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RESEARCH ARTICLE

AUTONOMOUS ELECTRICAL VEHICLES, CYBERTHREATS, AND THE FUTURE OF SMART LOGISTICS

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ABSTRACT

The advancement of technology allows for the adoption of smart systems operations exemplified by using autonomous vehicles in the logistics industry. Companies have embraced innovative technologies through the improvisation of truck platooning using autonomous networking. Approximately smart logistics using autonomous truck monitoring has attracted various benefits, such as reduced accidents and timely delivery of products to customers. However, it has drawbacks to high implementation costs and risk of data protection. Amazon has acquired the patent right for autonomous lane switching alongside testing various fully autonomous trucks in delivery through a partnership with independent manufacturing companies such as Embark.

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INTRODUCTION

The world has embraced technology in various business activities around the globe. The revolution of e-commerce comes along with the modernization of logistics as organizations and businesses seek to unravel the mystery of tracking products from the manufacturer to the ultimate consumer. The increase in online scams within logistics services has necessitated the demand by consumers to track goods ordered up to delivery, a feature necessitated by the application of artificial intelligence, machine learning, and computer vision technology (Monios, 2020). Intelligent technology assures smart logistics, facilitating autonomous vehicles for the delivery of goods within the supply chain ecosystem. Original Equipment Manufacturers (OEMs), alongside the manufacturers and suppliers, can improve the reliability of delivery schedules through mapping and intelligent traffic, which helps evade bottlenecks caused by traffic delays. The Internet of Things (IoT) has facilitated the tracking of goods from the manufacturer, container, haulage, and various delivery points (Dash, 2022). Automotive companies have championed smart logistics in manufacturing automotive vehicles, as exemplified by Embark, which has facilitated smart logistics in Amazon, an international logistics company (Dash, 2022). Amazon has adopted autonomous vehicles in logistics amid the Covid-19 pandemic, which has crippled deliveries through the imposition of lockdowns and restrictions (Castritius *et al*., 2020). As outlined below, e-commerce has revolutionized logistics to incorporate autonomous electric vehicles, as in Amazon. Autonomous logistics and transportation continue to rise alongside the advancement in technology. For instance, the transportation segment ruled the market with a significant rise in revenue owed to autonomous transportation, registering 93.8% revenue share application. The technology has fast spread as it has registered approximately 45% of the market share in the United States in 2021 due to government support and generated customer acceptance (Chauhan, 2021; Dash, 2022). The revenue generated in the United States from autonomous vehicle logistics accounted for $25.14 billion, as a study forecasted revenue of $193.97 billion by 2030. The growth of smart logistics alongside autonomous vehicles has presented a 25.7% growth, forecasting market share growth (Dash, 2022a; James, 2017). The statistics arise from fully autonomous and semiautonomous technology in the logistics industry.

Truck Platooning: The AVs technology in the logistics industry has incorporated the modern form of electrical coordination. The automated mode of transport and logistics include platooning. Platooning entails automotive technology involving two or more trucks circulating within a road in a joint and coordinated format. It incorporates cameras, radar, and wireless linkage for communication among the trucks through WIFI technology (Castritius *et al*., 2020).

The first vehicle connects with the various other trucks behind the platoon through the wireless connection. This mode of autonomous vehicle logistics requires the first vehicle to have a physical driver who determines the movement of the second truck connected to an autonomous truck. The platooning technology incorporates vehicle detection and anti-collision alongside lateral control technologies, which increase truck safety (Castritius *et al*., 2020; Panda, 2022). The modernization of the technology allows linkage and unlinking, allowing other road users to cross between the platoon vehicles. Through the utilization of artificial intelligence, the technology allows for vehicle detection, anti-collision, and lateral control technologies, which have increased road safety. The platooning technology has attracted various benefits upon its commercialization. For instance, the technology enables fuel saving as the driving of the commercial vehicle becomes lighter with the use of renewable energy alongside the trucks depending on the first truck, which experiences the highest air friction and hence limited resistance (Taylor, 2021; Duong, 2020). The trucks have efficient driving allowing for circulation at a constant and regular speed as the trucks keep the same speed and acceleration alongside maneuvers and speed recovery (Bennett, 2021). This smart feature allows for the timely delivery of products to the ultimate consumer with limited delays. The smart platooning truck system enables vehicle detection and automatic braking using the sensor, which activates the detection of slow and stopped vehicles, reducing accidents. Accidents have caused customer dissatisfaction due to the failure of the logistics company to deliver the products after accidents.

