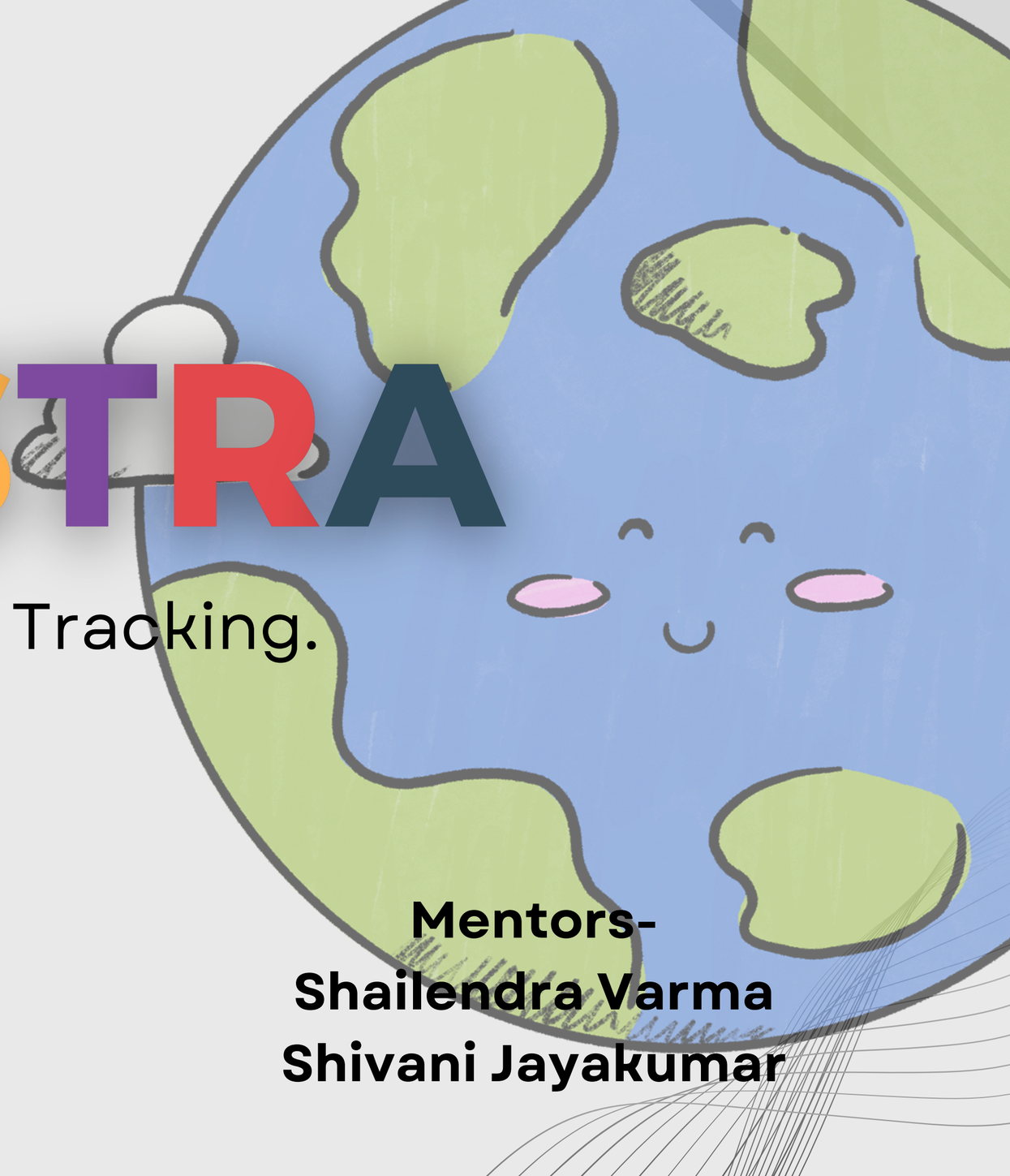
DUSTRA

.Dustbin. Tracking.



