MUST-CARE: Smart Waste Sorting Machine based IoT and Machine Learning Approaches

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Background :

- The amount of waste generated by the residents of Bandung City is increasing
- Bandung (a city in West Java, Indonesia) face a garbage crisis due to waste piling up at Waste Collection Points
- Lack of waste-sorting practices in household level

Fig 1. Fire fighters try to extinguish the fire that burned down the Sarimukti landfill (CNN Indonesia, 12/09/2023)

Targets:

1. Provide awareness about waste separation to address the lack of waste separation practices among residents
2. Establish community recycling centers located within neighborhoods

First activity

1. Waste separation awareness
   a. Strategic partnership
   b. Workshop and Seminars

Fig 2. Strategic partnership

Second activity

2. Develop smart waste sorting machines
   a. IoT Device
   b. Waste Sorter
   c. Waste Collection Application

Fig 3. Smart Waste Sorting Machine Design Environment

Waste separation awareness

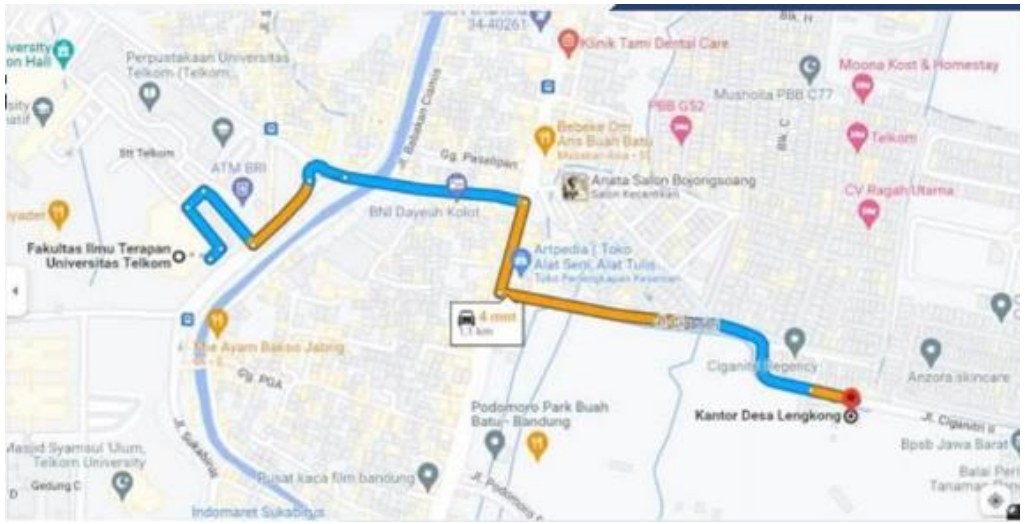

Fig 5. The distance between Telkom University and Lengkong village

Lengkong villages, Bojongsoang – Bandung, West Java - Indonesia

Fig 4. Head of village with team using TelU dropbox

Fig 6. Telkom University student with Lengkong youth organization

Develop smart waste sorting machines

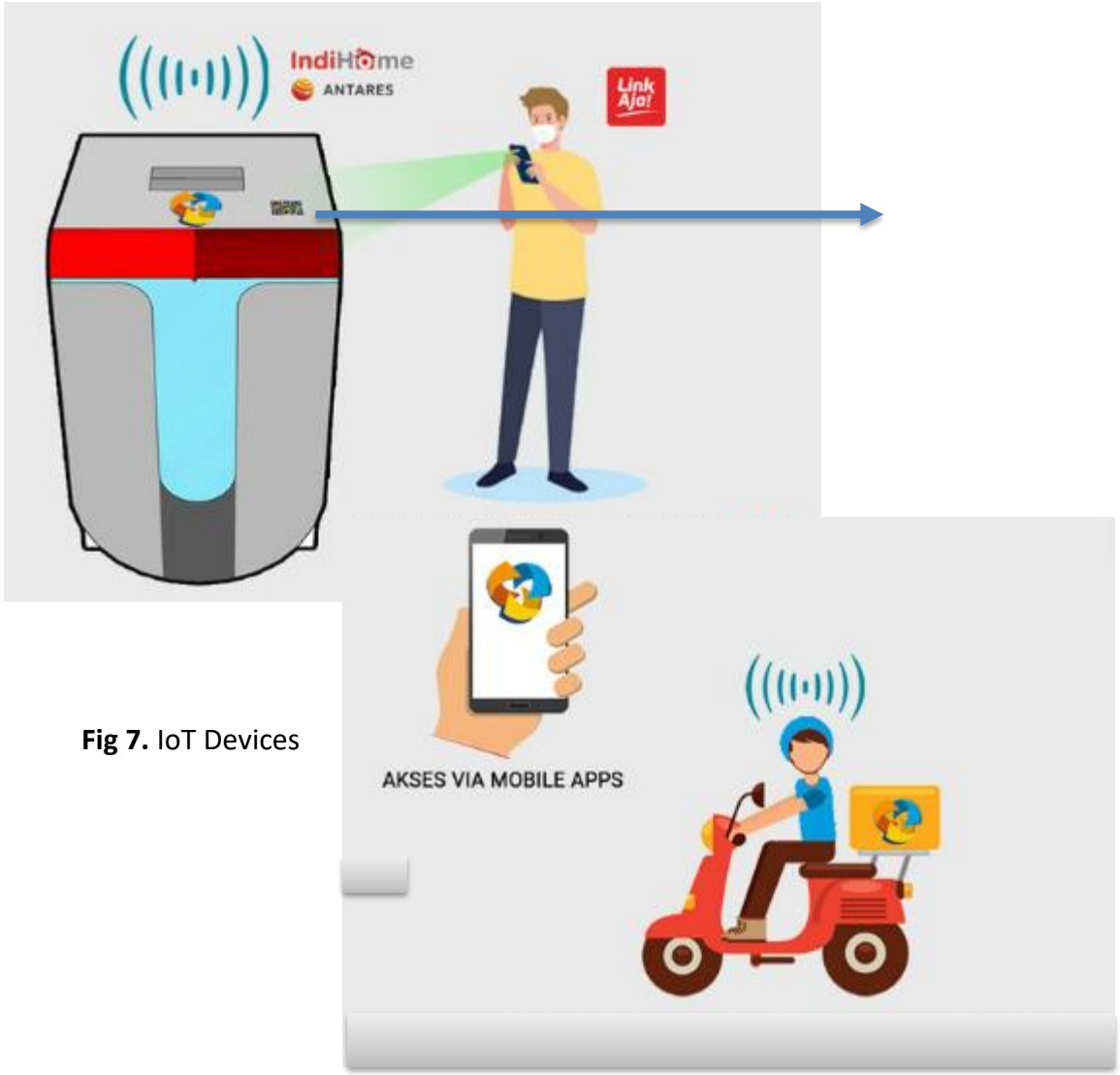

Fig 7. IoT Devices

IoT Devices

- Raspberry Pi 4
- Sensors: LDR, infrared
- Camera: Logitech C270

How to use

- User open feeder using QRCode Scan
- User obtained Point Reward through application
- Waste collectors received a notification when drop box was full

