurrencies.

#### IV. Role of Digital Solutions in Transformation of EV Industry into Smart EV Industry

The EV sector seeks huge advantage from multiple technologies as a result of digitalization, helping it to become a smart industry. Here are some of the most prevalent digital technologies being used in this sector:

**Table-1. Digital Solutions in Transformation of EV Industry into Smart EV Industry**

S.	IT	Application inEV Industry	User Indian
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No.	Application		Company
1.	<b>Artificial Intelligence (AI)</b>	<p><b>Artificial intelligence</b> enables predictive maintenance (AI) Machine learning (ML) algorithms are used to forecast when infrastructure or machinery may fail, allowing preventative maintenance to be performed prior to a breakdown. AI may be used to analyze data from sensors and other sources to discover trends and expect when maintenance is needed on the vehicle's different components, including the battery, engine, and other systems. This can aid to:</p> <ul style="list-style-type: none"> <li>✓ Decrease Downtime</li> <li>✓ Lower Maintenance Costs</li> <li>✓ Enhance The Overall Performance</li> <li>✓ Enhance Dependability on EVs.</li> </ul>	<p>✚ Mahindra Electric,                      ✚ Tata Motors,                      ✚ Ashok Leyland,                      ✚ Hero Electric,                      ✚ Ather Energy</p>
2.	<b>Machine Learning (ML)</b>	<p><b>Machine learning (ML)</b> may be used to battery performance and lifetime in electric vehicles (EVs). Large volumes of data generated from EV batteries may be analyzed by ML algorithms to forecast remaining life and possible difficulties. Give recommendations for optimizing charging and discharging cycles and ideal charging times or places. The EV employs a battery management system, which takes data from the battery pack and sends it to the cloud, where machine learning algorithms analyze the data and give insights to perfect the battery's performance and longevity. The system may offer:</p> <ul style="list-style-type: none"> <li>✓ Real-time information on the battery's status</li> <li>✓ Charge Level</li> <li>✓ Temperature</li> <li>✓ Health</li> </ul>	<p>✚ Mahindra Electric,                      ✚ Tata Motors,                      ✚ Ashok Leyland,                      ✚ Hero Electric,                      ✚ Ather Energy</p>
3.	<b>Internet of Things (IoT)</b>	<p><b>IoT</b> is used in the electric vehicle (EV) sector for real-time monitoring of different vehicle components and systems:</p> <ul style="list-style-type: none"> <li>✓ Battery</li> <li>✓ powertrain</li> </ul>	<p>✚ Mahindra Electric                      ✚ Tata Motors</p>

		<ul style="list-style-type: none"> <li>✓ charging infrastructure</li> </ul> <p>Real-time monitoring of EV components via IoT can aid in the early detection of any anomalies or possible breakdowns, allowing for prompt maintenance and repairs to minimize costly downtime.</p> <p>IoT usage can also increase safety by recognizing possible threats and immediately warning drivers or operators.</p>	<ul style="list-style-type: none"> <li>✚ Ashok</li> <li>Leyland</li> <li>✚ Hero</li> <li>Electric</li> <li>✚ Ather</li> <li>Energy</li> </ul>
4.	<b>Telematics</b>	<p><b>Telematics</b> is a technology that combines telecommunications and informatics to perform multiple functions.</p> <ul style="list-style-type: none"> <li>✓ Real-Time Tracking</li> <li>✓ Remote Monitoring</li> <li>✓ Vehicle Control</li> </ul> <p>Telematics is a major element of autonomous technology. <b>Autonomous vehicles</b> rely on a variety of sensors, and telematics provides the communication infrastructure that allows these sensors to work without the assistance of a human.</p> <ul style="list-style-type: none"> <li>○ It allows autonomous cars to interact with one another and with the surrounding infrastructure in order to navigate roadways and make driving decisions.</li> <li>○ It supplies real-time data to onboard computers such as vehicle position, speed, and road conditions.</li> <li>○ Without human interaction, this data is analyzed by powerful algorithms to make driving decisions:                     <ul style="list-style-type: none"> <li>✓ Accelerating</li> <li>✓ Braking</li> <li>✓ Turning</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>✚ Tata</li> <li>Motors,</li> <li>✚ Mahindra</li> <li>Electric,</li> <li>✚ Ashok</li> <li>Leyland,</li> <li>✚ MG</li> <li>Motor</li> <li>India,</li> <li>✚ Hyundai</li> <li>Motor</li> <li>India</li> </ul>
5.	<b>Biometrics</b>	<p><b>Biometric</b> technology may be utilized to improve the user experience in the EV business by giving personalized settings for each driver:</p> <ul style="list-style-type: none"> <li>✓ Preferred Seating</li> <li>✓ Climate Control Setups</li> <li>✓ Used to Regulate Vehicle Entry</li> <li>✓ Prevent Theft</li> </ul>	<ul style="list-style-type: none"> <li>✚ Tata</li> <li>Motors,</li> <li>✚ Mahindra</li> <li>Electric,</li> <li>✚ MG</li> <li>Motor</li> <li>✚ Ashok</li> </ul>