Group 23-

Astha Chand

Vamaxi Maheshwari

Samruddhee Jadhav

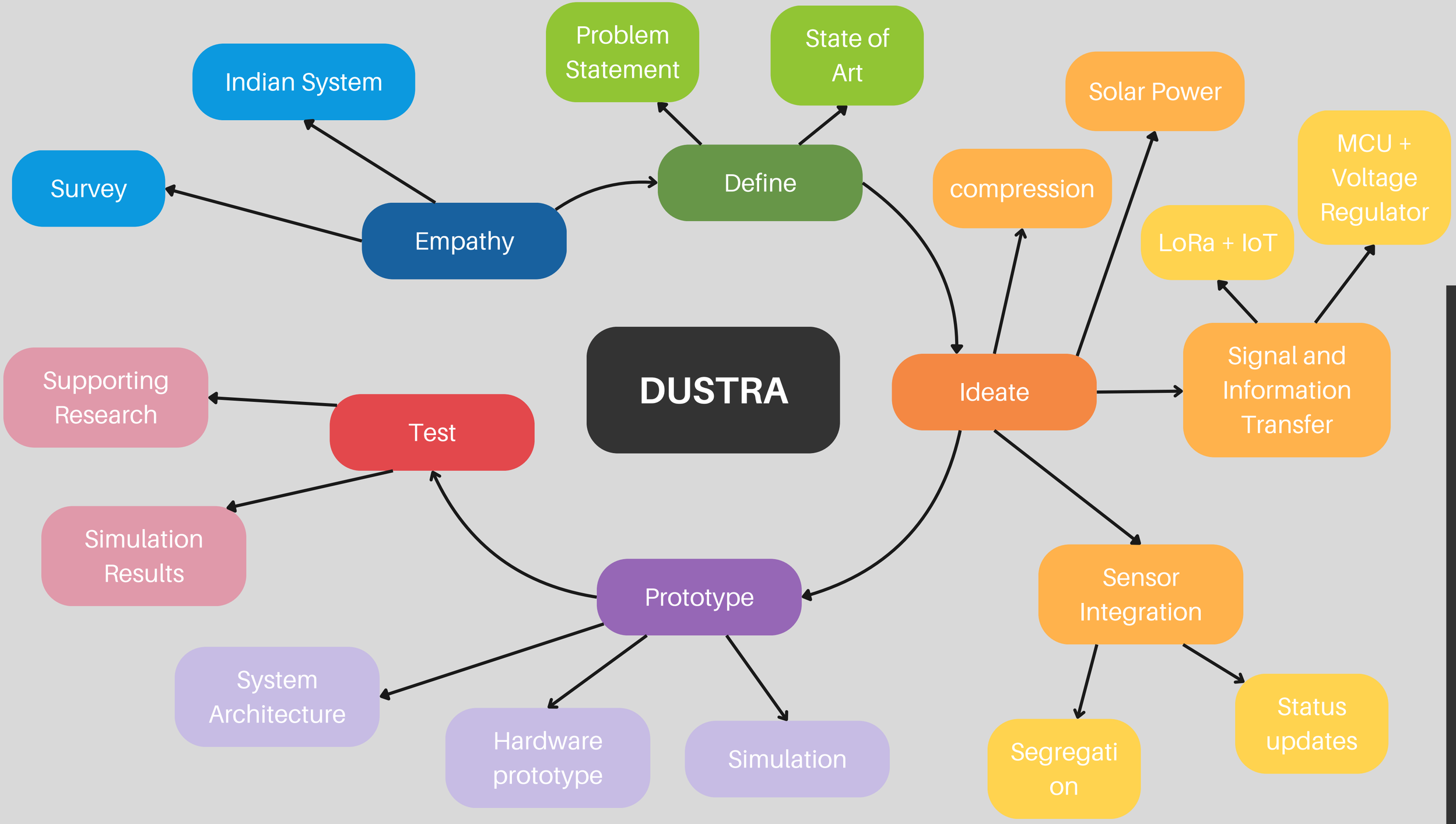
Kavya Palla

Arfa Rubeen

Mentors-

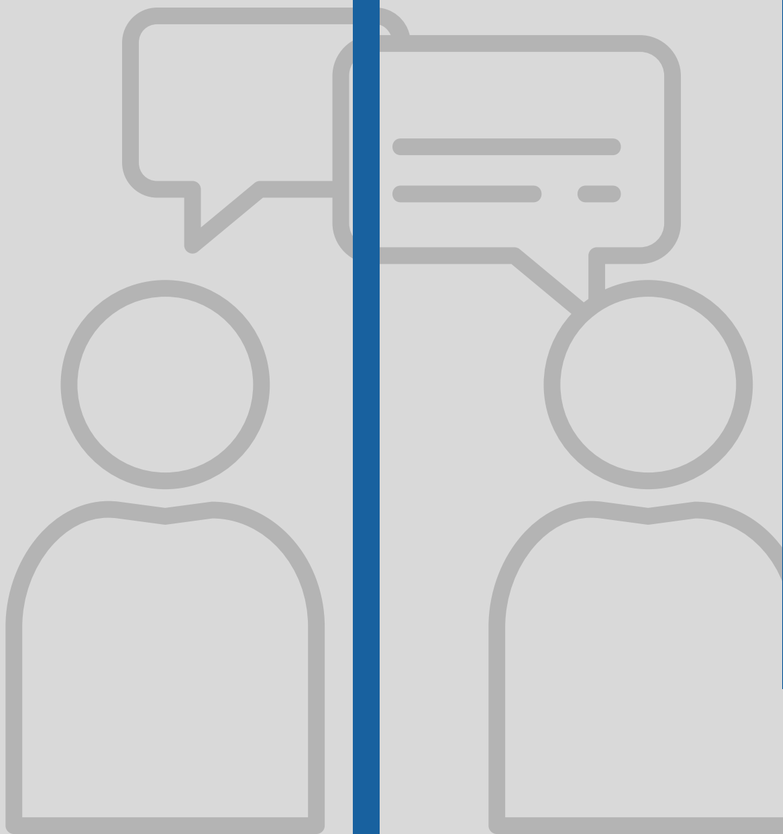
Shailendra Varma

Shivani Jayakumar


DUSTRA
Empathy
Indian System
Survey
Define
Problem Statement
State of Art
Ideate
compression
Solar Power
LoRa + IoT
MCU + Voltage Regulator
Signal and Information Transfer
Prototype
System Architecture
Hardware prototype
Simulation
Test
Supporting Research
Simulation Results
Sensor Integration
Segregati on
Status updates

EMPATHY

STAGE 1



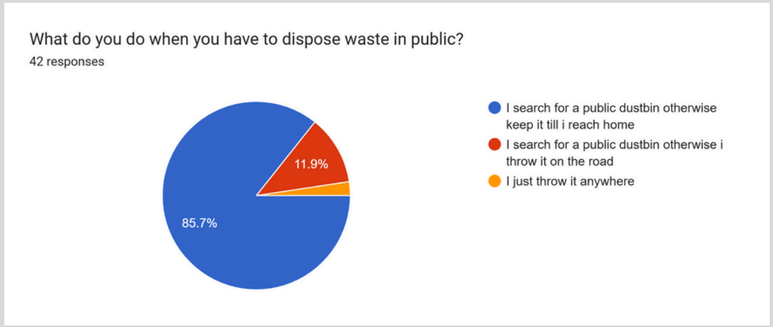
EMPATHY

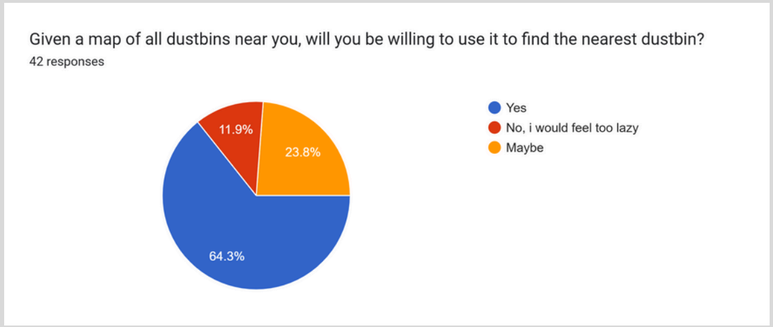
Indian system

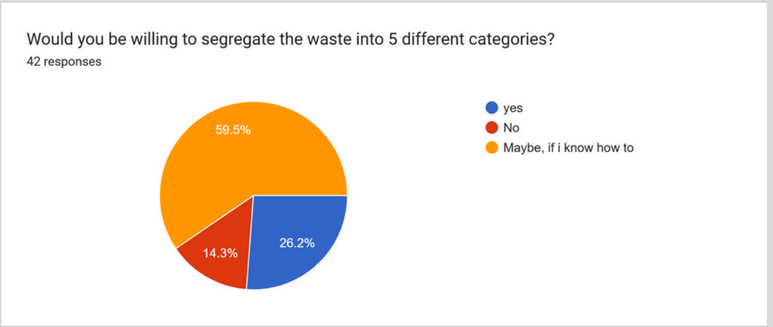
- Urban areas with 377 million people generate about 62 million tons of solid waste every year. However, only 43 million tons are collected, and the rest ends up untreated or in landfills.
- Only about 30% of waste is properly sorted, leading valuable materials like aluminum and plastics to end up in landfills instead of being recycled.

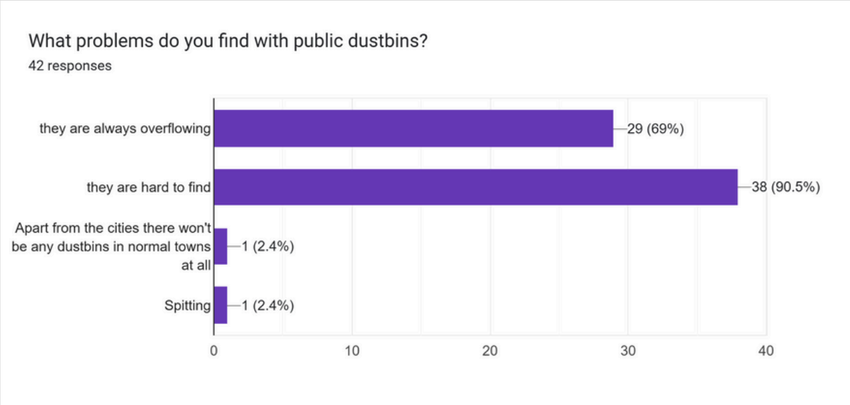
EMPATHY

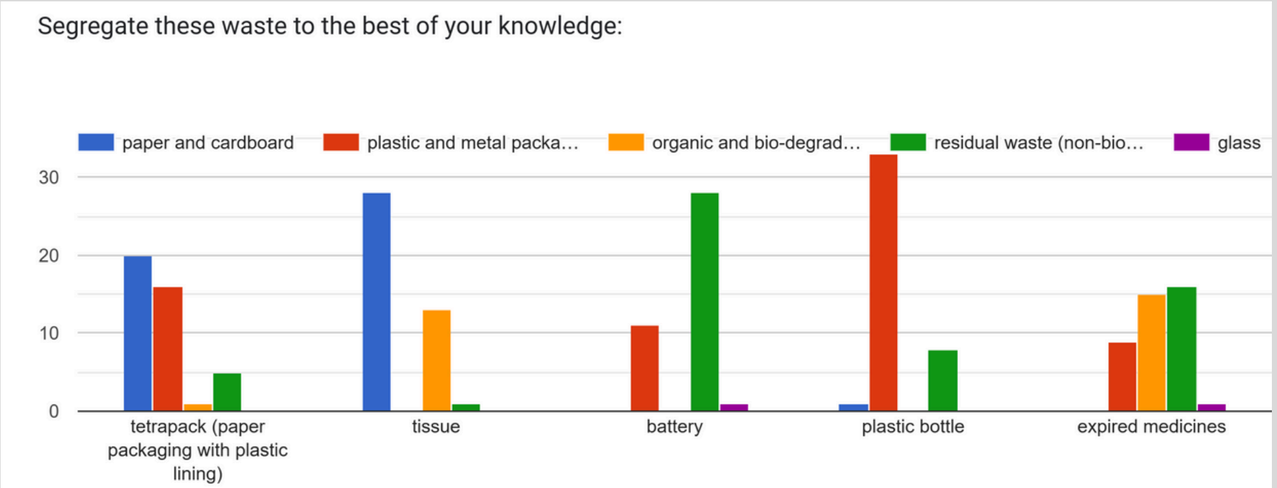
SURVEY











EMPATHY

Empathizing with the

User

- Unawareness about the segregation system
- Can’t locate the dustbins
- Overflowing dustbins, hence unhygienic
- Dissatisfaction due to contact based dustbins

