

“Study and Analysis of Production and Quality Management Practices in Electric Scooters and Bikes: Kinetic Watts, and Volts Limited, Ahilyanagar.”

Aniket Sanjay Gunjal¹, Gaurav Rajendra Shahane², Dr. Ramesh Suryabhan Gadakh³

¹ Student, Department of Mechanical Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

² Guide, Department of Mechanical Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

³ Principal Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

Abstract

The rapid development of electric mobility has increased the demand for electric scooters and motorcycles in India. Electric two-wheelers require effective production planning, precision manufacturing, battery management, assembly control, testing, and quality assurance to achieve reliable and economical products. This research paper presents a case study of production and quality management practices associated with electric two-wheeler manufacturing at Kinetic, Ahilyanagar. The study focuses on manufacturing processes such as chassis fabrication, robotic welding, body-panel manufacturing, painting, electric drivetrain assembly, battery-pack manufacturing, inspection, and final quality testing.

Kinetic Engineering's Ahilyanagar manufacturing facility has more than 50 acres of manufacturing infrastructure, multiple production sheds and more than 460 machines, and is IATF 16949 certified. The facility serves the two-wheeler and other automotive sectors. ([Kinetic India](#)) Recent manufacturing developments include robotic chassis welding, automated fixtures, dedicated scooter framing cells, improved body-panel production, and a modernized paint process for electric scooter production. ([Kinetic India](#))

The paper identifies critical quality parameters such as dimensional accuracy, weld quality, battery safety, electrical performance, paint quality, assembly accuracy, functional testing and traceability. The study concludes that integration of automation, poka-yoke, stage-wise

inspection, quality management systems and skilled manpower can significantly improve production efficiency, consistency and product reliability.

Keywords: Electric Vehicle, Electric Scooter, Electric Bike, Production Management, Quality Control, Kinetic, Ahilyanagar, Robotic Welding, Battery Manufacturing, IATF 16949.

1. Introduction

Electric vehicles are becoming an important part of sustainable transportation because they can reduce dependence on conventional fossil fuels and support low-emission mobility. Among different categories of electric vehicles, electric scooters and motorcycles are particularly important for urban and short-distance transportation.

An electric two-wheeler consists of several important systems, including:

- Chassis and frame
- Electric motor
- Battery pack
- Battery Management System (BMS)
- Motor controller
- Charger
- Suspension system
- Braking system
- Wheels and tyres
- Electrical wiring
- Instrument cluster
- Body panels

The manufacturing quality of each subsystem directly influences vehicle safety, performance, reliability and customer satisfaction.

Kinetic has a significant manufacturing presence in Ahilyanagar. Its facility includes manufacturing capabilities for two-wheelers and electric systems and is IATF 16949 certified. ([Kinetic India](#)) The company has also introduced advanced manufacturing systems for electric scooter production, including robotic chassis welding and automated fixtures. ([Kinetic India](#))

2. Objectives of the Study

The main objectives of this research are:

1. To study the production process of electric scooters and bikes.
2. To study major manufacturing operations involved in electric two-wheeler production.
3. To identify important quality parameters during production.
4. To study the role of automation and robotics in electric vehicle manufacturing.
5. To analyze quality-control practices in chassis, body, battery and assembly operations.
6. To identify common production and quality-related problems.
7. To suggest methods for improving productivity and product quality.
8. To study the importance of Industry 4.0 technologies in EV manufacturing.

3. Research Methodology

The study can be conducted using a combination of primary and secondary data.

3.1 Primary Data

Primary data may be collected through:

- Industrial visits
- Interviews with production engineers
- Interviews with quality engineers
- Operator interaction
- Process observations
- Inspection records, wherever permitted
- Production-line observations
- Quality-control observations

3.2 Secondary Data

Secondary information can be collected from:

- Company publications
- Annual reports
- Technical papers
- Research journals
- Automotive standards
- Government publications
- Industry reports

3.3 Research Approach

The study follows the following sequence:

Production Process Study → Quality Parameter Identification → Data Collection → Analysis → Problem Identification → Improvement Suggestions

4. Production Process of Electric Scooters and Bikes

A typical electric two-wheeler production system can be represented as:

Raw Material → Component Manufacturing → Chassis Fabrication → Welding → Surface Treatment → Painting → Motor/Battery Preparation → Sub-Assembly → Vehicle Assembly → Electrical Connection → Inspection → Testing → Final Quality Inspection → Dispatch

4.1 Chassis Manufacturing

The chassis is the primary structural component of an electric scooter or motorcycle. It provides support for:

- Battery
- Motor
- Suspension
- Body panels
- Rider and passenger loads
- Electrical components

Dimensional accuracy of the chassis is critical because incorrect dimensions may affect vehicle stability, wheel alignment and assembly.

