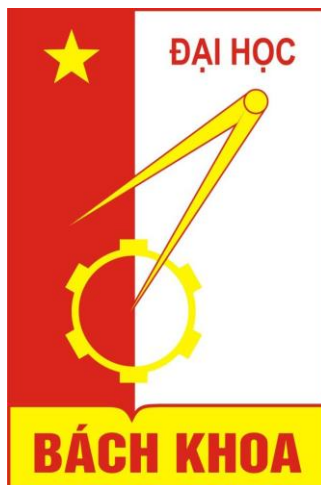


HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

School of Information and communications technology



Software Design Document

Version 1.3

EcoBike Rental Software

Subject: Phát triển phần mềm theo chuẩn kỹ năng ITSS

ISD.VN.20211-Group2

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Hanoi, November 25th 2021

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1 Introduction

The project is to create an EcoBike Rental software for Ecopark township. The Software Design Document provides documentation which will be used to aid in software development by providing the details for how the software should be built. The designs described, follow the requirements specified in the Software Requirements Specifications document prepared for the project. Within the Software Design Document are narrative and graphical documentation of the software design for the project including interaction diagrams, system and subsystem architecture, user interface design, database design, class diagrams and other supporting requirement information.

1.1 Objective

The purpose of this document is to present a detailed description of the designs of the EcoBike Rental Software. This document is intended for the programming group in Group 2, to use the designs as guidelines to implement the project.

This document provides a comprehensive architectural overview of the system, using a number of different architectural views to depict different aspects of the system. It is intended to capture and convey the significant architectural decisions which have been made on the software.

1.2 Scope

Our application will provide managers with automatic bike rental and return services in dock lots. But in this problem, we will skip the login part and focus on the function related to renting and returning the bike. The goal is to create a fully automated management application that provides customers with the most basic functionality.

A simple way the user after accessing, will see a list of dock lots. After that, users can view information about dock lots and perform bike rental functions through bike codes. After the initial payment process, customers can use the registered bike. Before or during use, customers can also view information about their rented bike such as bike status, battery status. At the end of the usage period, the user will be able to perform the function of returning the bike and making the final payment.

1.3 Glossary

1.4 References

Centers for Medicare & Medicaid Services. (n.d.). *System Design Document Template*. Retrieved from Centers for Medicare & Medicaid Services: <https://www.cms.gov/Research-Statistics-Data-and-Systems/CMS-Information-Technology/XLC/Downloads/SystemDesignDocument.docx>

2 Overall Description

2.1 General Overview

The Software Design Document is divided into 5 sections with various subsections.

Section 1 and 2 are introduction and overall description about the Software Design Document of the EcoBike Rental Software. Section 3 contains discussions of the system architecture and architecture design for the project with interaction diagrams and analysis class diagrams.... Section 4 shows samples of user interface design for the software, database design and contains the class diagrams. Lastly, section 5 discusses about design considerations such as coupling and cohesion, design principles, design patterns.

