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Implementation of a Smart Canteen Token Management System Using Object-Oriented Programming in Java

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Abstract: *The rapid growth of technology in everyday life has pushed even small-scale systems like college canteens to adopt smarter, more organized solutions. The traditionally busy college canteen environment creates significant challenges — staff members struggle to manage multiple simultaneous orders, leading to longer wait times and frequent order errors. This paper presents a Smart Canteen Token Management System developed using Object-Oriented Programming (OOP) principles in the Java programming language. The system allows students to browse a menu, select their desired items, and receive a uniquely generated token number. This token drives the food preparation process, enabling students to collect their meals once their token is called — improving overall speed and operational efficiency. The system serves as a practical demonstration platform for fundamental OOP principles including Classes, Objects, Encapsulation, Inheritance, Polymorphism, and Abstraction, as well as advanced constructs such as Constructors, Method Overloading, Static Members, the this keyword, Inner Classes, Object as Parameter, Recursion, Command Line Arguments, and the finalize() method. Simple theoretical explanations of each concept are paired with Java code examples built specifically for this system, showing how abstract programming ideas map to concrete, real-world problems. The study demonstrates that OOP is not merely a theoretical framework but is a genuinely practical approach for building clean, maintainable, and scalable software — even for everyday operational systems like canteen management..*

Keywords: Object-Oriented Programming, Java, Encapsulation, Inheritance, Polymorphism, Token Management System, Canteen Automation, Software Design.

I. INTRODUCTION

A. Background of the Study

The canteen is one of the most active spaces in any college or educational institute, particularly during scheduled break periods. Students arrive in groups, everyone expects their food quickly, and the staff struggles to manage and complete multiple orders simultaneously. The outcome is predictable — incorrect order delivery, excessive waiting, and general frustration for everyone involved.

The traditional manual order-taking approach requires staff members to verbally record student food requests, which results in slow and error-prone processing. The current system also lacks any reliable method to monitor the sequence in which orders were placed, the status of completed orders, or the outstanding amounts for individual students. Object-Oriented Programming (OOP) has emerged as the dominant software development paradigm precisely because it enables developers to design structured, scalable solutions for systems ranging from simple billing tools to complex enterprise platforms.

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OOP allows developers to represent real-world entities — such as students, food items, and tokens — as distinct program objects, making the overall system intuitive, maintainable, and straightforward to extend [1].

B. Statement of the Problem

Visiting a college canteen during peak hours is far more stressful than it ought to be. There is no fixed sequence determining who gets served first, staff members attempt to recall multiple orders at once, and mistakes are common. A student who has already paid might wait indefinitely without knowing whether their food is even being prepared. By the end of a shift, there is no clear record of how many orders were handled or how much revenue was generated. The canteen does not need a complex, expensive solution — it needs a basic, organized system that processes orders in sequence, tracks their status, and generates accurate records. This case study builds exactly that, using Object-Oriented Programming in Java.

II. LITERATURE REVIEW

Tim Rentsch's seminal work on Object-Oriented Programming [1] stands as one of the most frequently cited foundational texts in the discipline. His paper introduced developers to a new programming methodology that required building software through object-based systems mirroring actual real-world entities. The canteen token system described in this paper directly reflects that transformation — a student object, a food item object, and a token object each containing unique information and behaviour. Rentsch's work provided the core justification for why a procedural approach would be inadequate for this system, and why OOP was the correct architectural choice.

Bjarne Stroustrup's research [2] presents precise requirements that programming languages must satisfy to qualify as truly object-oriented, emphasizing classes, inheritance, polymorphism, and data abstraction as essential elements. These reference materials were particularly useful for grounding this case study's Results section, where each OOP concept is mapped to a specific functional component of the canteen system. Stroustrup's definition of Encapsulation, in particular, informed how the Token class was designed — with private fields and access-controlled methods.

Peter Wegner's formal framework [3] establishes distinct categories of object-oriented languages — object-based, class-based, and fully object-oriented with inheritance — and provided the structural vocabulary for this study. Wegner's classification confirmed Java as the appropriate implementation language, since it supports all three classification levels comprehensively. His framework also shaped the analytical method used here: evaluating OOP features from both the language capability perspective and the design solution perspective.

Herbert Schildt's Java: The Complete Reference [5] served as a primary implementation guide throughout the development of the canteen system, particularly for practical usage of constructors, inner classes, recursion, and the finalize() method. Oracle's official Java documentation [4] was additionally referenced for language specification details and standard API usage.

