TITLE : Design and implement a smart, automated system for product labeling and traceability

TECHNOVA TEAM MEMBERS :

DATE :

ABSTRACT :

This project presents a smart, automated system for product labeling and traceability that simulates industrial workflows using affordable and accessible technologies. It features dual entry modes (Admin/Sensor), QR code generation, virtual 3-stage testing with time logging and issue detection, OCR-based label validation, and an admin dashboard for PDF report export and analytics. Built using Python, Streamlit, and EasyOCR — and virtually simulated with Tinkercad — the system offers a cost-effective solution for industries seeking traceability without physical hardware.

Objectives :

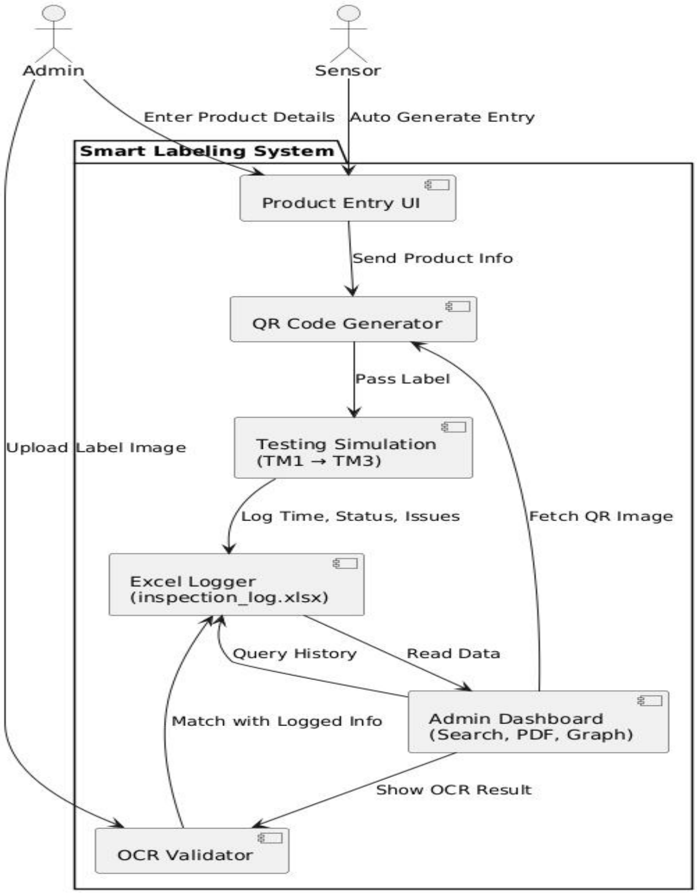
- Automate product label generation using unique QR codes
- Simulate quality testing using virtual test machines (TM1–TM3)
- Log product data, status, and time into an Excel file
- Allow label verification using OCR image upload
- Provide an admin dashboard for traceability and reporting
- Offer graphical analytics of test machine failures

System Architecture :

Each component communicates through Python scripts. All data is stored locally in an Excel file, enabling traceability without cloud dependency.

The system follows a modular, left-to-right architecture. It starts with a Streamlit-based UI where product details are entered manually or simulated via sensor logic. A QR code generator creates unique labels, after which the product passes through three virtual test machines (TM1–TM3), each logging status, time, and issues to an Excel file.

An OCR module allows printed QR labels to be verified. The Admin Dashboard supports device lookup, PDF report generation, and failure trend graphs. A Tinkercad circuit simulates sensor-based hardware entry logic virtually.



Proposed Methodology :

The proposed system is built using Python and deployed via a Streamlit web interface. Users can input product data manually (admin mode) or trigger auto-generation using simulated sensors (sensor mode). Once entered, a QR code is generated containing product details like Device ID, Batch ID, and Manufacturing Date.

The product then virtually passes through three simulated test machines (TM1–TM3), where each stage records the time taken, pass/fail status, and any issue encountered. All test data is logged into a structured Excel file using OpenPyXL.