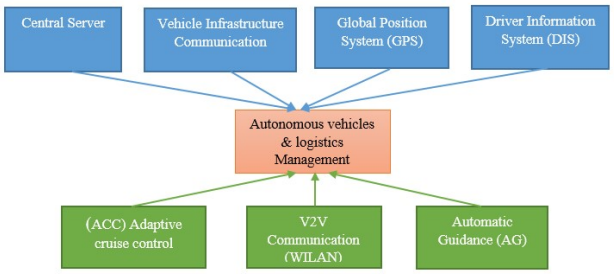

Fig. 1. Truck Platooning workflow

Autonomous Trucks Networking: Smart logistics allow for autonomous truck networking with the advancement in technology likely to facilitate the safe driving of autonomous vehicles through autonomous vehicles. For instance, through the 5G technology, the networked road traffic systems facilitate real-time communication between vehicles and share location alongside speed and security concerns (Kim, 2022). The coordination and networking enable the availing of potential danger sources exemplified by blind spots as vehicles to get information early hence autonomous intervention (Monios, 2020). Therefore, networking facilitates security improvement among autonomous vehicles.

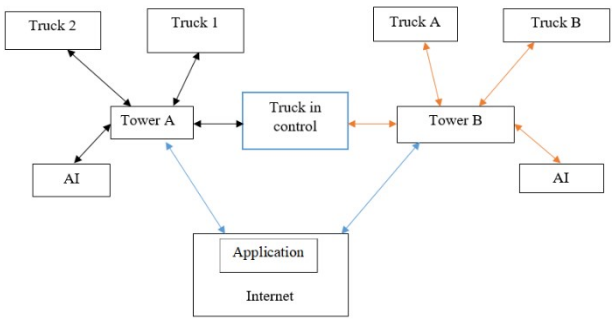

Fig. 2. Autonomous Trucks Networking

Operation Systems of AVs: A control center in any AV system design instructs AVs on how to route, operate, and charge in the transportation network depending on specific product delivery needs. The entire delivery process may be divided into two stages: planning and implementation (fig 3). The control center in the former establishes the routing and charging strategy for AVs as follows.

Each AV is considered to be parked in a specific depot, where the products to be transported are kept. The procedures outlined in (Möller, 2022) and (Schniederjans, 2020) are used to load goods into trucks. The control center then collects the necessary information about the transportation network, AVs, and logistical needs. At this moment, the participating digital units submit their estimated extra energy to the system, which can be utilized. Following that, it develops the routing and pricing plans for the AVs based on logistic requirements and real-time traffic circumstances. Finally, the AVs carry out the implementation plans. During the installation, information such as traffic speeds and DG energy projections must be updated in real-time at times. In such instances, the control center can recalculate the routing and billing strategy based on fresh data.

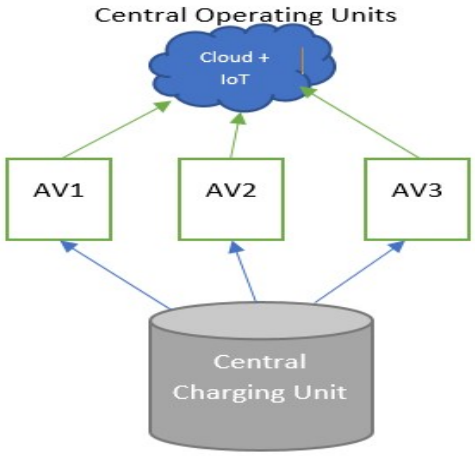

Fig. 3. Central Planning and Implementation unit in a warehouse

All these AV operations are controlled by cloud-based IoT techniques in all big and medium size warehouses with a central planning unit. In some SCM units, these are autonomous by Artificial Intelligence, and in some, these are very Hybrid in nature (Human + AI) (Simons, 2021; Tenorio, 2021).