2.2 Assumptions/Constraints/Risks

2.2.1 Assumptions

2.2.2 Constraints

2.2.3 Risks

3 System Architecture and Architecture Design

3.1 Architectural Patterns

3.2 Interaction Diagrams

Figure 1: View Dock Sequence Diagram

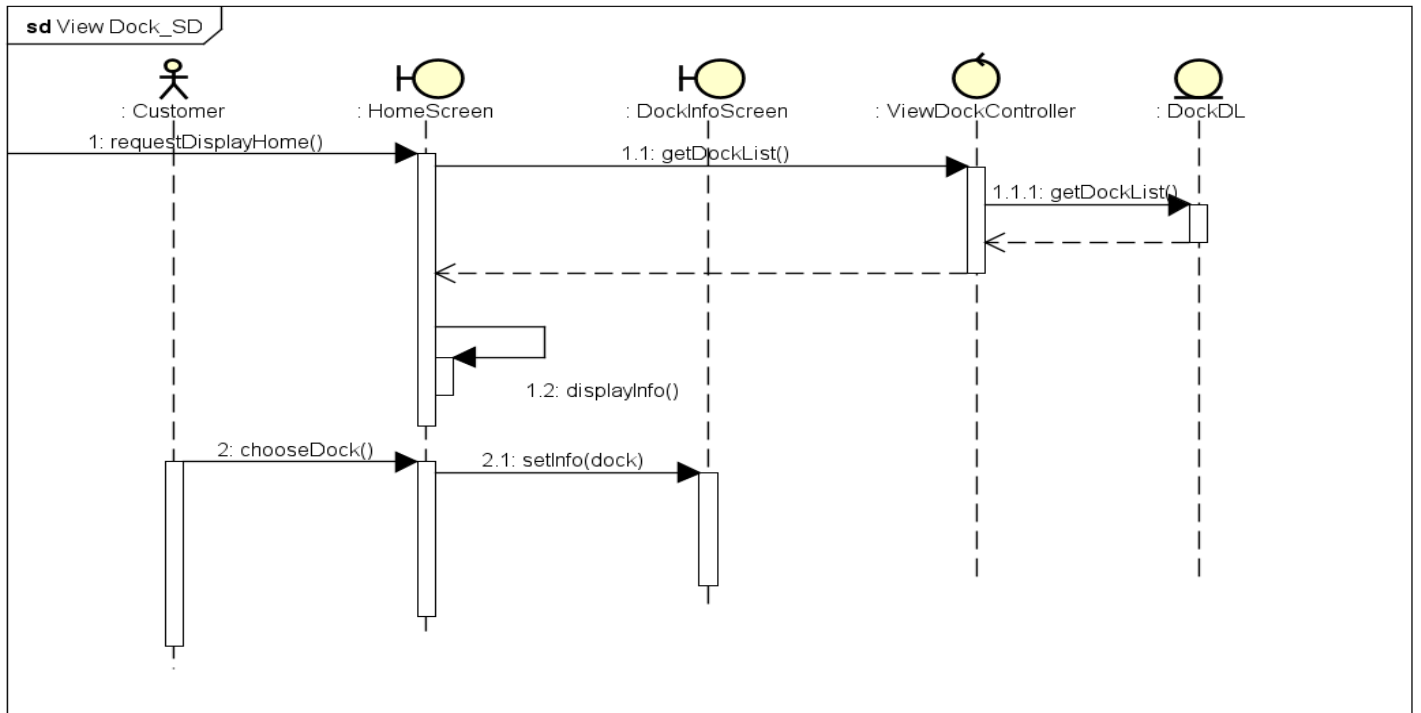


Figure 2: View Dock Communication Diagram

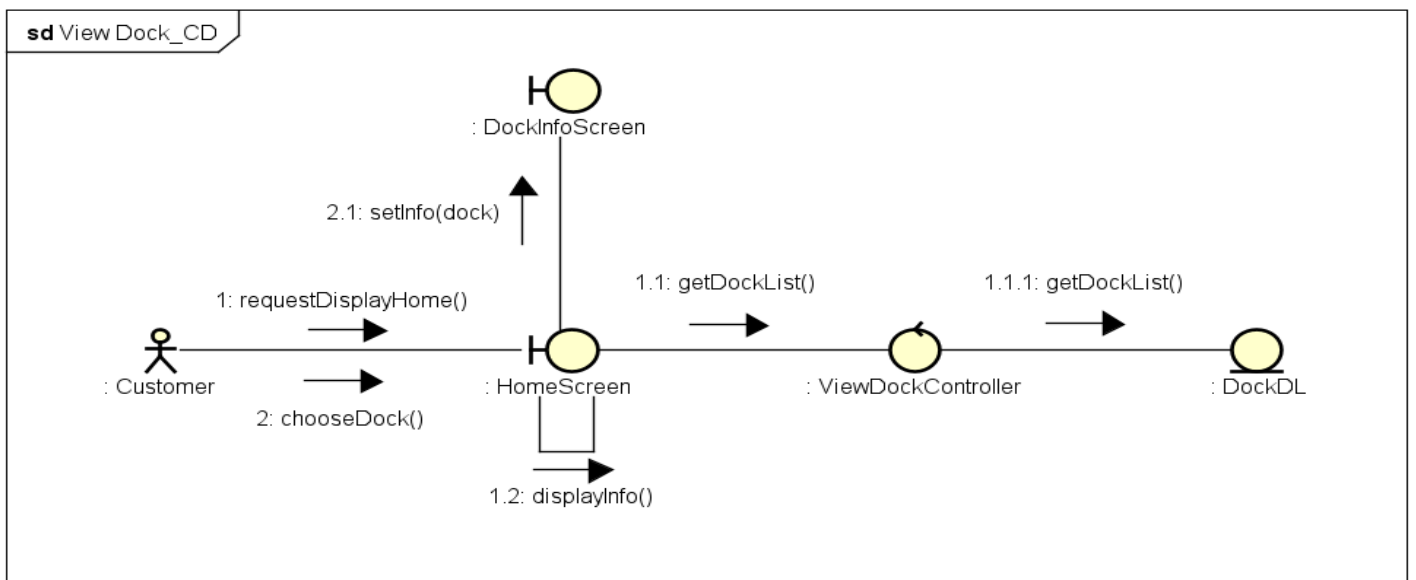


Figure 3: Rental Bike Sequence Diagram

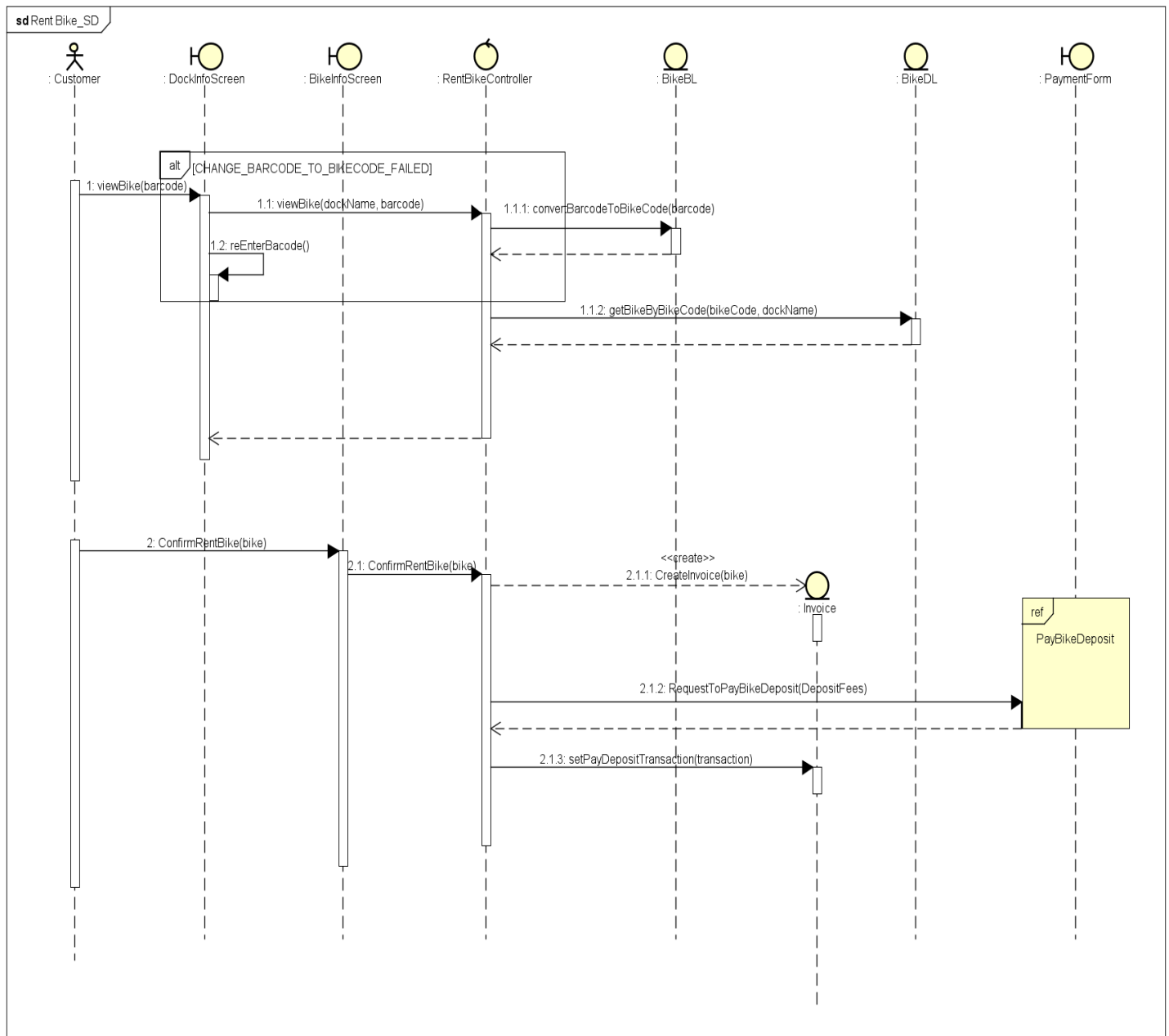


Figure 4: Rental Bike Communication Diagram

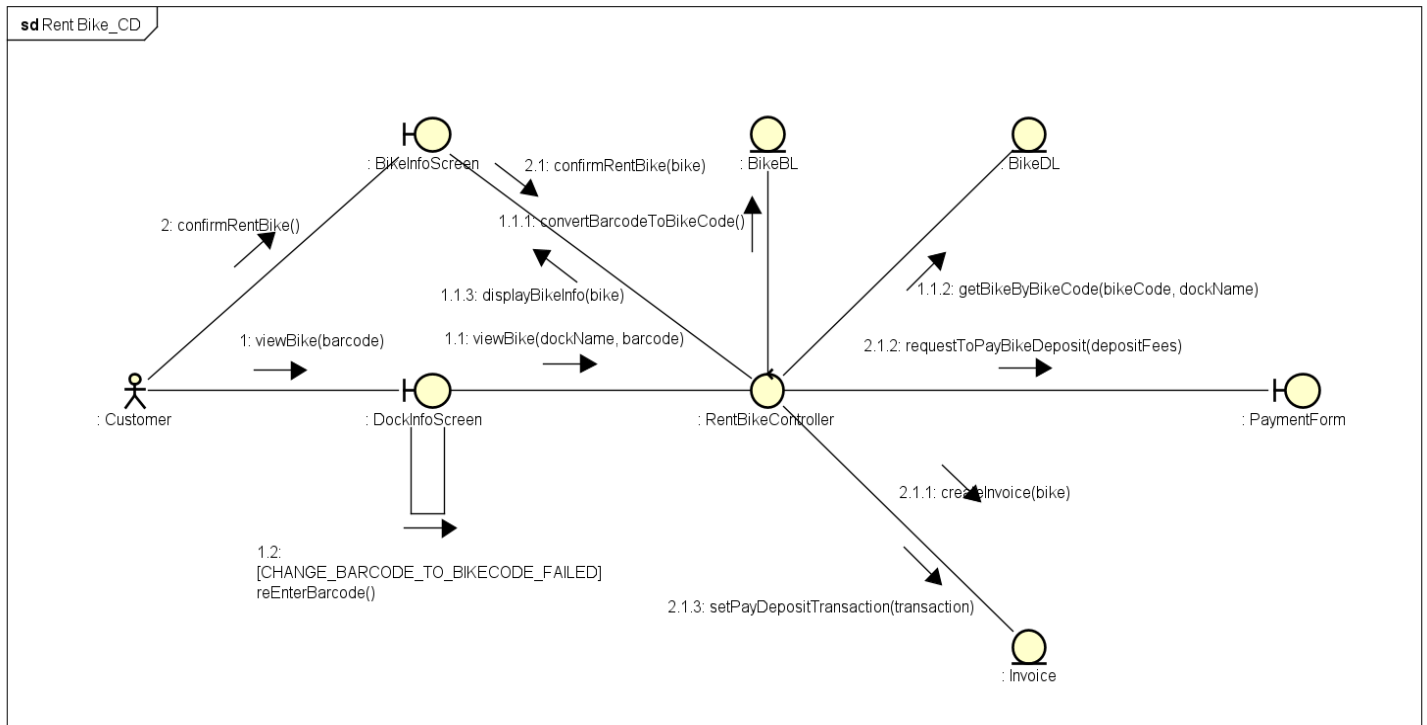


Figure 5: Pay Bike Deposit Sequence Diagram

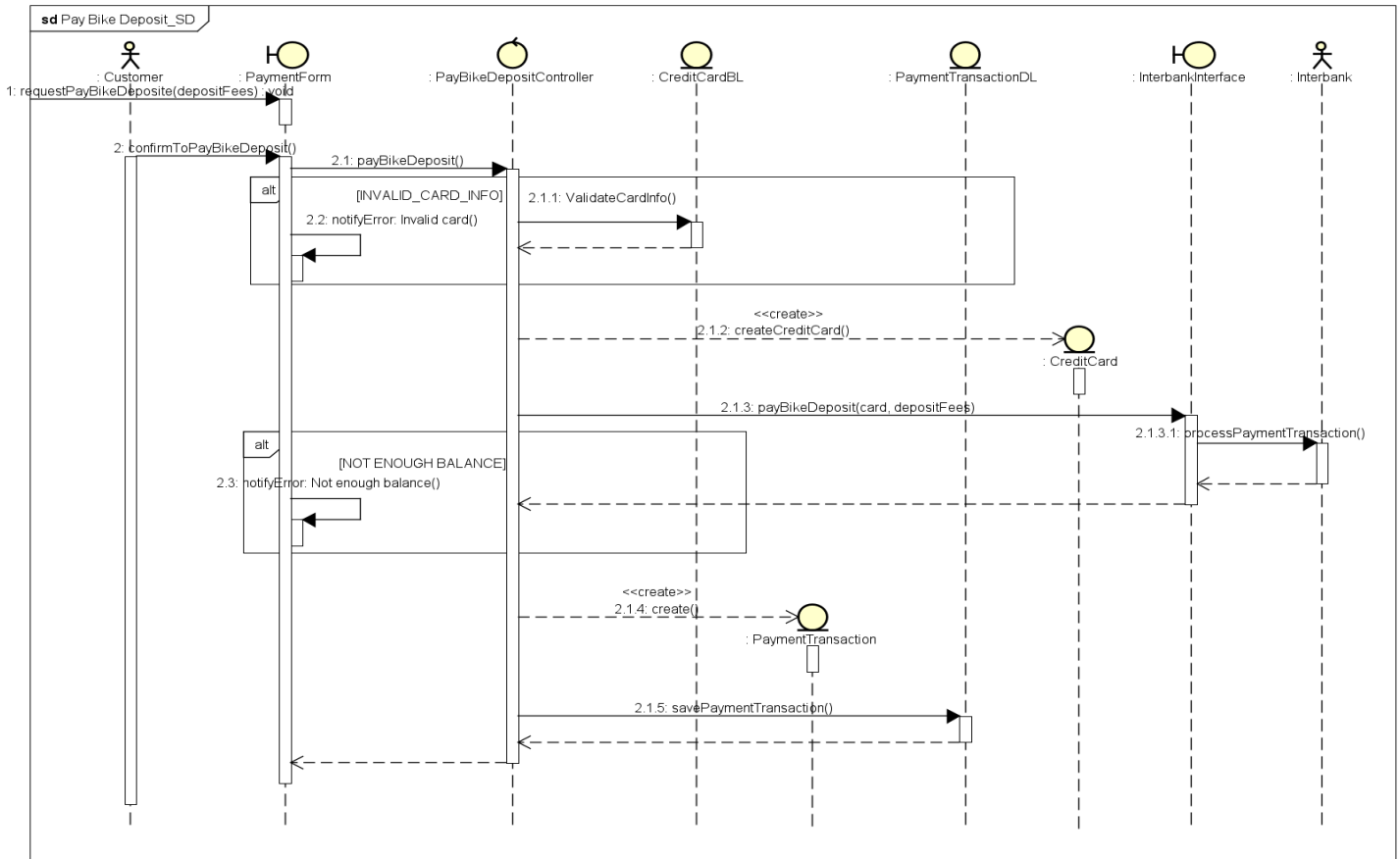


Figure 6: Pay Bike Deposit Communication Diagram

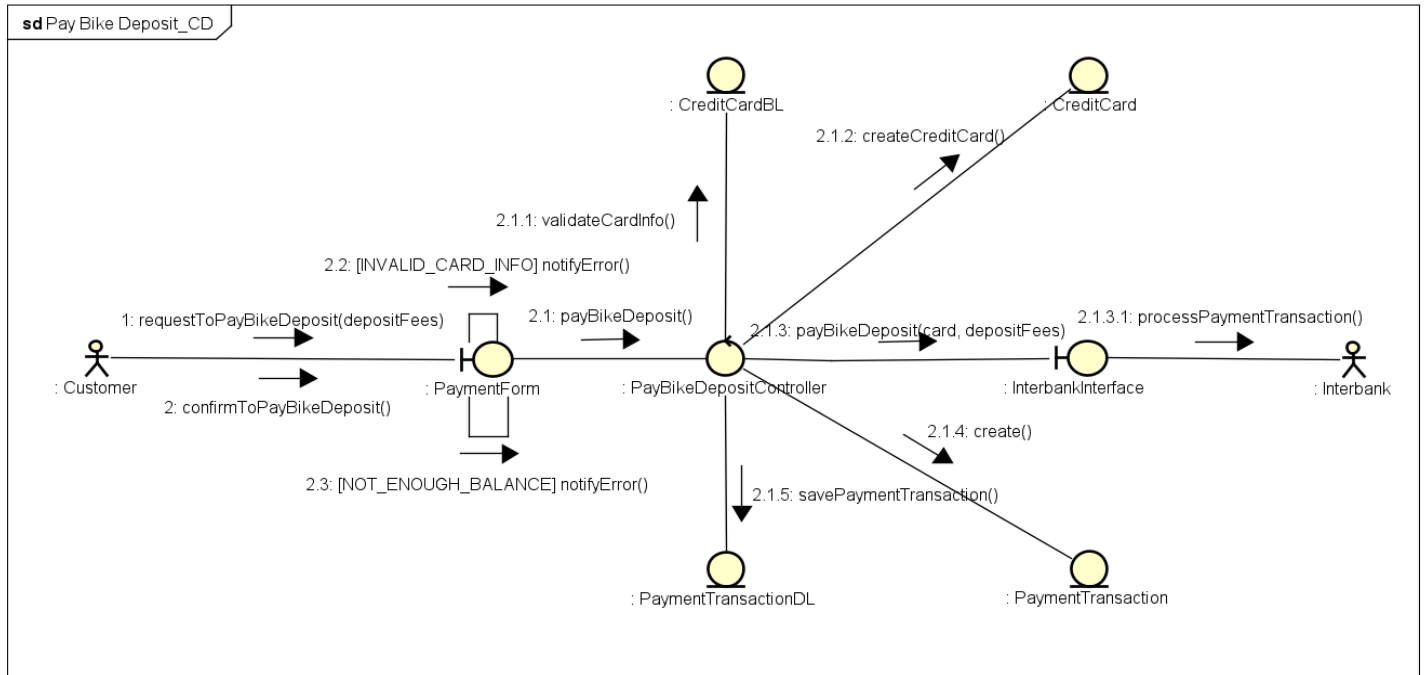


Figure 7: Return Bike Sequence Diagram

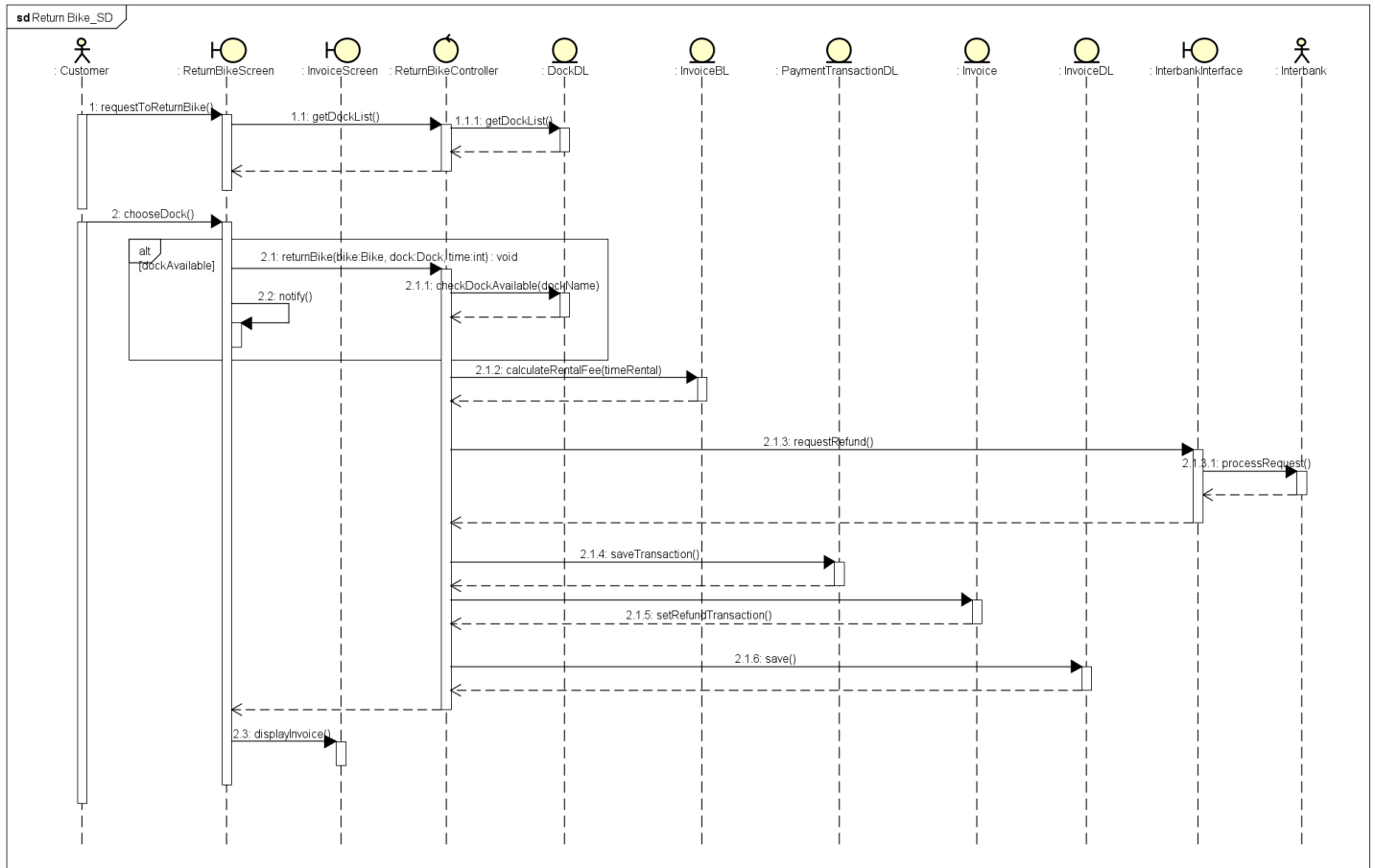
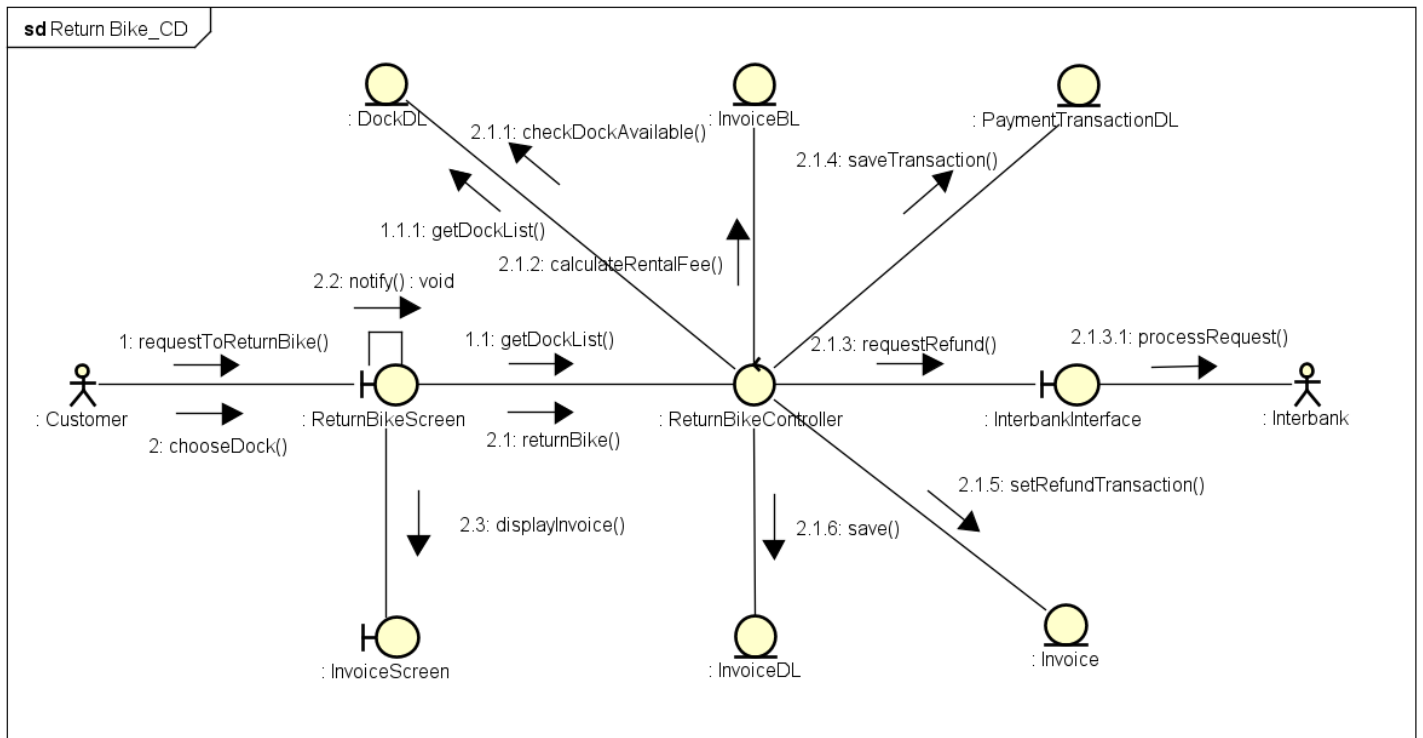