Key modules in the system include:

- Entry Module – Accepts admin or sensor-based product input with default ID logic
- QR Generator – Generates and saves a label with product metadata
- Testing Simulation – Mimics TM1, TM2, and TM3 operations using time delays
- Excel Logger – Stores testing outcomes locally for traceability
- OCR Validator – Verifies scanned label images using pyzbar
- Admin Dashboard – Allows searching for devices, downloading PDF reports, and viewing issue graphs
- PDF Report Generator – Compiles product traceability into downloadable documents
- Analytics Module – Visualizes test failures using Plotly bar charts

- Tinkercad Simulation – Demonstrates IR/LED-based entry logic in a virtual circuit environment

The modular design ensures each part works independently yet integrates seamlessly into the overall traceability system.

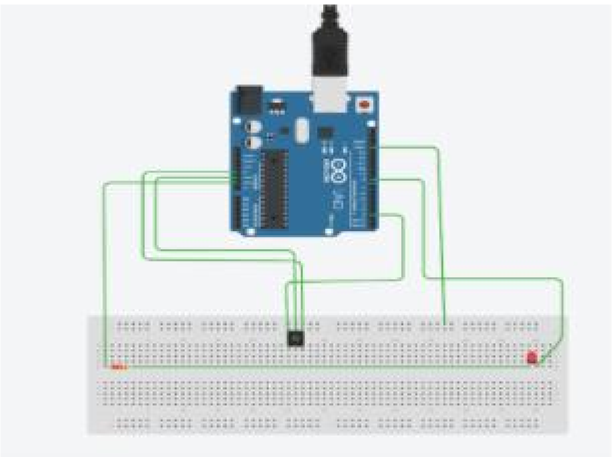
Technologies Used :

- Python: Core logic implementation
- Streamlit: Interactive frontend interface
- OpenPyXL: Excel-based data logging
- pyzbar
- Plotly: For data visualization
- FPDF / ReportLab: To generate downloadable reports
- Tinkercad: Simulated IR sensor behavior for testing

Features Offered :

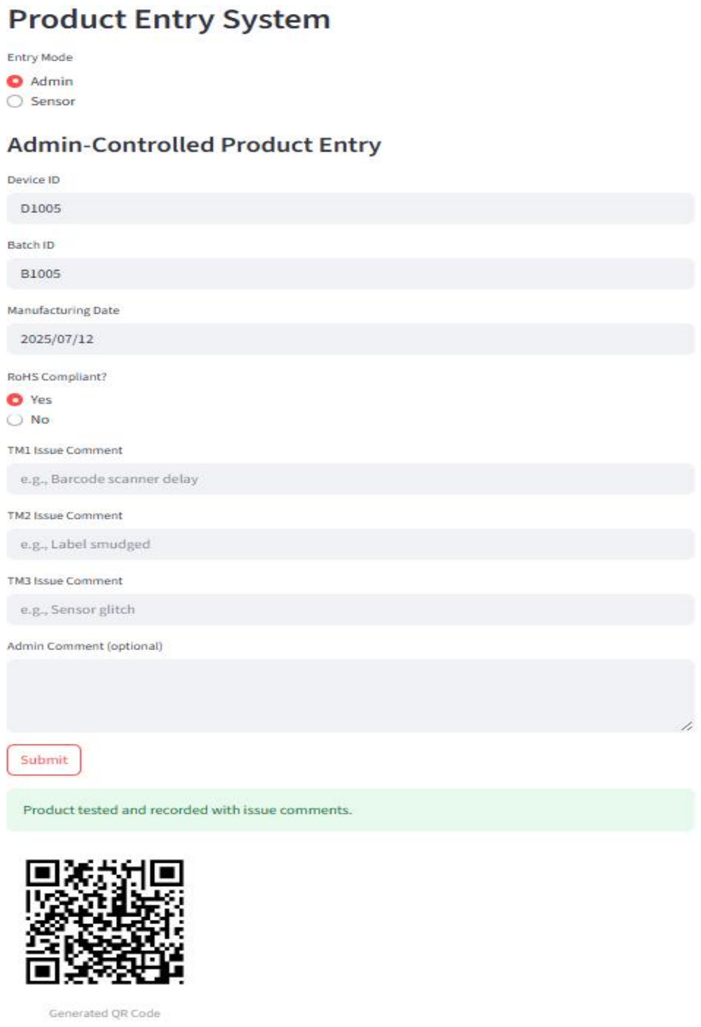
-Dual entry support (Admin & Sensor)
- QR code generation
- 3-stage quality simulation (TM1, TM2, TM3)
- Excel logging with time and issues
- OCR label verification
- PDF report download
- Failure graph analytics
- Tinkercad-based hardware simulation

CIRCUITORY:



Circuit Design For Product Detection

Output Screens :



Product Entry System

Entry Mode

● Admin
○ Sensor

Admin-Controlled Product Entry

Device ID: D1005

Batch ID: B1005

Manufacturing Date: 2025/07/12

RoHS Compliant?