Benefits of Autonomous Vehicles in SCM: Autonomous vehicles provide insight into the various opaque areas within the logistics industry. Through the utilization of smart logistics, autonomous vehicles have artificial intelligence fitted and advanced sensors helping provision datasets on the logistics (Panda, 2022) in modern Supply Chain Management (SCM). Incorporating smart technology opens logistics insight development, which seeks to highlight the existing gaps within the industry. Identifying the gaps will open the manufacturer to various regions where the company can improve. Besides, the gaps could highlight the opportunities the logistics company can actualize to increase the revenue generated from the logistics network.

Autonomous vehicle technology in logistics helps manage scarce and valuable resources in transit. Autonomous vehicles (AVs) provide an opportunity to improve delivery by using artificial intelligence to map the client and delivery location and assess the best route with little traffic jams. The aspect eliminates the challenges from traffic jams and insecurity for the various scarce equipment and material, ensuring on-time and safe delivery (Chung, 2021; Tsolakis, 2018). The incorporation of autonomous vehicles in the logistics also helps in the assessment of the unprecedented insights on the raw material location and the exact time for the availability of the materials for production, which helps in improving production and delivery of goods alongside building customer confidence depending on the distribution and delivery schedules. Advancements in technology to incorporate autonomous smart logistics will attract more entrants into the supply chain industry, reducing the monopoly while increasing the competition as companies strive to meet customer specifications. Various companies have dominated the logistics industry hence the failure in customer satisfaction and the introduction of smart logistics with autonomous vehicles breaking the monotony (Panda, 2022).

Besides, few barriers to market entry with autonomous vehicles will exist, spurring innovation in the supply chain industry. The adoption of AVs has led to introduction of new members into various sectors, such as hardware, software, and services (Kim, 2022; Wang, 2019). For instance, the adoption of AVs by Nvidia in the OEM end spectrum has facilitated collaboration with various manufacturers, leading to the production of heavy commercial trucks, as witnessed with the Paccar collaboration.

Importance of Cybersecurity in AEVs: Autonomous electric car ecosystems function like organisms do, with several systems collaborating under conditions that have improved and changed through time. Based on the dependability of the data going through it, it is an effective system. These systems are vulnerable to vulnerability and manipulation, much like living things. These dangers can take many different forms; some are haphazard and unintended, while others are quite deliberate and concentrated (Wang, 2020).To remain healthy and functional, vehicle ecosystems must be protected. The threats must be identified before they can be protected. The mechatronic systems of an autonomous EV must be attacked in order to detect vulnerabilities and develop effective solutions and countermeasures, similar to how a biological creature creates antibodies and grows stronger after being infected with a disorder.

Everything in today's smart logistics is powered by IoT and sensor devices, automation systems, and AI. As a result, cyber security is critical to all of the following functions:

- Traffic data for vehicles
- Collecting data on e-procurement, replenishment, and shipping
- Data from smart sensors for vehicle-to-vehicle communication
- Automated tracking and alert monitoring etc.

These are only a few of the numerous cloud service application categories that make up the core process. All of the foregoing information can be leaked or muffled due to hacks and malpractices, posing major problems for the entire warehouse ecosystem. Hence, improved cyber mechanisms are critical for the good health of the operation of warehouse management and supply chain processes.AI and machine learning are two emerging technical advancements that will have a significant impact on supply chain operations and other business activities in the future, which will also play a key role in preventing cyber threats (Dash, 2022a; Ansari, 2022).

Disadvantages of Autonomous Vehicles in Logistics: The introduction of autonomous vehicles in logistics has extensive risks associated with the technology. For instance, autonomous logistics vehicles have high data protection risks (Dash, 2022). The connection of autonomous vehicles to the whole environment challenges data protection from fraudsters and hacking, which could compromise product delivery (Monios, 2020; Seyedi, 2017). AVs technology has incorporated the customer data on the website; hence the compromising of the system by the cyber criminals could lead to the loss of confidential products and harm to the customer through analysis of bio cybercriminals. The improvisation of AVs in the logistics industry demands an extensive investment. For instance, the comprehensive technology demands 5G network coverage, which exposes the company to operation costs. The company may require the assistance of the government to invest in the infrastructure necessary to support autonomous vehicles, such as the 5G coverage across highways (18, 23). Besides, the company has to invest in autonomous vehicles, which demand high cash for acquisition and maintenance alongside the personnel to manage the automated system.

