HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

School of Information and communications technology

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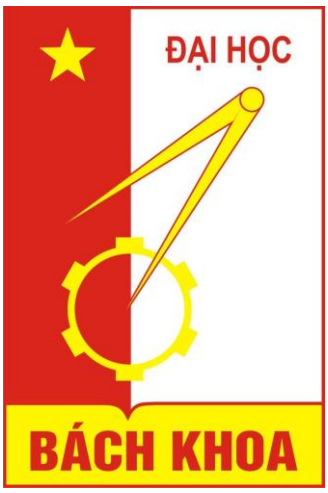

Software Design Document

Version 1.0

EcoBike Rental

Subject: Phát triển phần mềm theo chuẩn kỹ năng ITSS

ISD.VN.20211-Group2

Vũ Văn Long - 20184146

Trần Xuân Trường - 20184212

Mai Hoàng Minh - 20184151

Hanoi, november 21st 2021

<All notations inside the angle bracket are not part of this document, for its purpose is for extra instruction. When using this document, please erase all these notations and/or replace them with corresponding content as instructed>

<This document, written by Asst. Prof. NGUYEN Thi Thu Trang, is used as a case study for student with related courses. Any modifications and/or utilization without the consent of the author is strictly forbidden>

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1 Introduction

<The following subsections of the Software Design Document (SDD) document should provide an overview of the entire SDD.>

1.1 Objective

<Identify the purpose of this SDD and its intended audience. In this subsection, describe the purpose of the SDD and specify the intended audience for the SDD>

1.2 Scope

<In this subsection:

(1) Identify the software product(s) to be produced by name
(2) Explain what the software product(s) will, and, if necessary, will not do
(3) Describe the application of the software being specified, including relevant benefits, objectives, and goals
(4) Be consistent with similar statements in higher-level specifications if they exist

This should be an executive-level summary. Do not enumerate the whole requirements list here Note that this will be similar to what was written in the SRS.
>

1.3 Glossary

<Listing and explaining the terms appearing in the software's profession and this document. Any assumption of the reader's prior knowledge or experience on the subject is ill advised>

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

<Listing the referenced material used in this document, including the one related to the project>

2 Overall Description

<This section describes the principles and strategies to be used as guidelines when designing and implementing the system.>

2.1 General Overview

<Briefly introduce the system context and the basic design approach or organization. Provide a brief overview of the system and software architectures and the design goals. Include the high-level context diagram(s) for the system and subsystems provided in previous documents like SRS (e.g., general use case diagram, lower-level use case diagrams, activity diagrams), updated as necessary to reflect any changes that have been made based on more current information or understanding. If the high-level context diagram has been updated, identify the changes that were made and why>

2.2 Assumptions/Constraints/Risks

2.2.1 Assumptions

<Describe any assumptions or dependencies regarding the system, software and its use. These may concern such issues as: related software or hardware, operating systems, end-user characteristics, and possible and/or probable changes in functionality>

2.2.2 Constraints

<Describe any global limitations or constraints that have a significant impact on the design of the system's hardware, software and/or communications, and describe the associated impact. Such constraints may be imposed by any of the following (the list is not exhaustive):

- *Hardware or software environment*
- *End-user environment*
- *Availability or volatility of resources*
- *Standards compliance*
- *Interoperability requirements*
- *Interface/protocol requirements*
- *Licensing requirements*
- *Data repository and distribution requirements*
- *Security requirements (or other such regulations)*
- *Memory or other capacity limitations*
- *Performance requirements*
- *Network communications*
- *Verification and validation requirements (testing)*
- *Other means of addressing quality goals*
- *Other requirements described in the Requirements Document*

>

2.2.3 Risks

<Describe any risks associated with the system design and proposed mitigation strategies.>

