TPMS 4.0 PROTOTYPE PROJECT REPORT

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TPMS 4.0 IDEA DETAILED REPORT

Presented To:

Everyone

Prepared By:

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1. EXECUTIVE SUMMARY

1.1 IDEA BACKGROUND

Executive Summary:

Our proposed TPMS 4.0 solution is an advanced and comprehensive response to the requirements of the SIH1557 PS, fully aligning with the Ministry of Coal's expectations. Designed specifically for the coal industry, this system introduces a robust, real-time tyre pressure monitoring solution for coal dumpers, leveraging Bluetooth technology and a user-friendly Android app. TPMS 4.0 not only monitors but also addresses key operational challenges with innovative, data-driven solutions. Below are the core features and benefits:

1. Real-Time Tyre Pressure Monitoring:

TPMS 4.0 offers continuous monitoring of tyre pressure for all coal dumpers in real-time. Through Bluetooth integration, the system connects with an Android app to provide instantaneous alerts when pressure thresholds are breached, ensuring that drivers and operators can take immediate corrective actions to avoid potential failures or damage. This feature reduces manual inspection times and allows for quick, accurate assessments in the field.

2. Enhanced TKPH (Ton-Kilometer Per Hour) Measurement:

The system integrates TKPH data from a centralized health monitoring system. This data is combined with real-time tyre pressure readings to deliver a more comprehensive, advanced analysis. TKPH, a critical metric for assessing the operational efficiency and wear of tyres, provides invaluable insights for the maintenance of heavy machinery in demanding environments like coal mining.

3. Cloud-Based Data Storage and Access:

All data related to tyre pressure and individual TKPH values is continuously uploaded to the cloud, where it is securely stored and can be accessed in real-time from any device via the TPMS 4.0 website. This allows for seamless remote monitoring and management of tyre performance from any location, enabling stakeholders to stay updated without being physically present at the mining sites.

4. AI-Driven Predictive Analytics:

TPMS 4.0 stores and processes historical tyre pressure and performance data, paving the way for future-oriented, AI-powered predictive analytics. This capability enables the system to forecast potential tyre failures, suggest maintenance actions, and optimize tyre performance based on patterns identified in past data. By utilizing AI, the system promotes proactive maintenance, preventing costly downtime and unplanned tyre replacements.

Our solution effectively tackles several critical real-world problems that are prevalent in the coal industry, including:

→ Time-consuming and inefficient manual tyre pressure checks, which require extensive labor and often lack precision
→Infrequent or occasional inspections that can lead to undetected tyre damage, increasing the risk of failure
→Premature tyre failures, which result in unexpected downtime and costly disruptions in operations
→ High maintenance costs and replacement expenses, with new tyres costing as much as ₹25 lakh per unit
→ Significant safety risks associated with poorly maintained tyres, such as vehicle damage, injuries to personnel, and operational hazards
→ The absence of a proactive alert system that could warn operators of impending tyre issues before they escalate into larger problems

TPMS 4.0 aims to transform the way tyre pressure and performance are managed in the coal industry. By integrating advanced technology, real-time monitoring, and predictive maintenance, our solution will enhance operational efficiency, reduce maintenance costs, and improve overall safety. The system is designed to offer long-term benefits by ensuring the health of tyres and extending their life cycle, ultimately providing a cost-effective, data-driven approach to tyre management.

2. PROTOTYPE SUMMARY

2.1 PROJECT PROTOTYPE BACKGROUND

We have successfully developed a prototype that utilizes Industrial Internet of Things (IIoT) devices to monitor real-time tire pressure and temperature. Our team designed a

custom Android application that connects to a System-on-Chip (SoC) board via Bluetooth, enabling users to observe tire pressure and temperature in real time. The application also features an alert system that notifies users of any abnormal pressure readings, ensuring timely intervention.