Authorities

- Overflowing bins hinder waste collection
- Lack efficient, real-time monitoring system
- Poor segregation leads to landfill dumping
- Inefficient collection routes
- Increased environmental impact

DEFINE

STAGE 2

DEFINE

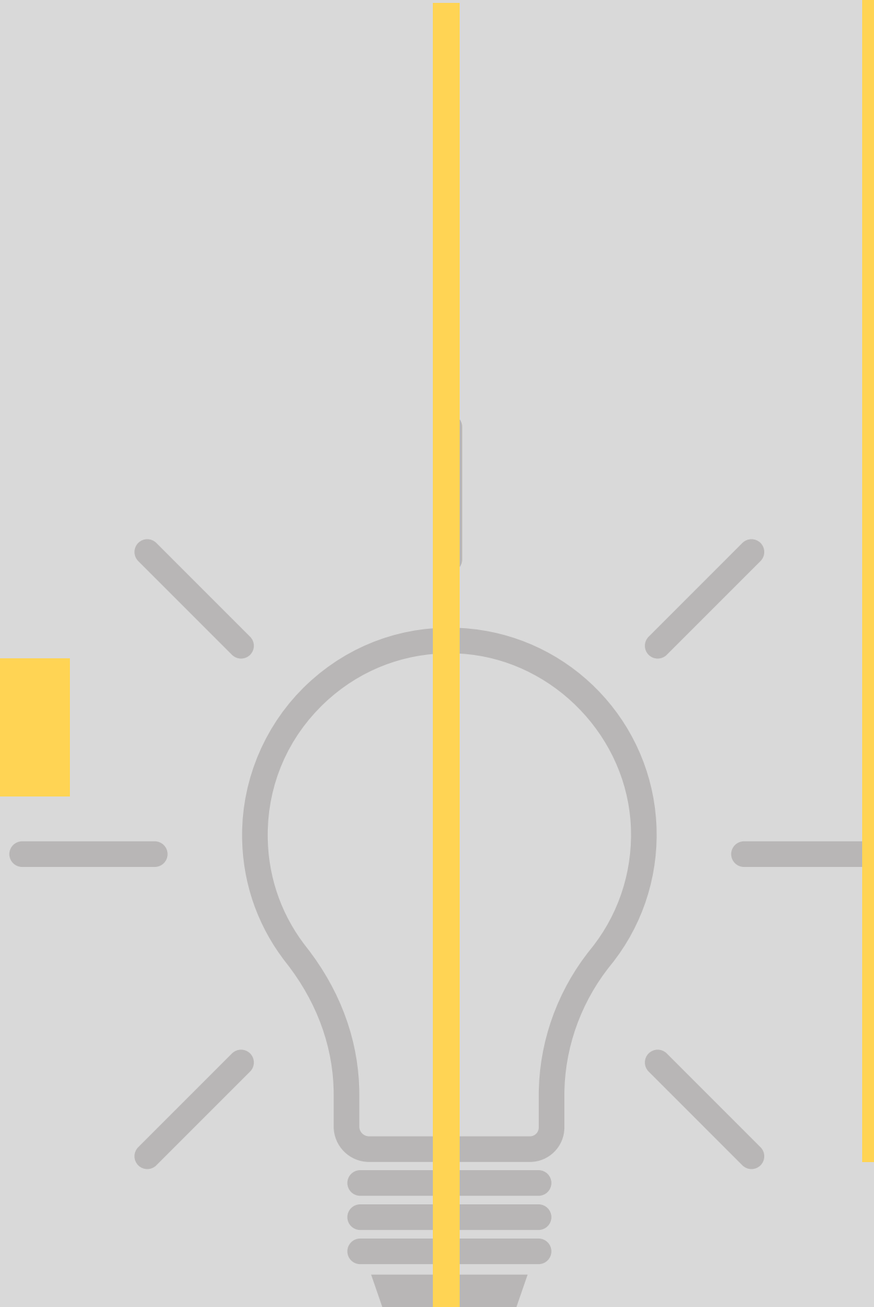
PROBLEMS FACED & SOLUTIONS

1. Lack of efficient, real-time monitoring
2. Overflowing bins (lack of work force)
3. Inefficient collection routes
4. Increased environmental impact

- IoT-Enabled Waste Fill Detection System
- App-based interface for real time monitoring
- Compression system + Shortest path selection based on fill level
- Waste segregation model relevant to india + Sensing interface for segregation

IDEATE

STAGE 3



IDEATE


Organic
Waste + Paper
Plastic
Metal &
Glass
SODA
E-Waste
Hazardous +
other Waste

IDEATE

SENSOR INTEGRATION

Capacitive Proximity Sensor

Spectral Sensor

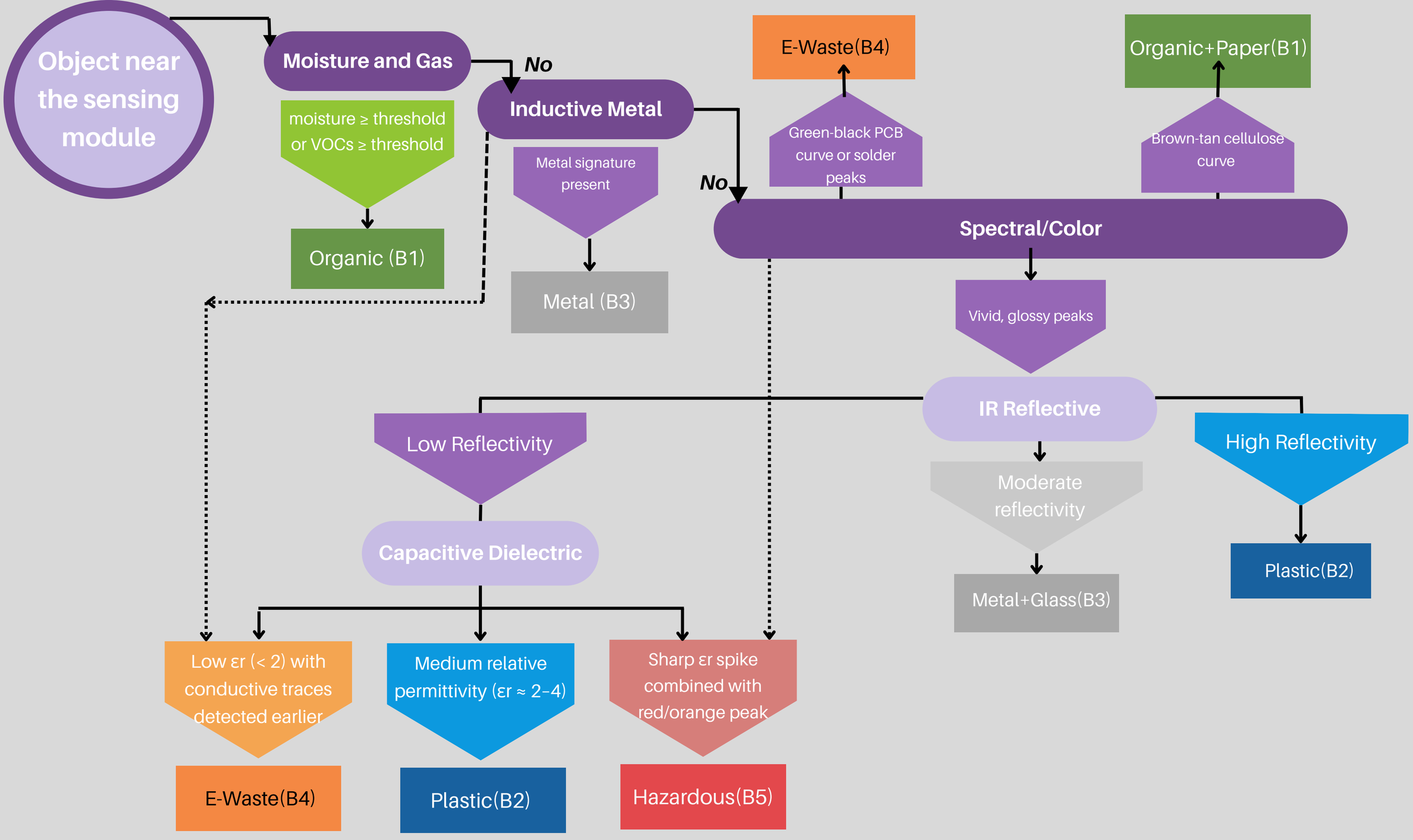
IR Reflective Sensor

Inductive Sensor

Moisture and Gas Sensors

Organic Waste + Paper	Plastic	Metal & Glass	E-Waste	Hazardous + Other Waste
Moisture detected + VOCs or no plastic signature	Capacitive moderate + spectral indicates colored/plastic signature	Inductive trigger → metal IR reflection moderately high + load cell high → glass	Inductive trigger + color signature in green/black + low dielectric	Gas/VOC detected strongly or Color match (red/orange) + weight moderate

