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# Edge-Powered Unmanned Automated Weighbridge System

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**ABSTRACT:** This project presents an Edge-powered Unmanned Automated Weighbridge System for vehicle identification and weight measurement using a Raspberry Pi. The system integrates IR sensors, an MCP23017 I/O expander, an IP camera, a YOLOv8-based license plate detection model, EasyOCR, and a load cell based weight measurement system using HX711 amplifier. When a vehicle arrives, IR sensors trigger image capture through the camera. The image is processed using YOLOv8 to detect the license plate, and EasyOCR extracts the plate number, which is validated for accuracy. At the same time, the system records the vehicle's weight. The captured image, plate number, timestamp, and weight data are combined and sent to a server for storage and monitoring. The system uses edge computing for fast and reliable processing with minimal cloud dependency. This automation reduces human intervention, improves accuracy, and enhances efficiency in applications such as logistics yards, industrial facilities, and automated weigh stations. This system also ensures real-time data logging and secure record maintenance for each vehicle transaction making it highly valuable for future operational needs. Furthermore, the system is designed with scalability in mind, allowing seamless integration with existing enterprise resource planning (ERP) and fleet management platforms. Its low-cost, modular architecture makes it a practical and scalable solution for modernizing weighbridge operations across diverse industrial environments.

**KEYWORDS:** Edge Computing, Intelligent Weighbridge System, Automatic Number Plate Recognition, YOLOv8, Optical Character Recognition, Raspberry Pi, Computer Vision, IoT Automation, Vehicle Weight Measurement, Smart Transportation.

## I. INTRODUCTION

The rapid advancement of intelligent transportation systems and industrial automation has increased the demand for efficient and accurate vehicle monitoring solutions. Traditional weighbridge systems commonly used in industries, logistics centers, mining areas, and transportation checkpoints often require manual operation for vehicle identification, weight recording, and data management. These manual processes can lead to operational delays, human errors, increased labor costs, and security vulnerabilities. To overcome these limitations, automated and intelligent weighbridge systems have become an important area of research and development.

This paper presents an Edge-powered Unmanned Automated Weighbridge System designed for real-time vehicle identification and weight measurement using embedded computing and computer vision technologies. The proposed system integrates a Raspberry Pi-based edge device with IR sensors, an IP camera, load cell sensors, and an HX711 amplifier to automate the complete weighbridge operation without human intervention. When a vehicle enters the weighing platform, IR sensors detect its presence and trigger image acquisition through the camera module.

For vehicle identification, the system employs YOLOv8, a state-of-the-art deep learning model, to detect license plates from captured images. The detected plate region is further processed using EasyOCR to extract the vehicle registration number accurately. Simultaneously, the load cell-based weighing mechanism measures the vehicle weight in real time. The collected information, including vehicle number, timestamp, and weight data, can be stored and monitored digitally for further analysis and management.

## II. LITERATURE SURVEY

Recent advancements in intelligent transportation systems and industrial automation have significantly improved the efficiency of vehicle monitoring and weighbridge management systems. Traditional weighbridge systems generally depend on manual supervision for vehicle identification, weight recording, and report generation, which often leads to operational delays, data inaccuracies, and increased labor costs. To overcome these limitations, researchers have focused on developing automated weighbridge solutions using IoT, embedded systems, and artificial intelligence technologies. Several studies have proposed IoT-enabled weighbridge monitoring systems that utilize sensors and cloud connectivity for real-time vehicle weight measurement and remote monitoring, thereby improving operational efficiency and data accessibility (Raut R., Singh A., "IoT-Based Smart Weighbridge Monitoring System," 2020). In recent years, computer vision and deep learning techniques have gained importance in intelligent vehicle identification systems. Automatic Number Plate Recognition (ANPR) systems based on deep learning models have demonstrated high accuracy in detecting and recognizing vehicle license plates under varying environmental conditions. Research on object detection algorithms shows that YOLOv8 provides improved speed and detection accuracy compared to traditional machine learning approaches, making it highly suitable for real-time embedded applications (Jocher G., "YOLOv8 Real-Time Object Detection Architecture," 2023). Furthermore, Optical Character Recognition (OCR) technologies have been widely integrated with ANPR systems to extract vehicle registration details from captured images. Studies indicate that EasyOCR offers efficient multilingual text recognition with lightweight implementation suitable for embedded platforms (Jaided AI, "EasyOCR: Deep Learning-Based Optical Character Recognition," 2022).