3 System Architecture and Architecture Design

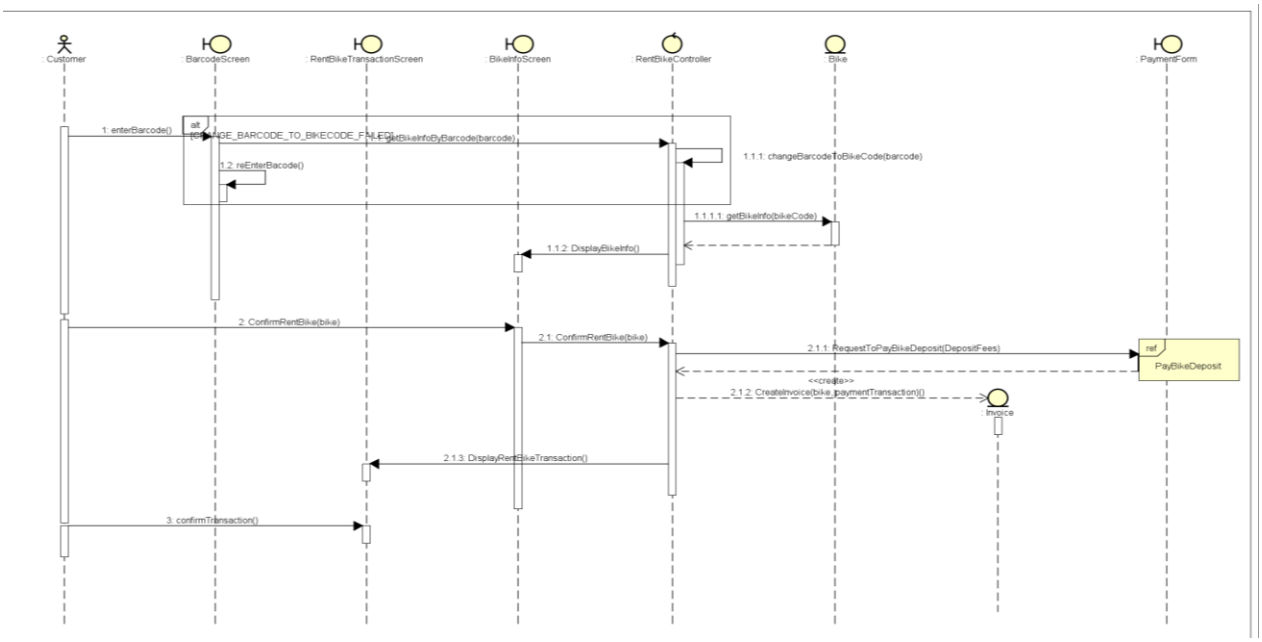
<Briefly describe the architectural design steps>

3.1 Architectural Patterns

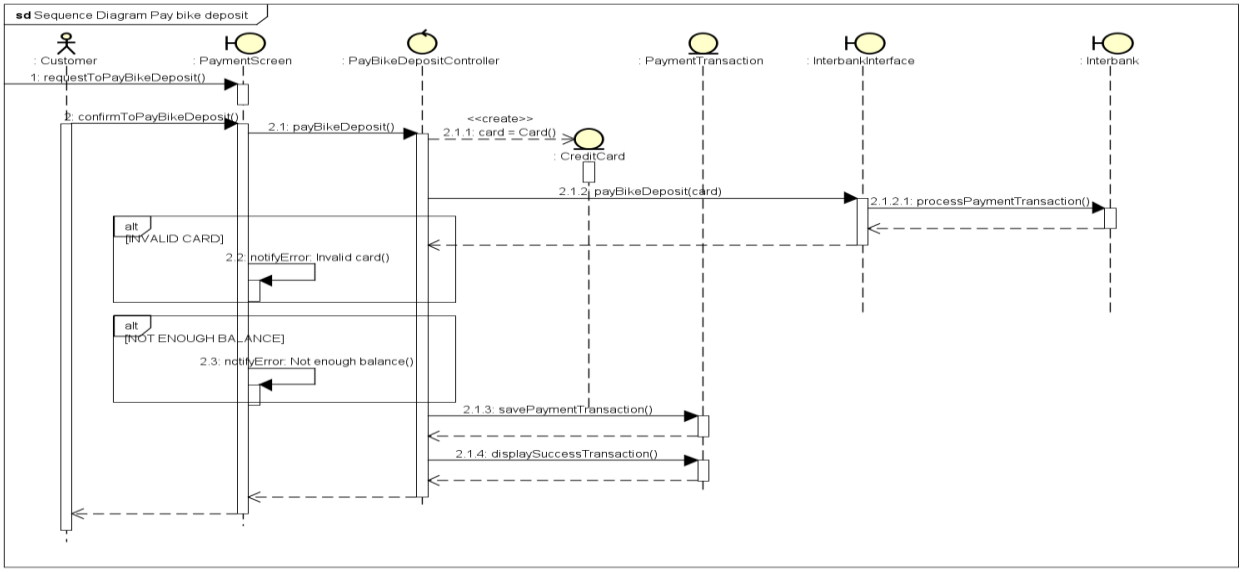
<Specify and briefly describe the chosen architectural patterns and the reasons why they were chosen>

