



COMSATS UNIVERSITY
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Lab Semester Project

Smart City Resource Management System

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OBJECT ORIENTED PROGRAMMING



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Abstract

The Smart City Resource Management System is a desktop-based Java application designed to simulate the dynamic resource management within a smart urban environment. The system manages multiple city services, including transportation, power distribution, and emergency services, using core Object-Oriented Programming principles. With an interactive GUI and data visualization features, this system demonstrates how a modern city can monitor and respond to infrastructure demands in real-time. The project provides a foundational platform for understanding distributed resource management, alert systems, and intelligent dashboards in urban planning.

Object Oriented Programming (OOP)

1. Introduction

This document outlines the semester project developed as part of the Object-Oriented Programming course. The purpose of the project is to simulate key aspects of a smart city using real-world modeling in Java. The project addresses the common issues in managing a city's transport units, energy grids, and emergency systems through a unified and scalable system. With an increasing shift toward smart cities, understanding the underlying software architecture of such systems is crucial.

From this project, students gain practical exposure to designing maintainable code using inheritance, interfaces, abstraction, and polymorphism. Additionally, the integration of GUI elements using Java Swing provides experience in building user-friendly applications. The project reinforces good software design practices and demonstrates how OOP principles can solve real-life management problems.

2. Proposed System

The proposed Smart City Resource Management System features a modular structure with three core services: Transportation Management, Power Grid Monitoring, and Emergency Response. Each service is modeled as an extension of an abstract class CityResource. Interfaces like Alertable and Reportable are used to add emergency response behavior and reporting capabilities.

The system allows users to view and manage these resources through a graphical user interface. A centralized city map shows each resource's status using color codes, and detailed forms allow CRUD operations for each service type. Optional features include data persistence using JSON and graphical reporting of usage metrics. The entire system is extensible, allowing for the addition of new resource types.

3. Advantages/Benefits of Proposed System

- Demonstrates real-world modeling using core OOP concepts.
- Allows simulation and visualization of city resource distribution.
- User-friendly GUI for managing resources.
- Includes emergency alert simulation.
- JSON-based data handling for persistence.
- Modular and extensible architecture.
- Supports real-time monitoring through color-coded statuses.

4. Scope

The project covers the simulation of a smart city's infrastructure management system. It includes the implementation of Transport Units (buses, trains), Power Stations, and

Object Oriented Programming (OOP)

Emergency Services. Each resource has properties like ID, location, and operational status, and functionalities like generating reports and sending alerts.

The user can add, update, delete, and view details of these resources via an interactive GUI. Visual elements like status indicators (colors), dynamic maps, and usage reports enhance usability. While actual real-time data feeds and geolocation services are out of scope, the system lays a strong foundation for such future enhancements.

5. Modules

Module 1: Transport Management

Allows users to add, update, and monitor transport units such as buses and trains. Each unit includes properties like route number, capacity, and status. The GUI shows transport units on a map and uses colors to indicate their operational condition.

Module 2: Power Grid Monitoring

Displays all power stations with details like output capacity, grid zone, and operational state. If a failure is detected, it triggers emergency alerts. Reports show usage and average downtime.

Module 3: Emergency Services

Handles fire, police, and ambulance services. These units respond to system-generated or manual alerts. EmergencyService implements Alertable to send immediate notifications.

Module 4: Smart Grid Simulation

Models power consumption by different consumer types (residential, industrial). Simulates electricity usage and balances loads across the grid.

Module 5: GUI and Dashboard

A Swing-based interface that integrates maps, forms, and visual charts. This module connects all others and provides the user interaction layer.

6. System Limitations/Constraints

- Real-time location tracking is simulated, not GPS-based.
- No actual network communication between services.
- Limited to local data persistence (JSON) instead of full-scale databases.
- GUI performance may degrade with a very high number of resources.

7. Tools and Technologies

Tool/Technology	Version	Rationale
Java	JDK 17	Core programming and OOP implementation
Java Swing	Built-in (JDK)	GUI development
GSON	2.10	JSON serialization and parsing
VS Code	2023	IDE for development
Git	Latest	Version control
Windows 10	OS	Execution environment

8. Conclusion

This project demonstrates a scalable and modular approach to managing smart city services using Java and OOP principles. It provides practical insight into building real-world simulations using abstract classes, interfaces, and GUI design. With potential for future enhancements, this system serves as a base for urban management applications.

9. References

- Java Documentation (docs.oracle.com)
- GSON Library (github.com/google/gson)
- Java Swing Tutorials (docs.oracle.com/javase/tutorial/uiswing/)
- Smart City Research (iee.org)
- Course slides and lectures by COMSATS Faculty