			Leyland, Hyundai Motor
6.	<b>Digital/ online Payments</b>	<p>With the increased popularity of EVs, it is critical to build a network of charging stations that are easily accessible and comfortable for drivers.</p> <p>In the EV business, digital payments can be utilized to fund charging infrastructure through numerous digital payment methods:</p> <ul style="list-style-type: none"> <li>✓ Credit/Debit Cards</li> <li>✓ Mobile Wallets</li> <li>✓ Internet Banking</li> </ul>	Tata Power, REIL, Fortum India, C&S Electric Limited

Thus, Digital solutions have a considerable influence on the electric vehicle (EV) production function because they provide numerous benefits that can improve efficiency, lower costs, and improve manufacturing quality.

### V. Benefits of Digital Transformation for EV Industry

Electronic vehicle companies, like other businesses, aspire to digitalize their operations, whether it's data, connectivity, or cybersecurity, to achieve several benefits such as productive output and observability.

Some of the prominent benefits of Digital Transformation are:

- **Increase efficiency and optimize production**

Electronic vehicle companies, like other businesses, aspire to digitise their operations, whether it's data, connectivity, or cybersecurity, to achieve several advantages such as productivity and observability.

- **Improve product and quality**

When there is a lack of real-time information from the production floor to the C-suite, it may be difficult to see critical information in time to change market moves or consumer requests. Installing successful digital solutions enables workers to get deep access into complicated work processes, enabling better data-driven insights, tighter management of product processes, staffing, and predictive maintenance scheduling.

- **Enhance business insights**

The power of information and insights provided by digital transformation may aid electric car manufacturers. Access to and understanding of product, supply chain, and quality analytics may allow EV companies to get ahead of possible supply chain issues, reduce competitive pressures, and identify possibilities.

- **Enhance the client experience**

By advanced technologies such as AI and machine learning, digital transformation may assist electric vehicle manufacturers in improving customer experience. These technologies can help in the development of predictive maintenance schedules, customised service, and personalised marketing campaigns that are tailored to the needs and preferences of each consumer.

- **Reduce expenses while increasing profits**

Electric vehicle manufacturers may also benefit from digital transformation by enhancing efficiency, optimising manufacturing, and minimising downtime through predictive maintenance. Furthermore, having access to real-time data can assist EV companies in identifying areas where cost-cutting measures can be implemented without sacrificing quality or service.

- **Allow for flexibility and innovation.**

Digital transformation may also help electric car manufacturers decrease costs and enhance revenues by improving efficiency, optimising manufacturing, and minimising downtime through predictive maintenance. Access to real-time data may also assist EV companies in identifying areas where cost-cutting measures can be applied without losing quality or service.

- **Ensure data security and privacy**

Electric vehicle manufacturers must guarantee that their operations are safe and protected against cyber threats as they become more reliant on digital technology. Strong cybersecurity safeguards and data protection processes are essential for protecting sensitive information, avoiding data breaches, and retaining customer confidence.

### **III. Digital Transformation Opportunities**

Digital transformation provides firms with several chances to innovate and improve their operations, products, and services. Here are a few of the most important digital transformation opportunities:



- a) **Increasing Understanding:** Digital transformation provides companies with access to real-time data and analytics, allowing them to gain deeper insights into their business operations. This knowledge can help businesses identify opportunities for improvement, optimize processes, and make informed decisions.
- b) **Improving Supply Chain Operations:** Digital technologies such as IoT, AI, and blockchain can be used to optimize supply chain operations, reduce costs, and increase efficiency. By using digital tools, companies can track inventory in real-time, optimize logistics, and ensure timely delivery of products.
- c) **Creating a Customer-Centric Product Design:** Digital transformation can help companies better understand their customers' needs and preferences. By collecting data from various sources, companies can develop more personalized products, improve customer experience, and create a competitive advantage.
- d) **Increasing Productivity While Lowering Operating Expenses:** Digital transformation can help companies automate routine tasks, reduce manual intervention, and improve operational efficiency. This can result in increased productivity, reduced operating expenses, and improved profitability.
- e) **Quality and Compliance Processes Must be Managed:** Digital transformation can help companies manage quality and compliance processes by providing real-time insights into quality issues, automating compliance checks, and improving overall visibility into these processes.
- f) **Facilitating Collaboration to Address Obstacles Caused by Unconnected Systems and Processes:** Digital transformation can help companies break down silos and improve collaboration between different departments and teams. This can help address obstacles caused by unconnected systems and processes, and drive innovation and growth.

