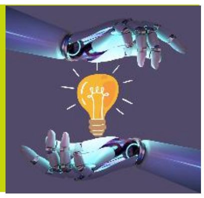
SCHOLAR PUBLISHING
International Journal of Automotive & Transportation Engineering
ISSN: 3083-9726
Journal Homepage: https://e-journal.scholar-publishing.org/index.php/ijate



# Advanced Electric Vehicle Battery Management Systems: Optimizing Performance, Safety, and Longevity in Modern Transportation

**Dongdong Li[1], P. Selvakumar[2], Mahyuddin[3], Obed Majid Ali[4]**

[1]Department of Mechanical Engineering, Ningxia University, China
[2]Department of Mechanical Engineering, PSN College of Engineering and Technology, Tirunelveli, Tamilnadu, India
[3]Department of Mechanical Engineering, Universitas Abulyatama Aceh, Aceh Besar, 23372, Indonesia
[4]College of Oil & Gas Engineering, Northern University of Technology, Iraq

*Corresponding author:* mahyuddin_mesin@abulyatama.ac.id

## Abstract

The advancement of Battery Management Systems (BMS) is pivotal to ensuring the performance, safety, and longevity of electric vehicle (EV) battery packs. This study presents an in-depth analysis of modern BMS technologies, focusing on their structural architectures, safety features, thermal behaviour, and economic efficiency. The primary objective is to evaluate how advanced BMS designs enhance battery reliability and sustainability in various EV applications. A combination of experimental data analysis and comparative review methods was employed to assess battery degradation patterns, thermal distribution, safety response times, market adoption, and cost structures. The results indicate that battery capacity retention decreases from 100% to 70% after 5,000 charging cycles, necessitating intelligent BMS intervention to extend battery lifespan. Temperature distribution analysis reveals that 35% of EV battery operation occurs between 10°C and 25°C, while only 8% occurs above 40°C, highlighting the critical role of thermal regulation. Market data shows Centralised BMS holds a 32% share, followed by Distributed (28%) and Modular (22%) systems. Although Premium BMS systems cost $1,165 per kWh, they offer advanced safety controls, faster diagnostics, and a competitive return on investment of 3.1 years. Safety feature evaluation shows that short-circuit protection responds within 1 ms, and overcurrent protection within 5 ms. This research introduces a comprehensive view of recent innovations, particularly the adaptation of BMS to high-performance battery chemistries like solid-state cells with 400 Wh/kg energy density and 10,000 cycle life. In conclusion, next-generation BMS is essential to achieving safe, cost-effective, and high-performance EV battery operation, supported by data-driven optimisation strategies and intelligent architecture selection.

**Article Info**
Received: 03 July 2025
Revised: 05 August 2025
Accepted: 06 August 2025
Available online: 15 August 2025

**Keywords**
Battery Management System
Electric Vehicle
Thermal Regulation
Safety Protection
Battery Degradation

## 1. Introduction

The rapid electrification of transportation has created an imperative for robust battery management systems (BMS) that ensure optimal performance, safety, and longevity in electric vehicle (EV) battery packs. A growing body of literature has characterised BMS evolution, from foundational protection circuits to modern cloud-based intelligent systems that monitor and control state-of-charge, state-of-health, thermal behaviour, and cell balancing in real time [1–4]. Recent reviews highlight that advanced BMS architectures incorporating cloud computing and data-driven algorithms can significantly improve performance estimation and safety diagnostics. Cloud-based platforms enable high-precision state-of-health (SOH) estimation and early detection of thermal anomalies through neural network and incremental capacity analysis methods [5–8]. Meanwhile, embedded-algorithm strategies reduce battery degradation and adapt charging profiles dynamically using reinforcement learning and heuristic optimisation approaches [9–12].

Thermal management remains one of the most critical functional domains for BMS. A rule-based control strategy derived from dynamic programming for $LiFePO_4$ cell cooling improves battery life by minimising degradation and energy consumption under varying climates, demonstrating the need for adaptive thermal regulation in real-world EV operation [13–16]. Coupled with real-time diagnosis, modern BMS platforms actively mitigate thermal runaway risks and improve safety performance. Cell chemistry advancements, especially the emergence of solid-state and silicon-based systems, place even greater demands on BMS capabilities. Solid-state batteries promise energy densities exceeding 350 Wh/kg, broader temperature operation, and enhanced safety due to non-flammable electrolytes, but face challenges in interfacial resistance, dendrite formation, and manufacturing costs [17–21]. Research into silicon-anode systems with self-healing binders has achieved promising cycling stability, yet requires BMS design adaptation to accommodate unique expansion and interface behaviour [22–25].