Figure 8: Return Bike Communication Diagram



3.3 Analysis Class Diagrams

Figure 9: Pay Bike Deposit UC

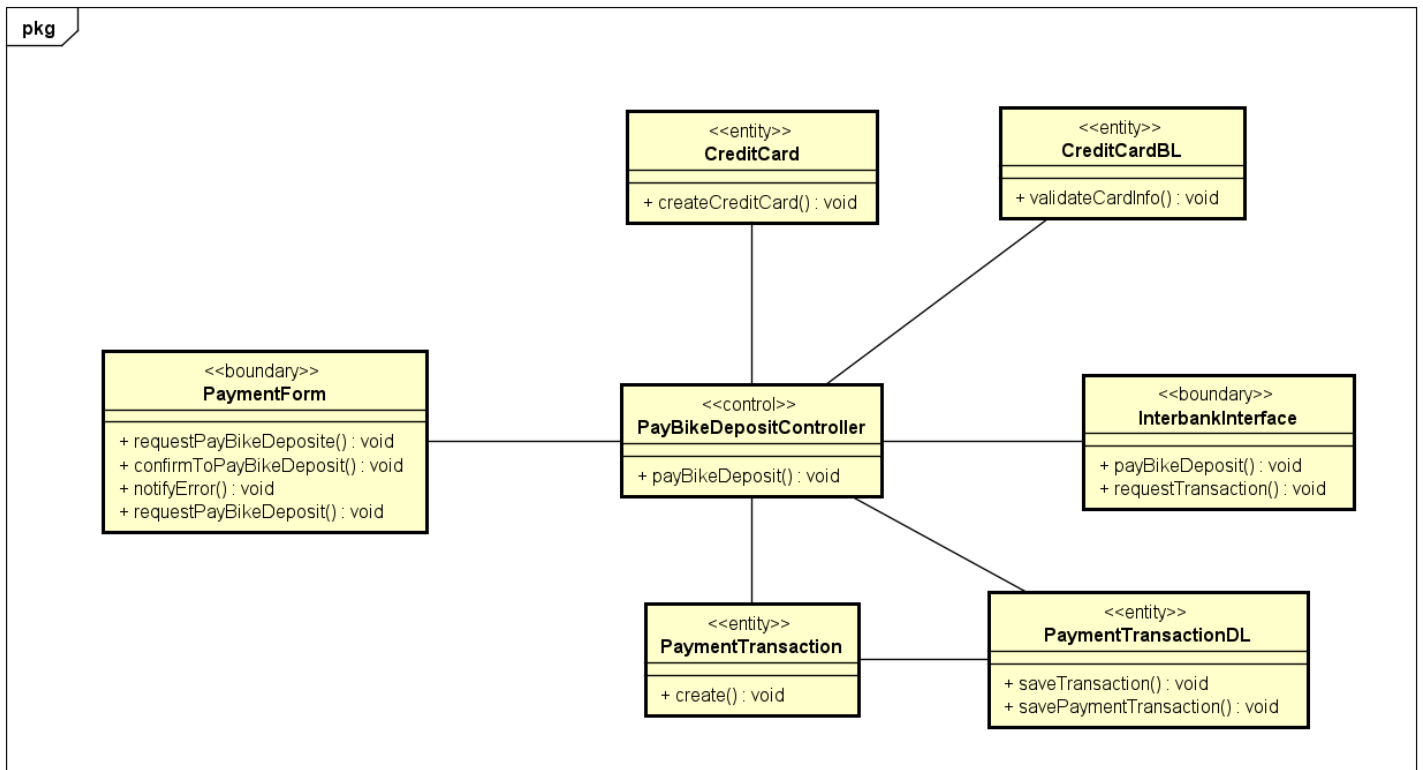


Figure 10: Rent Bike UC

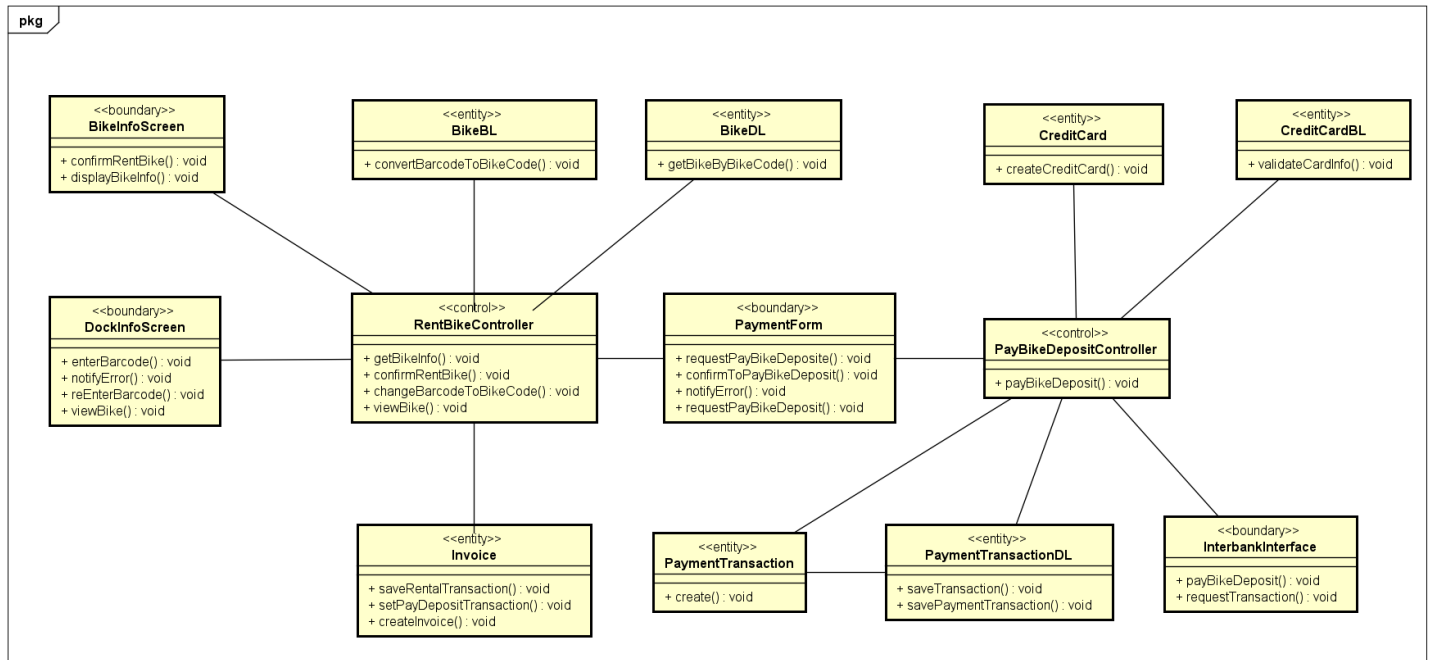
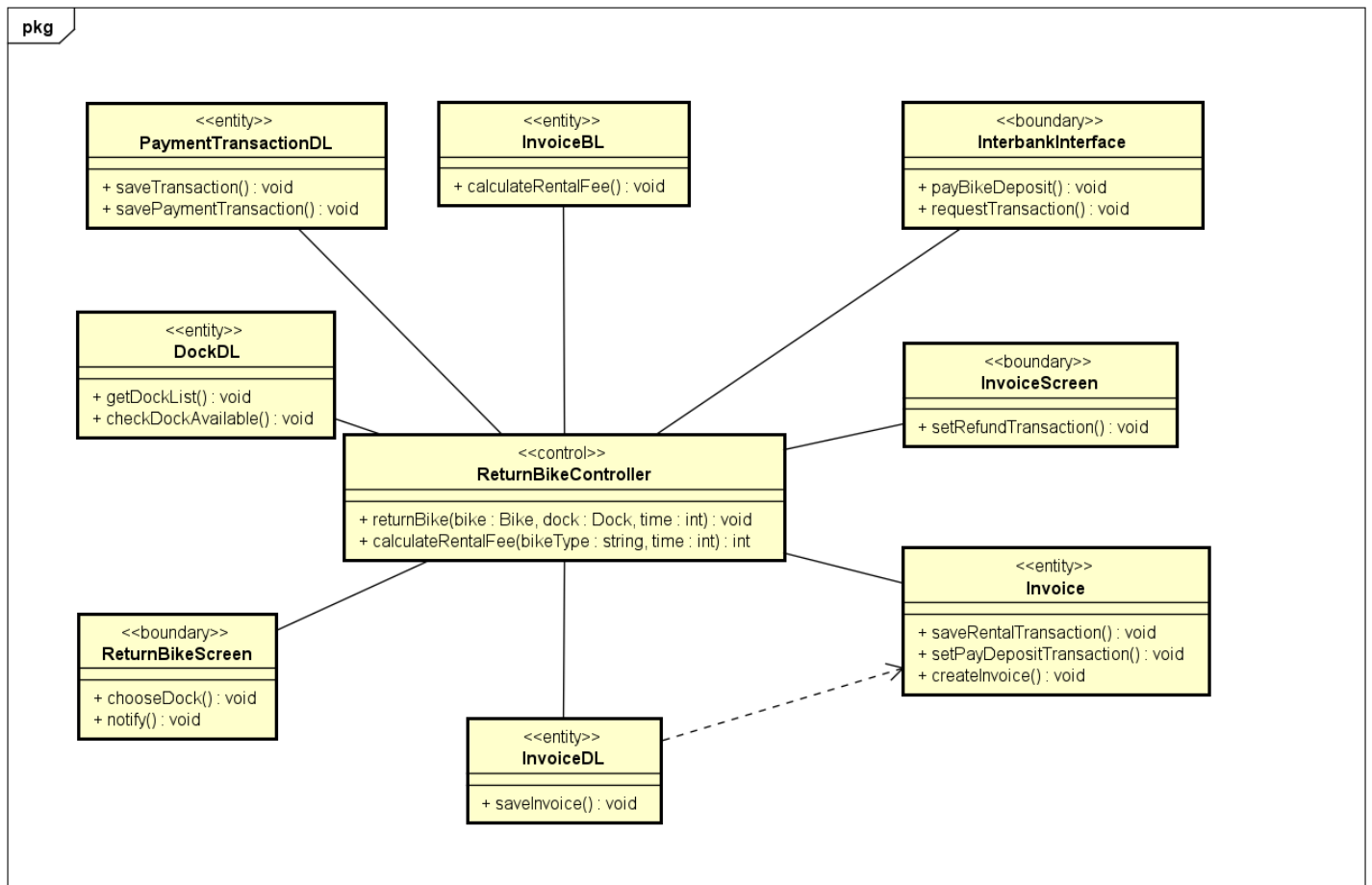


Figure 11: Return Bike UC



3.4 Unified Analysis Class Diagram

3.5 Security Software Architecture

In this project, we will not consider features such as user authentication (e.g sign up, sign in, sign out), but we focus on features related to bike renting and returning.

4 Detailed Design

4.1 User Interface Design

4.1.1 Screen Configuration Standardization

Display

Number of colors supported: 16,777,216 colors

Resolution: 1440×1024 pixels

Screen

Location of standard buttons: At the bottom (vertically) and in the middle (horizontally) of the frame

Location of the messages: Starting from the top vertically and in the middle horizontally of the frame down to the bottom.

Display of the screen title: The title is located at the top of the frame in the middle. Consistency in expression of alphanumeric numbers: comma for separator of thousand while strings only consist of characters, digits, commas, dots, spaces, underscores, and hyphen symbol.

Control

Size of the text: medium size (mostly 24px). Font: Segoe UI. Color: #000000 or #160C67

Input check process: Should check if it is empty or not. Next, check if the input is in the correct format or not

Sequence of moving the focus: There will be no stack frames. Each screen will be separated.

However, the manual is considered a popup message, as the main screen cannot be operated while the manual screen is shown. After the opening screen, the app will start with splash screen, and then the first screen (home screen) will appear.

Sequences of the system screens:

1. Splash screen (first screen)
2. Home screen
3. Dock details screen – view dock information
4. Bike details screen – view bike information
5. Credit card form screen – enter credit card information
6. Notification screen – notify status payment
7. Renting bike information screen – view Renting bike information
8. Return bike screen – return renting bike
9. Invoice screen – view rented bill

Direct input from the keyboard

There will be no shortcuts. There are back buttons to move back to the previous screen.

Error

A message will be given to notify the users what is the problem.

4.1.2 Screen Transition Diagrams

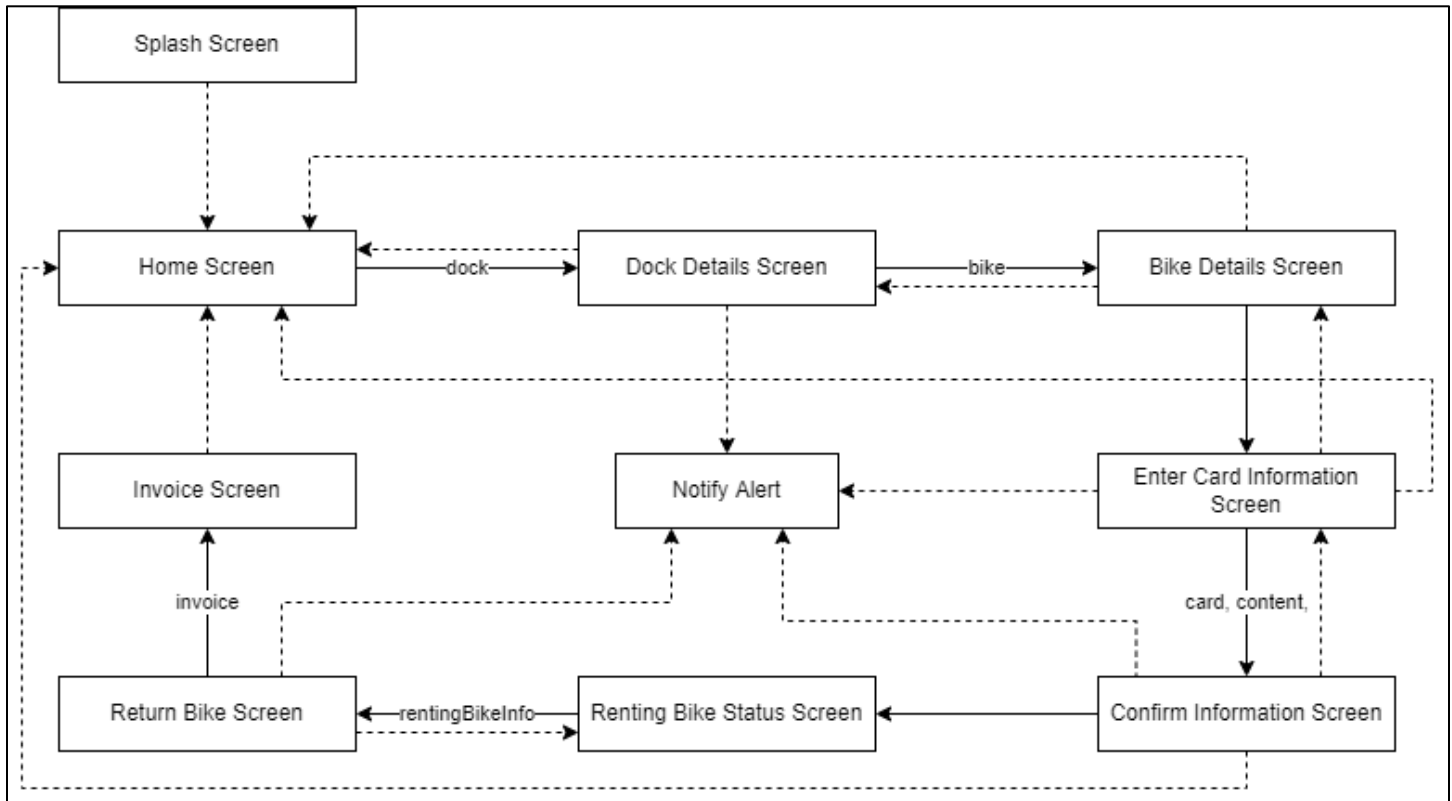


Figure 12: Screen Transition Diagram

4.1.3 Screen Specifications

Table 1: Screen Specification – Home Screen

| | | | | | |
|------------------------|-------------|--|-------------|--|---------------------|
| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personnel in charge |
| Screen Specification | Home screen | 08/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
| | | Control | Operation | Function | |
| | | Area of displaying the contact information | Initial | Display the contact information such as phone number, mail, Facebook page... | |
| | | Area of searching dock | Initial | Searching a dock | |
| | | Area of displaying the list of docks | Initial | Displaying the list of docks | |

