Web of Things Project

Scope Statement

Smart Trash bin Monitoring System

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1 General Introduction

Over 50% of the world's population now lives in cities, and the figure is set to rise to 75% by 2050. While the world's cities only cover 2% of the global land area, they account for a staggering 70% of greenhouse-gas emissions and share the burden of responsibility for global climate change.The problem we are facing is of the population, which is rising rapidly. In recent years, urban migration has skyrocketed. This has resulted in the rise of garbage waste everywhere. Dumping of garbage in public places creates a polluted environment in the neighborhood. It could cause a number of serious diseases to the people living around.atmosphere, health issues, extra collection costs and cleaning services.

2 Objectives

This project proposes an IoT-based smart system for efficient waste management, addressing the challenges associated with traditional methods. The system employs innovative sensory technologies to assess the fill levels of dustbins, optimizing the waste collection process. The essence of this approach lies in its ability to analyze past waste generation and fill level trends, which, in turn, optimizes collection routes, reduces fuel expenditures.

- **Efficient Garbage Monitoring:** Develop a system that efficiently monitors the fill levels of garbage bins to ensure timely waste collection.
- **Optimize waste collecting** : Utilize machine learning algorithms to predict peak waste accumulation hours based on historical data and real-time fill level information. This predictive analysis will enable proactive planning, allowing for the allocation of extra workers during peak times, such as holidays ensuring timely and efficient waste collection.
- **Real-time Data Communication:** Implement a reliable data communication mechanism to ensure real-time updates and alerts for fill level data.
- **Scalability:**The network should be salable, which means we could add new garbage containers to the IoT network's system easily.
- **User-Friendly Interface:** Create an intuitive hybrid Mobile interface that enables system administrators to manage and monitor the garbage monitoring system and provides end-user.

3 Functionalities

In this section, a detail of the functionalities of the project. We can split the functionalities into three parts: The first one details the sensors and the IoT network,the second part highlights the integration of ML prediction modal and location in our system and finally we give details of the mobile application used to control the appliances.

3.1 Sensors and Iot Network

- Ultrasonic Sensor is used to measure the distance between the sensor and the trash inside the bin.

- moisure sensor can help detect the presence of liquids or dampness within the garbage container. to This information can be valuable in certain situations, such as identifying leaks, detecting hazardous materials.

- a buzzer can provide audible alerts or notifications for various events, such as when the bin is full, when the lid is open for too long, or when specific conditions are met.

3.2 Machine Learning and Location functionalities

- Develop an ML model based on historical data from sensors to predict trash bin fill levels. Train the model on the edge to anticipate peak hours, holidays, and special events.

- During peak hours or holidays, allocate more workers to areas with high trash generation rates. Conversely, optimize the workforce during off-peak times.

- Integrate geolocation services into the mobile app used by workers by utilizing GPS data to track worker locations in real-time.As a result we can Leverage this information to assign workers to the nearest trash bins that require attention, optimizing travel time and fuel costs.

3.3 Mobile Application

- The mobile application can be installed on different platforms like Android, iOS and Web.

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- The head of the Smart-trashBin of the municipality can register and create an account with full access and he can register the waste collector as simple users .

- Waste collector get notified when a trash bin is full or defective .

4 Components

After considering our options, market availability and the different advantages and disadvantages of each component, we ended up picking the following parts:

- **Raspberry Pi 4 :**
  The Raspberry Pi 4 was released in June 2019 with a 1.5 GHz 64-bit quad core ARM Cortex-A72 processor, on-board 802.11ac Wi-Fi, Bluetooth 5, full gigabit Ethernet (throughput not limited), two USB 2.0 ports, two USB 3.0 ports, 4 of RAM,

- **Sensors:**

- ultrasonic sensor:
  An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal.

- moisture sensor :
  moisture sensor in a garbage monitoring system can help detect the presence of liquids or

dampness within the garbage container. This information can be valuable in certain situations, such as identifying leaks, detecting hazardous materials, or monitoring compost piles.

- Buzzer:
  A buzzer is an electromechanical or piezoelectric element which produces a characteristic sound when a voltage is applied to it: the beep.