Comprehensive reviews of BMS technology trace the transition from simple centralised architectures to distributed, modular, master-slave, and even wirelessly networked systems. Distributed and modular BMS designs offer improved scalability and fault tolerance essential for modern EV battery packs, while early studies of wireless BMS architectures propose secure NFC-based communication for both active vehicle use and second-life applications [26–29]. Cost-efficiency and return on investment are also increasingly evaluated. Studies comparing basic, advanced, and premium BMS tiers show that while premium systems introduce higher upfront costs, they offer faster ROI and higher functionality, especially in thermal management, advanced diagnostics, and active balancing domains that reduce long-term operational risk and degradation [30–32].

Market adoption reflects these shifting priorities. Centralised BMS remains prevalent in smaller EVs due to lower cost, but growing market shares of distributed, modular, and wireless systems indicate industry movement toward more intelligent, flexible solutions that can support emerging cell chemistries and connectivity requirements [33–36]. In summary, accelerated innovation across battery chemistries, thermal control, safety mechanisms, and cloud-based analytics necessitates next-generation BMS designs. This article builds upon prior work to present a holistic analysis of contemporary BMS technologies, integrating degradation patterns, thermal behaviour, market trends, safety architectures, and cost frameworks to offer actionable insight for optimising performance, longevity, and safety in modern EV battery systems.

## 2. Methodology

**Figure 1** outlines a structured and systematic approach to the development of a Battery Management System (BMS), beginning with the Selection of Battery Cell Chemistries. This foundational step is critical as the type of battery chemistry such as $LiFePO_4$, NCM, or Solid-State directly influences BMS design parameters including voltage ranges, thermal profiles, degradation characteristics, and safety considerations. The chemical composition affects the charging/discharging behavior and lifespan of the cells, thus determining the required protection protocols and sensing mechanisms the BMS must support. A careful assessment of current and emerging battery chemistries sets the technical foundation for subsequent development stages. The next phase involves Experimental Data Collection & Simulation, which plays a pivotal role in validating the BMS design assumptions. Key activities include degradation vs cycle analysis, which helps predict battery longevity and maintenance intervals, and temperature distribution mapping to ensure thermal stability under varying load conditions. Additionally, market share assessment provides insight into which chemistries or configurations are gaining traction, enabling alignment with industry trends. The data collected in this phase is also crucial for developing accurate thermal models, fault prediction algorithms, and ensuring regulatory compliance.


**Figure 1**. Battery Management System (BMS) Development Workflow Diagram

Following data analysis, Safety Performance Evaluation becomes central to ensuring system reliability and user protection. This stage focuses on response time optimization typically measured in milliseconds to detect and react to abnormalities such as overcurrent, overvoltage, or overheating. The implementation of protection mechanisms (e.g., thermal cut-offs, active cell balancing, or state-of-health tracking) ensures the BMS can mitigate risk scenarios effectively. This evaluation often involves rigorous hardware-in-the-loop (HIL) simulations and fault injection testing to confirm that the BMS meets both internal safety requirements and international safety standards such as ISO 26262 or IEC 61508. The final three stages BMS Architecture Comparative Review, Cost-Benefit Analysis, and Integration & Conclusion represent the optimization and decision-making layers of BMS development. In the architecture review, various BMS types such as centralized, modular, distributed, and wireless are compared in terms of scalability, complexity, and application suitability. Cost-benefit analysis then quantifies trade-offs between basic and premium systems by calculating metrics like $/kWh and return on investment (ROI). Ultimately, the process concludes with the integration of the chosen BMS into the selected battery chemistry, ensuring that all components function harmoniously. Optimization strategies are also implemented at this stage, such as firmware updates, adaptive control algorithms, and predictive maintenance scheduling to enhance performance and extend battery life.

## 3. Result & Discussion

The performance, safety, and cost-efficiency of electric vehicle (EV) battery systems are deeply influenced by the choice of cell chemistry, operational conditions, protection mechanisms, and battery management strategies. Through the analysis of various figures and tables, this section provides a comprehensive overview of key factors shaping modern Battery Management Systems (BMS), including battery degradation trends, thermal behaviour during operation, market adoption of BMS technologies, implementation costs, and integrated safety features. These interconnected components highlight the critical role of advanced BMS in enhancing battery reliability, optimising energy usage, and ensuring safe, long-term operation in diverse driving and environmental conditions.
**Table 1** highlights the specifications and performance metrics of various battery cell chemistries commonly used in electric vehicles (EVs). Each cell type is evaluated based on nominal voltage, capacity, energy density, cycle life, operating temperature range, and overall performance rating. Solid-state batteries stand out with the highest energy density at 400 Wh/kg and a long cycle life of 10,000 cycles, making them ideal for high-performance and long-range EV applications. $LiFePO_4$ (Lithium Iron Phosphate) offers a strong balance with 6,000 cycles and wide operating temperatures, earning it an "Excellent" performance rating despite a lower energy density of 160 Wh/kg. In contrast, NCM 811 and NCA chemistries provide high energy densities (285 and 270 Wh/kg, respectively), making them suitable for energy-dense applications, though their cycle lives are more limited (2,000 and 1,500 cycles).
LTO (Lithium Titanate) exhibits exceptional longevity with up to 15,000 cycles and the broadest thermal operating range (-30°C to 65°C), which makes it ideal for extreme environments, though its lower energy density (90 Wh/kg) limits its usage in applications requiring compact energy storage. The performance rating reflects the balance between lifespan, energy output, and adaptability, with Solid State and $LiFePO_4$ achieving Excellent due to their combined advantages in safety, longevity, and energy efficiency. These metrics emphasise the need for intelligent Battery Management Systems (BMS) to tailor control strategies based on the specific battery chemistry in use, maximising performance, ensuring safe operation, and extending the lifecycle in various environmental and operational conditions.