Data collected from the IIoT devices is stored locally and simultaneously uploaded to the cloud through the mobile device's cellular network. Following the successful cloud integration, we developed a comprehensive website that displays this real-time data, allowing users to access it from virtually any location worldwide.

Having completed the initial phase of this prototype, we are now looking forward to embarking on Phase 2. This phase will focus on integrating data from the central health monitoring system specifically for coal mining trucks. A detailed discussion of the technologies employed in the development of the prototype is available, providing insights into our innovative approach and the methodologies used to ensure the system's effectiveness and reliability.

2.2 PROJECT PROTOTYPE OBJECTIVES

O1: To underscore the feasibility of this project, demonstrating that the proposed solution is practical and achievable within the current technological landscape.

O2: To highlight that our solution is highly attainable, leveraging existing resources and technologies to ensure successful implementation.

O3: To emphasize our preparedness in executing the proposed solution, showcasing our hands-on experience and expertise that equip us to effectively bring this project to fruition.

2.3 PROJECT PROTOTYPE VISION

To highlight our research capabilities and commitment to delivering the proposed solution at the highest standards of quality and excellence. This vision reflects our dedication to leveraging innovative technologies and methodologies to ensure successful project completion that meets or exceeds expectations.

2.4 PROJECT PROTOTYPE COMPONENTS

TPMS 4.0 Prototype has the following Products/Components/Technology:

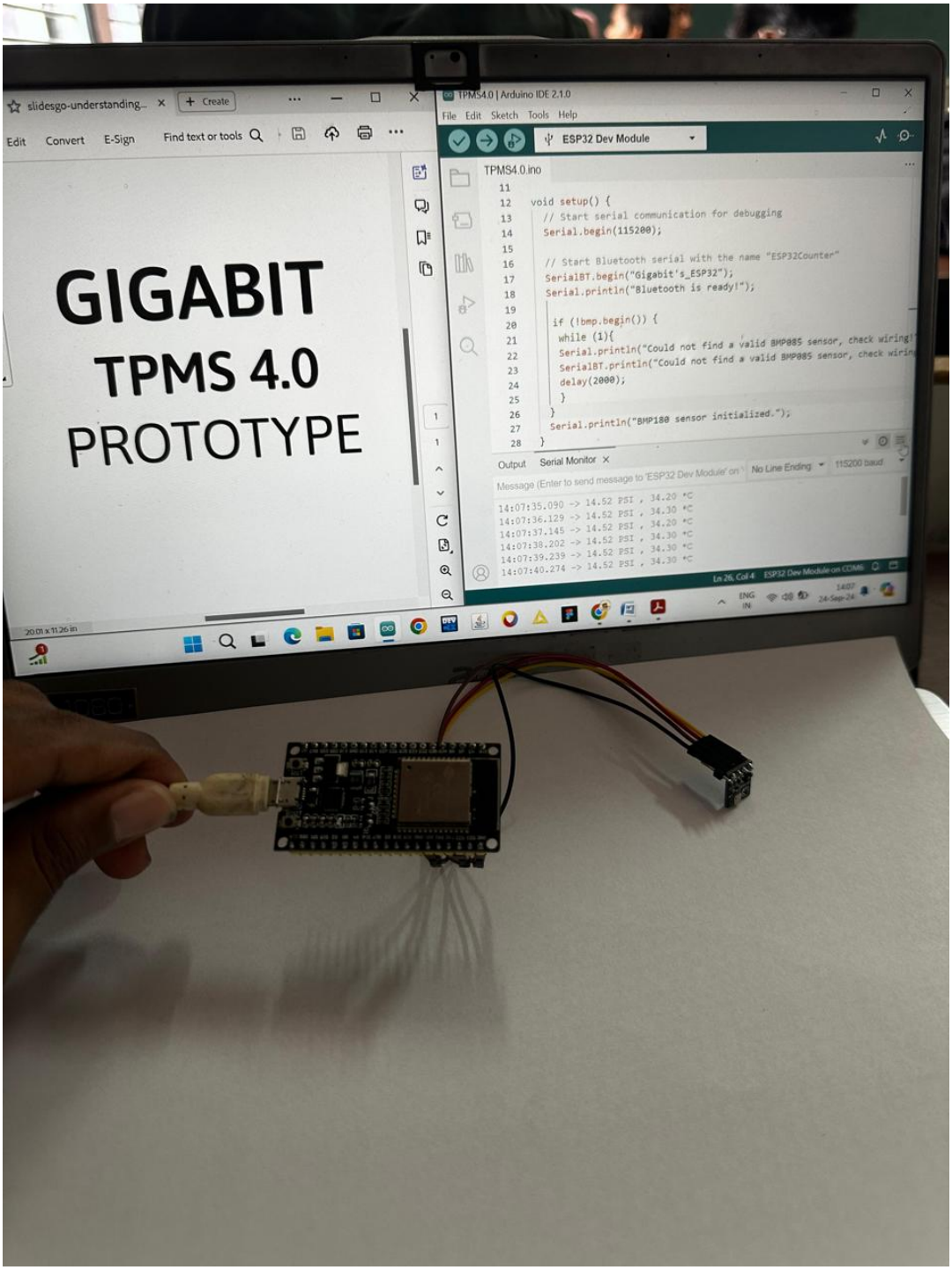
Products/Components/Technology:	**Price/Technology**
ESP32 WROOM 32 (Soc)	500 INR
BMP 180 (Air pressure and temperature Sensor)	150 INR
ANDROID APP	MIT APP INVENTOR
CLOUD SERVICE	GOOGLE
WEBSITE	Tailwind CSS , Nodejs , ReactJS
Communication	Classic Bluetooth

