Project Design Phase Report

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Project Title

Smart Waste Management System using IoT and Data Analytics

1. Objective of Design Phase

To create a clear system architecture and design blueprint that defines how different components of the Smart Waste Management System interact, ensuring scalability, efficiency, and ease of implementation.

2. System Architecture

The system consists of IoT-enabled waste bins connected to a cloud platform. Data from sensors is transmitted to the backend for processing and displayed on a web dashboard for analysis and route optimization.

3. Architectural Diagram

The architecture includes three layers:
• Sensor Layer: Collects data using ultrasonic sensors and NodeMCU.
• Cloud Layer: Transmits and stores data on cloud platforms (AWS/ThingSpeak).
• Application Layer: Displays analytics dashboard and notifications through a web interface.

4. Module Design

Module Name	Description
IoT Sensing Module	Detects waste bin fill levels using ultrasonic sensors and sends data to the
Cloud Integration Module	Receives sensor data and stores it in cloud databases for analysis.
Data Analytics Module	Processes waste data to generate insights and identify patterns.
Web Dashboard Module	Displays real-time bin status, alerts, and analytics visualizations.
Route Optimization Module	Calculates the most efficient waste collection routes using algorithms.

5. Data Flow Diagram (DFD)

The DFD shows the flow of data between the smart bin sensors, cloud database, and user dashboard. It illustrates how sensor data is processed and presented in the analytics system.

6. Database Design

The database stores information such as bin ID, location, fill level, timestamp, and alert status. Relationships are designed to ensure fast data retrieval and integration with the analytics module.

7. User Interface Design

The UI features a clean, interactive dashboard that provides:
• Real-time bin status indicators
• Graphical analytics
• Alerts and notifications
• Route visualization maps

8. Tools and Technologies Used

• Frontend: React, HTML, CSS
• Backend: Python (Flask/Django)
• Database: MySQL/Firebase
• IoT: NodeMCU, Ultrasonic Sensor
• Cloud: AWS / ThingSpeak
• Visualization: Power BI / Tableau

9. Expected Outcome

A complete design blueprint including architecture, data flow, and UI layouts for efficient implementation and testing in later phases.

10. Conclusion

The project design phase ensures that the Smart Waste Management System is structured, scalable, and user-friendly. The design decisions form the foundation for smooth development and integration of hardware and software components.