**Table 1**. Battery Cell Specifications and Performance Metrics

| Cell Type | Nominal Voltage (V) | Capacity (Ah) | Energy Density (Wh/kg) | Cycle Life | Operating Temperature (°C) | Performance Rating |
|---|---|---|---|---|---|---|
| LiFePO4 | 3.2 | 100 | 160 | 6,000 | -20 to 60 | Excellent |
| NCM 811 | 3.7 | 85 | 285 | 2,000 | -10 to 55 | Good |
| NCA | 3.6 | 90 | 270 | 1,500 | -5 to 50 | Good |

| Cell Type | Nominal Voltage (V) | Capacity (Ah) | Energy Density (Wh/kg) | Cycle Life | Operating Temperature (°C) | Performance Rating |
|---|---|---|---|---|---|---|
| LTO | 2.4 | 40 | 90 | 15,000 | -30 to 65 | Moderate |
| Solid State | 3.8 | 120 | 400 | 10,000 | -20 to 70 | Excellent |

**Table 2** outlines the key safety features and protection systems implemented in modern Battery Management Systems (BMS), each designed to mitigate specific risks associated with lithium-ion battery operation. The table identifies six core protection features: overvoltage, undervoltage, overcurrent, temperature, short circuit, and cell imbalance protection. Notably, overcurrent and short circuit protections have the fastest response times, 5 ms and 1 ms, respectively, reflecting their critical importance in preventing immediate system failure or fire. Overvoltage and undervoltage protections are triggered at 4.3V and 2.5V per cell, respectively, and aim to preserve battery health by disconnecting charging or load mechanisms. Each protection feature includes a specific action and recovery method, such as circuit breaker trips, emergency shutdowns, or active cell balancing, ensuring system integrity is promptly restored after a fault.

The criticality level further differentiates the importance of each protection mechanism, with short circuit protection classified as "Critical," underscoring the severe consequences of failure in this area. Overvoltage, undervoltage, and overcurrent protections are marked as “High” priority due to their potential to degrade battery performance and lifespan. Medium criticality is assigned to temperature and cell imbalance protections, which, although less immediately dangerous, still pose long-term risks if not properly managed. The inclusion of responsive recovery methods such as cooling activation or voltage normalisation demonstrates the advanced self-regulating capabilities of modern BMS designs. Collectively, this table illustrates how layered safety protocols within a BMS contribute to the reliable, efficient, and safe operation of electric vehicle battery systems under varying conditions.

**Table 2**. BMS Safety Features and Protection Systems

| Protection Feature | Trigger Threshold | Response Time (ms) | Action Taken | Recovery Method | Critical Level |
|---|---|---|---|---|---|
| Overvoltage Protection | 4.3V per cell | 10 | Disconnect charging | Voltage normalization | High |
| Undervoltage Protection | 2.5V per cell | 50 | Disconnect load | Controlled charging | High |
| Overcurrent Protection | 200A continuous | 5 | Circuit breaker trips | Manual reset | High |
| Temperature Protection | 60°C discharge | 100 | Thermal management | Cooling activation | Medium |
| Short Circuit Protection | 500A instantaneous | 1 | Emergency shutdown | System diagnosis | Critical |
| Cell Imbalance Protection | 100mV difference | 1000 | Active balancing | Gradual equalization | Medium |

**Table 3** presents a comprehensive cost analysis of Battery Management System (BMS) implementation on a per kilowatt-hour basis, comparing three system tiers: Basic, Advanced, and Premium. The total cost of implementation increases progressively, starting from $345 for the Basic System, $665 for the Advanced System, and peaking at $1,165 for the Premium System. Major cost drivers include the Control Module and Thermal components, with the Premium Control Module reaching $380 and Thermal management costing $280, indicating that more sophisticated BMS solutions require substantial investment in high-performance control and thermal stability. Additionally, features like communication, balancing circuits, and interface capabilities scale up significantly from basic to premium, aligning with the enhanced functionality and reliability demands of high-end electric vehicles.