● Yes
○ No

TM1 Issue Comment: e.g., Barcode scanner delay

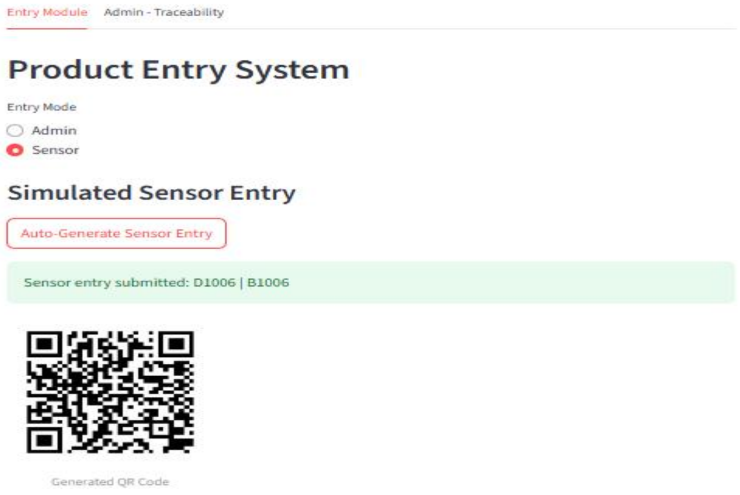
TM2 Issue Comment: e.g., Label smudged

TM3 Issue Comment: e.g., Sensor glitch

Admin Comment (optional):

Product tested and recorded with issue comments.

Admin Entry module



Product Entry System

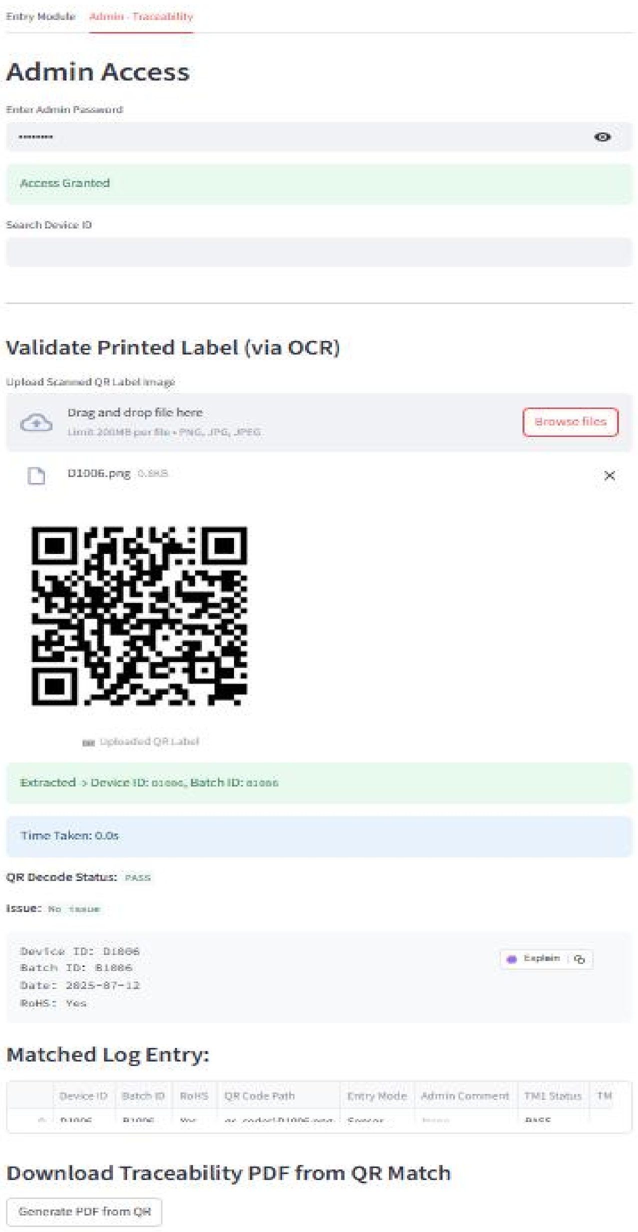
Entry Mode

○ Admin
● Sensor

Simulated Sensor Entry

Sensor entry submitted: D1006 | B1006

Sensor based Entry module



Admin Access

Enter Admin Password

••••••••

Access Granted

Search Device ID

Validate Printed Label (via OCR)