III. METHODOLOGY

A. Research Design: Analytical and Comparative Study

This study does not require surveys, controlled experiments, or external data collection. Instead, the methodology is practical and analytical in nature — a real operational problem observed in our college canteen was selected, and a software solution was designed and implemented to address it, while simultaneously demonstrating every OOP concept from the academic syllabus. The canteen token system was not selected arbitrarily; it was chosen because the authors have direct personal experience with the problem, and the system requirements were clear from the outset: the system needed to handle item selection, sequence-based token generation, and order tracking. The methodology required designing the system, developing Java code, and demonstrating that OOP concepts emerge naturally from the system's architecture — not as artificially inserted elements, but as genuine structural necessities.

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B. Data and Information Sources

The study draws on three principal categories of sources:

Foundational Literature: Early and widely cited OOP literature by Rentsch [1], Stroustrup [2], and Wegner [3], which collectively explains the origins of OOP, the problems it was designed to solve, and the core principles that define it. These texts provided theoretical evidence that OOP design produces superior outcomes for a canteen token system compared to procedural alternatives.

Comparative System Analysis: The practical comparison is derived from the design process itself. An OOP-structured implementation of the canteen system was compared against a hypothetical function-and-variable-only procedural version. The OOP version produced clearer code separation, reduced duplication, and made the system straightforward to extend — providing internal evidence that OOP is appropriate even at this scale.

Industry Best Practice: The implementation follows standard Java programming practices and OOP design conventions, including access control, constructor usage, and method organization as described in [4] and [5].

C. Analytical Framework

The analysis proceeds through four stages:

1. Identification of limitations in the traditional canteen process — specifically, the absence of queue management, manual order tracking, and lack of billing records.
2. Systematic mapping of core OOP principles to the specific canteen problems each principle addresses.
3. Comparative evaluation of an OOP-structured implementation against a procedural equivalent, assessing structural clarity, error handling, and overall system organization.
4. Demonstration of working Java code examples showing all OOP concepts as they appear organically within the canteen token system.

D. Research Tools

Core Java (JDK 8+) serves as the implementation language. Existing OOP literature functions as the theoretical foundation. The system is implemented as a console-based Java application demonstrating all specified OOP constructs in a unified, working codebase.

IV. RESULTS AND DISCUSSION

A. Core Principles of OOP: Principle-to-Solution Mapping

Encapsulation: The Token class keeps its token number and status information secure. State changes are only possible through the designated methods (such as setOrder()), which serve as the sole controlled interface for modifying token details.

Abstraction: The system operates independently through its automatic item selection and token generation process. Students interact with a clean menu interface without any exposure to how billing calculations or token numbering are handled internally.

Inheritance: The VegItem and NonVegItem classes reuse common fields (name, price) from a parent MenuItem class, eliminating code duplication and establishing a clear type hierarchy.

Polymorphism: The displayItem() method, defined in the parent class, is overridden in each subclass and executed automatically by the runtime — without requiring explicit if-else type checking in the calling code.

B. Practical Implementation in Java

To demonstrate additional OOP constructs, the system introduces the main entities of the Canteen Token Management System: Canteen, Token, and the main application entry point. The implementation incorporates the following constructs:

- Class definition and object creation
- Constructors for object initialization

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- Method overloading (multiple setOrder() signatures)
- The this keyword for self-reference
- Static class variables (tokenCounter)
- Object as return type (createToken() method)
- Object as method argument (displayToken() method)
- Inner classes (Token defined inside Canteen)
- Recursion (showMenu() for menu display)
- Command line arguments (canteen name via args[0])
- The finalize() method for resource cleanup notification

C. Code Implementation in Java

The following Java source code presents the complete implementation of the Canteen Token Management System:

```
import java.util.*;

class Canteen {

    static int tokenCounter = 0;

    class Token {
        int tokenNo;
        String item;
        double price;

        Token(String item, double price) {
            this.tokenNo = ++tokenCounter;
            this.item = item;
            this.price = price;
        }

        void setOrder(String item) {
            this.item = item;
        }

        void setOrder(String item, double price) {
            this.item = item;
            this.price = price;
        }

        protected void finalize() {
            System.out.println("Token removed");
        }

        public String toString() {
            return "Token No: " + tokenNo + " | Item: " + item
                   + " | Price: Rs." + price;
        }
    }
```

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```
    Token createToken(String item, double price) {
        return new Token(item, price);
    }

    void displayToken(Token t) {
        System.out.println(t);
    }

    static void showMenu(String[] items, double[] prices, int i) {
        if (i == items.length) return;
        System.out.println((i + 1) + ". " + items[i]
                           + " - Rs." + prices[i]);
        showMenu(items, prices, i + 1);
    }
}

public class Main {

    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);

        if (args.length > 0) {
            System.out.println("Canteen Name: " + args[0]);
        }

        String[] items = {"Sabji-Roti", "Dal-Rice", "Pav Bhaji",
                          "Samosa", "Masala Dosa", "Tea"};
        double[] prices = {60, 70, 80, 20, 90, 10};