2.5 STRENGTHS

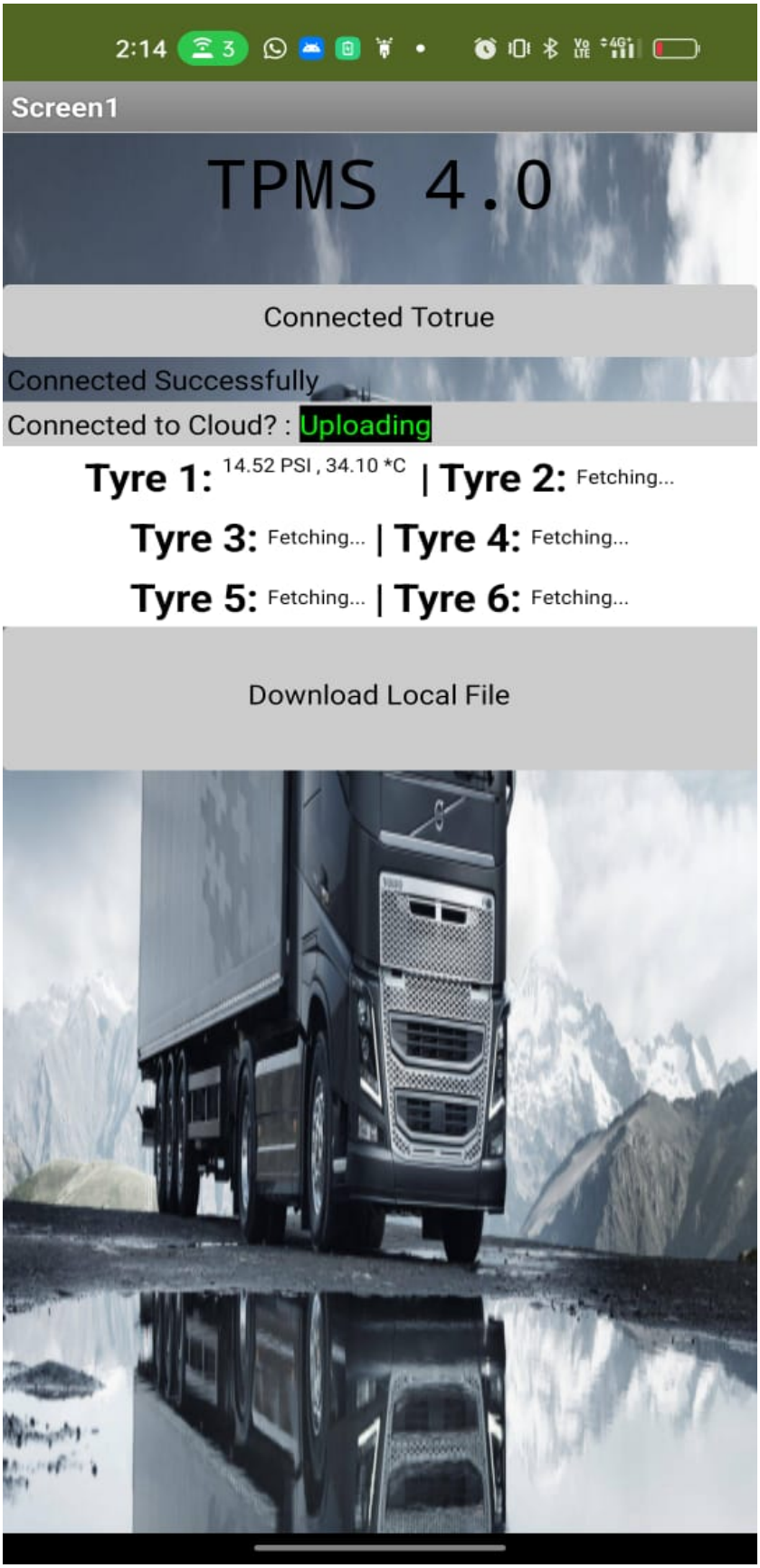
Four Main Strengths

1. **Android App Compatibility**: Our solution seamlessly integrates with Android devices, providing users with an accessible and user-friendly interface for real-time monitoring and alerts.
2. **TKPH Inclusion for Analysis**: The incorporation of Tire-Kilometers per Hour (TKPH) data enhances our analytical capabilities, allowing for deeper insights into tire performance and operational efficiency.
3. **Centralized Data Management**: Our system offers centralized data management, enabling users to easily access, analyze, and manage information from multiple sources, improving decision-making processes.
4. **Low Cost**: The overall design and implementation of our solution prioritize cost-effectiveness, making it an affordable option without compromising on quality or functionality.

