CPE 4750: Introduction to IoT System, Spring 2025

**Mid-Term Research Report**

**Title: IoT in Transportation Safety**

Bryce Owensby, Julia Johnson, Salini Ambadapudi

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Electrical and Computer Engineering

Kennesaw State University

Faculty: Dr. Jeffrey L Yiin

1. **Introduction**

The transportation industry is vast, providing a wide range of services that facilitate the movement of people and goods. This includes road transport such as cars, trucks, and buses; rail transport like trains; air transport with airplanes; and maritime transport, such as ships. Given the constant movement of these vehicles and the extensive infrastructure required, the implementation of the Internet of Things (IoT) has surged in recent years. IoT technologies are being increasingly adopted to enhance safety, optimize routes, reduce costs, and minimize environmental impacts within the transportation sector.

1. **Motivation of Research**

As a team, we realized that the transportation industry is extremely essential to the economy as a whole. Every day we see it at work as truck drivers, airplanes, and trains are constantly moving night and day as they are all necessary for any industry’s needs. We hope to find ways to not only make the jobs they do easier, but also safer and more consistent. With the number of people involved in this industry, each of our team members knows a family member or friend that makes a living through some form of transportation company or organization.

1. **Transportation Industry and its Roadblocks**

Urban areas are increasingly burdened by traffic congestion, leading to significant inefficiencies, time delays, and higher amounts of pollution. According to the Global Traffic Scorecard, the average person spends more than an extra 60 hours in traffic due to congestion, which in turn costs a person more than $700 in fuel yearly. Taking into consideration that many organizations will have numerous fleets of large trucks active at any given time, these inefficiencies compound into massive costs. The rapid growth of cities has exaggerated these issues, and despite the potential for IoT-based solutions to improve real-time traffic management, many cities still lack integrated systems that could address these problems effectively.

Safety is another critical concern within urban transportation, where accidents and unsafe driving patterns continue to pose serious risks. IoT innovations, such as smart traffic lights that adapt to traffic flow, collision avoidance systems, and connected vehicles, have the potential to significantly improve safety outcomes. Yet, a significant barrier to their effectiveness is that many vehicles and infrastructure components are still not equipped with the necessary technologies. As a result, the full benefits of these IoT solutions have not been realized on a large scale.

The environmental impact of transportation is also a growing concern, as emissions from vehicles contribute significantly to climate change. The push for greener alternatives, such as electric vehicles (EVs) and smart traffic management systems, is gaining momentum, but the adoption of these solutions remains slow and inconsistent. While EVs offer the promise of reducing emissions, their adoption is hindered by high upfront costs, limited charging infrastructure, and consumer hesitancy. Similarly, smart traffic management systems that could reduce fuel consumption and lower emissions are still in the early stages of implementation in many areas.

In terms of cost and efficiency, high operational costs in logistics and public transportation continue to be a significant challenge, particularly in freight and urban transit systems. IoT solutions hold promises for improving route planning, optimizing fuel usage, and enabling predictive maintenance to reduce costs and increase efficiency. However, businesses are often hesitant to adopt these technologies due to concerns about initial investment costs and uncertainties surrounding the return on investment. The long-term benefits of these systems may not be immediately apparent, leading to reluctance in fully embracing IoT-based solutions.

As transportation systems become more interconnected through IoT, cybersecurity becomes an increasingly critical issue. The more reliant transportation systems are on digital connectivity, the more vulnerable they become to cyberattacks. A successful cyberattack on transportation infrastructure could have disastrous consequences, including traffic disruptions, accidents, and potential loss of life. Ensuring robust cybersecurity measures are in place is essential to protect these increasingly connected systems from malicious threats and safeguard public safety.

1. **Industry Problems and Current Solution Analysis**

The transportation industry, especially trucking, is one of the deadliest jobs in the United States. Drivers are at a high risk for accidents, homicides, and other violent events. According to the U.S. Bureau of Labor Statistics, employees in the transportation and moving materials industries had the highest fatality rate in 2023. As seen in Figure 1, the risks of driving, especially for long periods of time, also puts non-working commuters at an increased risk of injury or death.

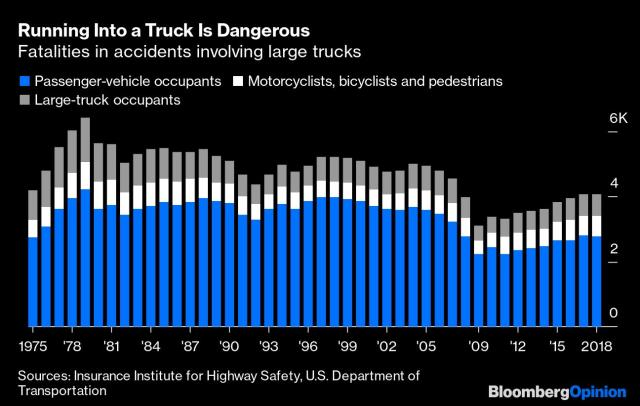


Figure 1: Fatalities Involving Accidents with Large Trucks

The risks of this industry aren’t isolated from just driving though. Other hazards, such as material handling, exist as well. There are risks of injury when handling bulky or heavy items. Workers may be expected to move high volumes of fragile, toxic, or flammable materials as well. These materials can injure the workers if they are mishandled at any point in the moving process. Exposure to toxic or cancerous materials over prolonged periods of time may also provide long-term health problems for workers even after they have retired.