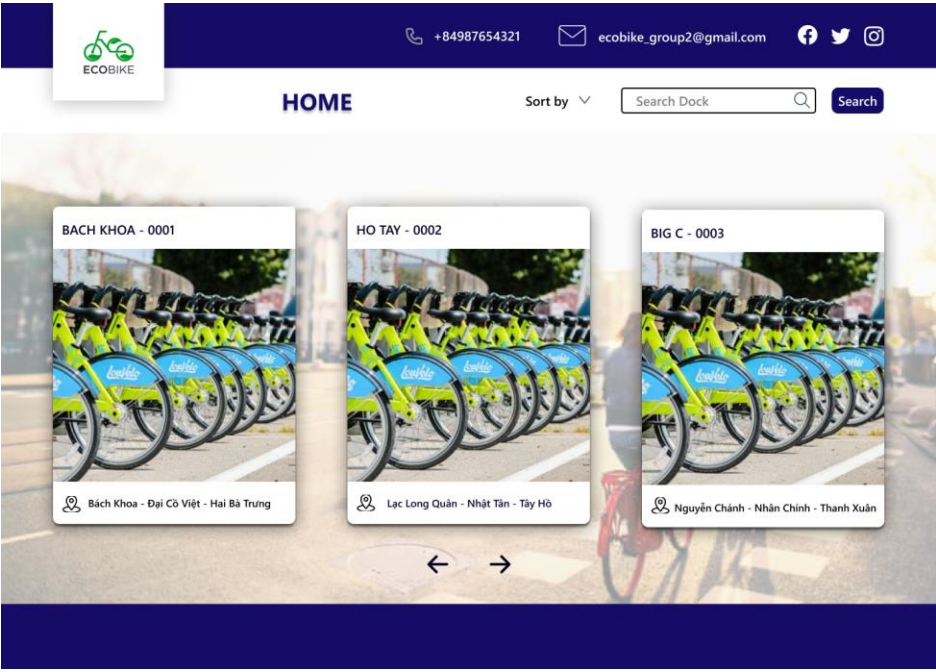
| | | | |
|--|--------------------|---------------------------------|--|
|  | 'Sort by' drop | Choose from list | Choose a sorting condition |
| | 'Search Dock' area | Enter input | Enter dock's id or dock's name |
| | Search button | Click | Search dock with entered data |
| | Dock item | Initial or after searching dock | Display the item of dock including dock's code, dock's image, dock's name. |

Table 2: Define the field attributes – Home screen

| Screen name | Home screen | | | |
|--------------|--------------------------|---|-----------------|-------------------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Dock code | 4 | Numeral | Blue | Each item of dock |
| Dock name | 50 | String | Blue | Each item of dock |
| Dock address | 100 | String | Blue | Each item of dock |
| Search Dock | 100 | String (address) or Numeral (dock code) | Box | Right-justified |

Table 3: Screen Specification – The detailed information of a dock screen

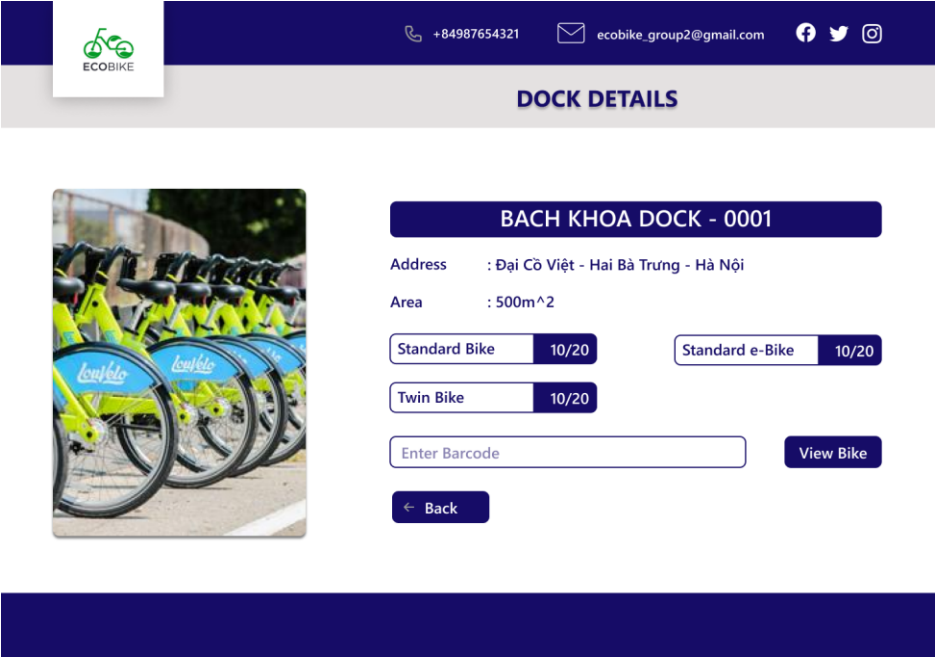
| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personal in charge |
|---|------------------------------------|---|---------------|--|--------------------|
| Screen Specification | The detailed information of a dock | 08/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
|  | | Control | Operation | Function | |
| | | Area of displaying the contact information | Initial | Display the contact information such as phone number, mail, Facebook page... | |
| | | Area of displaying the title | Initial | Display the title: DOCK DETAILS | |
| | | Area of displaying the dock details | Initial | Display a dock details screen | |
| | | Box of display the type of bikes | Initial | Display the type of bikes: Standard Bike, Standard e-Bike, Twin Bike | |
| | | Box of displaying the number of bike/max bike in a dock | Initial | Display the number of bike/max bike in a dock | |
| | | Enter barcode area | Enter barcode | Enter barcode of a bike | |
| | | View bike button | Click | Display detailed information of a bike | |
| | | Back button | Click | Back to list of docks/HOME screen | |

Table 4: Define the field attributes – The detailed information of a dock

| Screen name | The detailed information of a dock | | | |
|-------------|------------------------------------|-----------|-----------------|---------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Dock name | 50 | String | White | Center |
| Dock code | 4 | Numerical | White | Center |

| | | | | |
|--------------------|-----|-----------|------|----------------|
| Address | 100 | String | Blue | Left-justified |
| Area | 5 | Numerical | Blue | Left-justified |
| Enter barcode area | 10 | Numerical | Box | Left-justified |
| Bike name | 50 | String | Blue | Left-justified |

Table 5: Screen Specification – The detailed information of a bike

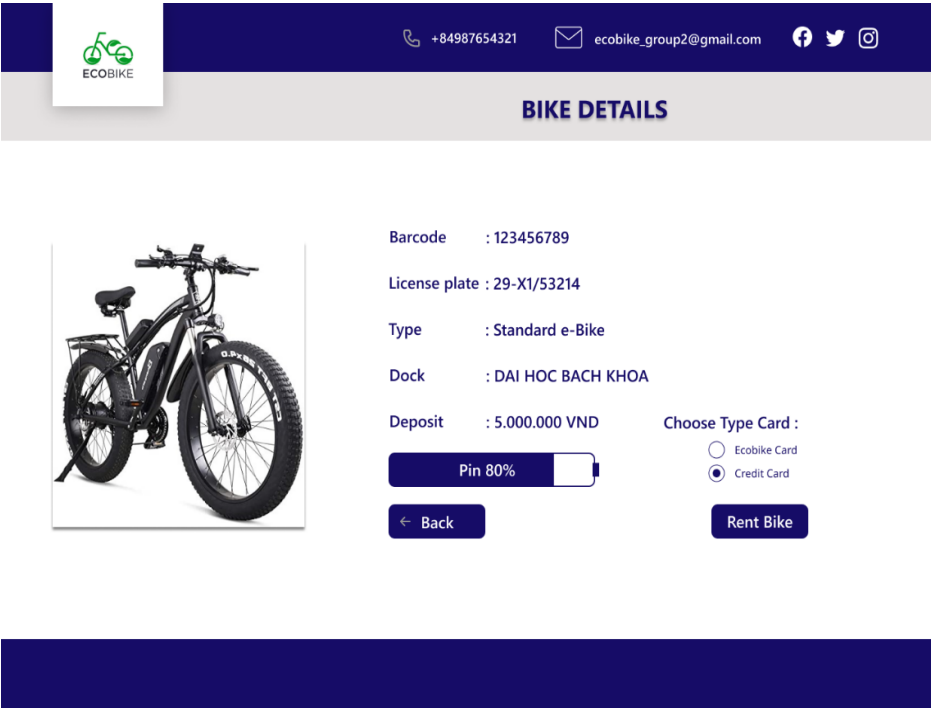
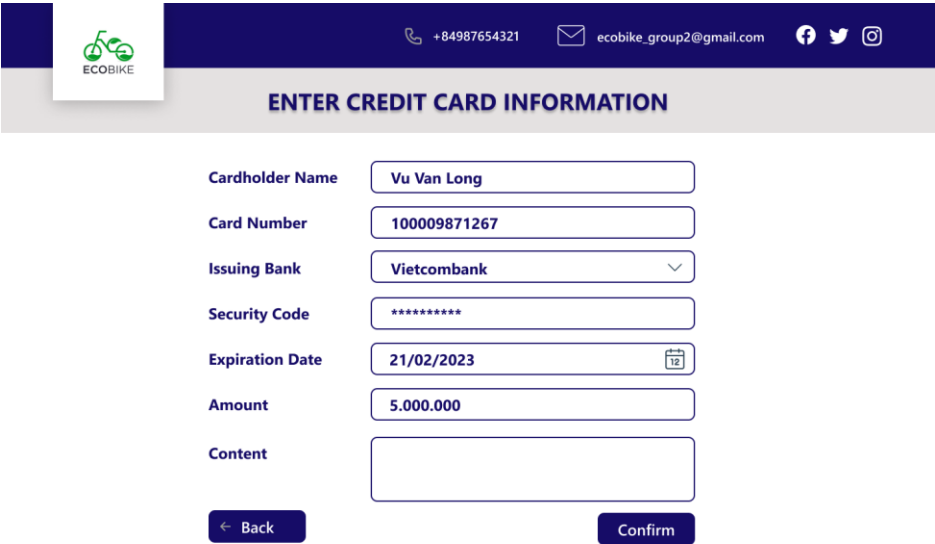
| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personal in charge |
|---|------------------------------------|--|--------------|---|--------------------|
| Screen Specification | The detailed information of a bike | 08/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
|  | | Control | Operation | Function | |
| | | Area of displaying the contact information | Initial | Display the contact information such as mail, Facebook page... | |
| | | Area of displaying the title | Initial | Display the title BIKE DETAILS | |
| | | Area of displaying the bike details | Initial | Display the bike details | |
| | | Box of displaying the pin of a bike | Initial | Display the pin of a bike if the bike is Standard e-Bike | |
| | | 'Choose Type Card' box | Choose radio | Choose type card for paying deposit if customer want to rent bike | |
| | | 'Rent Bike' button | Click | Display ENTER CREDIT CARD INFORMATION screen | |
| | | 'Back' button | Click | Back to DOCK DETAILS screen | |

Table 6: Define the field attributes – The detailed information of a bike

| Screen name | The detailed information of a bike | | | |
|---------------|------------------------------------|---------|-----------------|----------------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Barcode | 10 | Numeral | Blue | Left-justified |
| License plate | 20 | String | Blue | Left-justified |
| Bike type | 50 | String | Blue | Left-justified |
| Dock name | 50 | String | Blue | Left-justified |
| Deposit | 10 | Numeral | Blue | Left-justified |

Table 7: Screen Specification – Credit card information screen

| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personnel in charge |
|--|--------------------------------|--|------------------|--|---------------------|
| Screen Specification | Credit card information screen | 09/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
| | | Control | Operation | Function | |
|  | | Area of displaying the contact information | Initial | Display the contact information such as phone number, mail, Facebook page... | |
| | | Area of displaying the title | Initial | Display the title ENTER CREDIT CARD INFORMATION | |
| | | Area of displaying the card information | Initial | Display the card information | |
| | | 'Cardholder name' area | Enter input | Enter cardholder name | |
| | | 'Card Number' area | Enter input | Enter card number | |
| | | 'Issuing Bank' area | Choose from list | Choose bank name | |
| | | 'Security Code' area | Enter input | Enter security code of card | |

| | | | |
|--|------------------------|--------------------------------------|--|
| | 'Expiration Date' area | Enter input/ Choose from calendar | Enter/Choose the expiration date of card |
| | 'Amount' area | Initial | Amount of deposit of renting a bike. Amount is got from BIKE DETAILS screen |
| | 'Content' area | Enter input | Content for paying deposit |
| | 'Back' button | Click | Back to BIKE DETAILS screen |
| | 'Confirm' button | Click | Confirm the credit card information |

Table 8: Define the field attributes – Credit card information screen

| Screen name | Credit card information screen | | | |
|-----------------|--------------------------------|-------------------------|-----------------|---------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Cardholder Name | 50 | String | Box | Center |
| Card Number | 20 | Numeral | Box | Center |
| Issuing Bank | 50 | String | Box | Center |
| Security Code | 10 | Numeral | Box | Center |
| Expiration Date | 20 | Date: day/month/year | Box | Center |
| Amount | 10 | Numeral | Box | Center |
| Content | 200 | String | Box | Center |