Sensors for fill level detection and safety alerts.
Fill Level - Ultrasonic sensor and Load cell
Safety Alerts- Temperature sensor


Object near the sensing module
Moisture and Gas
moisture ≥ threshold or VOCs ≥ threshold
Organic (B1)
No
Inductive Metal
Metal signature present
Metal (B3)
No
E-Waste(B4)
Green-black PCB curve or solder peaks
Organic+Paper(B1)
Brown-tan cellulose curve
Spectral/Color
Vivid, glossy peaks
IR Reflective
Low Reflectivity
Capacitive Dielectric
Low εr (< 2) with conductive traces detected earlier
E-Waste(B4)
Medium relative permittivity (εr ≈ 2–4)
Plastic(B2)
Sharp εr spike combined with red/orange peak
Hazardous(B5)
Moderate reflectivity
Metal+Glass(B3)
High Reflectivity
Plastic(B2)

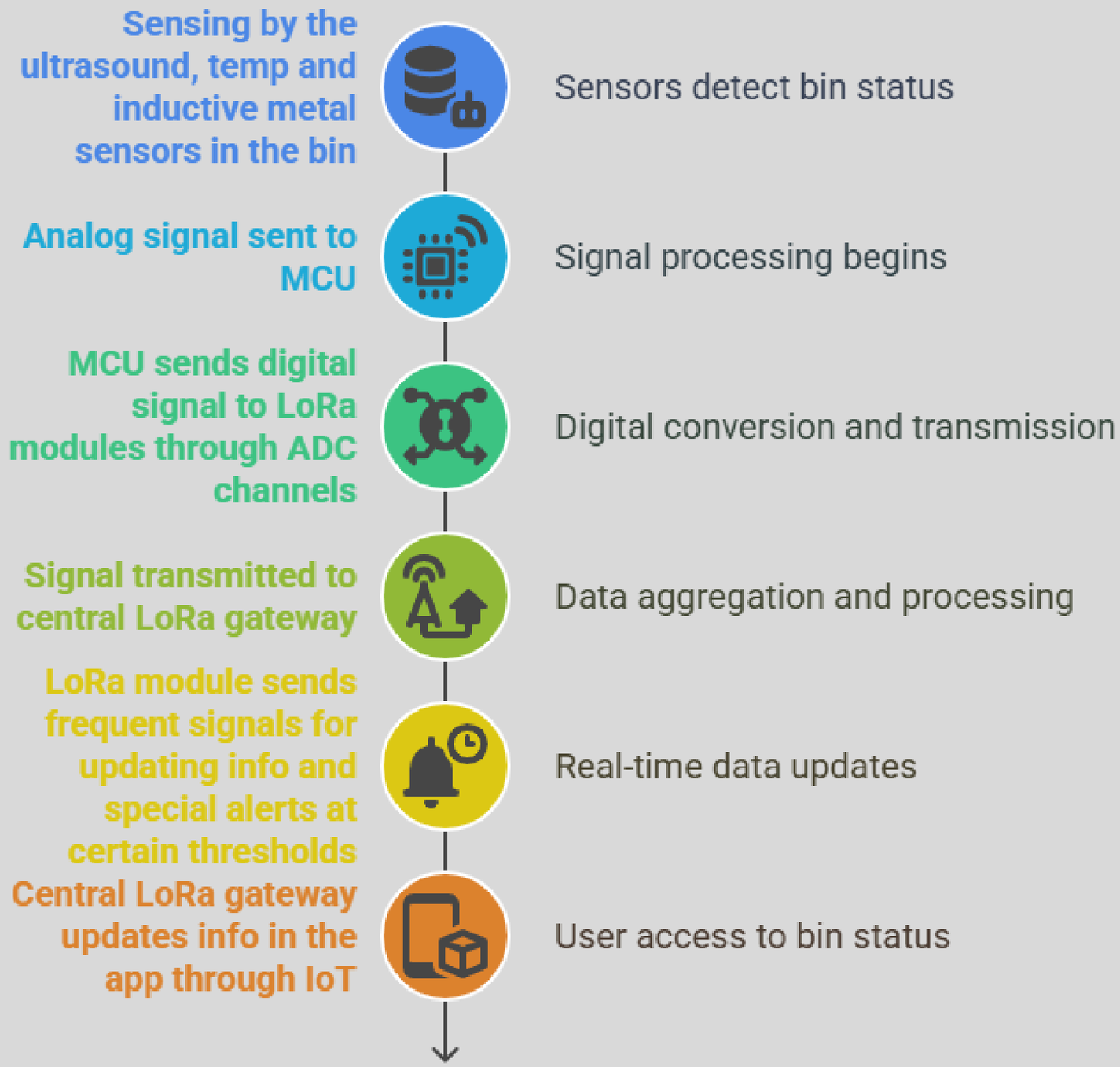
IDEATE

SYSTEM ARCHITECTURE

Why LoRa?

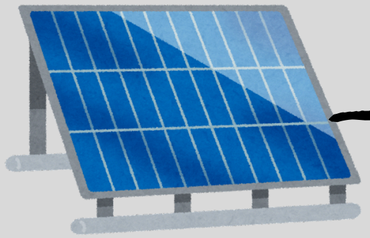
- Low Power (Years of battery life)
- Long Range: Multi km
- Low Cost than GSM or GPS
- Real-Time Alerts

Floyd-Warshall for Routing
Distance
Priority: Organic > Plastic > Others
Fill Level

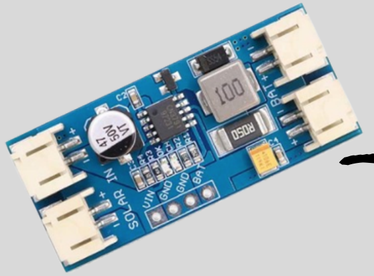


IDEATE

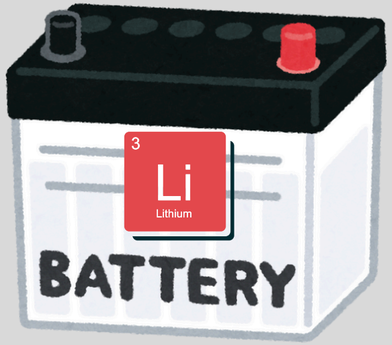
ENERGY FLOW



Solar Panel
Voltage: 12V
Power: 20W



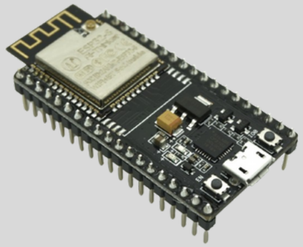
Solar Charge Controller-MPPT
Voltage: 6V - 24V
Current: 2A

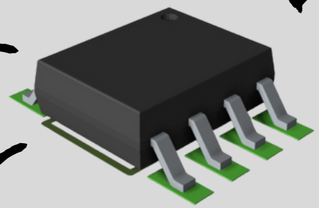


Battery Bank - Li ion
Voltage: 12V
Charge: 10Ah

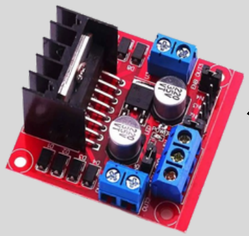
Sensors
Voltage: 3.6V - 12V
Total Power = 1W