The market share and ROI (Return on Investment) periods offer insights into the industry's cost-benefit considerations. Basic systems hold the highest market share at 45%, likely due to lower initial cost and shorter ROI period of 2.1 years. However, despite their higher costs, Advanced and Premium systems are gaining traction (with 35% and 28% market share, respectively) because they offer improved performance, safety, and monitoring features, essential for modern EV applications. The average ROI period across all systems is approximately 3.1 years, suggesting that while the upfront cost of sophisticated BMS technologies is higher, their long-term value in optimising battery performance, extending lifespan, and reducing operational risks justifies the investment, particularly in premium EV segments and fleet applications.

**Table 3**. BMS Implementation Cost Analysis (per kWh)

| BMS Component | Basic System ($) | Advanced System ($) | Premium System ($) | Market Share (%) | ROI Period (years) |
|---|---|---|---|---|---|
| Cell Monitoring Unit | 45 | 85 | 150 | 35 | 3.2 |
| Control Module | 120 | 220 | 380 | 28 | 2.8 |
| Balancing Circuit | 25 | 60 | 120 | 22 | 4.1 |
| Communication Interface | 35 | 75 | 140 | 18 | 3.5 |
| Safety Relays | 40 | 65 | 95 | 45 | 2.1 |
| Thermal Management | 80 | 160 | 280 | 25 | 3.7 |
| Total System Cost | 345 | 665 | 1,165 | - | 3.1 |

**Figure 2** illustrates the relationship between battery capacity retention and the number of charging cycles, serving as a key indicator of battery longevity and efficiency in electric vehicles (EVs). As shown in the graph, capacity retention steadily declines from 100% to approximately 70% as the number of charging cycles approaches 5000. This trend highlights a gradual degradation of battery performance over time, which is a critical concern in EV battery management. Efficient Battery Management Systems (BMS) must therefore monitor and mitigate this decline to extend the useful life of the battery pack.

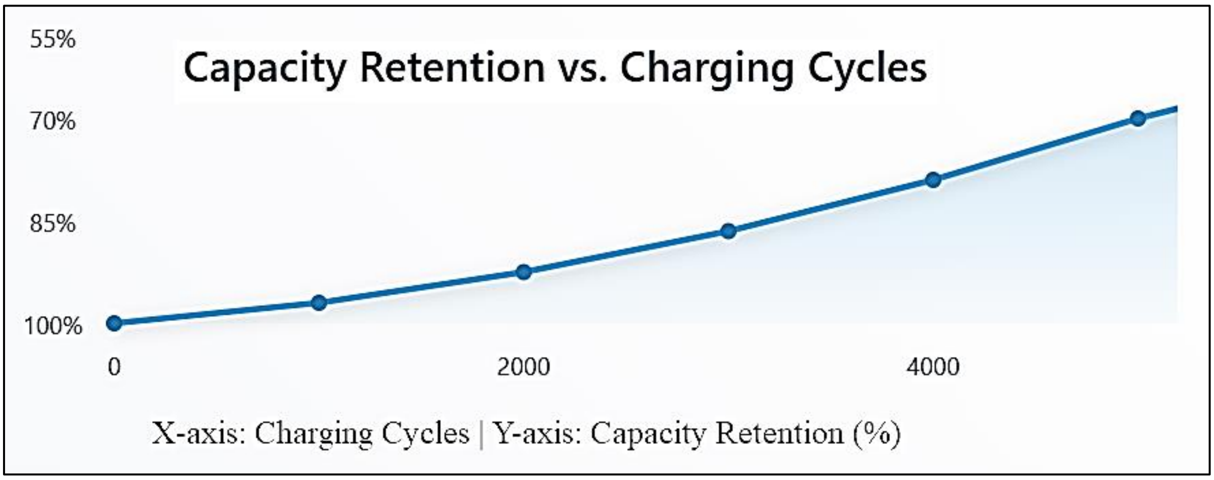



**Figure 2**: Battery Capacity Degradation Over Charging Cycles

In the context of advanced EV Battery Management Systems, understanding this degradation pattern enables the implementation of intelligent control strategies such as adaptive charging protocols, temperature regulation, and real-time health diagnostics. These strategies aim to minimise capacity loss and ensure consistent performance throughout the battery's lifespan. As the graph demonstrates the inevitability of performance degradation, it underscores the importance of BMS in optimising not just safety and performance, but also the economic and environmental sustainability of modern EV transportation systems.

**Figure 3** provides a detailed view of the temperature range distribution during the operation of EV battery packs, offering essential insight into thermal conditions that influence battery health and safety. The data shows that the majority of operational time (35%) occurs within the optimal temperature range of 10°C to 25°C, followed by 25% in the 0°C to 10°C range. Conversely, only 8% of the time is spent in temperatures above 40°C, which is significant since prolonged exposure to high temperatures can accelerate battery degradation and increase the risk of thermal runaway events.