## III. METHODOLOGY

The proposed system follows a structured and multi-stage methodology designed to provide accurate, reliable, and automated vehicle identification and weight measurement using edge computing, computer vision, and embedded sensor technologies. The overall process is divided into sequential phases to ensure efficient data acquisition, processing, analysis, and real-time monitoring within the automated weighbridge environment.

Initially, the system performs vehicle detection using IR sensors positioned near the weighbridge platform. These sensors continuously monitor vehicle movement and detect the arrival of a vehicle on the weighing area. Once the presence of a vehicle is identified, the sensors trigger the activation of the image acquisition and weighing modules. This automated triggering mechanism minimizes manual intervention and ensures smooth operation of the system.

Following vehicle detection, the image acquisition phase is carried out using an IP camera integrated with the embedded edge device. The camera captures real-time images of the vehicle, particularly focusing on the license plate region. The captured images are transferred to the Raspberry Pi for further processing and analysis. This stage forms the foundation for intelligent vehicle identification within the proposed system.

In the next phase, the system performs license plate detection using YOLOv8, a deep learning-based object detection framework. The model processes the captured vehicle image and accurately identifies the license plate region under different environmental and lighting conditions. The detected license plate is then cropped and forwarded to the text recognition stage for extracting the vehicle registration number.

To extract textual information from the detected license plate, the system utilizes EasyOCR. The OCR module processes the cropped license plate image and converts the visual text into machine-readable characters. This phase enables automatic vehicle identification and eliminates the need for manual data entry. The extracted registration number is stored for monitoring and record management purposes.

Finally, in the monitoring and reporting phase, the system generates automated records of vehicle identification and weight measurement for real-time observation and future analysis. The proposed methodology provides an efficient, scalable, and cost-effective solution for intelligent weighbridge automation by integrating embedded systems, computer vision, OCR technology, and IoT-based monitoring within a unified framework.