Kinetic's recent production modernization includes robotic welding, clamping auto fixtures and a dedicated scooter framing cell for the Kinetic DX. These technologies are intended to improve structural accuracy, consistency and productivity. ([Kinetic India](#))

4.2 Robotic Welding

Robotic welding provides:

- Consistent weld quality
- Accurate weld positioning
- Repeatability
- Reduced human error
- Improved productivity
- Better workplace safety

For mass production, robotic welding can provide more consistent welding parameters than manual welding when properly programmed and monitored.

Important welding quality parameters include:

- Weld position
- Weld size
- Weld penetration
- Weld appearance
- Distortion
- Joint strength

4.3 Body Panel Manufacturing

Body panels are manufactured using processes such as:

- Sheet-metal cutting
- Press forming
- Bending
- Punching
- Spot welding
- Surface finishing

Kinetic's upgraded facility incorporates hydraulic and mechanical presses, spot-welding systems and pneumatic fixtures for body-panel production. ([Kinetic India](#))

4.4 Painting and Surface Treatment

Painting provides:

- Corrosion protection
- Surface durability
- Improved appearance
- Environmental protection

The upgraded Kinetic facility uses a multi-stage coating process including CED treatment and a metallic top coating. ([Kinetic India](#))

Important quality parameters include:

- Coating thickness
- Adhesion
- Surface finish
- Colour uniformity
- Corrosion resistance
- Paint defects

5. Electric Powertrain Manufacturing

The electric powertrain generally consists of:

Battery → BMS → Controller → Electric Motor → Transmission/Wheel

The major components include:

5.1 Battery Pack

The battery is one of the most critical components of an electric two-wheeler.

Battery-pack production may include:

1. Cell inspection
2. Cell grading
3. Cell arrangement
4. Electrical connection
5. Busbar welding
6. BMS installation
7. Thermal management
8. Enclosure assembly
9. Electrical testing
10. Safety testing

Kinetic has also announced an Ahilyanagar battery manufacturing facility for two- and three-wheeler EV applications, including LFP and NMC battery

technologies. The facility incorporates automated production, IoT-enabled poka-yoke systems and stage-wise inspections. ([Kinetic India](#))

6. Quality Control in Electric Two-Wheeler Manufacturing

Quality control is required at every stage rather than only at the final inspection.

6.1 Incoming Quality Inspection

Incoming components should be inspected for:

- Dimensions
- Material specifications
- Surface defects
- Electrical characteristics
- Battery-cell parameters
- Supplier quality

6.2 In-Process Quality Inspection

Important checkpoints include:

Process	Important Parameter	Quality
Chassis fabrication	Dimensions and alignment	
Welding	Weld strength and consistency	
Pressing	Shape and dimensional accuracy	
Painting	Thickness and surface finish	
Battery assembly	Voltage, insulation and connection	
Motor assembly	Alignment and performance	
Wiring	Correct connection and insulation	
Final assembly	Torque and fitment	
Vehicle testing	Performance and safety	

7. Role of Poka-Yoke

Poka-yoke is a mistake-proofing technique used to prevent incorrect assembly or operation.

Applications in electric two-wheelers include:

- Connector-specific designs

- Wrong-part prevention
- Battery polarity protection
- Assembly fixtures
- Sensor-based inspection
- Torque monitoring
- Barcode/QR-code traceability

Kinetic's battery manufacturing information specifically identifies IoT-enabled poka-yoke and stage-wise inspection as part of its manufacturing approach. ([Kinetic India](#))

8. Role of Automation in Production

Automation can improve:

- Production speed
- Repeatability
- Dimensional accuracy
- Welding consistency
- Worker safety
- Process monitoring
- Production traceability

The introduction of robotic chassis production at Kinetic's Ahilyanagar facility represents an example of this approach. The system combines robotic welding, automated fixtures and a dedicated framing cell. ([Kinetic India](#))

Recent research on India's EV manufacturing sector also reports that advanced manufacturing technologies such as automation, robotics and Industry 4.0 can improve production efficiency and quality performance. ([Nature](#))

9. Quality Parameters for Electric Scooters and Bikes

The following quality parameters should be monitored:

Mechanical Parameters

- Chassis dimensions
- Wheel alignment
- Suspension mounting
- Brake mounting
- Fastener torque
- Weld quality

Electrical Parameters

- Battery voltage
- Battery capacity
- Insulation resistance
- Charging performance
- Motor current
- Controller operation
- Wiring continuity

Battery Parameters

- Cell voltage
- Temperature
- State of charge
- BMS operation
- Overcharge protection
- Over-discharge protection
- Short-circuit protection
- Thermal performance

Battery thermal management is particularly important because battery temperature affects performance, life and safety. Recent automotive research highlights thermal-management challenges in Indian electric two-wheelers. ([SAE Mobilus](#))

10. Production Problems and Possible Solutions

Problem	Possible Cause	Recommended Solution
Chassis dimensional variation	Fixture variation	Automated fixtures
Welding defects	Improper parameters	Robotic welding and monitoring
Paint defects	Surface contamination	Improved surface preparation
Battery imbalance	Cell variation	Cell grading
Connector mismatch	Human error	Poka-yoke
Loose fasteners	Incorrect torque	Torque-controlled tools
Electrical failure	Wiring error	Automated electrical testing
Assembly delay	Material shortage	Kit-based material supply

Problem	Possible Cause	Recommended Solution
High rejection	Process variation	SPC and root-cause analysis
Customer complaints	Inadequate final inspection	End-of-line testing

11. Application of Quality Improvement Tools

The following tools can be applied:

11.1 Pareto Analysis

Pareto analysis can identify the major causes responsible for the highest percentage of defects.