Table 9: Screen Specification – Information confirmation screen

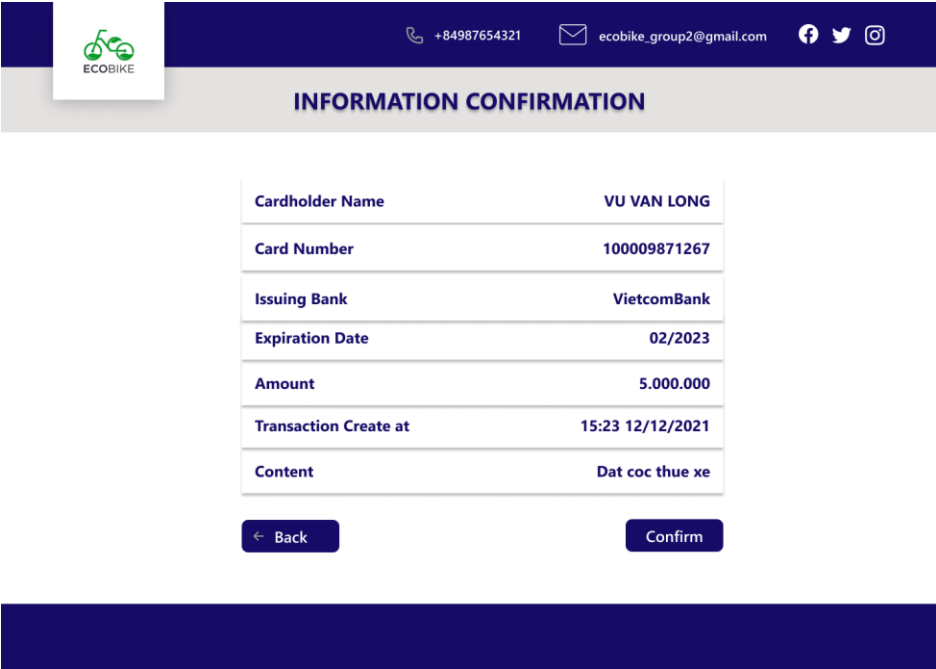
| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personnel in charge |
|---|---------------------------------|--|-------------|--|---------------------|
| Screen Specification | Information Confirmation screen | 09/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
|  | | Control | Operation | Function | |
| | | Area of displaying the contact information | Initial | Display the contact information such as phone number, mail, Facebook page... | |
| | | Area of displaying the title | Initial | Display the title INFORMATION CONFIRMATION | |
| | | Area of displaying the card information | Initial | Display the card information | |
| | | Area of displaying the information need to confirm | Initial | Display the pay deposit bike transaction need to confirm | |
| | | 'Back' button | Click | Back to BIKE DETAILS screen | |
| | | 'Confirm' button | Click | Confirm the credit card information | |

Table 10: Define the field attributes – Information confirmation screen

| Screen name | Information Confirmation screen | | | |
|-----------------|---------------------------------|----------------------|-----------------|---------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Cardholder Name | 50 | String | Blue | Center |
| Card Number | 20 | Numeral | Blue | Center |
| Issuing Bank | 50 | String | Blue | Center |
| Expiration Date | 20 | Date: day/month/year | Blue | Center |
| Amount | 10 | Numeral | Blue | Center |

| | | | | |
|-----------------------|-----|--------|------|--------|
| Transaction Create at | 50 | String | Blue | Center |
| Content | 200 | String | Blue | Center |

Table 11: Screen Specification - Notification screen

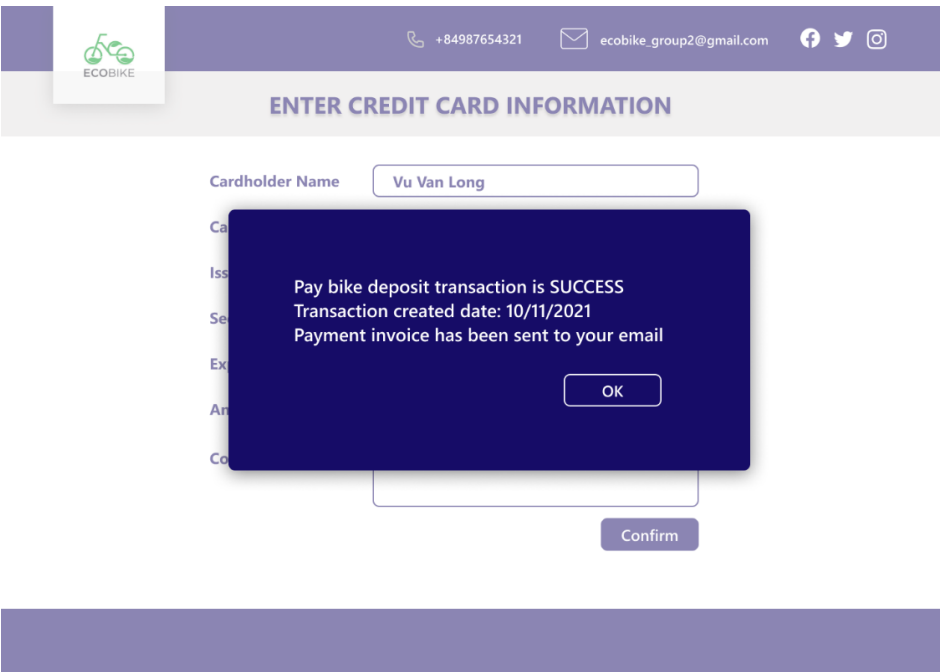
| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personnel in charge |
|---|----------------------|--|-------------|--|---------------------|
| Screen Specification | Notification success | 09/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
|  | | Control | Operation | Function | |
| | | Area of displaying the notification of payment transaction | | Displaying the notification of payment transaction, display successful transaction or error transaction, if transaction has error, display the detailed error. | |
| | | 'OK' button | Click | If the payment transaction is successful, display next screen. If not, display the current screen. | |

Table 12: Define the field attributes – Notification screen

| Screen name | Notify | | | |
|--------------|--------------------------|----------------------|-----------------|---------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Status | 30 | String | White | |
| Created date | 30 | Date: day/month/year | White | |

Table 13: Screen Specification– Bike state information screen

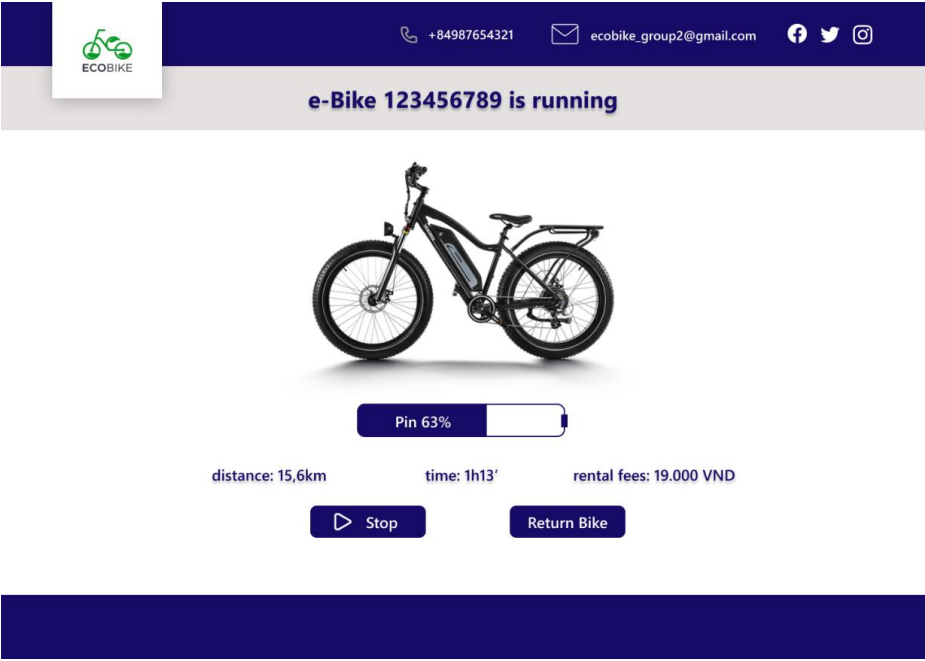
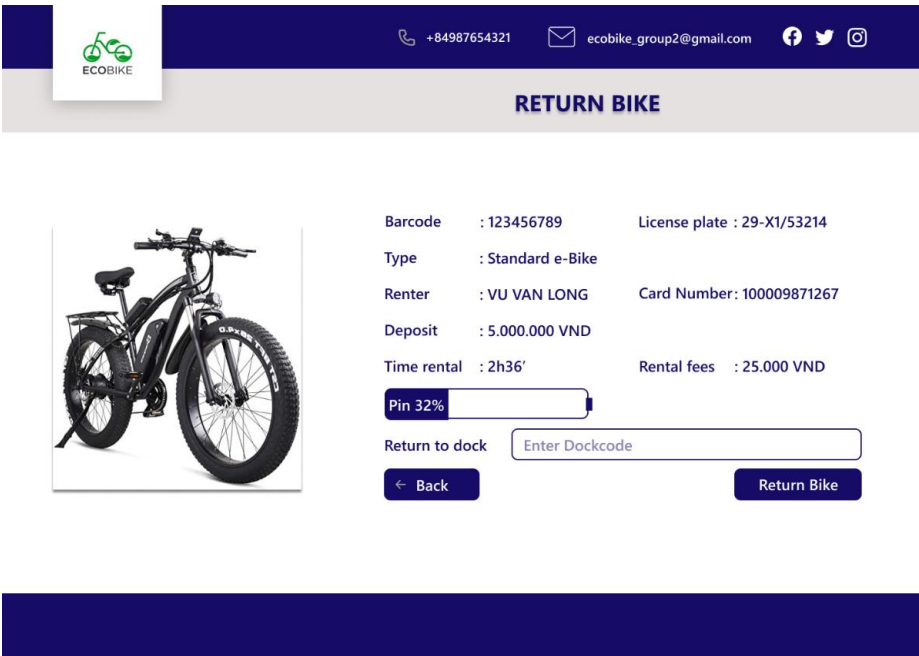
| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personal in charge |
|---|------------------------|---|-------------|--|--------------------|
| Screen Specification | Bike State Information | 09/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
|  | | Control | Operation | Function | |
| | | Area of displaying the contact information | Initial | Display the contact information such as phone number, mail, Facebook page... | |
| | | Area of displaying the title | Initial | Display the title | |
| | | Area of displaying the bike state details | Initial | Display the bike current state details that the customer is renting | |
| | | Box of displaying the current pin of a bike | Initial | Display the current pin of a bike if the bike is Standard e-Bike | |
| | | 'distance' box | Initial | Distance that the customer used | |
| | | 'time' box | Initial | Time period that the customer rents that bike | |
| | | 'rental fees' box | Initial | Rental fees that the customer pays | |
| | | 'Stop' button | Click | The customer continues to use that bike | |
| | | 'Return Bike' button | Click | The customer stops to return that bike. Display RETURN BIKE screen | |

Table 14: Define the field attributes – Bike state information screen

| Screen name | Bike State Information | | | |
|-------------|--------------------------|------|-----------------|---------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |

| | | | | |
|-------------|----|---------|------|-----------------|
| Distance | 10 | Numeral | Blue | Left-justified |
| Time | 10 | String | Blue | Center |
| Rental fees | 10 | Numeral | Blue | Right-justified |

Table 15: Screen Specification – Return bike screen

| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personal in charge |
|---|--------------------|--|-------------|--|--------------------|
| Screen Specification | Return bike screen | 09/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
|  | | Control | Operation | Function | |
| | | Area of displaying the contact information | Initial | Display the contact information such as phone number, mail, Facebook page... | |
| | | Area of displaying the title | Initial | Display the title RETURN BIKE | |
| | | Area of displaying the return bike information | Initial | Display the return bike information | |
| | | 'Barcode' area | Initial | Display the bike barcode | |
| | | 'License plate' area | Initial | Display the bike license plate | |
| | | 'Type' area | Initial | Display the bike type | |
| | | 'Renter' area | Initial | Display the customer's name | |
| | | 'Card Number' area | Initial | Display the card id of the customer | |
| | | 'Deposit' area | Initial | Display the deposit of the bike | |
| | | 'Time rental' area | Initial | Display the rental time | |
| | | 'Rental fees' area | Initial | Display the rental fee | |
| | | Box of displaying the remain | Initial | Display the remain pin of the bike after renting if the bike is Standard | |

| | | | |
|--|-------------------------------|----------------|---|
| | pin of the bike after renting | | e-Bike |
| | 'Return to dock' area | Enter Dockcode | Enter dockcode of the dock that the customer wants to return bike |
| | 'Back' button | Initial | Back to current state of the bike screen |
| | 'Return Bike' button | Initial | Confirm to return bike. Display the INVOICE screen |

Table 16: Define the field attributes – Return bike screen

| Screen name | Return bike screen | | | |
|----------------|--------------------------|-----------|-----------------|-----------------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Barcode | 10 | Numerical | Blue | Center |
| License plate | 20 | String | Blue | Right-justified |
| Type | 50 | String | Blue | Center |
| Renter | 50 | String | Blue | Center |
| Card Number | 20 | Numerical | Blue | Right-justified |
| Deposit | 10 | Numerical | Blue | Center |
| Time rental | 10 | String | Blue | Center |
| Rental fees | 10 | Numerical | Blue | Right justified |
| Return to dock | 5 | Numerical | Box | Right justified |

Table 17: Screen Specification – Invoice screen

| EcoBikeRental Software | | Date of creation | Approved by | Reviewed by | Personnel in charge |
|------------------------|----------------|--|-------------|--|---------------------|
| Screen Specification | Invoice screen | 09/11/2021 | | Vũ Văn Long | Trần Xuân Trường |
| | | Control | Operation | Function | |
| | | Area of displaying the contact information | Initial | Display the contact information such as phone number, mail, Facebook page... | |

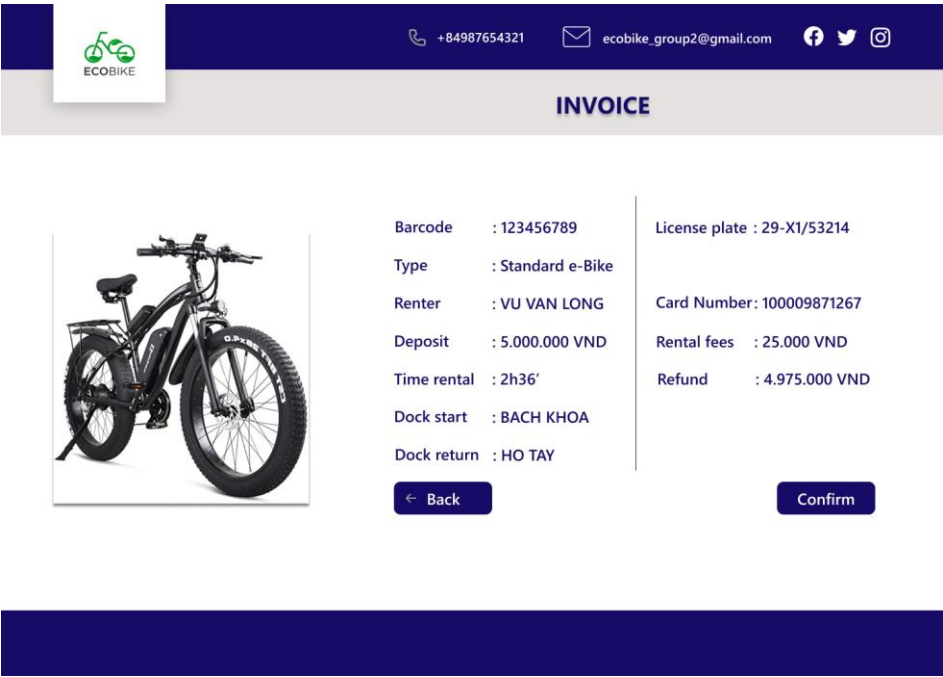
| | | | |
|---|--|---------|---|
|  | Area of displaying the title | Initial | Display the title INVOICE |
| | Area of displaying the invoice information | Initial | Display the invoice information |
| | 'Barcode' area | Initial | Display the bike barcode |
| | 'License plate' area | Initial | Display the bike license plate |
| | 'Type' area | Initial | Display the bike type |
| | 'Renter' area | Initial | Display the customer's name |
| | 'Card Number' area | Initial | Display the card id of the customer |
| | 'Deposit' area | Initial | Display the deposit of the bike |
| | 'Rental fees' area | Initial | Display the rental fee |
| | 'Time rental' area | Initial | Display the rental time |
| | 'Refund' area | Initial | Display the refund if the deposit < the rental fees |
| | 'Dock start' area | Initial | Display name of the dock that the customer rented that bike |
| | 'Dock return' area | Initial | Display name of the dock that the customer returned that bike |
| | Back button | Click | Back to the RETURN BIKE screen |
| | Confirm button | Click | Notify success transaction and return to HOME screen |