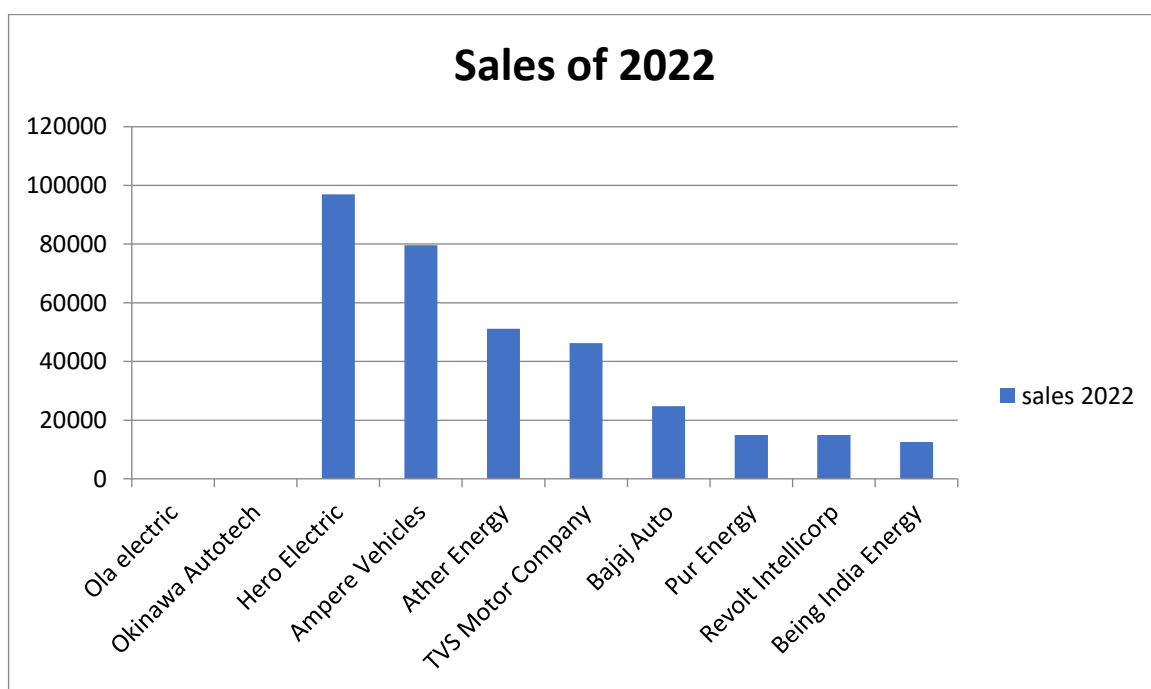
#### IV. Performance of Top 10 Indian EV Companies Using Digital Technologies:

Electric vehicle (EV) firms employ digital technology to improve their operations and goods in a number of ways. Here are ten Indian electric vehicle (EV) companies that are driving innovation and growth through the use of digital technologies:

**Table-2: Performance of EV companies using digital technology**

S. No.	Company Name	Digital Technologies Used	Sales 2022
1	Ola Electric	AI, ML, IoT, Telematics	1,08,130

2	Okinawa Autotech	AI	1,01,366
3	Hero Electric	AI, ML, IoT	96,906
4	Ampere Vehicles	IoT	79,592
5	Ather Energy	IoT, Digital Payments	51,192
6	TVS Motor Company	IoT	46,227
7	Bajaj Auto	IoT	24,767
8	Pur Energy	AI	14,913
9	Revolt Intellicorp	IoT	14,911
10	Being India Energy	IoT, AI, ML, Digital Payments	12,558



It is also evident that financial reports of these companies can provide valuable insights into their performance and the impact of digital transformation on their operations.

**Conclusion:**

Digital transformation is crucial for the success of electric vehicle companies in India. By adopting digital technologies like AI, ML, IoT, telematics, and biometrics, EV companies can perfect their production, improve product quality, enhance business insights, and offer better user experiences.

Top 10 electric vehicle companies in India that are leveraging digital technologies include Tata Motors, Mahindra Electric, Ashok Leyland, Hero Electric, Ather Energy, TVS Motor Company, JBM Auto, Hriman Motors, Emflux Motors, and PURE EV.

Thus, by digitizing their operations, EV companies can improve their productivity, gain observability, and stay ahead of potential supply chain concerns. Overall, digital transformation has the potential to drive innovation, growth, and sustainability in the Indian electric vehicle industry and make a smart EV Industry.

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