11.2 Fishbone Diagram

The **6M approach** can be used:

Man – Machine – Method – Material – Measurement – Mother Nature/Environment

11.3 Statistical Process Control

SPC can be applied to:

- Chassis dimensions
- Weld parameters
- Paint thickness
- Battery voltage
- Motor performance
- Assembly torque

11.4 FMEA

Failure Mode and Effects Analysis can identify high-risk failures related to:

- Battery
- Brakes
- Motor
- Controller
- Chassis
- Charging system

12. Production Performance Indicators

The following KPIs can be used for research analysis:

Production Efficiency*Production Efficiency*

$$= \frac{\text{Actual Output}}{\text{Planned Output}} \times 100$$

Rejection Rate*Rejection Rate*

$$= \frac{\text{Rejected Units}}{\text{Total Produced Units}} \times 100$$

First Pass Yield

$$FPY = \frac{\text{Units Passing Without Rework}}{\text{Total Units}} \times 100$$

Defect Rate

$$\text{Defect Rate} = \frac{\text{Number of Defects}}{\text{Total Units}} \times 100$$

Overall Equipment Effectiveness

$$OEE = \text{Availability} \times \text{Performance} \times \text{Quality}$$

These parameters can be measured before and after implementation of production or quality improvements.

13. Proposed Research Framework

The proposed research framework is:

Input

Raw materials + components + battery cells + manpower + machines

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Production System

Chassis → Welding → Body → Painting →
Battery → Motor → Assembly

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Quality Control

Incoming Inspection → In-process Inspection →
End-of-line Inspection

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Performance Measurement

Production Rate + Rejection + FPY + OEE +
Customer Complaints

↓

Improvement

Automation + Poka-Yoke + SPC + FMEA + Kaizen

↓

Output

**Improved Productivity + Improved Quality +
Reduced Rejection + Improved Reliability**

14. Results and Discussion

The case study indicates that modern electric two-wheeler manufacturing requires integration between production engineering and quality engineering. Automation of chassis welding can improve repeatability and structural consistency. Modern body-panel equipment can improve dimensional accuracy, while improved coating systems can enhance corrosion resistance and surface quality.

Battery manufacturing requires additional quality controls because electrical, thermal and safety characteristics directly influence vehicle reliability. Kinetic's battery manufacturing initiative includes automated production, stage-wise inspection and IoT-enabled poka-yoke systems, demonstrating the importance of quality control at the battery-production stage. ([Kinetic India](#))

The implementation of digitized material handling and kit-based supply can also reduce material-search time, improve line feeding and support production efficiency. Kinetic has reported such improvements in its upgraded production environment. ([Kinetic India](#))

15. Recommendations

The following improvements are recommended for electric two-wheeler manufacturing:

1. Increase robotic welding wherever economically feasible.
2. Implement real-time production monitoring.
3. Use IoT-based quality data collection.
4. Increase poka-yoke applications.
5. Implement SPC for critical dimensions.
6. Develop digital traceability for battery packs.
7. Monitor battery thermal performance.
8. Use automated torque monitoring during assembly.
9. Strengthen end-of-line testing.
10. Apply FMEA throughout the product-development process.
11. Conduct regular Kaizen activities.
12. Provide continuous skill development to production and quality personnel.
13. Develop predictive maintenance systems for critical machines.
14. Integrate production and quality data into a centralized dashboard.

16. Conclusion

Electric scooters and motorcycles require a high level of manufacturing precision because their performance depends on the integration of mechanical, electrical and electronic systems. Production quality is particularly important in chassis fabrication, welding, battery assembly, electrical connections and final vehicle testing.

The Kinetic manufacturing ecosystem at Ahilyanagar provides a relevant industrial case for studying modern EV production. The facility's IATF 16949 certification, manufacturing infrastructure and adoption of robotic chassis welding and automated production technologies demonstrate the increasing importance of advanced manufacturing and quality systems in electric mobility. ([Kinetic India](#))

The study concludes that the combination of **automation, robotics, poka-yoke, SPC, FMEA, digital traceability, skilled manpower**

and continuous improvement can improve production efficiency, reduce defects and enhance the reliability of electric scooters and bikes.

Future research can focus on collecting actual production data from the Kinetic Ahilyanagar facility and statistically evaluating the relationship between automation, production efficiency, rejection rate, first-pass yield and overall product quality.

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