Table 18: Define the field attributes – Invoice screen

| Screen name | Invoice screen | | | |
|-------------|--------------------------|---------|-----------------|---------|
| Item name | Number of digits (bytes) | Type | Field attribute | Remarks |
| Barcode | 10 | Numeral | Blue | Center |

| | | | | |
|---------------|----|---------|------|-----------------|
| License plate | 20 | String | Blue | Right-justified |
| Type | 50 | String | Blue | Center |
| Renter | 50 | String | Blue | Center |
| Card Number | 20 | Numeral | Blue | Right-justified |
| Deposit | 10 | Numeral | Blue | Center |
| Rental fees | 10 | Numeral | Blue | Right justified |
| Time rental | 10 | String | Blue | Center |
| Refund | 10 | Numeral | Blue | Right-justified |
| Dock start | 50 | String | Blue | Center |
| Dock return | 50 | String | Blue | Center |

4.2 Data Modeling

4.2.1 Conceptual Data Modeling

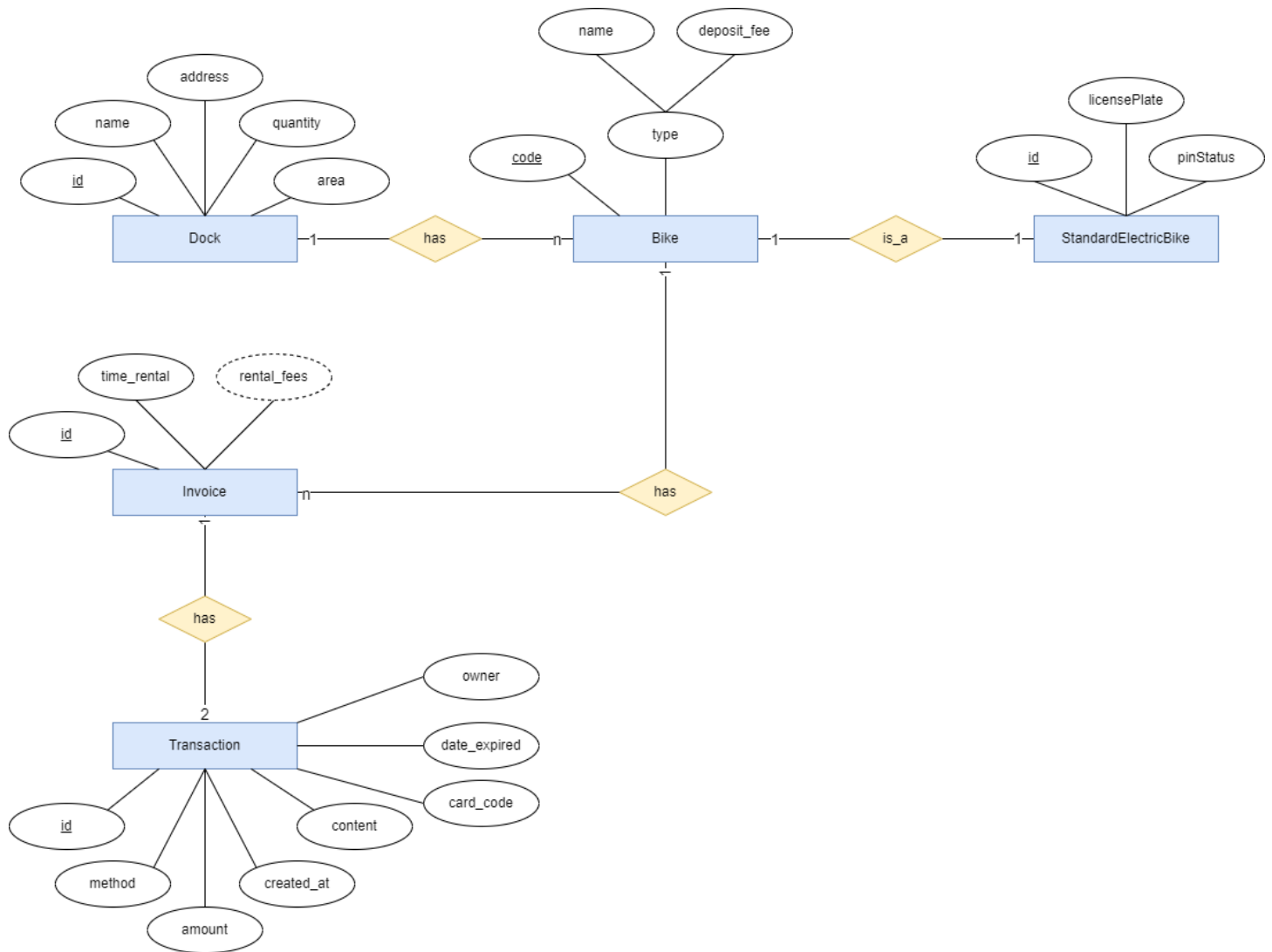


Figure 13: Conceptual Data Modeling

4.2.2 Database Design

4.2.2.1 Database Management Systems

4.2.2.2 Logical Data Model

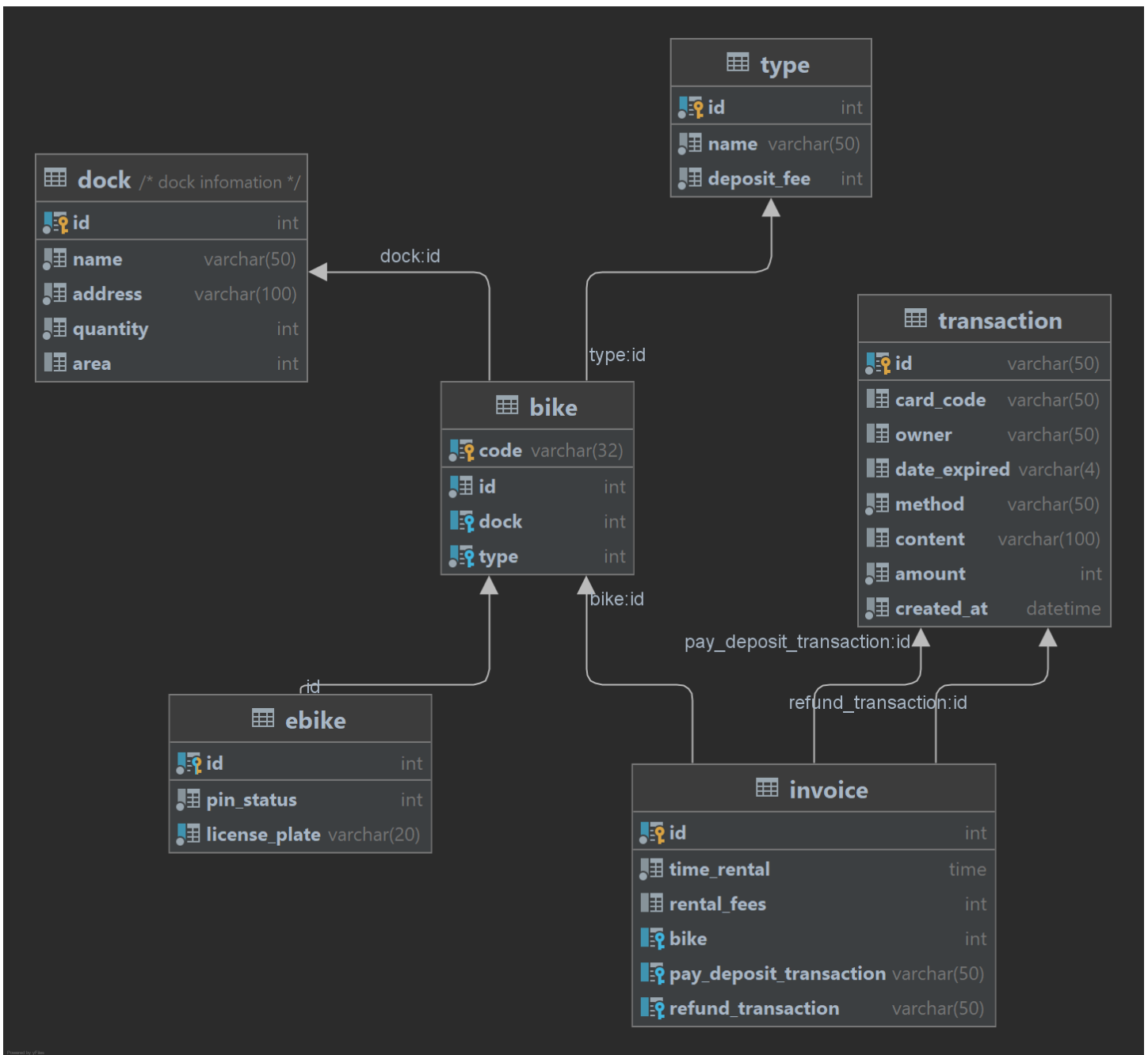


Figure 14: Logical Data Model

4.2.2.3 Physical Data Model

Table 19: Dock DB

| # | PK | FK | Column Name | Data Type | Mandatory | Description |
|---|----|----|-------------|--------------|-----------|-------------------------------|
| 1 | x | | id | Integer | Yes | ID of dock |
| 2 | | | name | VARCHAR(50) | Yes | Name of dock |
| 3 | | | address | VARCHAR(100) | Yes | Address of dock |
| 4 | | | quantity | Integer | Yes | Quantity of bikes at the dock |
| 5 | | | area | Integer | Yes | Area of dock |

Table 20: Bike DB

| # | PK | FK | Column Name | Data Type | Mandatory | Description |
|---|----|----|-------------|-------------|-----------|----------------------------------|
| 1 | x | | code | VARCHAR(32) | Yes | Code of bike |
| | | | id | Integer | Yes | Id of bike |
| 4 | | x | type | Integer | Yes | ID of bikeType |
| 5 | | x | dock | Integer | No | ID of dock where bike is located |

Table 21: EBike DB

| # | PK | FK | Column Name | Data Type | Mandatory | Description |
|---|----|----|---------------|-------------|-----------|---|
| 1 | x | x | id | Integer | Yes | ID, same of the ID of bikeType is Standard e-bike |
| 2 | | | license_plate | VARCHAR(20) | Yes | License plate of bike |
| 3 | | | pin_status | Integer | Yes | Current battery percentage of e-bike |

Table 22: Type DB

| # | PK | FK | Column Name | Data Type | Mandatory | Description |
|---|----|----|-------------|-------------|-----------|-----------------------------|
| 1 | x | | id | Integer | Yes | ID of bikeType |
| 2 | | | typeName | VARCHAR(50) | Yes | Name of bikeType |
| 3 | | | deposit_fee | Integer | Yes | Fee to deposit when renting |

Table 23: Invoice DB

| # | PK | FK | Column Name | Data Type | Mandatory | Description |
|---|----|----|-------------------------|-------------|-----------|-----------------------------------|
| 1 | x | | id | Integer | Yes | ID |
| 2 | | | time_rental | VARCHAR(10) | Yes | Rental time |
| 3 | | | rental_fees | Integer | Yes | Rental fees |
| 4 | | x | bike | Integer | Yes | ID of the bike |
| 5 | | x | pay_deposit_transaction | Integer | Yes | ID of the pay deposit transaction |
| 6 | | x | refund_transaction | Integer | Yes | ID of the refund transaction |

Table 24: Transaction DB

| # | PK | FK | Column Name | Data Type | Mandatory | Description |
|---|----|----|--------------|--------------|-----------|---------------------------------|
| 1 | x | | id | Integer | Yes | ID |
| 2 | | | method | VARCHAR(50) | Yes | Method: pay or refund |
| 3 | | | amount | Integer | Yes | Amount |
| 4 | | | created_at | DATETIME | Yes | Date of creation |
| 5 | | | content | VARCHAR(100) | No | Transaction content |
| 6 | | | owner | VARCHAR(50) | Yes | Name of renter |
| 7 | | | card_code | VARCHAR(50) | Yes | Code of the credit card |
| 8 | | | date_expired | VARCHAR(4) | Yes | Expired date of the credit card |