ESP 32 Microcontroller
Voltage: 3.3
Total Power = 0.5W





Alllergo A4402
Voltage Regulaotr
input : 6V-50V
Adjustable Dual Output



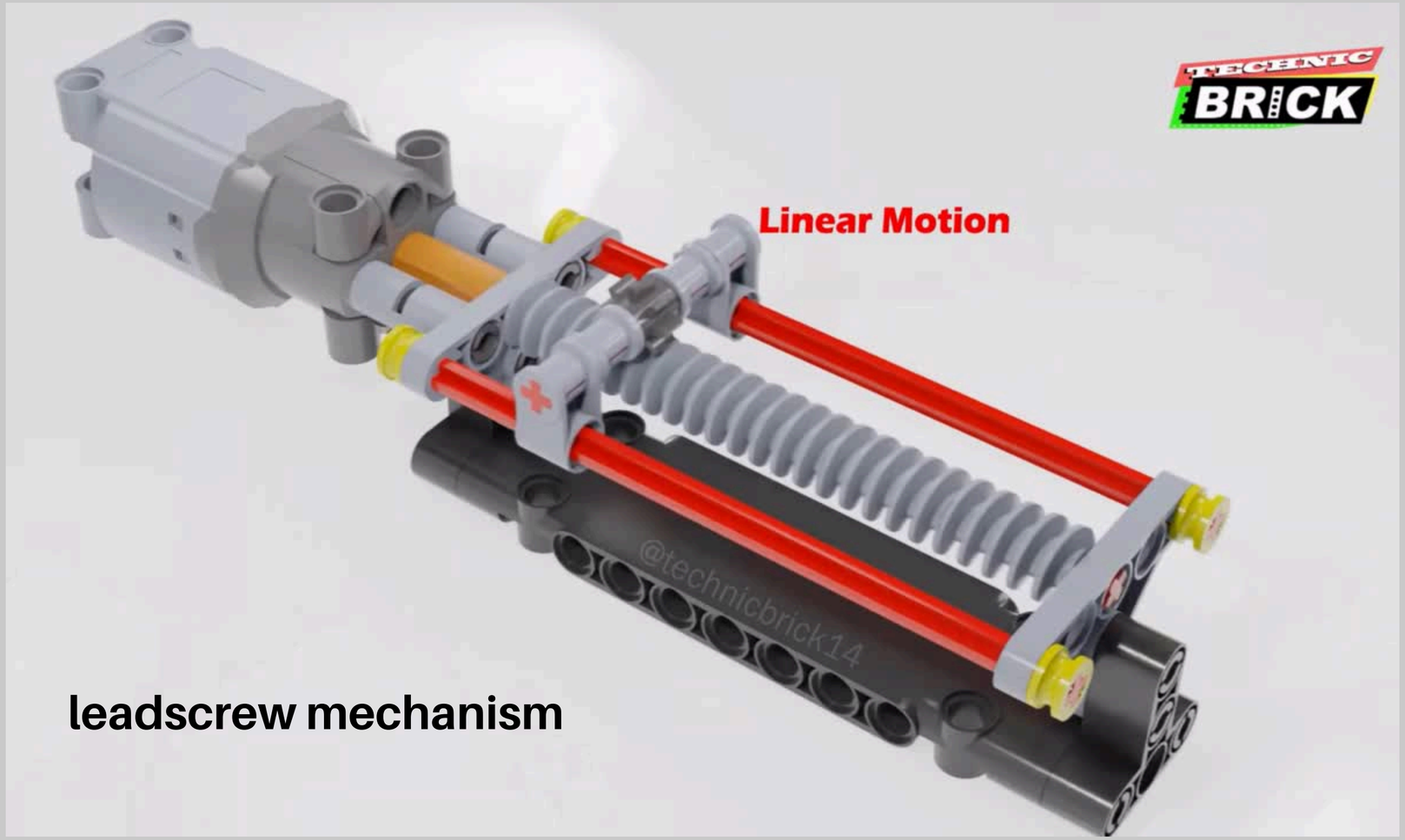
L298N
Motor Driver
Drive Voltage: 5V-35V
Drive Current: 2A
Max power: 25W

DC Motor
Voltage: 12V
Current: 2.2A
Power: 17W
Speed: 4500 RPM
Torque: 4-16 Ncm

IDEATE

COMPRESSION MECHANISM (Manual+ Motorized)

Added in
- plastic bin
- organic bin



IDEATE

WHAT AFTER COLLECTION?

 Organic Waste + Paper	 Plastic	 Metal & Glass	 E-Waste	 Hazardous+ Other Waste
• Sent to composting plants or biogas units	• Transported to Material Recovery Facility (MRF)	• Goes to scrap yards or MRFs	• Sent to authorized e-waste dismantling units	• Sent to TSDF (Treatment, Storage and Disposal Facility) in sealed condition
• Sold as compost to farmers, gardens, or parks	• Sold to authorized recyclers ,recycled into granules → pipes, bags, roads	• Melted → bottles, utensils, rods		• Incinerated, neutralized, or treated chemically

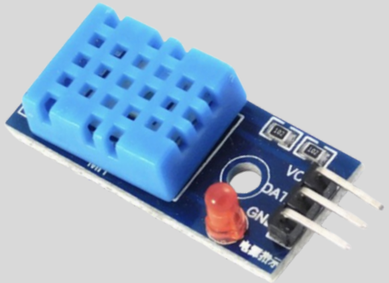
"When We Segregate, Waste Doesn't Aggregate!"

PROTOTYPE

STAGE 4

PROTOTYPE

Sensor Comparison: Features and Specifications



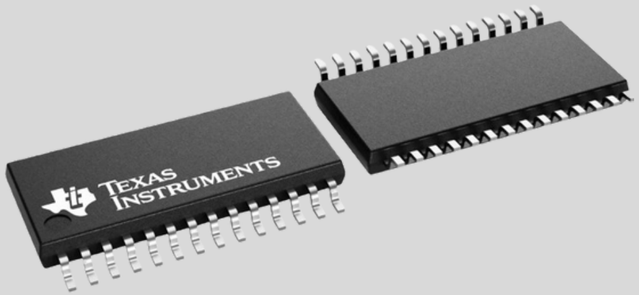
Temp and Moisture DHT11 Sensor

- Voltage: 3.3-5.5V
- Current: 2.5mA
- Cost: Rs. 125-200

AS7262 Spectral Sensor

- Voltage: 3.3V or 5V
- Current: 20-70mA
- Cost: Rs. 1700-1800

Ultrasonic Sensor TDC1000

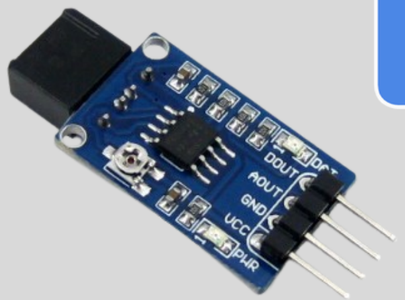


- Voltage: 2.7-5.5V
- Current: 2.74mA
- Cost: Rs. 380

Sensors

Capacitive Proximity Sensor

- Voltage: 12V DC
- Current: 10-30mA
- Range: 8mm
- Cost: Rs. 1500



Waveshare IR Reflective Sensor

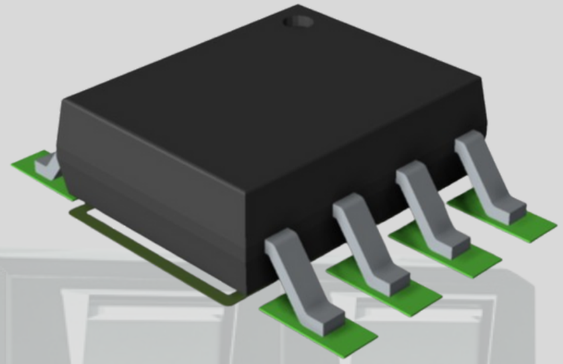
- Voltage: 3-5V
- Current: 20mA
- Range: 2cm to 30cm
- Cost: Rs. 280