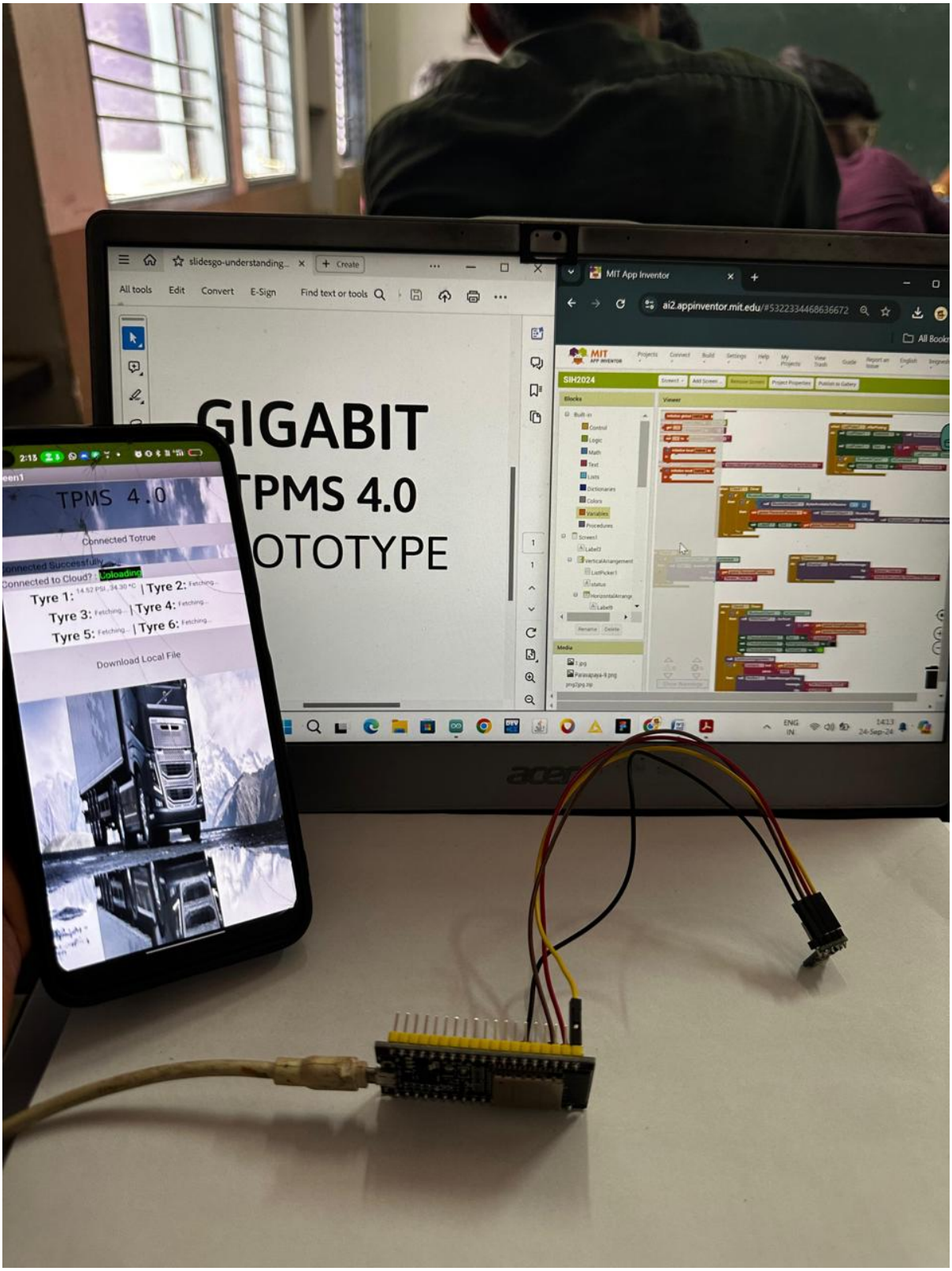
2.6 IMAGES