5 Technologies

In order to implement the different functionalities into the mobile application, different technologies will be used in this context:

- **Back-end:**
  - **MongoDB:** A NoSQL document-oriented database. MongoDB is used to store users data. MongoDB is practical and easy to use with Node.js
  - **MQTT:** A lightweight publish-subscribe network protocol used to communicate sensor-collected data to a cloud MQTT broker (Mosquitto).
  - **Node RED:** Handles and manages sensor collected data based on specific events.
  - **Mosquitto:** Mosquitto is an open source message broker that implements the MQTT protocol. It is lightweight and is suitable for use on all devices from low power single board computers to full servers.
- **Middle-ware:**
  - **Jakarta EE:** Jakarta EE is a set of software components, APIs, for developing specifically enterprise Java applications. These components are often referred to as specifications. Jakarta EE specifications extend Java SE (standard edition Java programming language) with ways to perform the functions particularly useful for an enterprise application.
  - **WildFly:** WildFly is a powerful, modular, secure lightweight application server compatible with Jakarta EE.
- **Front-end:**
  - **HTML5, CSS3, Vanilla JavaScript:** The front-end is developed using the core web technologies - HTML5, CSS3, and Vanilla JavaScript - to create a user-friendly and responsive interface for the Progressive Web Application (PWA).

6 Architecture

Figure 1 describes the global architecture of the system:

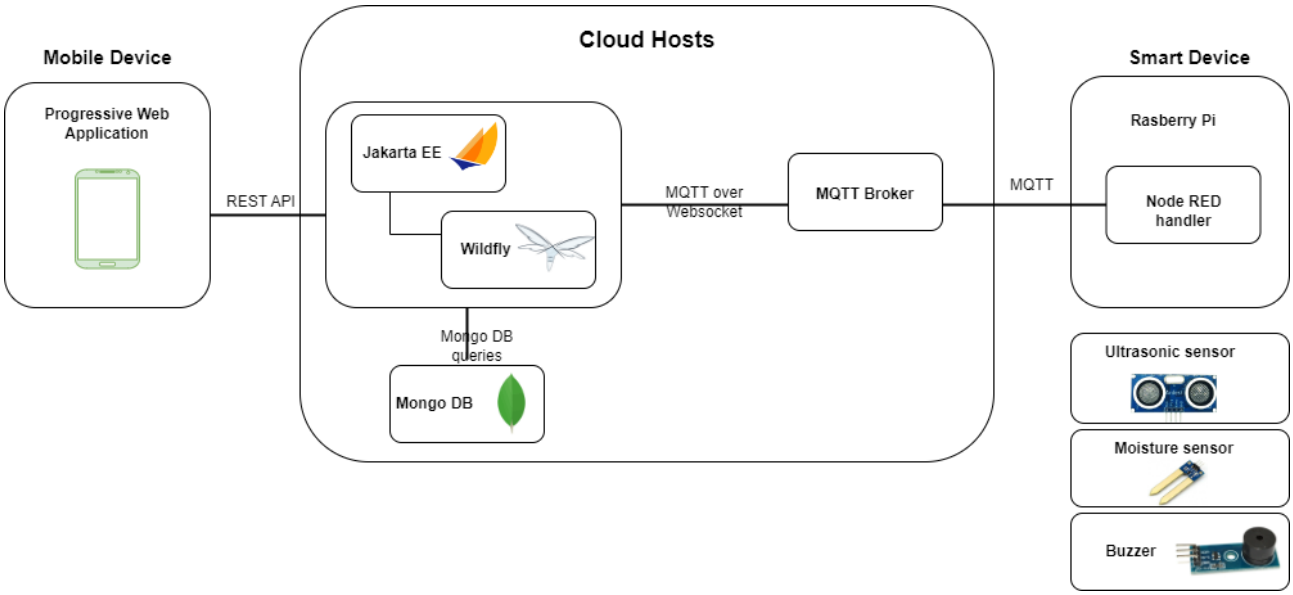

Figure 1: Smart garbage monitoring system architecture

7 Deployment Diagram

A deployment diagram is an UML diagram for visualizing the hardware components and devices, the links of communication between these different components. Figure 2 shows the deployment diagram for the smart garbage monitoring system:

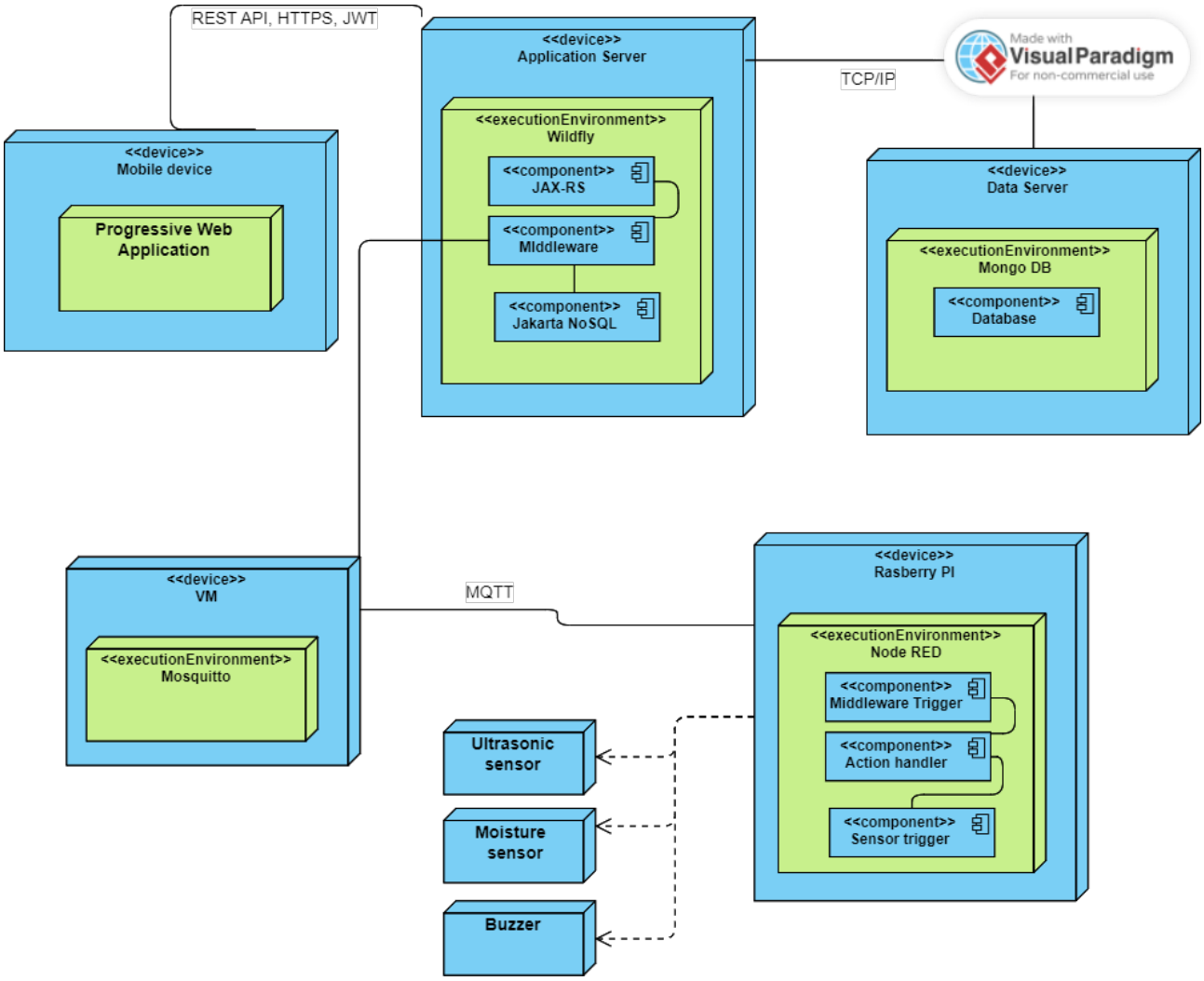

Figure 2: Deployment Diagram

8 Timeline & Tasks

The project development will undergo different steps:

- Planning smart garbage collection architecture and connecting objects.
- Handling collected data and connecting to cloud MQTT broker.
- Implementing database logic.
- Developing necessary APIs and connecting to database.
- Hosting Jakarta EE on a cloud server.
- Developing a progressive web application and connecting to the web server endpoint.
- Creating a Smart garbage collection system prototype and simulation.
- Organize and update the project repository with a Design Book, Full source code, Technical documentation and a Demo video.