3.2 Interaction Diagrams

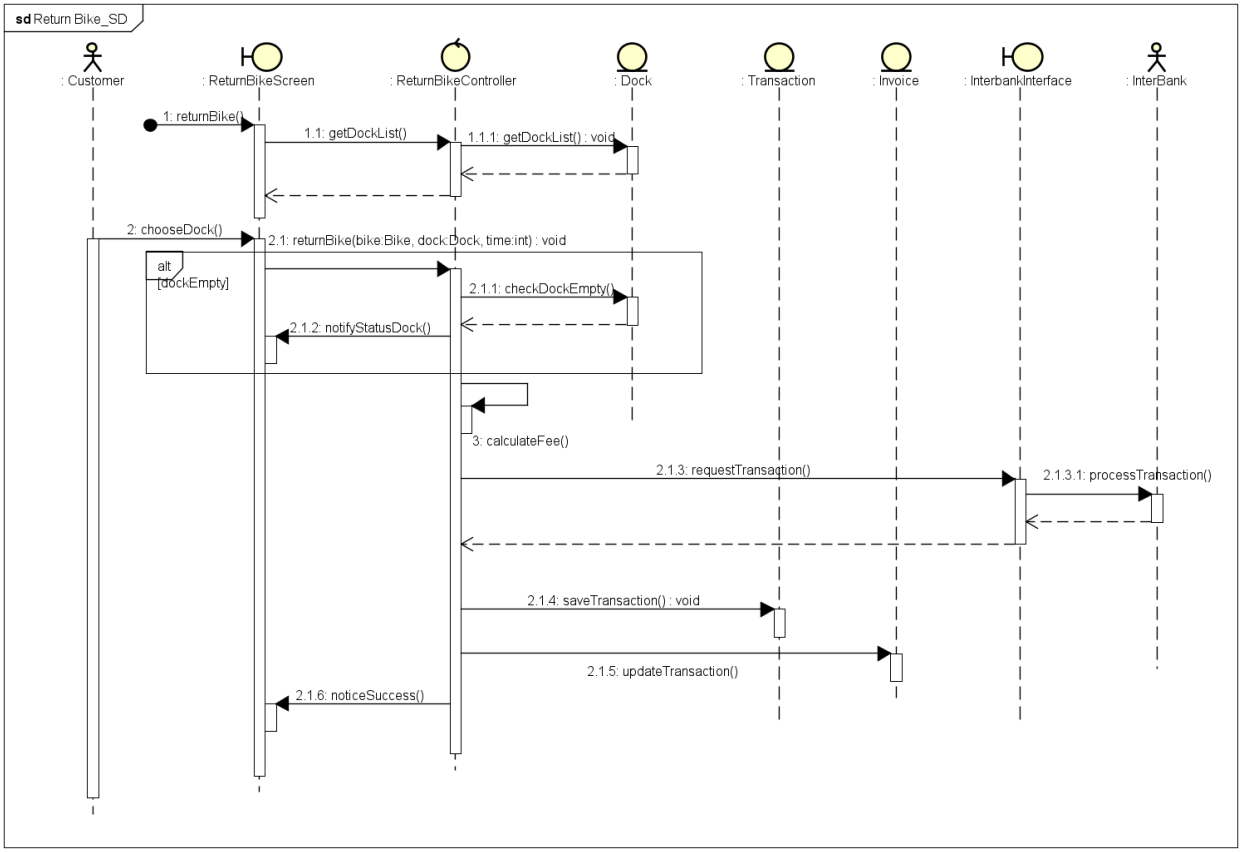
- Rental Bike Sequence Diagram



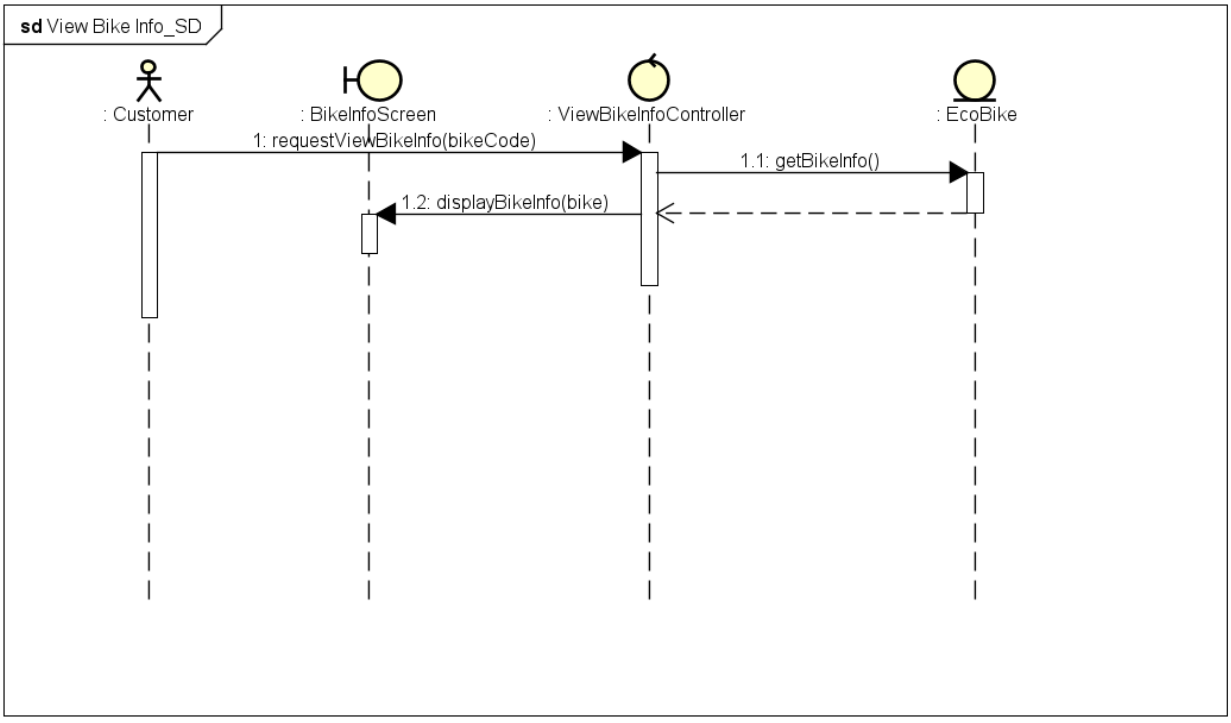
