

Universiti Teknologi MARA

**SMART WAREHOUSE INVENTORY TRACKING
WITH AI-BASED ANOMALY DETECTION USING
SYNTHETIC DATA FRAMEWORK**

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SUPERVISOR APPROVAL

**Smart Warehouse Inventory Tracking with AI-Based Anomaly Detection Using
Synthetic Data Framework**

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This thesis was prepared under the supervision of the project supervisor, Dr Yong Yueh Tiam. It was submitted to the Faculty of Computer and Mathematical Sciences and was accepted in partial fulfilment of the requirements for the degree of Bachelor of Computer Science (Hons.).

Approved by

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Dr Yong Yueh Tiam

Project Supervisor

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ABSTRACT

An effective warehouse inventory management system is crucial for ensuring operational efficiency, accurate stock tracking, and timely decision-making. Traditional warehouse management approaches often rely on manual inventory tracking and limited environmental monitoring, which can delay the identification of abnormal conditions. This project developed a smart warehouse inventory tracking system that integrates Radio Frequency Identification (RFID), Internet of Things (IoT) sensors, synthetic data generation, and an AI-based anomaly detection model using the Isolation Forest algorithm. The objectives were to design a synthetic data generation framework for simulating warehouse RFID and sensor data streams, develop an Isolation Forest-based anomaly detection module for identifying abnormal environmental conditions, and evaluate the performance of the proposed system through system testing. The developed system integrates RFID technology, an ESP32-based IoT sensing module, MQTT communication, a Python-based AI processing backend, a MySQL database, and a web-based monitoring dashboard. Synthetic normal operating data were generated and used to train the Isolation Forest model using temperature, humidity, and voltage as input features. Incoming sensor readings were subsequently evaluated by the trained model, which classified observations as normal or anomalous based on their deviation from the learned data distribution. System evaluation demonstrated successful RFID tracking, environmental monitoring, and anomaly classification, with an average real-time processing latency of approximately 2 seconds. The 27 simulated test records were evaluated against their predefined validation labels to assess the anomaly detection performance. The results demonstrate the feasibility of integrating RFID, IoT, synthetic data generation, and machine learning for intelligent warehouse monitoring. Future work may incorporate larger and more diverse datasets, real-world warehouse deployment, improved model evaluation using additional performance metrics, and scalable cloud-based infrastructure.

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