Disruptive Innovation : A Case Study of Autonomous Vehicles using IoT and ML Scenario

Ajeet K. Jain

Associate Professor, Computer Science and Information Technology, Acropolis Institute of Technology and Research Indore (India) ajeetjain@acropolis.in

JVS Srinivas

Professor, Keshav Memorial Institute of Technology, Hyderabad (India) srinivasjvs@kmit.in

Tadinada Phani Divya Sree and Sambidi Pranav Reddy tpds2003@gmail.com, pranavreddy0709@gmail.com

Scholar, Keshav Memorial Institute of Technology, Hyderabad (India)

Abstract

Autonomous vehicles are a disruptive innovation with the potential to fundamentally alter transportation and related industries. This includes changes in how vehicles are driven, how people access mobility, and how cities are planned. The integration of autonomous driving into existing transportation systems will require adjustments in business models, infrastructure, and regulations. This article emphasizes case studies for autonomous vehicles with multidimensional perspective and their relative capabilities and advancements using AI driven IoT and ML technology.

1.0 Introduction

Autonomous cars are self-driving vehicles that use advanced sensors, computing power, and artificial intelligence to navigate and operate without human input, making decisions in real-time to safely transport from one location to another.

Society of Automotive Engineers (SAE) have categorized the progression of autonomous driving into five distinct levels. Each level outlines the degree to which a vehicle assumes control over driving tasks and responsibilities from the driver, as well as the nature of interaction between the vehicle and the driver. Below is an explanation of these five levels of vehicle automation.

Level 0	"No Automation," means the driver is fully in control of the car, with no help from any driver assistance systems.
Level 1	"Driver Assistance," means the car can help the driver with one specific task, like steering or controlling speed, but not both at the same time. The driver is still responsible for most of the driving and must stay fully engaged.
Level 2	"Partial Automation," means the car can control both steering and speed at the same time.However, the driver must always pay attention and be ready to take control at any moment. The car can assist more, but the driver is still responsible for the driving.
Level 3	"Conditional Automation," means the car can drive itself in certain situations, like on highways. The driver doesn't need to pay full attention all the time, but must be ready to take over when the car asks for help.
Level 4	"High Automation," means the car can drive itself fully in specific boundaries, like within a city or designated area, without needing any input from the driver. The driver can relax or even do other activities, but the car is designed to handle all driving tasks on its own in those conditions.
Level 5	"Full Automation," means the car can drive itself anywhere, anytime, without any input from the driver. There's no need for a steering wheel or pedals, and the car handles all driving tasks on its own, so the driver can completely relax or do other things.

Table 1: Levels of Autonomous Driving

Manufacturing an autonomous car involves integrating numerous disruptive technologies that are not necessary for conventional vehicles. Automotive companies must prioritize these
innovative technologies and meticulously manage their implementation, as they represent the future of automotive design and production.

Some of the disruptive technologies include sensor technologies, Artificial Intelligence (AI) and Machine Learning (ML), advanced computing systems, mapping and localization technologies, communication systems, Human-Machine Interface (HMI), cybersecurity, energy Storage and Management etc.

These technologies are generally employed in the production of autonomous vehicles and are not typically used in traditional car manufacturing. Companies must recognize the shift in industry trends and adapt to these innovative, disruptive technologies. Embracing and incorporating these advancements into their manufacturing processes is crucial for staying
competitive and leading in the future of automotive technology.

2.0 Background:

Autonomous vehicles are revolutionizing transportation by reshaping how we move people and goods. Although fully driverless cars aren't quite here yet, they're getting closer as technology continues to advance. Innovations in artificial intelligence, computer vision, and edge computing are pushing these vehicles toward true autonomy, where they can operate without any human intervention. For car manufacturers, keeping pace with these
developments means not only integrating the latest technologies but also forging strategic
partnerships and ensuring extensive testing, both in simulated environments and on the road.

These vehicles rely on a suite of sophisticated technologies to drive themselves. They're equipped with sensors such as LiDAR, radar, and cameras to perceive their surroundings. LiDAR creates detailed 3D maps by emitting laser pulses, while radar uses radio waves to detect objects and measure their speed. Cameras capture visual details like road signs, lane markings, and other vehicles. The data from these sensors is then processed by the car's
computer systems, enabling the vehicle to recognize and interpret what's happening around it.

Artificial intelligence plays a critical role in decision-making, guiding the car through traffic by determining when to stop, go, or change lanes. High-definition maps and GPS technology ensure the vehicle knows its precise location and follows the correct route. The car's control systems take care of steering, acceleration, and braking, ensuring it stays on course and
navigates safely. All these elements work together to allow the car to operate autonomously, with safety systems in place to manage unexpected challenges on the road.

3.0 Case Studies:

1. Waymo: Autonomous Ride-Hailing in Phoenix, Arizona:

Background: Waymo, a subsidiary of Alphabet Inc., has been at the forefront of autonomous vehicle development. Since 2017, the company has been operating a fleet of fully
autonomous taxis in Phoenix, Arizona, as part of its Waymo One service. Main Points:

Waymo is a game changer in vehicles in Phoenix by providing practical implementation of
autonomous vehicles in urban habitat.Vehicles were appreciated by early customers but faced challenges depending on the area, traffic conditions and regulatory environment.Safety and real-world conditions were the company's prior focus.