LJ12A3-4-Z/BX Inductive Proximity Sensor

- Voltage: 6V-36V
- Current: 8-10mA
- Range: 4mm
- Cost: Rs. 180

PROTOTYPE

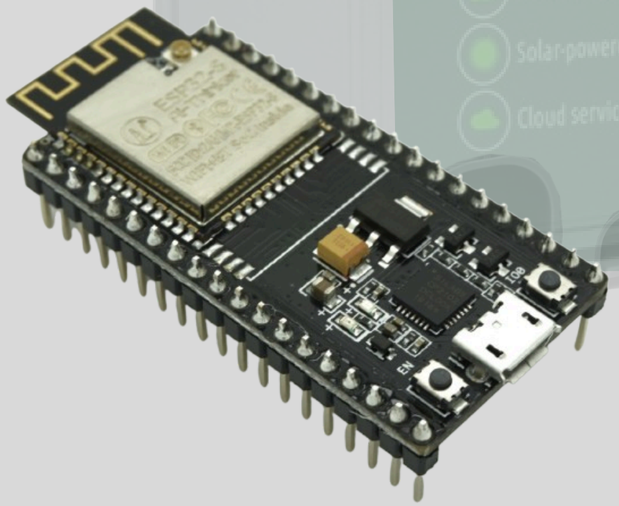
Voltage Regulator



Allegro A4402

- A dual-output regulator configured to provide 5V (buck) for sensors & 3.3V (LDO) for ESP32 and specific low-power sensors.
- Handles input 6–50V; 5V rail supports up to 1A, 3.3V LDO supports 250mA - max output current drawn from regulator.
- Costs ₹150–₹250 based on configuration.

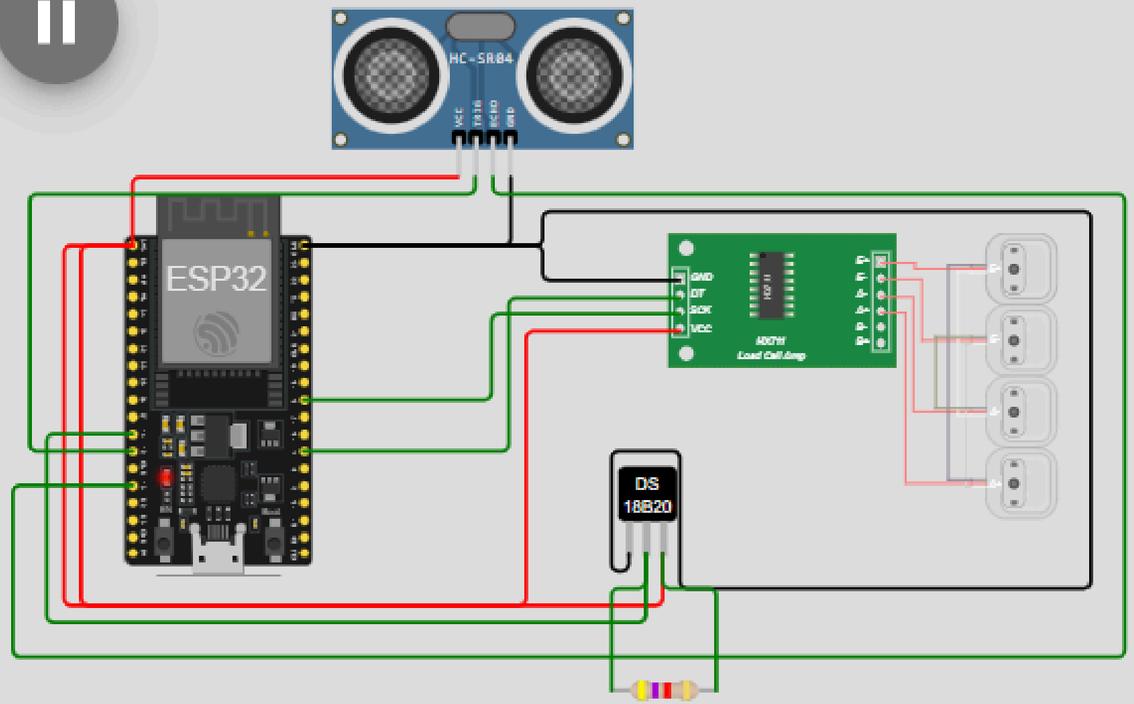
Microcontroller



ESP32 Microcontroller

- Low-power dual-core MCU used for sensor interfacing and control.
- Operates at 3.3V; consumes 50–150mA in active mode when WiFi is disabled, <10µA in deep sleep mode.
- Cost: ₹250–₹400
- Wi-Fi is disabled via code to save power and to enable all 18 ADC channels, but can be re-enabled later for real-time monitoring without any hardware changes.

PROTOTYPE



SIMULATION LINK

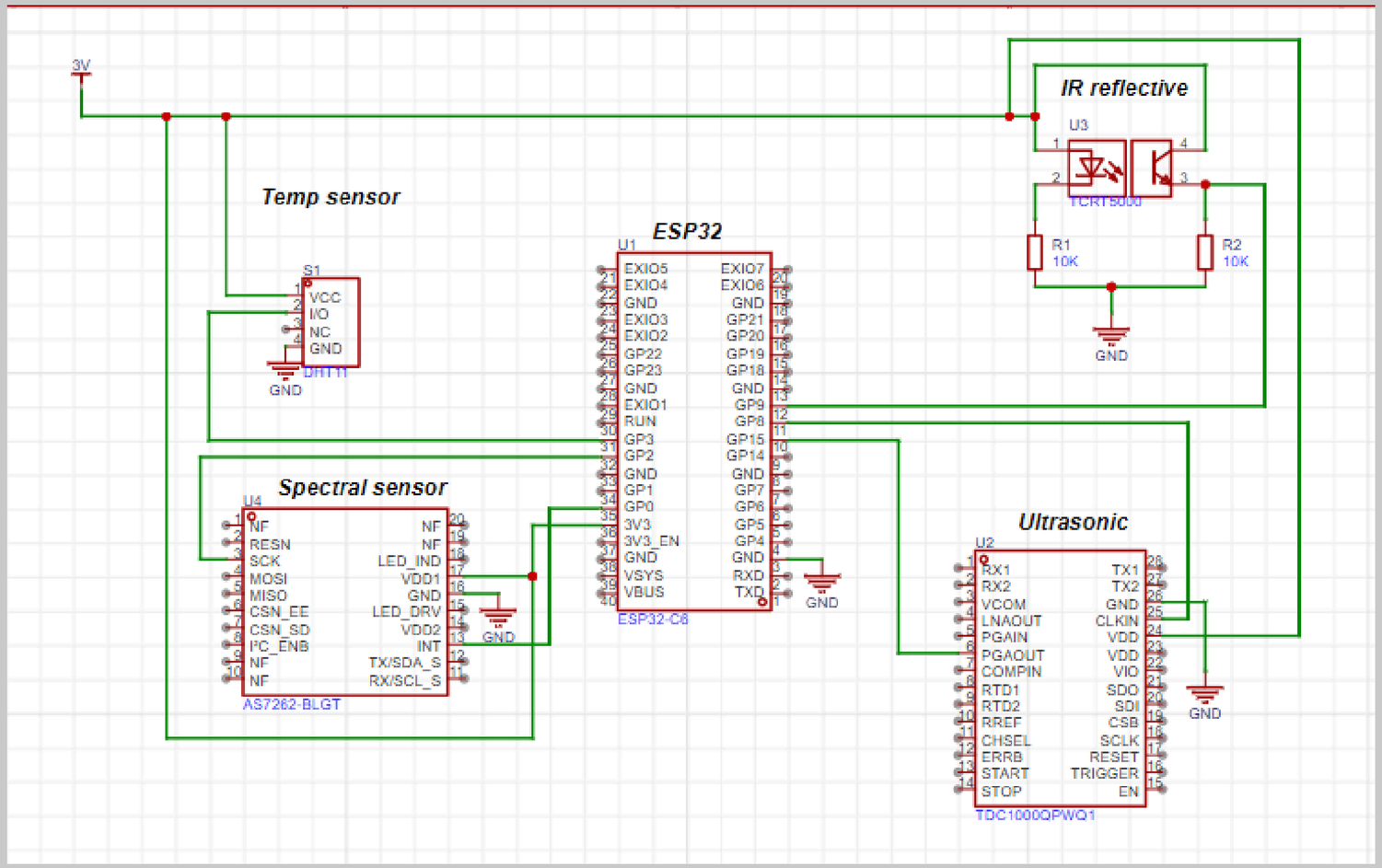
- This simulation (built with Wokwi) showcases a **smart monitoring system** mechanism integrating an **ESP32 MCU** with an **ultrasonic sensor**, **load cell**, and **temperature sensor**.
- We successfully simulated an example output that showcases the fill level and fire status based on the data collected.