A conceptual model of the digital warehouse ecosystem. A robust information infrastructure must be built with careful coordination and smart resource utilization to address contemporary supply chain difficulties. Most of the components for a future integrated system are already in place; the next phase is to standardize or translate these components and agree on governance structures and exact definitions of roles and duties.

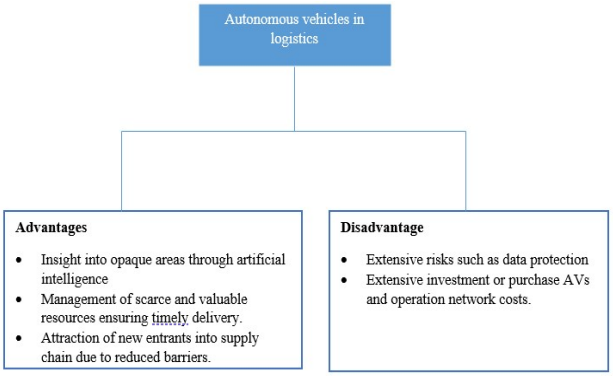

Fig . 4. Advantages and disadvantages of AV logistics

Amazon - A Comprehensive Study: Amazon boasts of the extensive control of its market, which has met various challenges prompting the move to intelligent logistics coupled with autonomous vehicles. Amazon has drafted an outline of the extension of the company products' trucking through autonomous long-haul trucking and last-mile delivery for customers. Autonomous technology in vehicles incorporates the user interface between self-driving cars and a large ecosystem with an extension to the car connection hosted by the cloud storage as accelerated by the Covid-19 pandemic (9). Amazon has already tested various technologies to blend with the autonomous vehicle technology in vehicles, as exemplified by pick-and-pack robots within warehouses, long-haul trucks, and last-mile delivery drones and vehicles. Although Amazon has built everything to adopt smart logistics, the company has attracted third-partycompaniesto produce self-driving vehicles. The company incorporated the move to transit to autonomous logistics through the application of autonomous lane–switching technology in 2015 with a consequent patent grant in 2017. The international company hence opened a partnership with various automotive vehicles in 2018, which included Toyota. It demoed the company in designing the e-Palette, a multifunction autonomous minivan for the supply of goods, vehicles, and mobile offices (Wang, 2019; Vasco, 2016). In 2018, Amazon filed a patent for the personalization of the autonomous vehicle experience, which aimed at enabling the individualized passenger profile to detect customer identity through facial recognition, voice recognition, and biometric data (Dash, 2022). In 2019, Amazon formulated a six-wheeled electric–powered delivery robot capable of navigating along the sidewalks and delivering packages to the door through which customers can open and receive their packages. Amazon has already utilized some autonomous vehicles in the trucking of logistic products. For instance, in 2019, motorists encountered a self-driving in Arizona bearing Amazon prime logo. By the time of capture, Amazon demonstrated a working relationship with Embark, a multinational company building self-driving trucks alongside their partnership with shipping companies. The mode of the operations partnered with Amazon entailed the Embark human driver picking the goods at the warehouse and driving through the local traffic onto the highway, from which they pulled into a rest stop (4). Upon disengaging from active driving, the embark driver attaches the trailer onto Embark truck, with the Embark employee only acting as a self-driving truck for hauling cargo across the highway to the cargo destination, onto which the transfer back to the local driver occurs (Bennett, 2021). However, the company has fostered continuous research and innovation, allowing for a completely autonomous process.

Conclusion

Ultimately, the autonomous vehicle technology improvisation in logistics entails incorporating self-driving vehicles blended with artificial technology, machine learning, and cloud storage system for remote sensing. Smart logistics has featured in the truck platooning facilitated by autonomous vehicle networking. Smart logistics using technology has enabled timely product delivery and reduced accidents caused by trucks, although the technology has risks in cyberattacks.

Amazon logistics company has demonstrated an investment in autonomous technology through the application of patent rights and collaboration with various self-driving trucks investment.

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