4.3 Non-Database Management System Files

4.4 Class Design

4.4.1 General Class Diagram

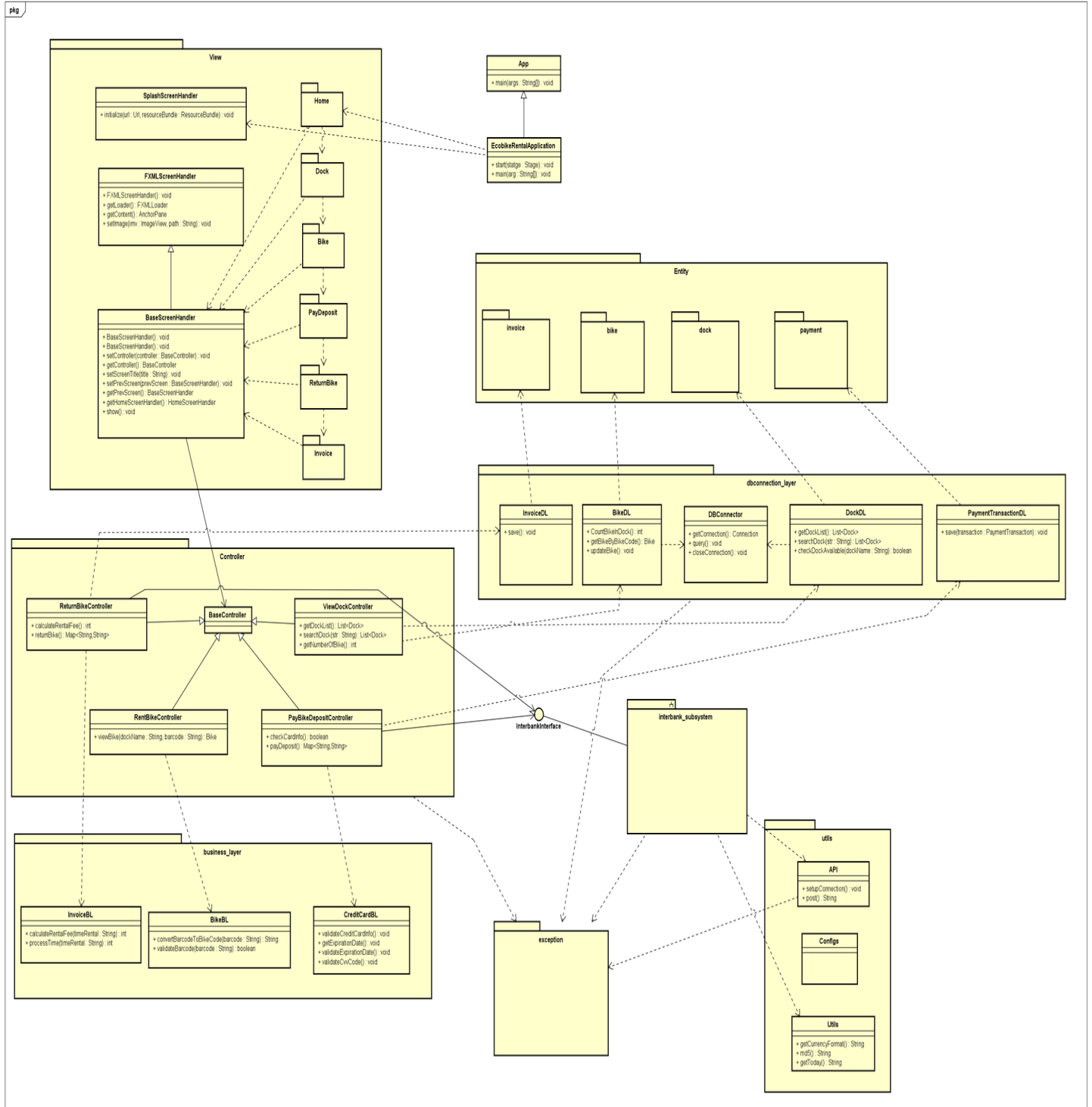


Figure 15: General Class Diagram

4.4.2 Class Diagrams

4.4.2.1 Class Diagram for Interbank Subsystem

Figure 16: Identify InterbankSubsystem

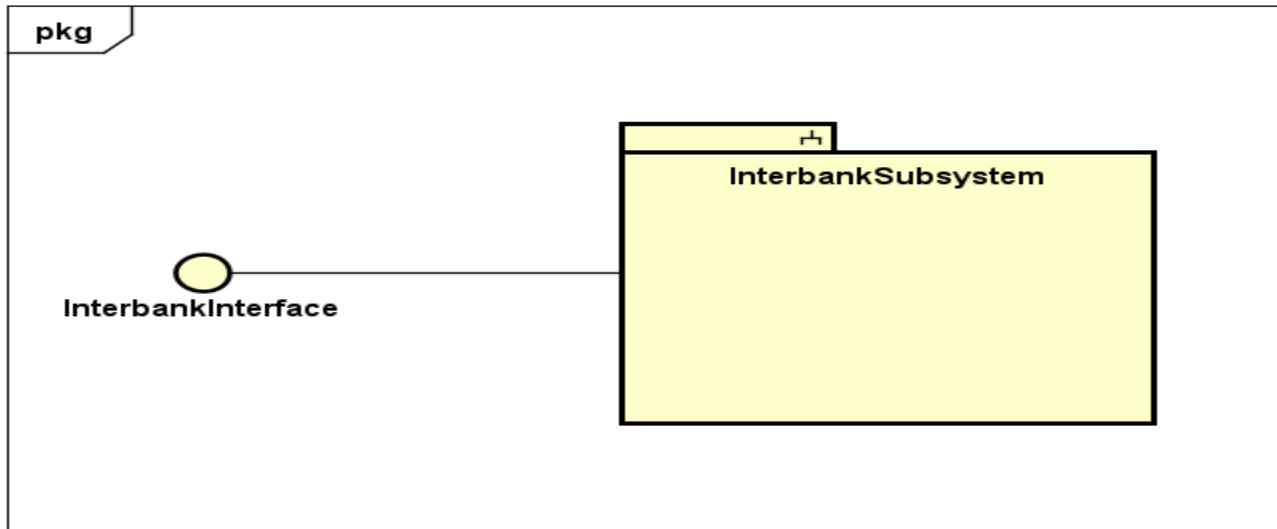


Figure 17: Identify InterbankSubsystem Interface

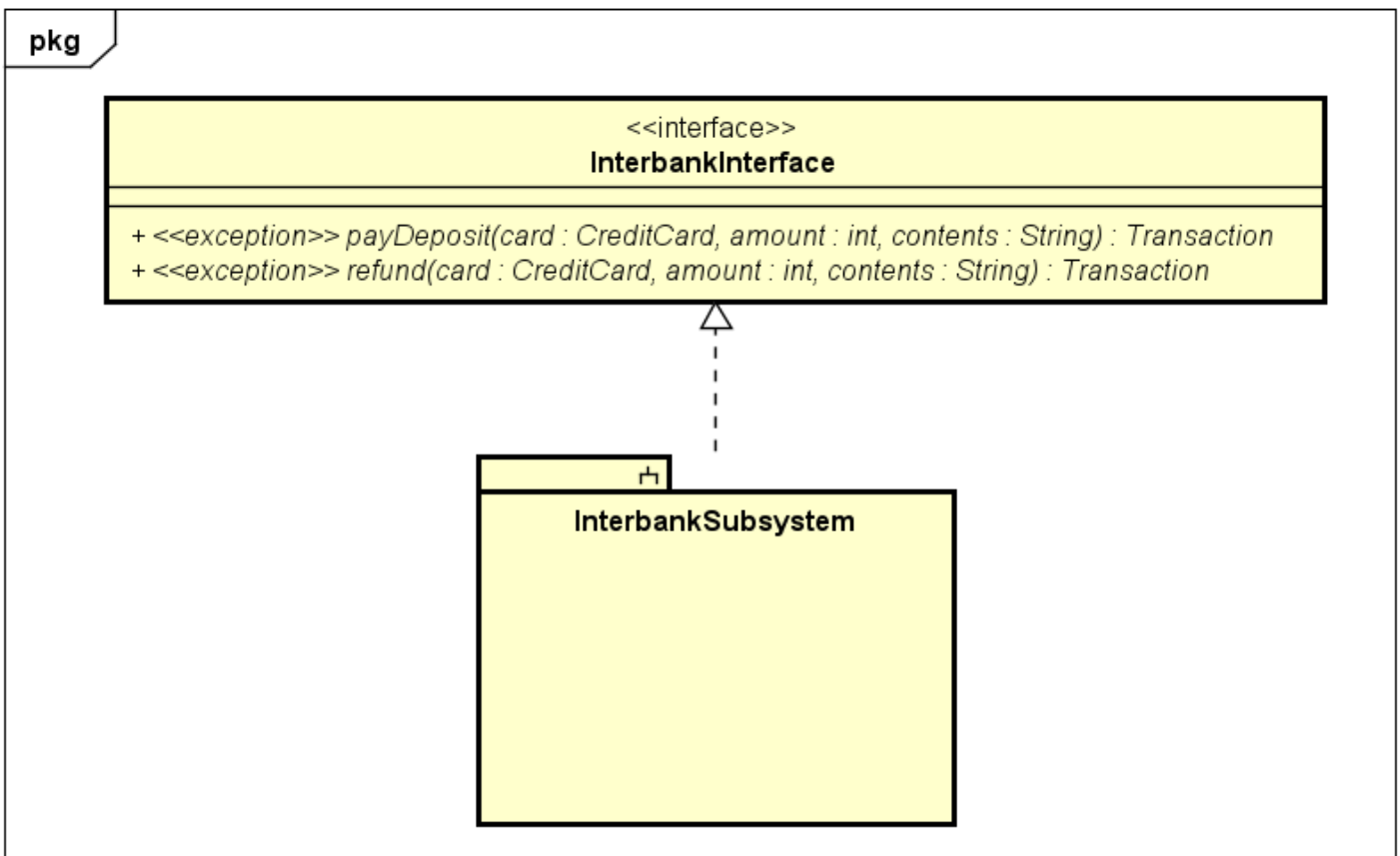


Figure 18: Distribute subsystem behavior to subsystem elements

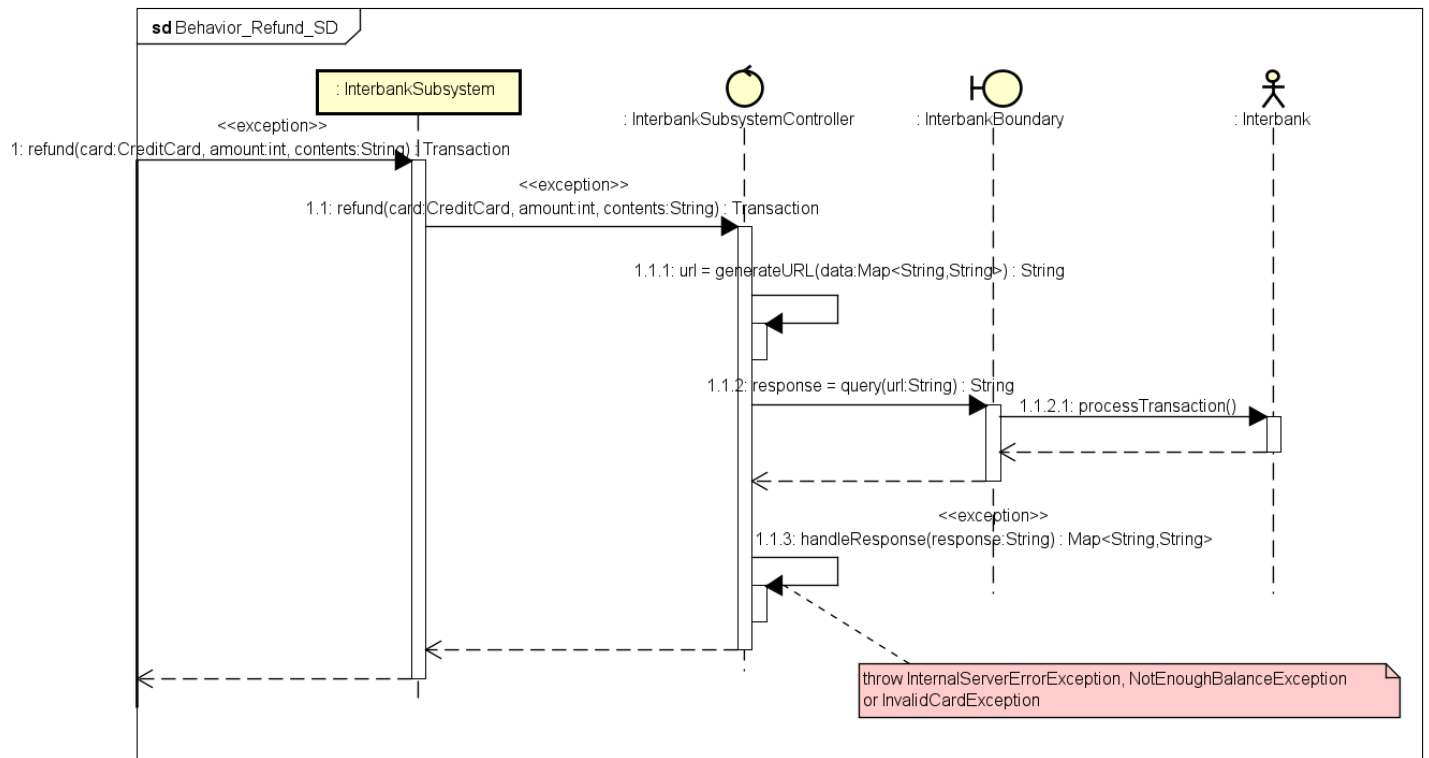
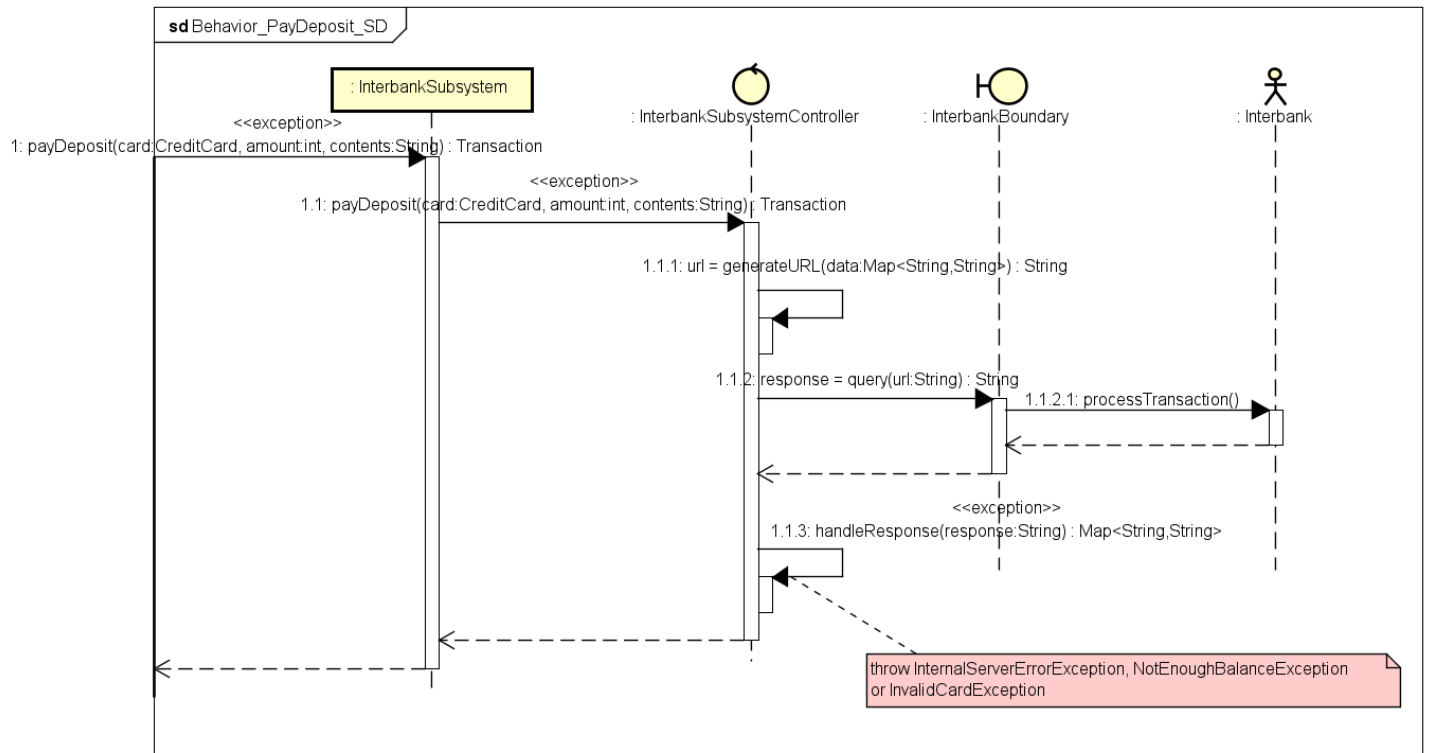