SERIAL MONITOR CHIPS CONSOLE

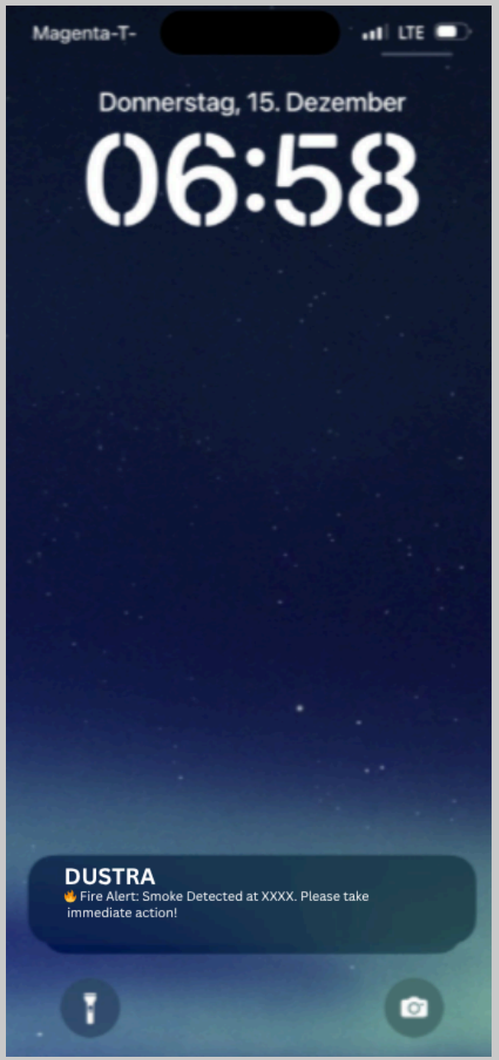
```
Initializing...
Load Cell (Weight): 28.50 kg
Distance: 81 cm
Fill Level: 32%
Temperature: 73.00 °C
```