## PROCESS FLOW DIAGRAM

### Edge-Powered Unmanned Automated Weighbridge System

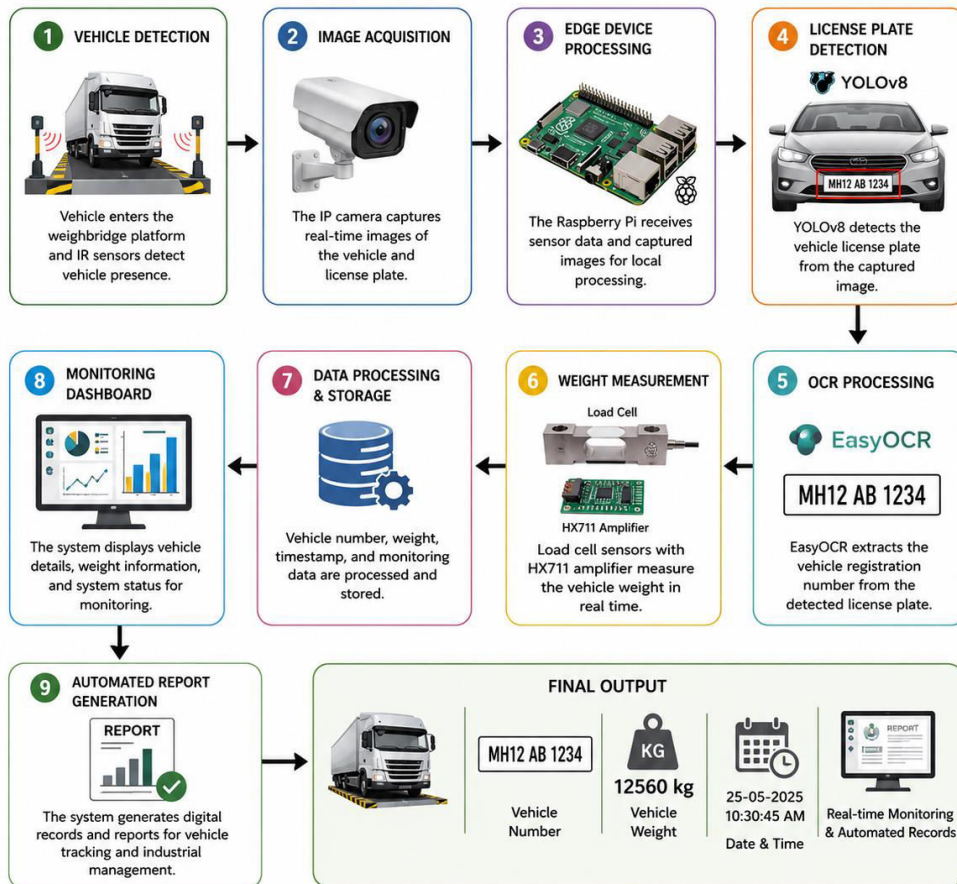


Fig.1 Process Flow Diagram of the System

## IV. EXPERIMENTAL RESULTS

The proposed system was implemented and evaluated to demonstrate its effectiveness in delivering personalized career recommendations. The experimental results highlight the functionality of various system modules through user interface snapshots and system outputs.

### 4.1 Login Page

The Login Page serves as the secure entry point to the proposed AI-based career guidance and recommendation system. It enables users to access personalized career assessment features and recommendation services through authenticated login credentials. The interface is designed with a simple and user-friendly layout to ensure easy accessibility for students and users of different technical backgrounds.