Figure 19: Document subsystem elements

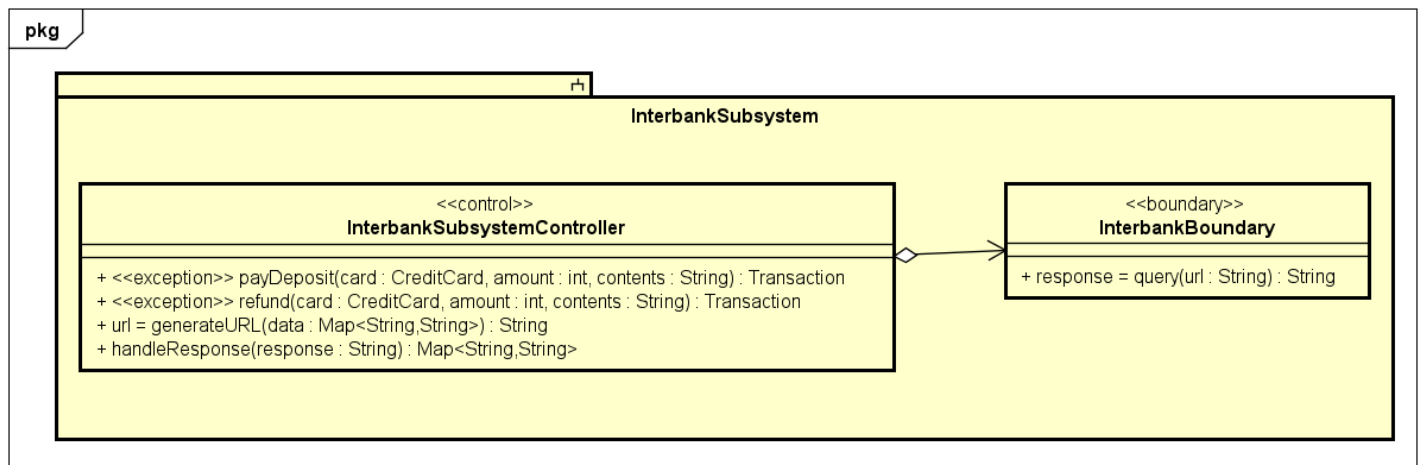


Figure 20: Describe subsystem dependencies

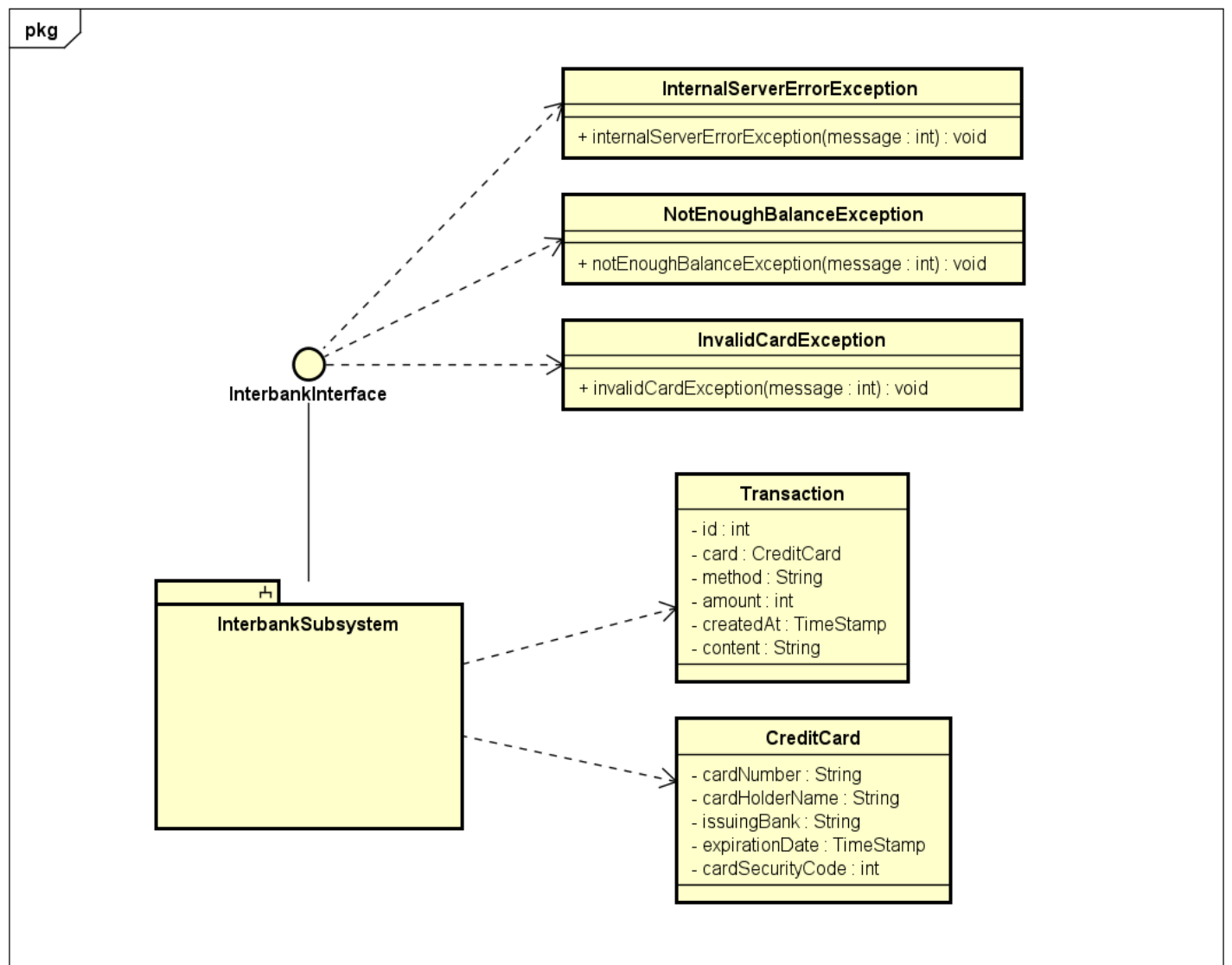
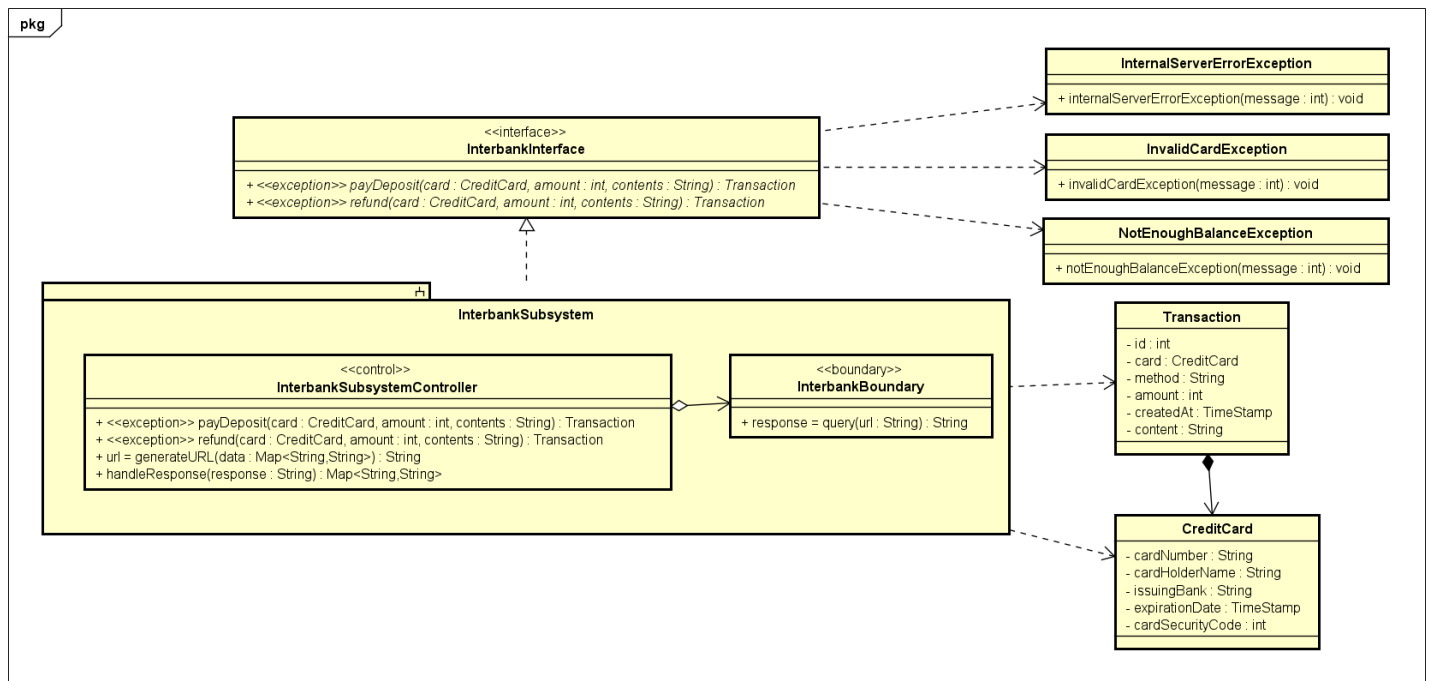
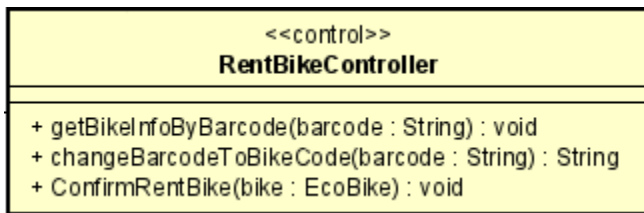


Figure 21: Checkpoints



4.4.3 Class Design

4.4.3.1 Class “RentBikeController”



Attribute

None

Operation

| # | Name | Return type | Description |
|---|-------------------------|-------------|---|
| 1 | getBikeInfoByBarcode | void | User enters barcode, system gets info |
| 2 | changeBarcodeToBikeCode | String | Input barcode then convert to bike code |
| 3 | confirmRentBike | void | User confirm, system process |

Parameter:

1. getBikeInfoByBarcode()
 - a. Parameter

- Barcode: User enters barcode with string
- b. Exception
 - None
- 2. changeBarcodeToBikeCode
 - a. Parameter
 - Barcode: barcode from getBikeInfoByBarcode()
 - b. Exception
 - InvalidBarcode: Barcode empty or invalid barcode
- 3. confirmRentBike
 - a. Parameter
 - bike: bike with info
 - b. Exception

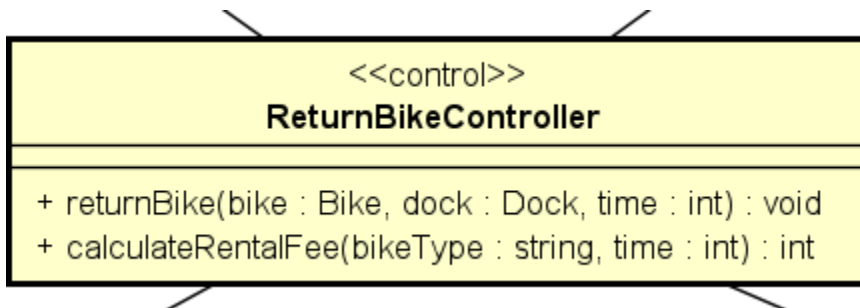
Method

1. getBikeInfoByBarcode(): Then user enter barcode, system process barcode, convert to bike.
2. changeBarcodeToBikeCode(): Change barcode to bike code, to display to screen
3. confirmRentBike(): Get bike info to pay order.

State

None

4.4.3.2 Class “ReturnBikeController”



Attribute

None

Operation

| # | Name | Return type | Description (purpose) |
|---|--------------------|-------------|--------------------------------------|
| 1 | returnBike | void | Return the bike to the selected dock |
| 2 | calculateRentalFee | int | Calculate rental fee |

Parameter:

- bike – the renting bike
- time – bike rental time
- dock – selected dock to return the bike
- bikeType – type of the bike

Exception:

None

Method

None

State

None

5 Design Considerations

5.1 Goals and Guidelines

5.2 Architectural Strategies

5.3 Coupling and Cohesion

- Coupling
 - Content:
 - HelloApplication - FadeTransition, HomeScreenHandle (Set value in other module)

```
fadeOut.setOnFinished(event -> {  
    try {  
        HomeScreenHandler homeHandler = new HomeScreenHandler(stage, Configs.HOME_SCREEN_PATH);  
        homeHandler.setScreenTitle("Home Screen");  
        homeHandler.show();  
    } catch (IOException e) {  
        e.printStackTrace();  
    }  
})
```

- Cohesion:
 - Procedural:
 - RentBikeController – Barcode process + Invoice process (Steps, not relate)

5.4 Design Principles

- RentBikeController: Vi phạm nguyên lý S.
Method không liên quan đến nhau -> có thể chia thành các module BarcodeController, InvoiceController.
Các method validate không nên đặt trong lớp này -> Đặt sang lớp Utils chuyên về validate

=> Đưa vào lớp Business để chứa các xử lý liên quan đến Barcode và Validate


```

public class BikeBL {
    /**
     * this method validate format barcode.
     *
     * @param barcode - barcode of bike
     *
     * @return - true if format barcode is valid else false
     */
    public static boolean validateBarcode(final String barcode) {
        if (barcode == null || barcode.length() != 13) {
            return false;
        }
        return barcode.matches("[0-9]+");
    }

    /**
     * @param barcode -
     *
     * @return String: bike code
     */
    public static String convertBarcodeToBikeCode(final String barcode) {
        if (!validateBarcode(barcode)) {
            return null;
        }
        return barcode + "123456" + barcode;
    }
}

```

- EntityClass: Vi phạm nguyên lý S
Không nên có các phương thức lấy dữ liệu từ database trong lớp entity -> Thêm các lớp DatabaseConnectionLayer để lấy dữ liệu từ database

```

public class BikeDL {
    private List<Bike> bikeList;

    public BikeDL() throws SQLException {
        this.bikeList = new ArrayList<>();
        String sql =
            "select bike.id as id, code, type.name as type, dock.name as dock_name,
        ResultSet res = DBConnector.query(sql);
        Bike bike;
        while (res.next()) {
            bike = new BikeFactory().getBike(res.getString("type"));
            bike.setBikeId(res.getInt("id"));
            bike.setBikeCode(res.getString("code"));
            bike.setType(res.getString("type"));
            bike.setDockName(res.getString("dock_name"));
            bike.setDeposit(res.getInt("deposit_fee"));
            bikeList.add(bike);
        }
        // System.out.println(bike.toString());
    }
}

```

- InterBankSubsystem: Vi phạm nguyên lý O
 Khi thanh toán, phương thức payDeposit và refund đều được truyền CreditCart, muốn thêm phương thức thanh toán khác sẽ phải sửa mã nguồn -> Thay bằng một lớp abstract.

5.5 Design Patterns

- Singleton:
 - Invoice
 - Dock
- Factory:
 - Bike (Standard Bike – Twin Bike)

```
public class Invoice {
    /**
     * Represent for bike
     */
    private Bike bike;
    private String rentalTime;
    private int rentalFee;
    /**
     * Represent for payment transaction.
     */
    private PaymentTransaction payDepositTransaction;
    private PaymentTransaction refundTransaction;

    private static Invoice instance = new Invoice();

    private Invoice() {
    }

    .

    /**
     * This method saves the invoice.
     */
    public void save() {
    }
}
```

```
public class BikeFactory {
    public Bike getBike(String type) {
        if (type.equals("Standard bike") || type.equals("Twin bike")) {
            return new Bike();
        } else if (type.equals("Standard e-bike")) {
            return new ElectricBike();
        }
        return null;
    }
}
```