- Pay Bike Deposit Sequence Diagram



- Return Bike Sequence Diagram

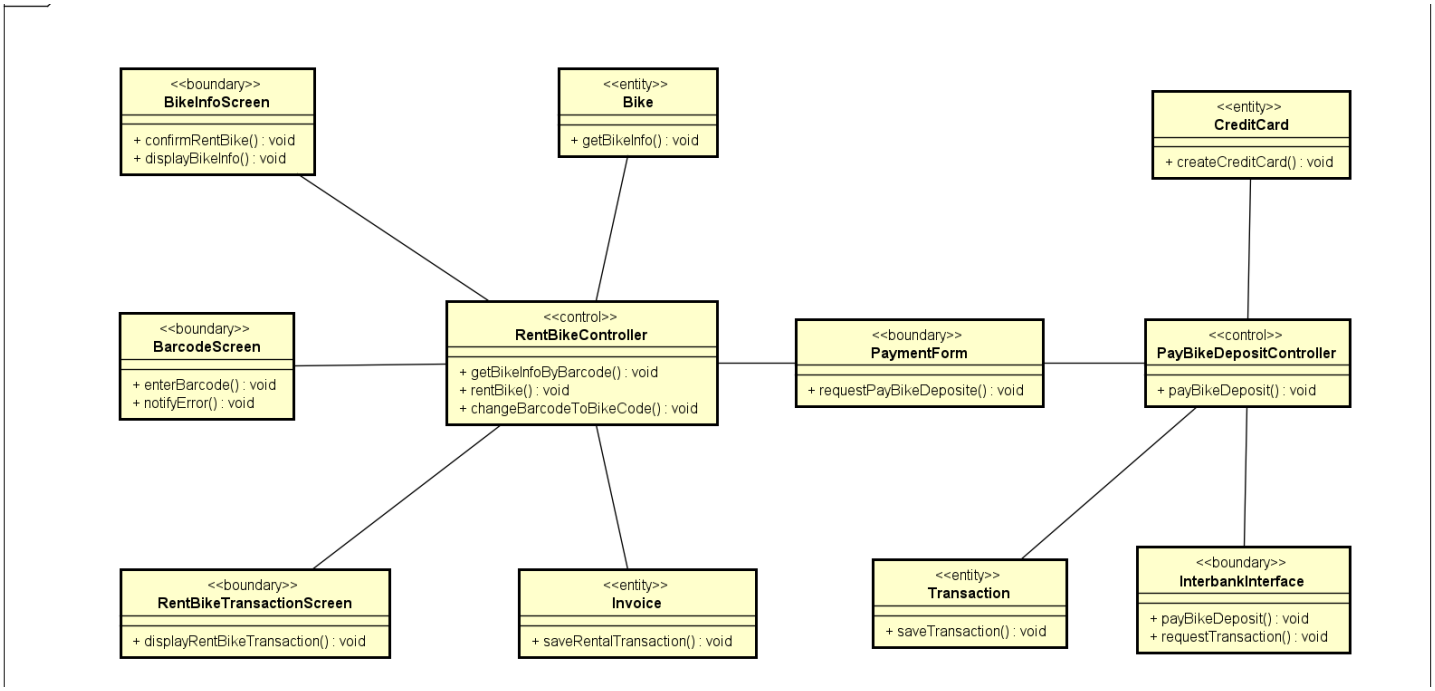