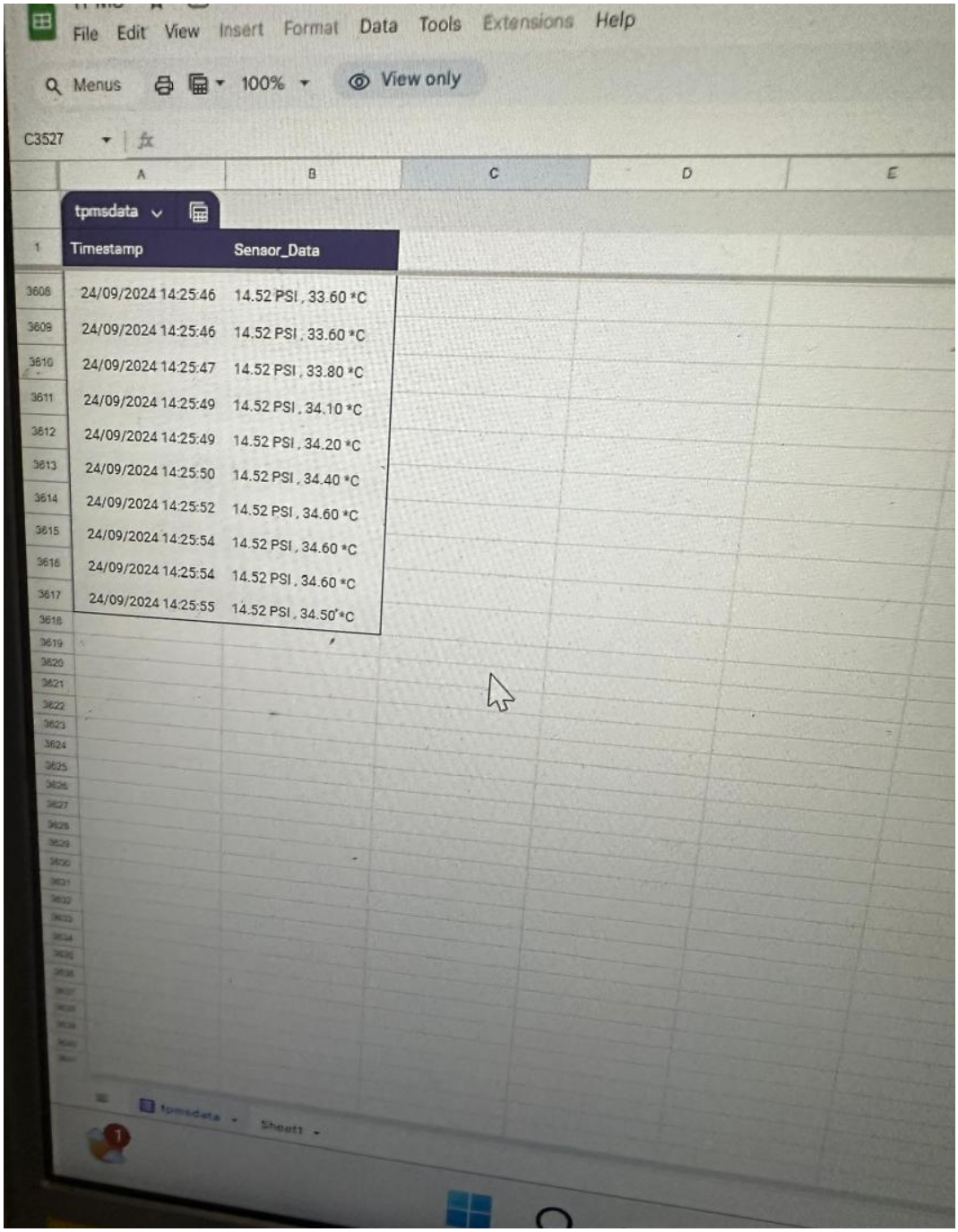
SERIAL MONITORING OF THE BMP 180 SENSOR.



