INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 08 (2025)

EPS IN ASSOCIATION WITH ARTIFICIAL INTELLIGENCE: A NEW CONCEPT IN AUTOMOTIVE SECTORS

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Abstract. In this paper, the position and development trend and prospect of Electric Power Steering (EPS) systems and Artificial Intelligence (AI) integration on the automotive market is discussed. EPS systems are a critical technology for increased fuel economy combined with safety and autonomous driving. Alongside AI, they can provide "smarter," more efficient vehicle control.

Keywords. EPS, industry, steer wheel, motor

Over the past decades, the global automotive industry has undergone significant technological advancement, particularly related to the digitization and automation of vehicle control systems. Traditional hydraulic steering systems are gradually being replaced by modern, energy-efficient, and intelligent systems like Electric Power Steering (EPS) due to their complexity, weight, high maintenance needs, and energy consumption.

Even though it started in the 1990s, a EPS tech is used by car makers a lot now. This tech uses electric motors to help steer wheel, so it makes it easier. Research shows that when looking at things, important points are gas use, how heavy the car is, and needing to steer well and quick. EPS systems, when you look at normal hydraulic systems, can help save gas by about 3 to 5 percent, and it makes. There is a big fall in the world's CO_2 air gas. Also, progress with the EPS tech has A new way to use smart machines is now here. Right now, people see these smart machines as something other than just a tool. AI in cars helps to make important choices by looking at what the driver does, it plays a big role in how the vehicle is controlled. Watch how people act, the road is bad or good, and any dangers right now to help make control better. The ongoing digital transformation in the global automotive sector, development of autonomous vehicles, shift to "green technologies," and the demand for fuel-efficient systems have made the integration of EPS and AI a strategic direction. By the end of 2024, EPS systems accounted for over 70% of the global automotive steering market, and this figure is expected to reach 90% by 2030.

This article explores the global integration of EPS systems and AI, their technological development stages, economic and ecological benefits, and future prospects. The analysis is based on modern statistical data, the experiences of global companies, and key market trends.

Advantages of EPS Systems:

- ✓ **Energy Efficiency:** Lower energy consumption compared to hydraulic systems, ensuring fuel savings.
- ✓ **Safety:** Enhanced adaptability and safety with AI integration.
- ✓ **Integration:** Seamless compatibility with ADAS (Advanced Driver Assistance Systems).
- ✓ **Maintenance:** Requires less technical maintenance, reducing operational costs.

EPS Optimization through AI:

- ✓ **User Adaptation:** Adjusts to the driver's steering habits, speed, and turning angles.
- ✓ **Safety Systems:** Automatically adapts to weather, road conditions, and other risk factors.

✓ **Autonomous Driving:** Forms the foundation for fully automated transport systems.

In 2024, the worldwide Electric Power Steering (EPS) market was worth about USD 25.32 billion and it showing no signs of slow down. Predictions say a steady yearly growth rate of 6.6% from 2024 to 2030. In fact, by the end of year 2024, market had already hit USD 29. 62 billion, and guesses show a big rise—up to the 45. 30 billion by a year of 2033 [1].

A nearer view of 2023 shows that EPS had a big 50.5% part of the world car steering market. A lot of this rise was pushed by big production places like China and India, where makers are strongly broadening their reach. At the same time, rules are also playing an important role. In European Union, strict fuel use and emission goals have made EPS systems more appealing. Similarly, in the United States, CAFE standards enforced by the National Highway Traffic Safety Administration (NHTSA) continue to push automakers toward adopting fuel-saving technologies.