2. Tesla: Autopilot and Full Self-Driving (FSD) Capabilities:

Background: Tesla is one of the most prominent names in the autonomous vehicle market, offering Autopilot and Full Self-Driving (FSD) features in its electric vehicles. These systems allow for varying levels of automation, from lane-keeping to full navigation on highways and city streets.

Main Points:

Tesla's approach to autonomy has been both innovative and controversial. While the
company's vehicles are equipped with advanced AI and sensor systems, several high-profile accidents have raised questions about the safety and reliability of Tesla's autonomous features. Tesla's experience highlights the challenges of developing and deploying
autonomous technology while managing public perception and regulatory scrutiny.

3. Baidu Apollo: Autonomous Vehicles in China:

Background: Baidu, China's leading search engine company, has developed the Apollo platform, an open-source autonomous driving initiative. Baidu has partnered with multiple automakers and technology companies to test and deploy autonomous vehicles in China, particularly in Beijing.

Main Points:

Baidu's Apollo project showcases the importance of collaboration in advancing autonomous vehicle technology. By working with various industry players, Baidu has accelerated the development and testing of autonomous systems. The project also highlights the role of government support, as Chinese authorities have provided favorable regulations and
infrastructure to facilitate autonomous vehicle testing and deployment.

Fig:1 Radar graph of case studies
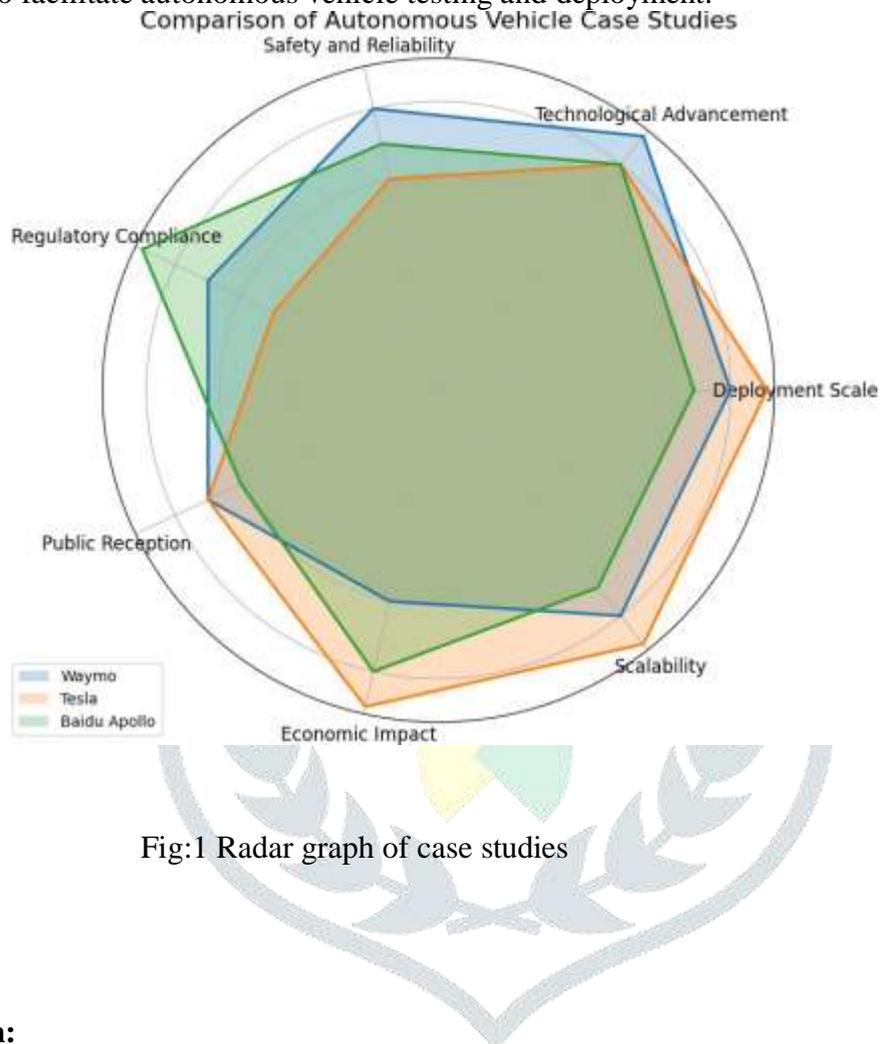
4.0 Conclusion:

The meteoric rise in self-driving cars is due to the evolution of technologies like Artificial Intelligence, machine learning and connectivity technologies (5G). Real-time data processing, enhancing decision-making and safety enabled using these technologies. Autonomous
vehicles implement IOT for navigation, decision-making, and vehicle-to-everything(V2X) communication, making them more safe and efficient.

Electrification, autonomous driving, diverse mobility solutions, and connectivity are likely to increase revenue streams by up to 30 percent by the year 2030, whereby the growth in shared mobility, fit-for-purpose vehicles, and autonomous cars will drive this growth. However, this comes with challenges in the form of regulatory issues, consumer acceptance, and technological readiness. Unless traditional manufacturers innovate, forge strategic partnerships, and adapt new business models, they will not remain competitive in such changing times.

In a nutshell, the autonomous vehicle market is about to see massive development and will be driven by disruptive technologies alongside changing consumer preference. How well the
industry is able to stomach these changes will dictate the pace at which autonomous vehicles become real across the masses.

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