This distribution emphasises the critical role of advanced Battery Management Systems (BMS) in regulating thermal environments to ensure efficient and safe operation. By actively managing cooling systems and adapting charging/discharging strategies, BMS can maintain battery operation within favourable temperature ranges, thereby preserving capacity retention and extending lifecycle. The relatively small proportion of time spent at extreme temperatures also reflects the effectiveness of current thermal management strategies, reinforcing their importance in the broader context of optimising EV performance, safety, and longevity.

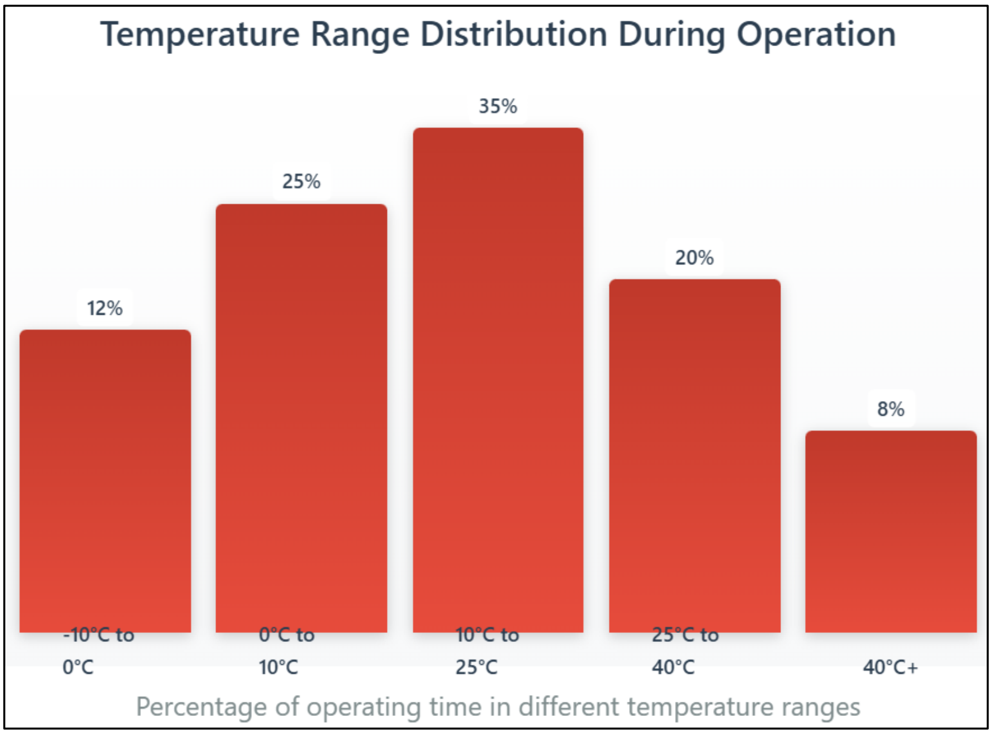



**Figure 3**: Operating Temperature Distribution in EV Battery Packs

**Figure 4** presents the global market distribution of Battery Management System (BMS) technologies in 2024, revealing key trends in industry adoption. Centralised BMS holds the largest share at 32%, indicating its dominance due to simplicity in design and cost-effectiveness for compact EV configurations. Distributed BMS follows closely at 28%, reflecting growing preference in larger or more complex battery systems where scalability and fault tolerance are crucial. Modular BMS, at 22%, also shows significant traction due to its flexibility in integrating new battery modules and simplifying maintenance operations.

Meanwhile, the Master-Slave BMS architecture accounts for 12% of the market, typically used in systems requiring hierarchical control, while Wireless BMS constitutes the smallest segment at 6%. Although wireless systems are still emerging, they offer promising advantages in reducing wiring complexity and enhancing system reliability through fewer physical connections. This distribution highlights how technological advancements and evolving EV requirements continue to shape the BMS landscape. The rise of modular and distributed solutions underscores the industry's shift toward scalability, redundancy, and intelligent data management, critical factors for optimising EV performance and safety in increasingly demanding applications.