Upload Scanned QR Label Image

Drag and drop file here
Limit 200MB per file • PNG, JPG, JPEG

D1006.png 0.8KB

Uploaded QR Label

Extracted -> Device ID: D1006, Batch ID: B1006

Time Taken: 0.0s

QR Decode Status: `PASS`

Issue: `No issue`

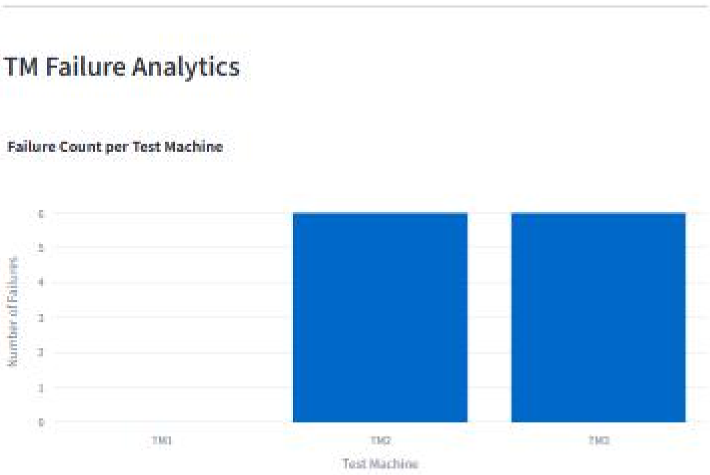
```
Device ID: D1006
Batch ID: B1006
Date: 2025-07-12
RoHS: Yes
```

Matched Log Entry:

	Device ID	Batch ID	RoHS	QR Code Path	Entry Mode	Admin Comment	TM1 Status	TM
0	D1006	B1006	Yes	qr_codes\D1006.png	Sensor	None	PASS	

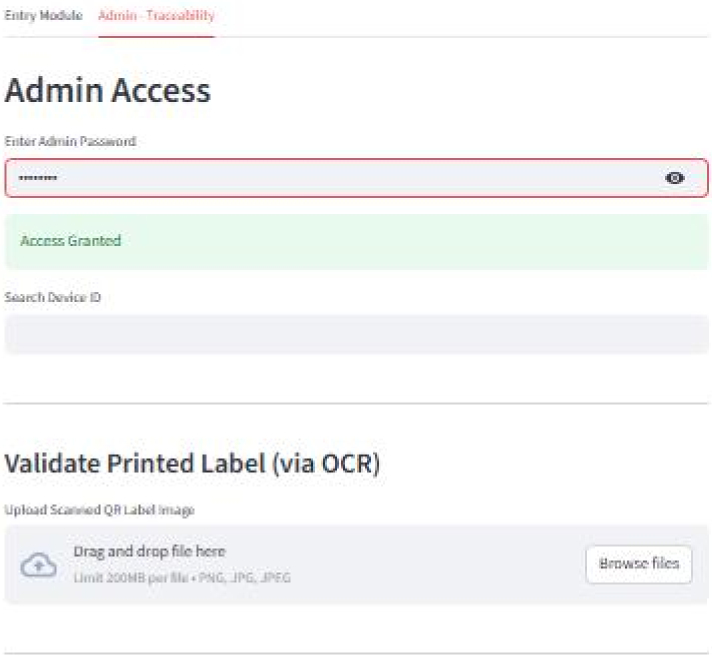
Download Traceability PDF from QR Match

Traceability module



TM Failure Analytics

Testing Machine Analysis



Admin Access

Enter Admin Password

••••••••

Access Granted

Search Device ID

Validate Printed Label (via OCR)

Upload Scanned QR Label Image

OCR validation module

CONCLUSION :

We developed a practical system that automates labeling and traceability using only software. By simulating real production flows, recording data locally, and offering validation through OCR, we’ve created a scalable prototype for smart manufacturing. This solution is ideal for low-cost environments and educational applications, and serves as a strong foundation for future IoT integration.