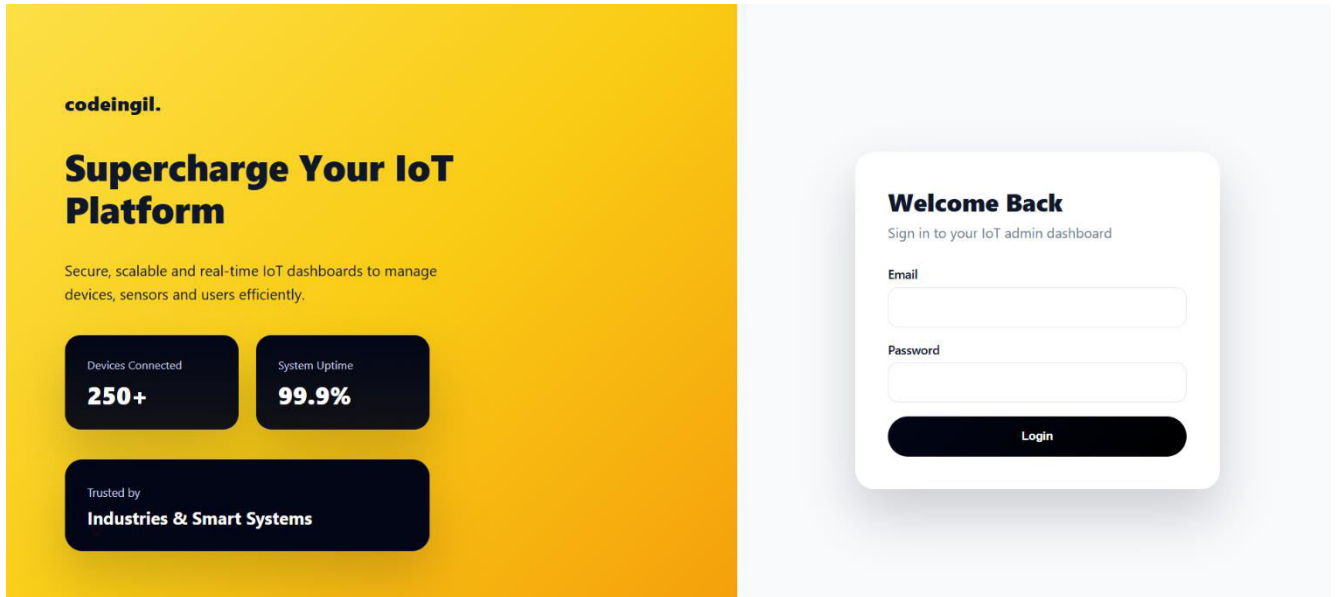


Fig.2 User Login Interface

#### 4.2 Dashboard

The Dashboard Page acts as the main control panel of the Edge-powered Unmanned Automated Weighbridge System. It displays real-time vehicle information, detected license plate numbers, and measured vehicle weight through an interactive interface. The dashboard also provides access to vehicle logs, captured images, and system monitoring features for efficient operation. Its responsive and user-friendly design enables smooth navigation and accurate monitoring of weighbridge activities.