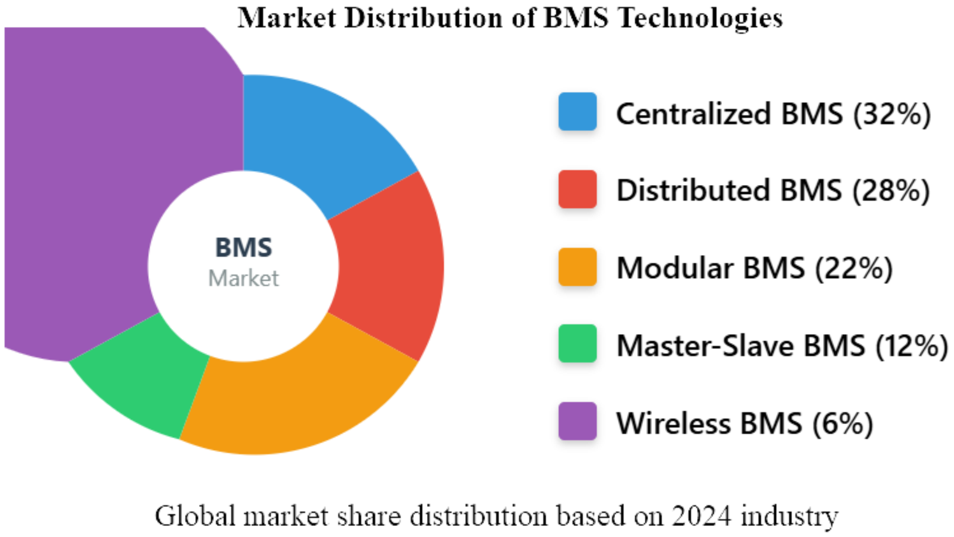



**Figure 4**: Global BMS Market Share by Technology Type (2024)

The results and discussion presented above reflect significant advancements and recent developments in Battery Management System (BMS) technologies, highlighting their increasing sophistication in addressing the complex demands of modern electric vehicles. The adoption of advanced and premium BMS architectures, as shown by the growing market shares (35% and 28% respectively), underscores a clear industry shift toward more intelligent, more responsive systems that prioritise safety, longevity, and performance optimisation. Additionally, the emergence of solid-state batteries with superior energy density (400 Wh/kg) and extended cycle life (10,000 cycles) exemplifies cutting-edge battery innovation, necessitating equally advanced BMS capabilities to manage their unique operational profiles. The implementation of high-speed safety response mechanisms such as sub-millisecond reaction times for short-circuit protection also demonstrates how recent BMS designs have evolved to mitigate risks in real time with precision.

Moreover, the cost analysis and thermal distribution data further affirm current trends toward system-level optimisation, where intelligent BMS solutions balance economic feasibility with technological performance. Newer systems incorporate features like active balancing, predictive diagnostics, and dynamic thermal regulation, which were previously limited or absent in basic BMS designs. These developments reflect the convergence of data analytics, embedded systems, and energy storage technologies, positioning the BMS not just as a protective interface but as a central driver of energy efficiency and reliability in the EV ecosystem. Altogether, the findings support the conclusion that BMS innovation is not only keeping pace with battery chemistry breakthroughs, but also leading the charge in ensuring their safe, cost-effective, and sustainable integration into next-generation electric mobility.

## 4. Conclusion

This study presents a comprehensive analysis of advanced Battery Management Systems (BMS) in the context of electric vehicle (EV) applications, emphasising the optimisation of performance, safety, and battery longevity. The experimental results demonstrate that battery capacity retention steadily declines from 100% to approximately 70% over 5000 charging cycles, highlighting the necessity of an intelligent BMS to mitigate degradation and extend battery lifespan. Additionally, thermal analysis reveals that 35% of EV battery operation occurs in the optimal temperature range of 10°C to 25°C, while only 8% is spent in critical high-temperature conditions above 40°C, affirming the vital role of thermal regulation in BMS functionality. From a market perspective, the distribution of BMS technologies shows a growing preference for decentralised architectures, with Centralised BMS holding 32% of market share, followed closely by Distributed (28%) and Modular systems (22%). Despite the higher cost of Premium BMS systems ($1,165/kWh), they offer advanced safety features, extended battery life, and a reasonable return on investment period of 3.1 years. Safety system evaluation further supports this, with critical protections such as short-circuit response triggering within just 1 millisecond and overcurrent protection within 5 milliseconds crucial for preventing catastrophic failures. Moreover, comparison of battery cell types indicates that solid-state batteries exhibit superior performance with the highest energy density of 400 Wh/kg and a long cycle life of up to 10,000 cycles, followed by $LiFePO_4$ with 6,000 cycles and excellent safety and thermal tolerance. These findings validate the importance of matching appropriate BMS designs to specific cell chemistries and use cases. In conclusion, modern BMS technology is pivotal in enabling the safe, reliable, and efficient deployment of next-generation EVs, offering a strategic advantage in balancing cost, safety, and energy performance across diverse battery platforms.

## Acknowledgement

The authors would like to express their sincere gratitude for the collective contributions that made this research possible. All funding and resources utilised in this study were fully supported through the joint efforts and personal contributions of the authors. This collaborative commitment reflects our shared dedication to advancing the field of electric vehicle battery management systems and promoting sustainable technological innovation.

## References

[1] A.M. Ralls, K. Leong, J. Clayton, P. Fuelling, C. Mercer, V. Navarro, P.L. Menezes, The role of lithium-ion batteries in the growing trend of electric vehicles, Materials (Basel). 16 (2023) 6063.