Interestingly, the Collapsible EPS (CEPS) segment stood out in 2023, accounting for 57.2% of the EPS market. Its popularity largely stems from its adaptability and improved safety features, making it a preferred option for many manufacturers. At the same time, the Column Assist Type (C-EPS) dominated among the different system types. It's especially common in small to mid-sized passenger vehicles, where space efficiency and precision handling are critical. Speaking of passenger vehicles, they made up 68.6% of the EPS market in 2023, underscoring just how widespread the adoption of this technology has become. With growing demand for efficiency, comfort, and intelligent systems, EPS appears to be firmly on track as a defining component in modern automotive design. EPS technology is not just a convenient steering solution but one of the key technologies shaping the future of the global transportation system. Today, these systems are being developed as more complex and adaptable solutions integrated with AI. Below are key innovations, practices of leading companies, and future trends in this field:

Advanced EPS Technologies:

✓ **Adaptive Control Algorithms:** Automatically adjusts steering sensitivity based on driving behavior, e.g., lighter in urban areas, stiffer on highways.

✓ **Sensor Analysis Modules:** High-sensitivity systems monitoring steering input, speed, road conditions, brake pressure, and road signs.

✓ **Automatic Adaptation:** Changes control strategies based on weather (icy roads, rain) and vehicle load.

Industry Innovations:

✓ **Nexteer Automotive** developed a modular rack-assist EPS (mREPS) system with a flexible architecture suitable for various vehicle platforms.

✓ **DENSO** introduced a new-generation EPS-MCU motor control unit that improves system efficiency and meets ISO 26262 safety standards.

✓ **Toyota** developed the "One Motion Grip" steer-by-wire technology that eliminates mechanical steering connections, using AI to predict driver input and adjust response accordingly.

✓ **Bosch** integrated AI algorithms into its EPS systems for ADAS and autonomous driving, targeting Level 3–5 autonomous vehicles.

✓ **Tesla** equipped its electric vehicles with EPS systems featuring over-the-air (OTA) updates, continuously optimizing steering precision through AI-based algorithms.

Future Developments in EPS Technology:

✓ **Level 5 Autonomous Control:** EPS systems will be a key component for steering without human intervention, with AI making real-time decisions.

✓ **Personalized Control:** Automatically adjusts steering response and feel to each driver's unique style, greatly enhancing user experience.

✓ **Environmental Priority:** Electronic systems reduce fuel consumption and minimize emissions. Studies show EPS helps prevent nearly 10 million tons of CO_2 emissions annually.

✓ **Cybersecurity:** One of the main challenges of AI-integrated systems is protection against hacking. Future EPS systems will utilize cryptographic algorithms and real-time monitoring technologies.

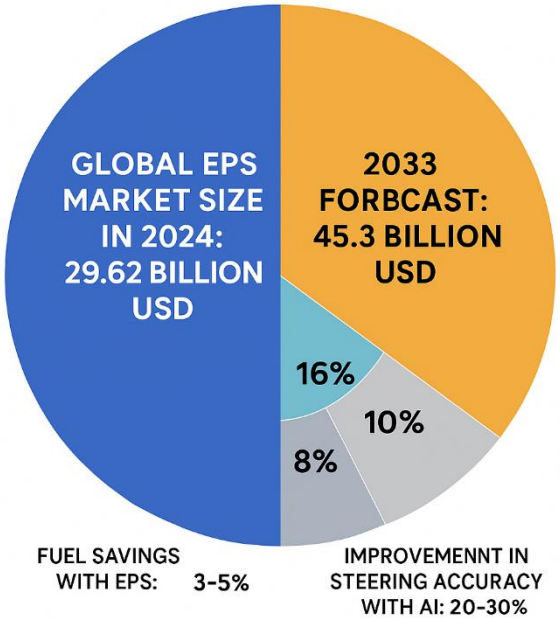

Diagram 1: EPS Market Size

✓ Global EPS Market in 2024: USD 29.62 billion

✓ 2033 Forecast: USD 45.3 billion; Annual Growth Rate – 5.4%

✓ EPS Share in Automotive Steering Market (2024): ~70%

✓ Fuel Savings with EPS: 3–5%

✓ Steering Accuracy Improvement with AI: 20–30% [2].

This analysis demonstrates that the integration of EPS and AI is not only a technological breakthrough but also a vital tool for global environmental sustainability, road safety, and driver comfort. Ongoing international research and the experience of major companies affirm that EPS technologies will become a cornerstone of future transport systems.

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