9 Deliverables

At the end of the project, the following items will be delivered:

- Scope statement.
- Design document.
- Source code for different project components on GitHub.
- Garbage collection system Progressive Web Application.
- A miniature prototype for demonstration purposes.

10 Constraints and Assumptions:

- The project is subject to budget and time constraints defined in the project plan.
- The success of machine learning algorithms relies on the availability and accuracy of historical data.
- The project assumes a stable and reliable internet connection for data communication.

11 Business Study:

11.1 Business Model Canvas:

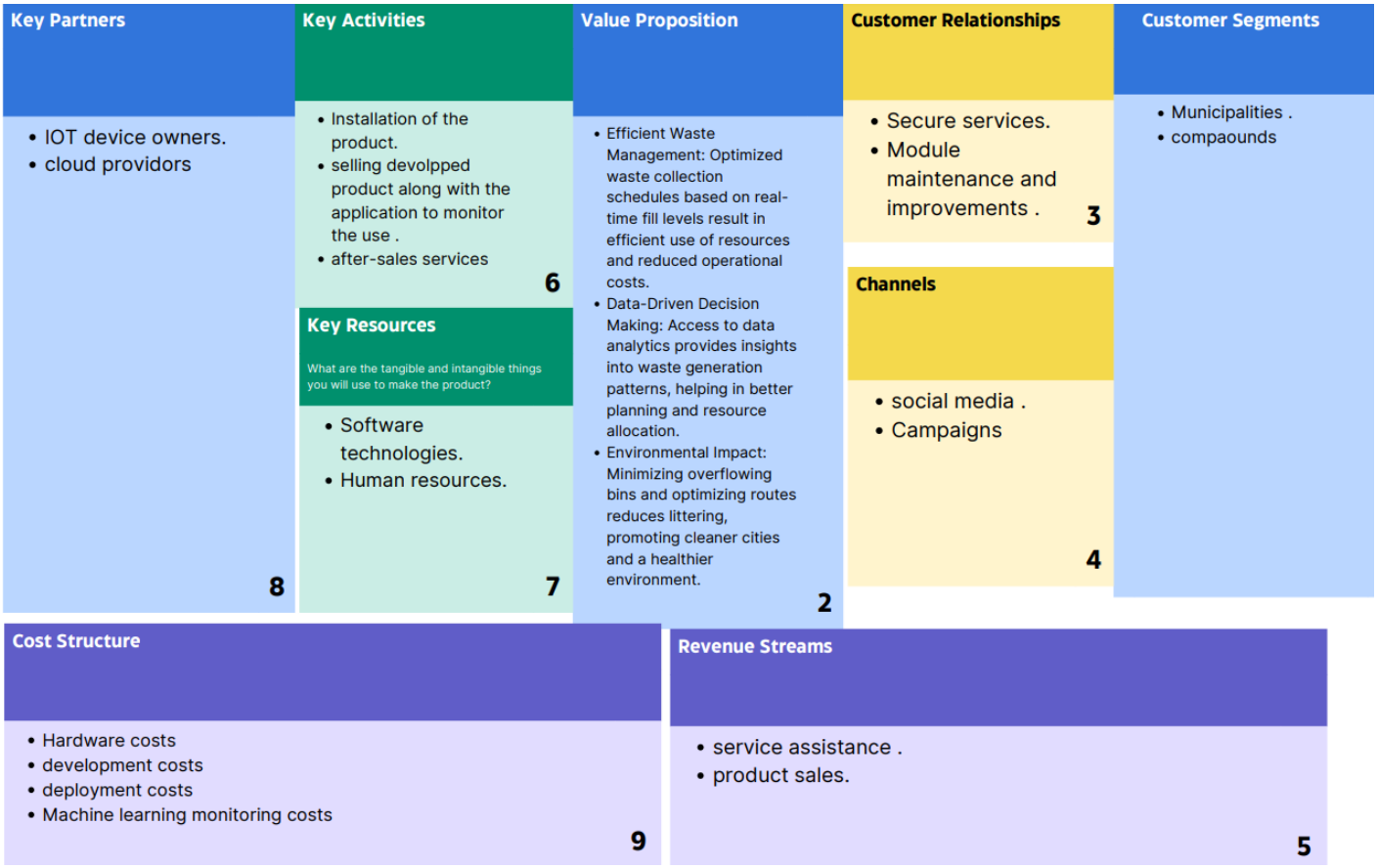

Figure 3: Smart trash bin monitoring Business Model Canvas

11.2 SWOT Analysis:

SWOT analysis is a vital strategic planning tool that can be used to perform a situational analysis of the firm . It is an important technique to evaluate the present Strengths (S), Weakness (W), Opportunities (O) Threats (T) Smart Parking Limited is facing in its current business environment.

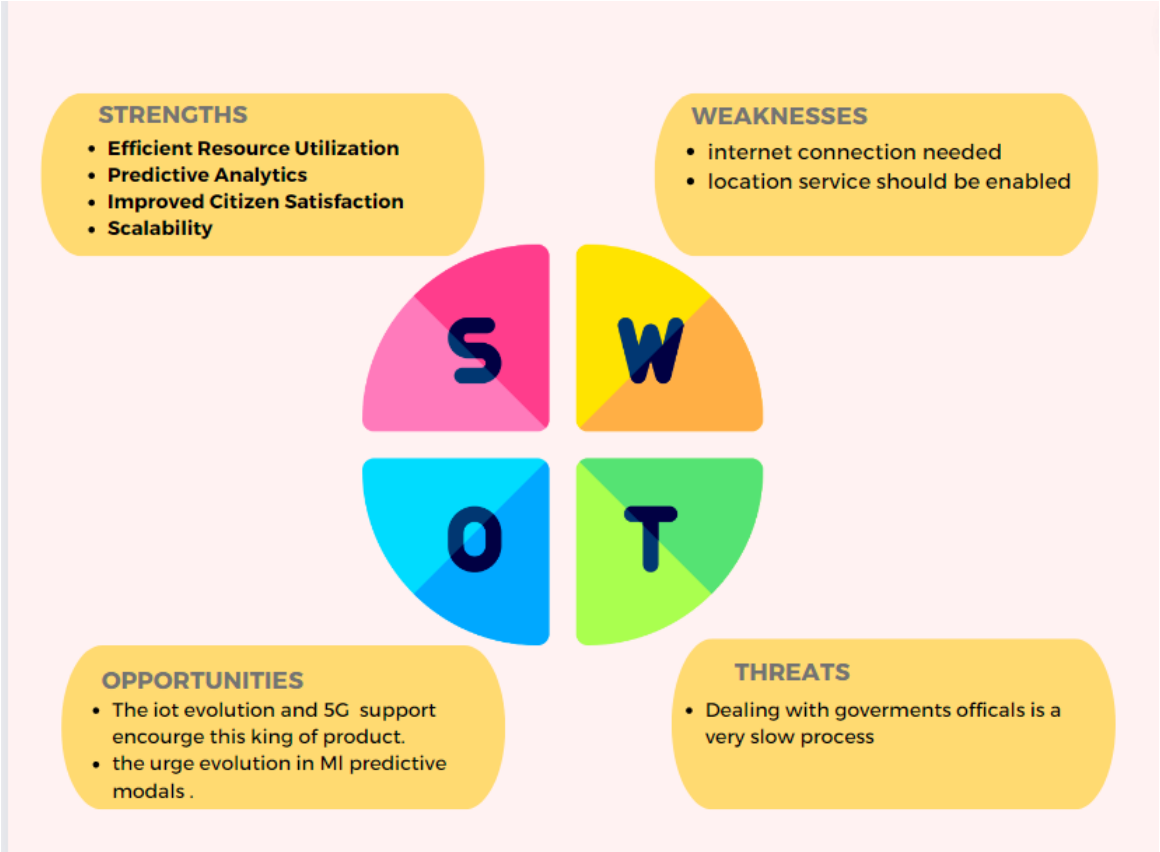

Figure 4: SWOT Analysis