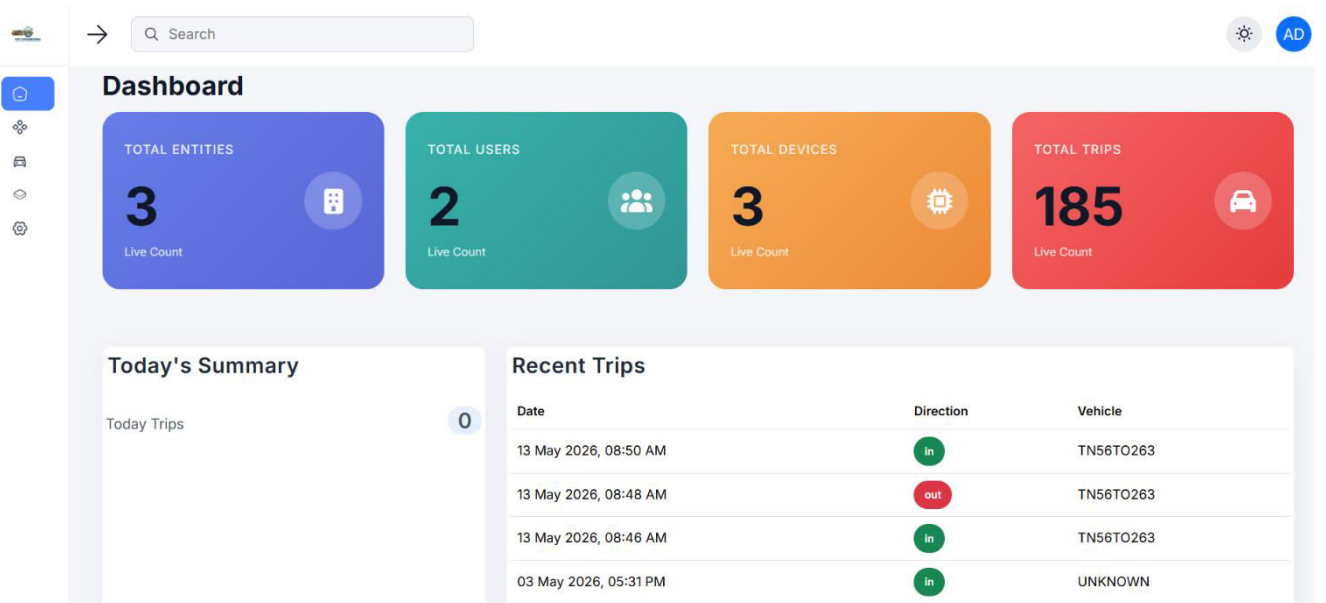
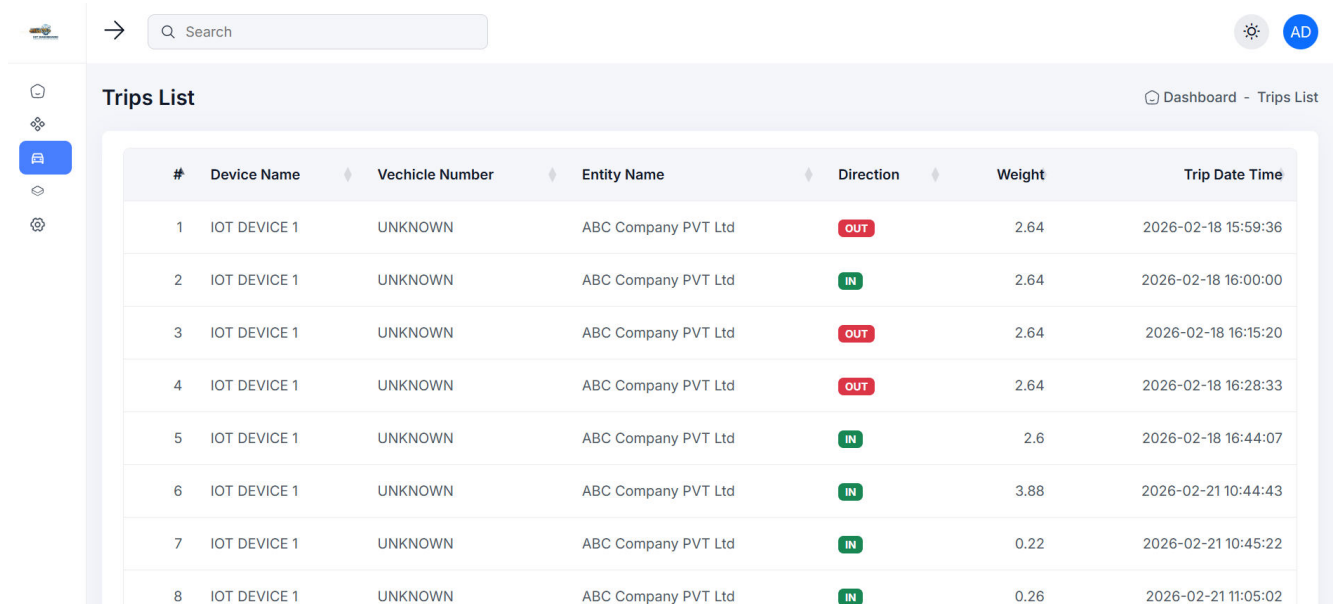


Fig.3 Dashboard Interface

#### 4.3 Trip List Page

The Trip List Page displays the complete history of vehicle trips recorded by the Edge-powered Unmanned Automated Weighbridge System. It provides details such as vehicle number, entry and exit time, measured weight, and trip status

in a structured format. The page enables users to easily search, view, and manage trip records for monitoring and reporting purposes. Its organized and user-friendly interface ensures efficient tracking of vehicle movement and weighbridge operations.