Develop smart waste sorting machines

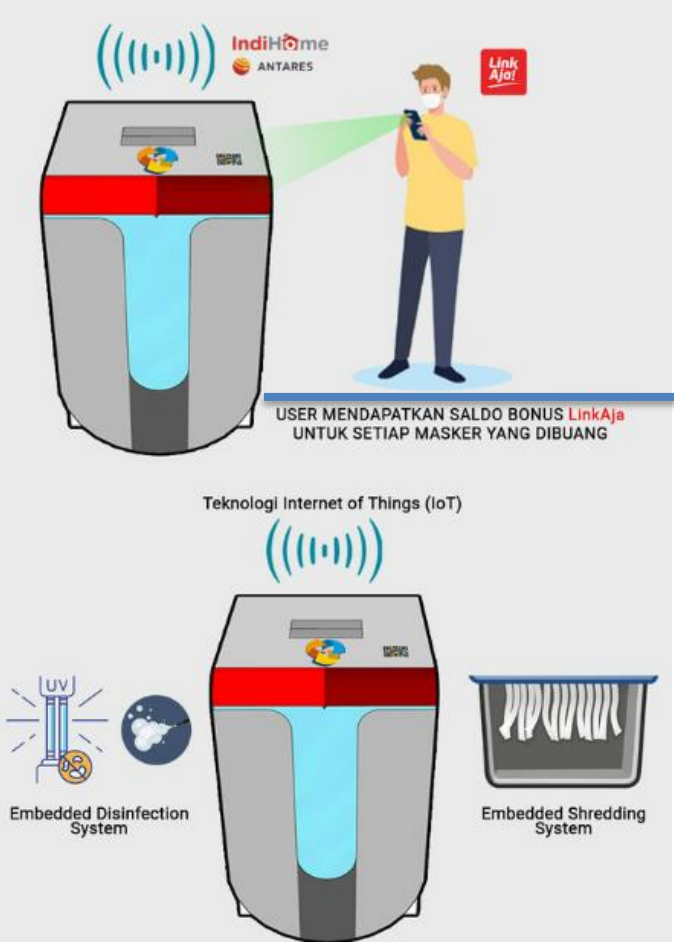

Fig 8. Waste Sorter

Waste sorter

- Object: face masks, cans, plastic bottles, glass bottles.
- We used Convolutional Neural Network (CNN) model and MobileNetV2 architecture
- Dataset: freely available + collected independently ➔ 1,500 pictures
- Testing
  - Four scenarios: input size, optimizer selection, learning rate adjustments, batch size configurations
  - Optimal result: input size of 128x128, Adam optimizer, LR 0.0001, batch size 8

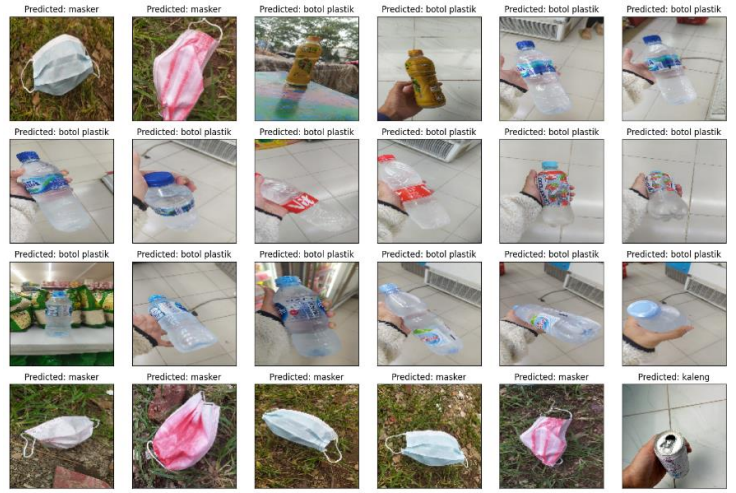

Fig 9. Testing result (https://github.com/amaliaaudah/Waste_ClassificationCNN/tree/main)