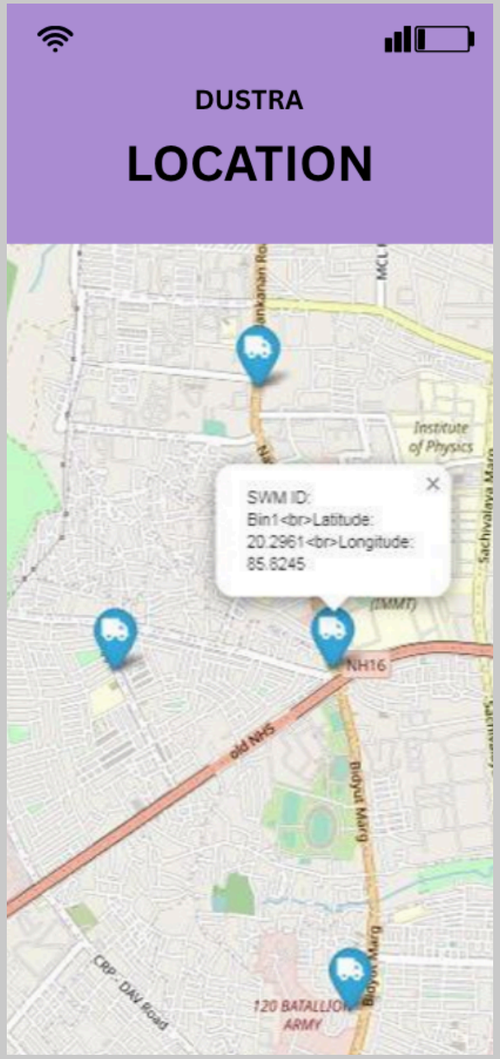
PROTOTYPE

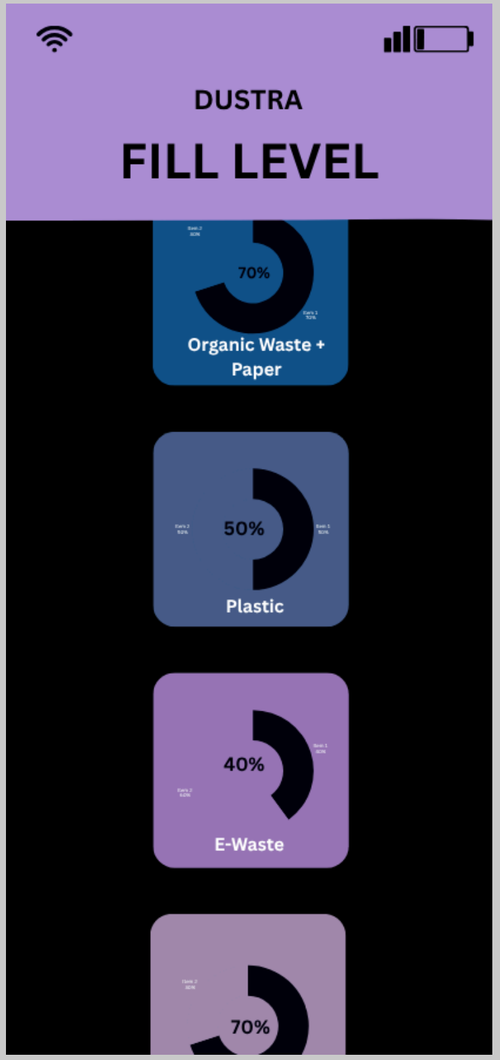
Schematic of circuit diagram



PROTOTYPE



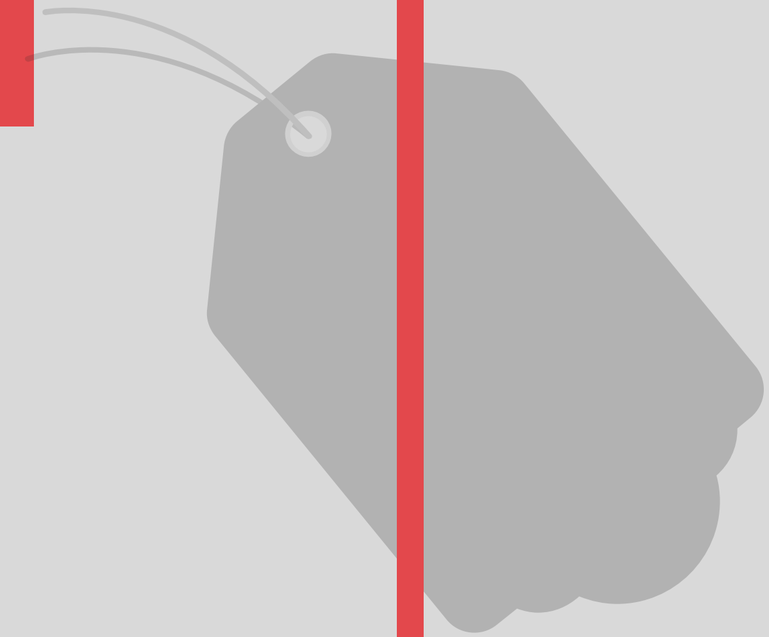




APP INTERFACE

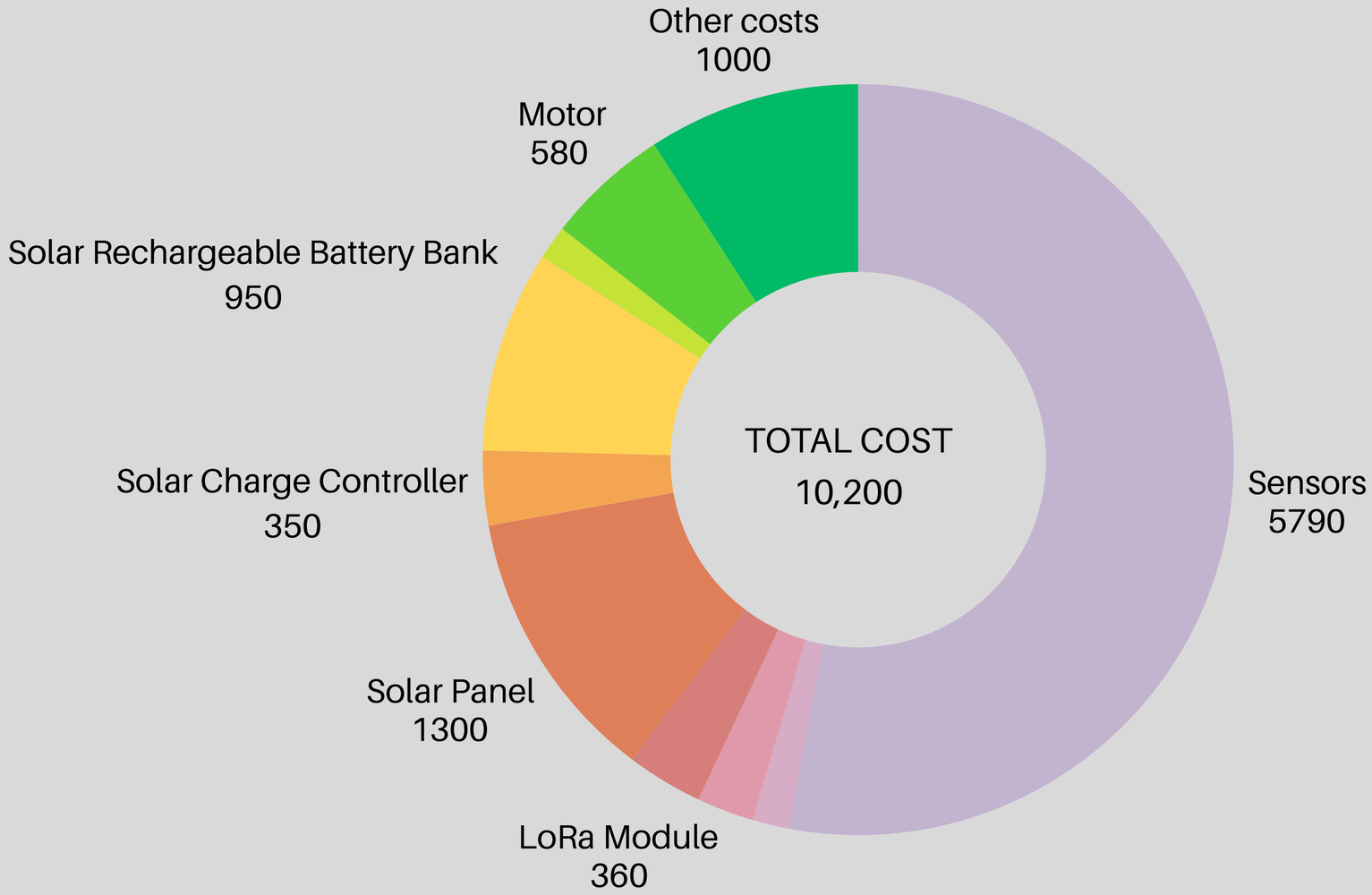
END PRODUCT

STAGE 5



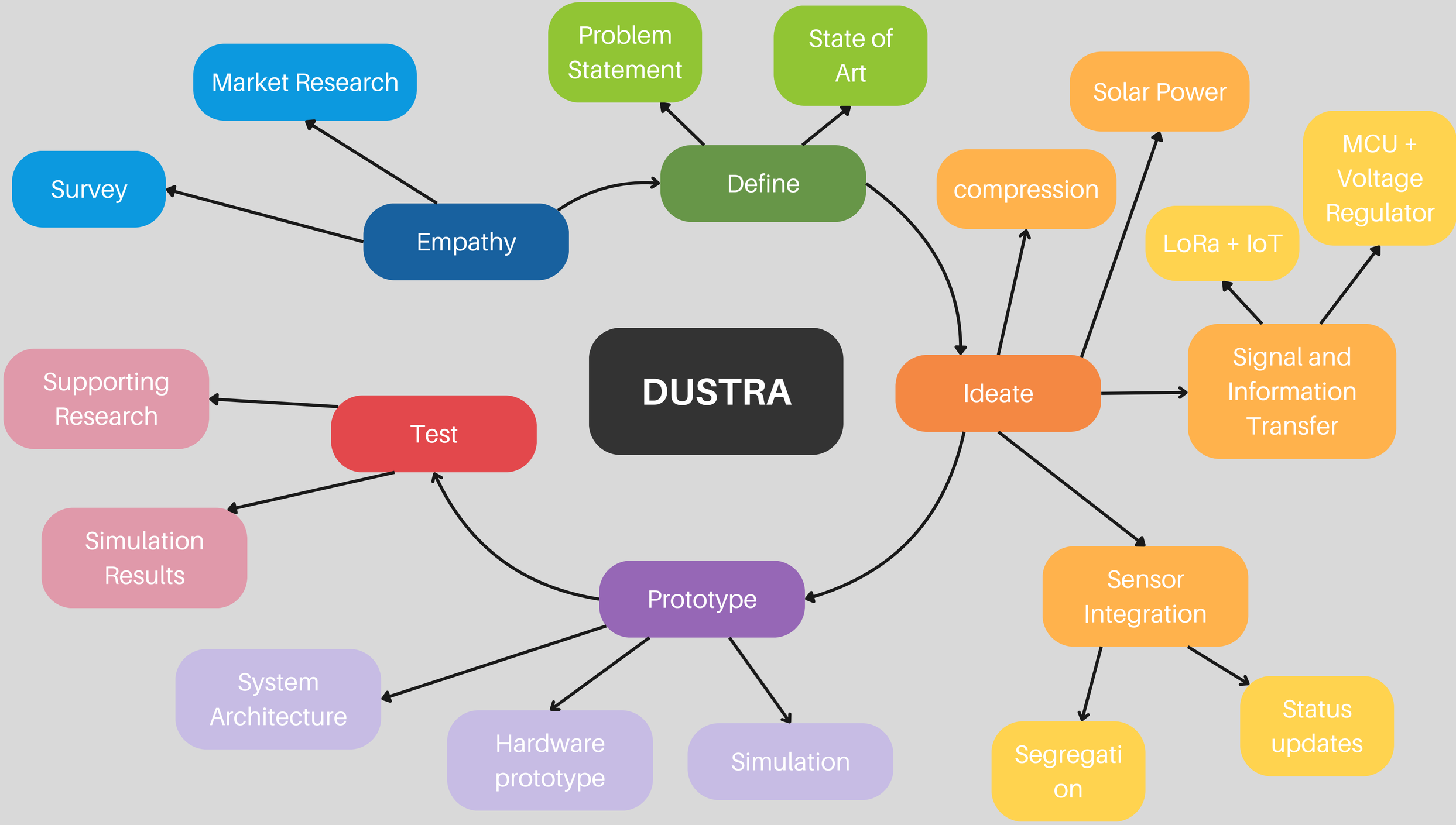
END PRODUCT

COMPONENT COST BREAKDOWN



END PRODUCT

- Segregation System customized for Indian waste categories
- High Segregation Accuracy via custom sensor architecture
- Overflow Control using fill-level sensors and real-time UI
- Compression Mechanism reduces collection frequency
- Shortest Path Algorithm for easy bin discovery and optimized collection
- LoRa Connectivity eliminates Wi-Fi dependency in remote areas
- Power Efficient with solar energy, LoRa, and dual-mode compressor
- Cost-Optimized Design delivering maximum accuracy at minimal cost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MCU + Voltage Regulator
Signal and Information Transfer
Sensor Integration
Segregati on
Status updates
Prototype
System Architecture
Hardware prototype
Simulation
Test
Supporting Research
Simulation Results

THANK YOU

References

- https://drive.google.com/drive/folders/1nb8nM-sC-MA9R9vdb44lYDFUSoGJkeSr?usp=drive_link