By utilizing IoT technology, such as smart traffic signals and connected vehicles, real-time monitoring and management could alleviate congestion, streamline traffic flow, and reduce the environmental impact caused by idling vehicles. However, the widespread implementation of these technologies remains limited. A 2024 document published by IEEE, describes a major effort to convert a city in India into a smart city by implementing IoT devices to detect the number of vehicles passing through intersections and creating predictions for upcoming traffic jams.

While some non-IoT solutions already exist, such as requiring portable fire extinguishers and regulations for emergencies and hazardous materials, they aren’t always effective. A fire extinguisher will not help a toxic chemical spill, and a fire extinguisher will not be enough to extinguish the resulting inferno from a crashed truck carrying flammable liquids or gases.

Our goal is to create an IoT solution that will decrease the associated risks of transportation and increase emergency prevention and response time. Most current IoT solutions target enhanced tracking, fuel management, and fleet management. While these implementations do have value, they do not do much to enhance safety in the industry. Our solution will prioritize worker safety, which in turn will decrease risks and costs associated with injuries and accidents on the job.

1. **Proposed IoT Solutions**

Real-time Fleet and Cargo Tracking

* GPS-based IoT solutions can provide real-time location tracking for fleet management, reducing theft risks and optimizing delivery routes.
* Smart cargo sensors can monitor environmental conditions (e.g., temperature and humidity) to ensure the safe transport of sensitive goods such as pharmaceuticals and perishable food items.
* Accelerometers can track rapid vibrations as a way to detect poorly maintained roads that could cause safety issues with larger vehicles. Once a road is seen to be of a low quality, an alternate and safer route can be found.

Smart Monitoring and Predictive Maintenance

* IoT-enabled sensors can be integrated into vehicles to monitor engine performance, tire pressure, and fuel consumption in real-time. Automated alerts to drivers and fleet managers can ensure timely maintenance and replacements.
* Predictive maintenance using AI-driven analytics can detect early signs of wear and tear, reducing the likelihood of breakdowns and accidents.

Vehicle Emergency Alert System

* IoT-enables sensors plugged into vehicles to monitor various data points, such as speed, vehicle orientation, vehicle sway, internal temperature, etc. to detect unusual or potentially dangerous events such as vehicle flipping, accidents, or driver medical events.
* If an unusual activity is detected, an alert is sent to both the driver and company. If the company is alerted, they can contact the authorities with details of the event in case of emergency. In cases of false alarms, the driver will have an allotted time period to disable to alert before anyone is contacted.
* Drivers can also send silent emergency alerts in the events of a failed automated alert or other non-detectable emergencies such as carjacking and kidnapping.

1. **Conclusion**

The transportation industry is a critical component of the global economy, but it faces numerous challenges, including traffic congestion, safety risks, high operational costs, and environmental concerns. While IoT technologies have the potential to address these issues, their widespread adoption has been slow due to financial, technical, and regulatory barriers.

Among the various solutions proposed, the Vehicle Emergency Alert System stands out as the most impactful due to its potential to enhance safety and emergency response capabilities. By focusing on IoT-enabled vehicle monitoring, automated emergency alerts, and real-time driver assistance, we can create a system that significantly reduces response times during critical situations.

Moving forward, our primary focus will be on the development and implementation of the Vehicle Emergency Alert System. Through further research, collaboration, and investment in innovative technologies, we aim to accelerate the adoption of IoT-driven transportation solutions, ultimately building a safer, smarter, and more resilient transportation ecosystem for the future.

**References**

Inrix. (n.d.). *Global Traffic Scorecard*. INRIX. <https://inrix.com/scorecard/>

James. (2024, October 6). *14 recent cyber attacks on the Transport & Logistics Sector*. Wisdiam. <https://wisdiam.com/publications/recent-cyber-attacks-transport-logistics-sector/>

Parkyddigital. (2024, February 15). *Navigating the future: The role of IOT in transportation and Logistics*. ServiceCentral. <https://www.servicecentral.com/news/role-of-iot-in-transportation-and-logistics/#:~:text=IoT%20enables%20real-time%20tracking,that%20may%20arise%20during%20transit>.

Singh, S., Singh, B., Ramandeep, Singh, B., & Das, A. (2019, July 29). *Automatic vehicle counting for IOT based Smart Traffic Management System for Indian Urban Settings | IEEE Conference publication | IEEE Xplore*. IEEEXplore. <https://ieeexplore.ieee.org/document/8777722/>

*Transportation Industry Risks*. MEMIC. (n.d.). <https://memic.com/workplace-safety/resource-library/transportation/transportation-industry-risks>

*Trucking industry - related safety and health info*. Occupational Safety and Health Administration. (n.d.). <https://www.osha.gov/trucking-industry/safety-information>

U.S. Bureau of Labor Statistics. (2024, December 19). *Census of fatal occupational injuries summary, 2023 - 2023 A01 results*. U.S. Bureau of Labor Statistics. <https://www.bls.gov/news.release/cfoi.nr0.htm\>

Fox, J. (2020a, February 21). *Trucking is deadly for truckers, and lots of other people*. Yahoo! Finance. <https://finance.yahoo.com/news/trucking-deadly-truckers-lots-other-143016325.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAADfw8CSYcP9pPKK-F0Xd_kUcgpHVuAOe6WcJRjVCBXKjC9OCgIzT5NJ4kUN-GaAb-m8_jUyqzyL1H8NfrxunrGNSdII7_VQq8EmSk6WOK5BTqHV843_NNHQofqxUkV-FDUmLi-R2ydX5NS2MaJzROAObs1uDiMGv-zOrV1Hzea0r>