Develop smart waste sorting machines

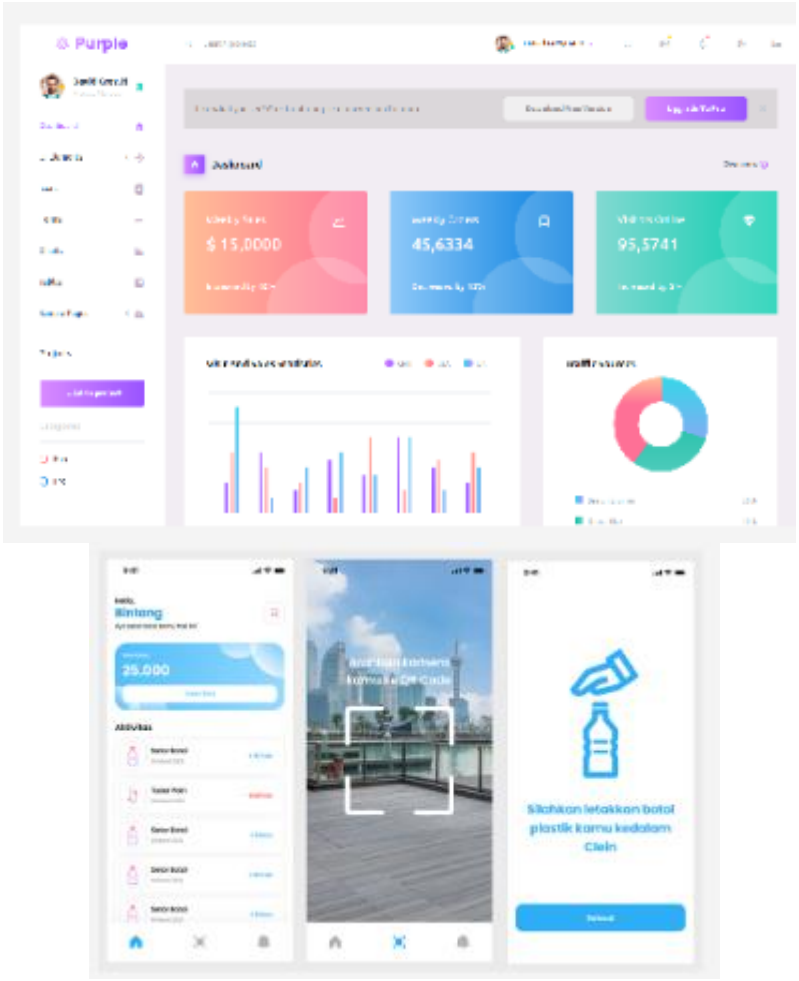

Fig 10. Web based monitoring & Mobile apps

Waste Collection Application

- Waste pickups
- Waste bank
- Reporting issues
- Waste management initiatives

Impact of activities

Impact of waste management

1. Scientific and technological
    - Environmental protection
    - Health and public safety
    - Generates valuable data
    - Renewable energy
2. Collaboration
    - Knowledge sharing
    - Multi-stakeholder collaboration
    - Innovation and research
    - Policy development
    - Circular economy

Impact of activities

Society

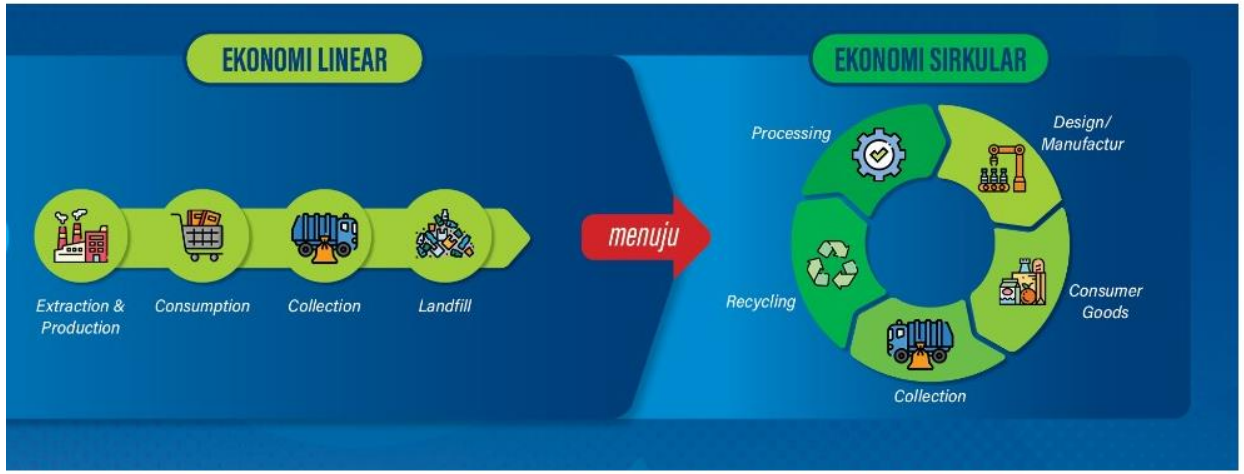

Fig xx. Circular economy in Indonesia is included in the National Medium Term Development Plan (RPJMN) 2020 – 2024, under the National Priorities agenda

Rp 593-638 T

Potential GDP in 2030

4,4 Juta

Green jobs created (75% are women) in 2030

126 Juta Ton

CO2 emissions are reduced by 2030

18 - 52 %

Waste reduction in priority sectors in 2030

- *Food and Drink*
- *Textiles*
- *Construction*
- *Wholesale and retail (plastic)*
- *Electronics*

6,3 Milyar m^3

Reducing water use by 2030

https://lcdi-indonesia.id/ekonomi-sirkular/

Further plans and conclusion

Ongoing commitment to increasing awareness of waste separation is important for creating a cleaner and more sustainable environment. Some of the activities are:

1. Conduct waste sorting awareness seminars for the community
2. Expand the waste sorting machine to include additional waste types: cooking oil, plastic containers, batteries, small electronic devices
3. Enhance the waste collection application: integration with the Waste Bank in Bandung city, waste pickup service
4. Collaborative partnership with relevant stakeholder