

# **SWENG304: Software Design and Architecture**

## **Shopping Mall Java Project**

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### **ShoppingCart Refactoring and Design Pattern Application**

#### **Problem Review**

Given the initial implementation of the ShoppingCart class:

```
public class ShoppingCart {  
    private List<Item> items = new ArrayList<>();  
  
    public void addItem(Item item) {  
        items.add(item);  
        System.out.println("Item added: " + item.getName());  
        sendNotification("Added " + item.getName());  
    }  
  
    public void checkout() {  
        processCreditCardPayment();  
        sendNotification("Order placed.");  
    }  
  
    private void sendNotification(String message) {  
        System.out.println("Email to user: " + message);  
    }  
}
```

```

        private void processCreditCardPayment() {
            System.out.println("Paid with Credit Card");
        }
    }
\end{verbatim*}

```

\subsubsection\*{Problems Identified}

\begin{enumerate}

```

    \item \textbf{Tightly coupled implementation}: Notification and pay
    \item \textbf{Violates the Open/Closed Principle}: To add new behav
    \item \textbf{Low testability}: Since the class is not modular, it'
\end{enumerate}

```

\subsection\*{Refactoring Using Strategy and Observer Patterns}

\subsubsection\*{Strategy Pattern: Payment Handling}

\textbf{PaymentStrategy Interface}

\begin{verbatim}

```

public interface PaymentStrategy {
    void pay(double amount);
}

```

### **CreditCardPayment Implementation**

```

public class CreditCardPayment implements PaymentStrategy {
    public void pay(double amount) {
        System.out.println("Paid $" + amount + " using Credit Card");
    }
}

```

### **PayPalPayment Implementation**

```

public class PayPalPayment implements PaymentStrategy {
    public void pay(double amount) {
        System.out.println("Paid $" + amount + " using PayPal");
    }
}

```

## **Observer Pattern: Notifications**

### **CartObserver Interface**

```
public interface CartObserver {
    void update(String message);
}
```

### **EmailNotifier**

```
public class EmailNotifier implements CartObserver {
    public void update(String message) {
        System.out.println("Email to user: " + message);
    }
}
```

### **SMSNotifier**

```
public class SMSNotifier implements CartObserver {
    public void update(String message) {
        System.out.println("SMS to user: " + message);
    }
}
```

### **Refactored ShoppingCart Class**

```
public class ShoppingCart {
    private List<Item> items = new ArrayList<>();
    private List<CartObserver> observers = new ArrayList<>();
    private PaymentStrategy paymentStrategy;

    public void addItem(Item item) {
        items.add(item);
        notifyObservers("Added " + item.getName());
    }

    public void setPaymentStrategy(PaymentStrategy strategy) {
        this.paymentStrategy = strategy;
    }

    public void addObserver(CartObserver observer) {
        observers.add(observer);
    }

    private void notifyObservers(String message) {
        for (CartObserver observer : observers) {
            observer.update(message);
        }
    }
}
```

```

        }
    }

    public void checkout() {
        double total = items.stream().mapToDouble(Item::getPrice).sum();
        if (paymentStrategy != null) {
            paymentStrategy.pay(total);
            notifyObservers("Order placed.");
        } else {
            System.out.println("No payment method selected.");
        }
    }
}

```

## Demonstration

```
public class Main {
    public static void main(String[] args) {
        ShoppingCart cart = new ShoppingCart();

        cart.addObserver(new EmailNotifier());
        cart.addObserver(new SMSNotifier());

        cart.addItem(new Item("Book", "B001", "S001", 50.0));
        cart.setPaymentStrategy(new CreditCardPayment());
        cart.checkout();

        System.out.println("\nSwitching payment strategy to PayPal...\n");

        cart.setPaymentStrategy(new PayPalPayment());
        cart.checkout();
    }
}
```

## Reflection

### 1. How did using design patterns improve the flexibility of your code?

Using the Strategy and Observer patterns allowed the separation of concerns and enabled dynamic behavior configuration at runtime. New payment methods or notification types can be added and injected without modifying the core class, increasing maintainability and scalability.

### 2. Would this design make testing easier? Why or why not?

Yes. This design facilitates unit testing of each component (payment strategies, notifiers) in isolation. It also allows mocking of interfaces during testing and simulates different behaviors without rewriting the ShoppingCart logic. The modular nature improves overall testability and code quality.