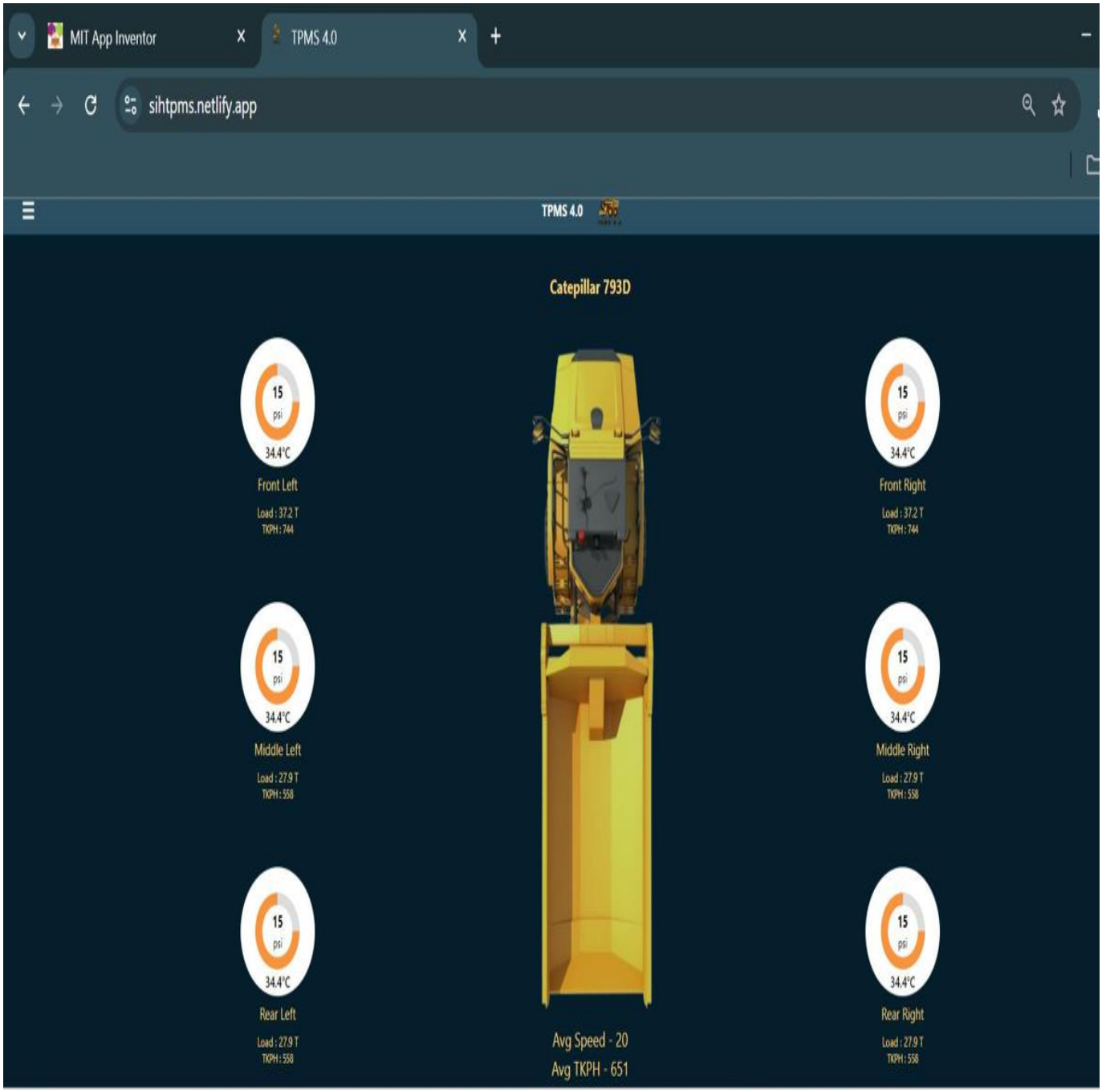
ANDROID APP WITH REAL-TIME MONITORING.