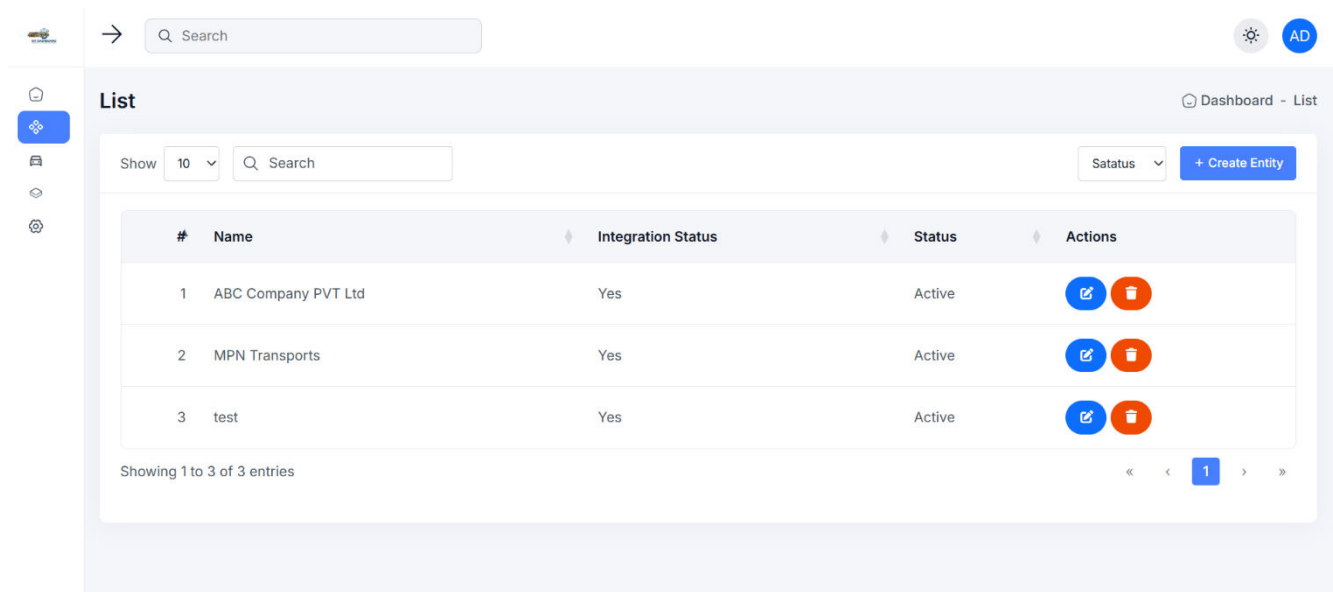








#	Device Name	Vehicle Number	Entity Name	Direction	Weight	Trip Date Time
1	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	OUT	2.64	2026-02-18 15:59:36
2	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	IN	2.64	2026-02-18 16:00:00
3	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	OUT	2.64	2026-02-18 16:15:20
4	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	OUT	2.64	2026-02-18 16:28:33
5	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	IN	2.6	2026-02-18 16:44:07
6	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	IN	3.88	2026-02-21 10:44:43
7	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	IN	0.22	2026-02-21 10:45:22
8	IOT DEVICE 1	UNKNOWN	ABC Company PVT Ltd	IN	0.26	2026-02-21 11:05:02

Fig.4 Trip list Interface

#### 4.4 Entity Page

The Entity Page is used to manage and display detailed information related to vehicles, drivers, and weighbridge records in the Edge-powered Unmanned Automated Weighbridge System. It provides organized data such as vehicle details, trip information, weight measurements, and captured license plate records. The page allows users to efficiently view, update, and monitor entity-related information through a structured interface. Its responsive and user-friendly design improves data management and operational efficiency.



#	Name	Integration Status	Status	Actions
1	ABC Company PVT Ltd	Yes	Active	 
2	MPN Transports	Yes	Active	 
3	test	Yes	Active	 

Showing 1 to 3 of 3 entries

Fig.5 Entity Page

#### 4.5 Manage Devices Page

The Manage Devices Page is used to monitor and control the hardware components connected to the Edge-powered Unmanned Automated Weighbridge System. It displays the status of devices such as cameras, IR sensors, load cells, and edge computing modules in real time. The page allows users to configure, enable, or troubleshoot connected devices through a centralized interface. Its user-friendly design ensures efficient device management and smooth system operation.