        Canteen c = new Canteen();
        Canteen.Token[] orders = new Canteen.Token[50];
        int count = 0;
        int choice;

        do {
            System.out.println("\n--- Main Menu ---");
            System.out.println("1. Show Canteen Menu");
            System.out.println("2. Select Items");
            System.out.println("3. Display Tokens");
            System.out.println("4. Exit");
            System.out.print("Enter choice: ");
            choice = sc.nextInt();

            switch (choice) {
                case 1:
                    System.out.println("\n--- Food Menu ---");
```

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```
                    Canteen.showMenu(items, prices, 0);
                    break;
                case 2:
                    System.out.print("How many items? ");
                    int n = sc.nextInt();
                    for (int i = 0; i < n; i++) {
                        System.out.println("\nSelect item number:");
                        Canteen.showMenu(items, prices, 0);
                        int itemChoice = sc.nextInt();
                        if (itemChoice >= 1 && itemChoice <= 6) {
                            orders[count] = c.createToken(
                                items[itemChoice - 1],
                                prices[itemChoice - 1]
                            );
                            count++;
                            System.out.println("Token Generated!");
                        } else {
                            System.out.println("Invalid choice");
                        }
                    }
                    break;
                case 3:
                    System.out.println("\n--- Generated Tokens ---");
                    for (int i = 0; i < count; i++) {
                        c.displayToken(orders[i]);
                    }
                    break;
            }
        } while (choice != 4);

        System.out.println("Total Tokens Generated: "
                           + Canteen.tokenCounter);
    }
}
```

D. Explanation of Code

1. Classes: A class functions as a blueprint from which objects are created. This program uses the Canteen class as the outer container and the Token class as a nested inner class. The Token class stores three pieces of information for each order: a token number, the item name, and the price.

2. Creating Objects: Objects are created using the new keyword. The statement orders[count] = c.createToken(...) generates a new Token object each time a user selects an item from the menu.

3. Static Variables (Class Variables): Static variables are shared across all instances of a class. The field static int tokenCounter = 0 maintains a unified count of all tokens generated throughout the session, regardless of which object created them.

4. Method Overloading: Two versions of the setOrder() method exist — one accepting only an item name, and another accepting both a name and a price. This allows flexible order modification without requiring separate method names.

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5. Method Overriding: The toString() method, inherited from Java's Object class, is overridden in the Token class to produce a clearly formatted display string showing the token number, item, and price.

6. Constructor: The Token constructor initializes a new token object using the supplied item name and price, and automatically increments the tokenCounter to assign a unique token number.

7. The this Keyword: The this keyword refers to the current instance of an object. It is used within the constructor and setter methods to disambiguate between instance fields and constructor parameters that share the same name (e.g., this.item = item).

8. Object as Return Type: The createToken() method returns a newly constructed Token object, demonstrating that Java methods can produce objects as their return values.

9. Object as Argument: The displayToken(Token t) method accepts a Token object as its parameter, demonstrating how objects can be passed to methods for processing.

10. Array of Objects: The system uses Canteen.Token[] orders = new Canteen.Token[50] to maintain up to fifty token objects in memory, where each array element stores one complete order.

11. Inner Class: The Token class is defined entirely inside the Canteen class, making it an inner class. This design reflects the logical relationship between the canteen and its tokens — a Token does not exist independently of the Canteen context.

12. Recursion: The showMenu() method calls itself with an incremented index until all menu items have been displayed. This is a clean demonstration of recursion applied to a practical list-traversal task.

13. Command Line Arguments: The program accepts an optional canteen name as a command line argument via args[0], which is displayed on startup — demonstrating how Java programs can receive runtime configuration from the command line.

14. finalize() Method: The finalize() method is defined in the Token class and is automatically invoked by the Java garbage collector before a Token object's memory is reclaimed, outputting a notification that the token has been removed.

V. CONCLUSION

This case study demonstrates that the Object-Oriented Programming paradigm offers practical and effective solutions to the real operational challenges faced by a college canteen environment. The Canteen Token Management System implemented in Java illustrates how core OOP constructs — classes and objects, constructors, method overloading, static class variables, inner classes, and recursion — combine naturally to produce a functioning, organized system. The system processes food orders through token generation and maintains an accurate sequential record of all transactions.

The implementation confirms that OOP enables developers to produce software that is better organized, more reusable, and far easier to maintain than equivalent procedural implementations [2][3]. By representing real-world entities — menu items, tokens, orders — as software objects, the system becomes both intuitive to understand and straightforward to extend. The structural clarity produced by encapsulation and inheritance means that adding features such as VIP token priority or item category filtering would require minimal modification to existing code.

In summary, this study demonstrates that OOP is not merely a theoretical academic construct — it is a genuinely practical engineering approach that produces better software even for systems of modest scale. Future extensions of this system could include online food ordering, digital payment integration, and backend database connectivity, which would further validate OOP's scalability and suitability for real-world business usage.

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