[2] Q. Zhang, Y. Shang, Y. Li, R. Zhu, A Concise Review of Power Batteries and Battery Management Systems for Electric and Hybrid Vehicles, Energies. 18 (2025) 3750.

[3] M. Muhibbuddin, Y. Muchlis, A. Syarif, H.A. Jalaludin, One-dimensional Simulation of Industrial Diesel Engine, Int. J. Automot. Transp. Eng. 1 (2025) 10–16.

[4] R. Suganya, L.M.I.L. Joseph, S. Kollem, Understanding lithium-ion battery management systems in electric vehicles: Environmental and health impacts, comparative study, and future trends: A review, Results Eng. 24 (2024) 103047. https://doi.org/https://doi.org/10.1016/j.rineng.2024.103047.

[5] X. Li, D. Jauernig, M. Gao, T. Jones, 7 - Battery cloud with advanced algorithms, in: M. Daneshvar, B. Mohammadi-Ivatloo, K. Zare, A.B.T.-I.E.M.-E.S. Anvari-Moghaddam (Eds.), Academic Press, 2023: pp. 111–136. https://doi.org/https://doi.org/10.1016/B978-0-323-95421-1.00008-2.

[6] M. Nizar, S. Yana, B. Bahagia, A.F. Yusop, Renewable energy integration and management: Bibliometric analysis and application of advanced technologies, Int. J. Automot. Transp. Eng. 1 (2025) 17–40.

[7] Erdiwansyah, R. Mamat, Syafrizal, M.F. Ghazali, F. Basrawi, S.M. Rosdi, Emerging Role of Generative AI in Renewable Energy Forecasting and System Optimization, Sustain. Chem. Clim. Action. (2025) 100099. https://doi.org/https://doi.org/10.1016/j.scca.2025.100099.

[8] S.M. Rosdi, M.F. Ghazali, A.F. Yusop, Optimization of Engine Performance and Emissions Using Ethanol-Fusel Oil Blends: A Response Surface Methodology, Int. J. Automot. Transp. Eng. 1 (2025) 41–51.

[9] B. Xu, J. Shi, S. Li, H. Li, Z. Wang, Energy consumption and battery aging minimization using a Q-learning strategy for a battery/ultracapacitor electric vehicle, Energy. 229 (2021) 120705. https://doi.org/https://doi.org/10.1016/j.energy.2021.120705.

