AI & SUSTAINABILITY
IN VET EDUCATION

AI-VET MOOC PROJECT SUBMISSION TEMPLATE

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1. Project Title:
Reverse Vending Machine with a donation option

2. Project Category:

- ☐ **AI for Sustainable Development**
- ☐ **Connected Systems and Smart Data (AI + IoT)**
- ☐ AI for Industry 4.0
- ☐ **Social Impact and Inclusive AI**
- ☐ **Computer Vision and Image Recognition**
- ☐ Predictive Analytics and Decision Support
- ☐ Intelligent Automation and Control Systems
- ☐ Smart Environments and Monitoring
- ☐ Other:_____

3. Project Description:

Our project combines the traditional reverse vending machine that encourages recycling with an option to donate the given points to selected causes.

4. Keywords:

Recycling, image recognition, kiosk

5. Target Audience:

- ☐ Educators
- ☐ Students
- ☐ **Both Educators and Students**
- ☐ **VET Institutions**

6. Project Objectives:

Objective 1: Develop an automated system for material identification using computer vision (OpenCV) and barcode decoding (pyzbar).
Objective 2: Implement a real-time full-stack IoT architecture using Python, Flask, and WebSockets for immediate user feedback.
Objective 3: Create a secure session-based user reward system that interfaces with a local database to track recycling contributions.

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7. Project Timeline:

- Start Date: 23.01.2026
- End Date: 17.03.2026

8. Tools and Technologies Used:

Hardware: Raspberry Pi 5, Raspberry Pi Camera Module 3, and a Servo Motor for the physical sorting mechanism.

Software Libraries:

- **OpenCV (cv2):** For image processing and camera stream management.
- **Pyzbar:** For high-speed barcode detection and decoding.
- **Flask & Flask-SocketIO:** To handle the backend server and real-time "heartbeat" communication between the scanner and the UI.
- **Systemd:** For creating reliable background services (rvm-client.service and rvm-server.service) to ensure the system starts on boot.

Data: A custom JSON database (bottles.json) containing thousands of valid barcode entries for validation.

Chromium (kiosk mode)

9. Step-by-Step Implementation Plan:

System Architecture Design: Establishing a client-server model where the Raspberry Pi acts as a dedicated scanner (Client) and a Flask app manages the logic and UI (Server).

Vision System Development: Configuring the Picamera2 to capture 1280x720 video and implementing a loop that continuously scans for barcodes while maintaining a connection "heartbeat".

Backend Logic & Validation: Writing the server-side logic to handle login via the first scan, validating items against the database, and managing the 5-minute session timeout.

Hardware Integration: Connecting the Servo motor to the GPIO pins to physically process the bottle once a valid scan is received.

Deployment & Automation: Creating Linux system services to make the RVM standalone, allowing it to function as a "kiosk" without manual terminal input.

The challenges we faced were two-way communication over websockets for the web ui, jitter when controlling the servo, the difficulty reading tiny barcodes in software and creating system services to automatically launch the server.

This project can be improved by adding liquid detection via sensors, integrating into a bigger SCADA system, using AI for fraud detection and adding hardware to read the barcodes more reliably and faster.

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10- Code

https://github.com/Silverdimond/rvm

11. Evaluation Criteria:

- **Project Success Metrics: Successful completion of robotic tasks using AI applications.**
- **Skills Assessment: Measure students' proficiency in AI programming and robotics assembly.**

12-Credits

Filip Velickovski

https://wiki.archlinux.org/title/Systemd
https://github.com/NaturalHistoryMuseum/pyzbar
https://github.com/miguelgrinberg/flask-socketio
https://github.com/pallets/flask/

13- Video presentation link (max. 5 minutes)

https://drive.google.com/file/d/1rcNFDR2ehdhSCRk4Hh_8hvfQ0Zc0jv4Q/view?usp=sharing

14- Declarations

I declare that I have read and agree with the following statements:

1- The project is original and developed by the listed team members.
2- All technologies and sources are properly cited.
3- The project was developed using components from the AI-VET kit.
4- We authorize the dissemination of the project for educational and promotional purposes (non-exclusive rights).

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