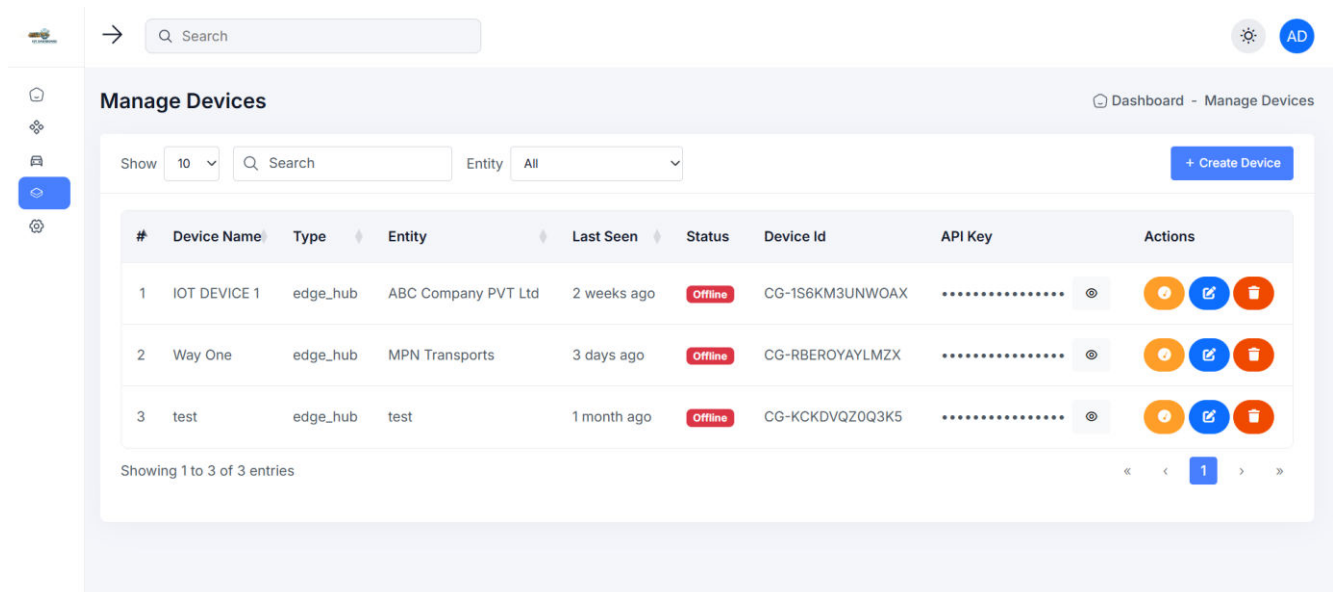


Fig.6 Manage devices

#### V. CONCLUSION

The Edge Powered Unmanned Automated Weighbridge System successfully demonstrates the integration of Internet of Things (IoT), edge computing, and machine learning to automate vehicle monitoring and weight measurement processes. The system eliminates manual intervention by combining real-time vehicle detection, license plate recognition, and automated weight acquisition into a unified workflow.

The use of Raspberry Pi as the central processing unit enables efficient edge-level computation, reducing latency and dependency on cloud infrastructure. The integration of YOLOv8 for license plate detection and EasyOCR for text extraction ensures accurate and reliable vehicle identification under varying conditions, while the load cell with HX711 amplifier provides precise weight measurements for accurate transaction logging.

The inclusion of a web-based dashboard further enhances the system by providing real-time visualization, centralized data management, and user-friendly monitoring capabilities, allowing operators to track vehicle movements and analyze system performance efficiently.

The system has been tested in real-time conditions and demonstrates reliable performance with fast processing times and minimal errors. Although limitations such as network dependency and OCR sensitivity exist, the overall architecture remains robust, scalable, and suitable for industrial applications.

In conclusion, the proposed system provides a cost-effective, efficient, and intelligent solution for automated weighbridge operations, with strong potential for future enhancements such as advanced analytics, mobile integration, and AI-based monitoring.

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