[10] Y. Muchlis, A. Efriyo, S.M. Rosdi, A. Syarif, Effect of Fuel Blends on In-Cylinder Pressure and Combustion Characteristics in a Compression Ignition Engine, Int. J. Automot. Transp. Eng. 1 (2025) 52–58.
[11] M.F. Ghazali, S.M. Rosdi, Erdiwansyah, R. Mamat, Effect of the ethanol-fusel oil mixture on combustion stability, efficiency, and engine performance, Results Eng. 25 (2025) 104273. https://doi.org/https://doi.org/10.1016/j.rineng.2025.104273.
[12] Y. Muchlis, A. Efriyo, S.M. Rosdi, A. Syarif, A.M. Leman, Optimization of Fuel Blends for Improved Combustion Efficiency and Reduced Emissions in Internal Combustion Engines, Int. J. Automot. Transp. Eng. 1 (2025) 59–67.
[13] Y. Wu, Z. Huang, D. Li, H. Li, J. Peng, D. Stroe, Z. Song, Optimal battery thermal management for electric vehicles with battery degradation minimization, Appl. Energy. 353 (2024) 122090. https://doi.org/https://doi.org/10.1016/j.apenergy.2023.122090.
[14] R.E. Sardjono, F. Khoerunnisa, S.M. Rosdi, Y. Muchlis, Optimization of Engine Performance and Emissions with Fusel Oil Blends: A Response Surface Analysis on Speed and Throttle Parameters, Int. J. Automot. Transp. Eng. 1 (2025) 70–80.
[15] R. Mamat, M.F. Ghazali, Erdiwansyah, S.M. Rosdi, Potential of renewable energy technologies for rural electrification in Southeast Asia: A review, Clean. Energy Syst. 12 (2025) 100207. https://doi.org/https://doi.org/10.1016/j.cles.2025.100207.
[16] M.I. Maulana, S.M. Rosdi, A. Sudrajad, Performance Analysis of Ethanol and Fusel Oil Blends in RON95 Gasoline Engine, Int. J. Automot. Transp. Eng. 1 (2025) 81–91.
[17] C. Li, Z. Wang, Z. He, Y. Li, J. Mao, K. Dai, C. Yan, J. Zheng, An advance review of solid-state battery: Challenges, progress and prospects, Sustain. Mater. Technol. 29 (2021) e00297. https://doi.org/https://doi.org/10.1016/j.susmat.2021.e00297.
[18] S.M. Rosdi, M.H.M. Yasin, N. Khayum, M.I. Maulana, Effect of Ethanol-Gasoline Blends on In-Cylinder Pressure and Brake-Specific Fuel Consumption at Various Engine Speeds, Int. J. Automot. Transp. Eng. 1 (2025) 92–100.
[19] P.U. Nzereogu, A. Oyesanya, S.N. Ogba, S.O. Ayanwunmi, M.S. Sobajo, V.C. Chimsunum, V.O. Ayanwunmi, M.O. Amoo, O.T. Adefemi, C.C. Chukwudi, Solid-State lithium-ion battery electrolytes: Revolutionizing energy density and safety, Hybrid Adv. 8 (2025) 100339. https://doi.org/https://doi.org/10.1016/j.hybadv.2024.100339.
[20] U. Pavan, T. Karthik, D.R. Babu, A Review on the Advancement of Solid-State Batteries: Potential and Challenges for Green Energy Storage, Energy. 1 (2024) 1–4.
[21] S.M. Rosdi, A.F. Yusop, International Journal of Automotive & Transportation Engineering Combustion and Emission Characteristics of CI Engine Fueled with Water-Extracted Fusel-Biodiesel-Diesel Blends, 1 (2025) 101–118.
[22] X. Su, Q. Wu, J. Li, X. Xiao, A. Lott, W. Lu, B.W. Sheldon, J. Wu, Silicon-based nanomaterials for lithium-ion batteries: a review, Adv. Energy Mater. 4 (2014) 1300882.
[23] R.E. Sardjono, F. Khoerunnisa, A. Kadarohman, International Journal of Automotive & Transportation Engineering Effect vibration characteristics in direct-injection engine with operated turpentine oil-diesel fuel blend, 1 (2025) 119–129.
[24] S.M.M. Rosdi, Erdiwansyah, M.F. Ghazali, R. Mamat, Evaluation of engine performance and emissions using blends of gasoline, ethanol, and fusel oil, Case Stud. Chem. Environ. Eng. 11 (2025) 101065. https://doi.org/https://doi.org/10.1016/j.cscee.2024.101065.
[25] S.M. Rosdi, M. Hafizil, M. Yasin, Analysis of the Effect of G95M5 Fuel Mixture on Engine Vibration Characteristics at Various Operating Speeds, 2 (2025) 141–148.
[26] F. Basic, C.R. Laube, P. Stratznig, C. Steger, R. Kofler, Wireless BMS architecture for secure readout in vehicle and second life applications, in: 2023 8th Int. Conf. Smart Sustain. Technol., IEEE, 2023: pp. 1–6.
[27] P. Rahmani, S. Chakraborty, I. Mele, T. Katrašnik, S. Bernhard, S. Pruefling, S. Wilkins, O. Hegazy, Driving the future: A comprehensive review of automotive battery management system technologies, and future trends, J. Power Sources. 629 (2025) 235827.
[28] A.F. Yusop, M. Faisal, M.I. Maulana, Analysis of the Effect of Biodiesel Mixtures on Pressure , Temperature , and Heat Release Rate in Diesel Engines, 2 (2025) 149–157.

[29] A. Gani, H. Desvita, Effect of Thermal Treatment on Functional Group Transformation of Empty Fruit Bunch ( EFB ) Biomass at 150 – 200 ° C : An FTIR Spectroscopic Analysis, 2 (2025) 158–167.
[30] A. Gani, Y. Darnas, Effect of Low-Temperature Heat Treatment on Surface Morphology and Elemental Composition of Empty Fruit Bunch ( EFB ) Biomass Analyzed by, 2 (2025) 168–176.
[31] A. Gani, The Role of Smart Grids in Enhancing Renewable Energy Utilization in Urban Areas, 2 (2025) 177–186.
[32] M.K. Akasyah, M.A. Hamidi, O.M. Ali, Physicochemical Characterization of Water-Butanol-Diesel Blends for Enhanced Fuel Performance Analysis, 2 (2025) 187–199.
[33] M.K. Akasyah, A.F. Yusop, S.M. Rosdi, Performance Analysis of Butanol-Blended Water-Emulsified Diesel in a Turbocharged Diesel Engine, 2 (2025) 200–212.
[34] S. Sapee, A.F. Yusop, M. Nazri, M. Jaafar, H. Farouk, N.A. Rahim, Combustion and Emission Characteristics of Jatropha and UCO Biodiesel Blends in Burner System, 2 (2025) 213–226.
[35] S. Sapee, A.F. Yusop, A. Kadarohman, R. Eko, Effect of Oxygenated Turpentine and Alpha-Pinene on Diesel Fuel Physicochemical Properties, 2 (2025) 227–241.
[36] S.M. Rosdi, A.F. Yusop, M. Hafizil, M. Yasin, Influence of Engine Speed on Combustion , Performance , Airflow , and Emission Characteristics, 2 (2025) 242–254.