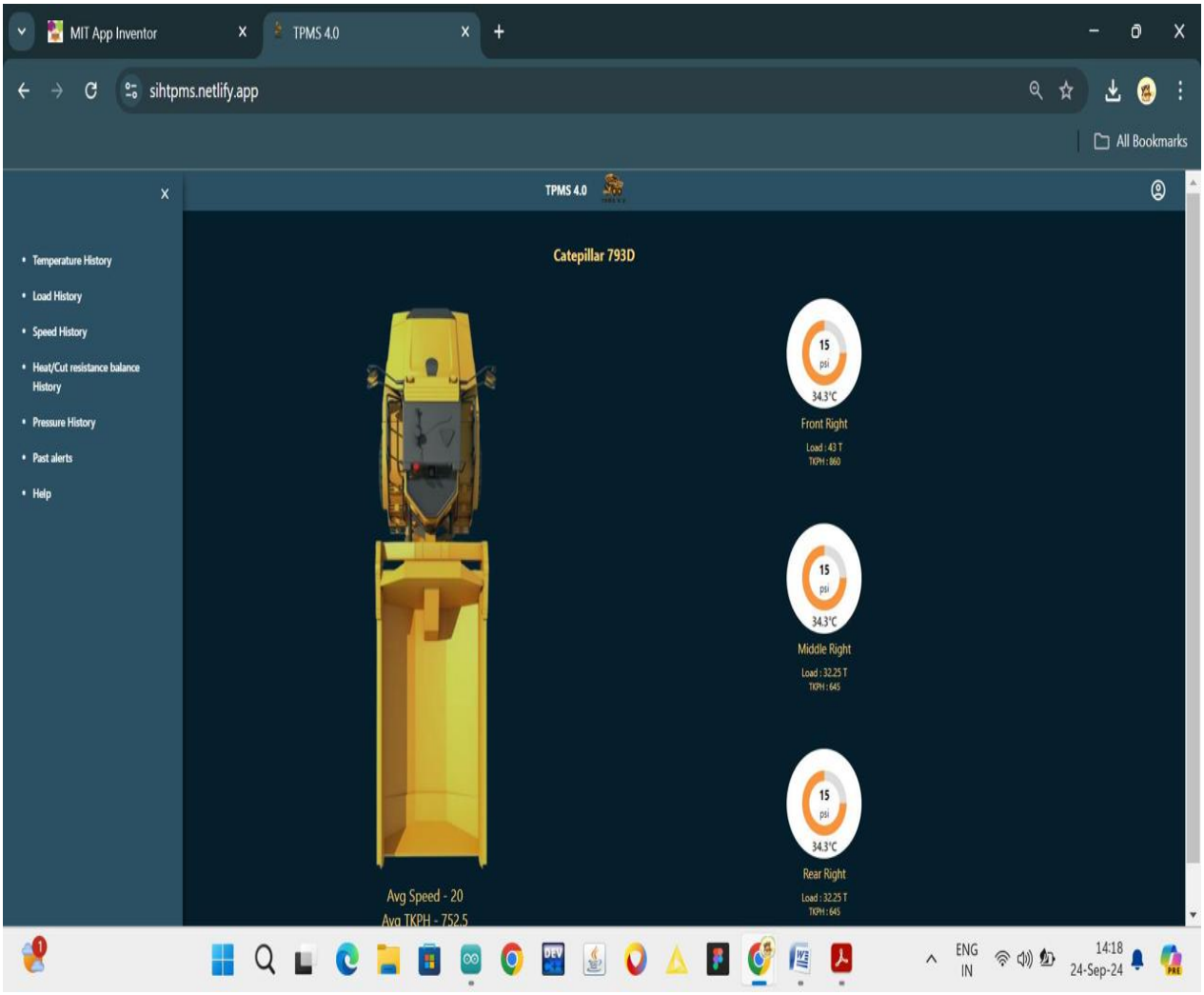
ANDROID APP DEVELOPMENT AND FETCHING OF SENSOR DATA FROM ESP32 VIA CLASSIC BLUETOOTH.



LIVE DATA UPLOAD FROM THE TPMS4.0 ANDROID APP.



LIVE UPDATING REMOTE MONITORING WEBSITE WITH REAL TIME UPDATING VALUES.



MENU WHERE FEATURES ARE PLANNED TO BE ADDED IN FUTURE.

2.7 Live Links

YOUTUBE LINK: https://youtu.be/09Ck3kHFj_I

ANDROID APK :
https://drive.google.com/file/d/1BviR7_pzRveVAVz-drdZWfbORa8TNYGt/view?usp=sharing

LIVE WEBSITE : https://sihtpms.netlify.app/

LIVE DATA SHEET:
https://docs.google.com/spreadsheets/d/1OcQ5n-DG_6Gpt6exVGyPmTBwACwZTnu8DF8ypQL8Q0E/edit?usp=sharing