- View Bike Information Sequence Diagram

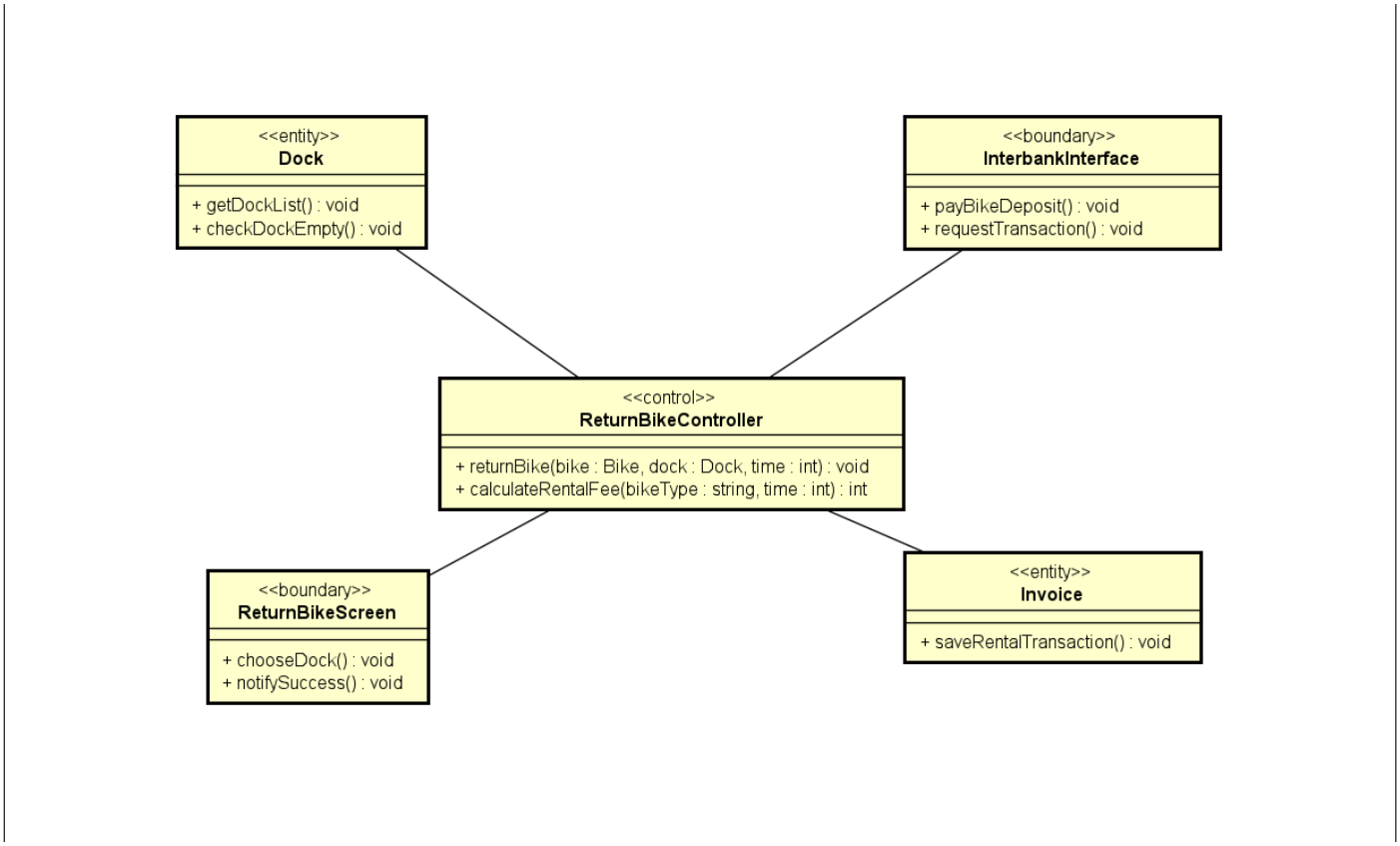


3.3 Analysis Class Diagrams

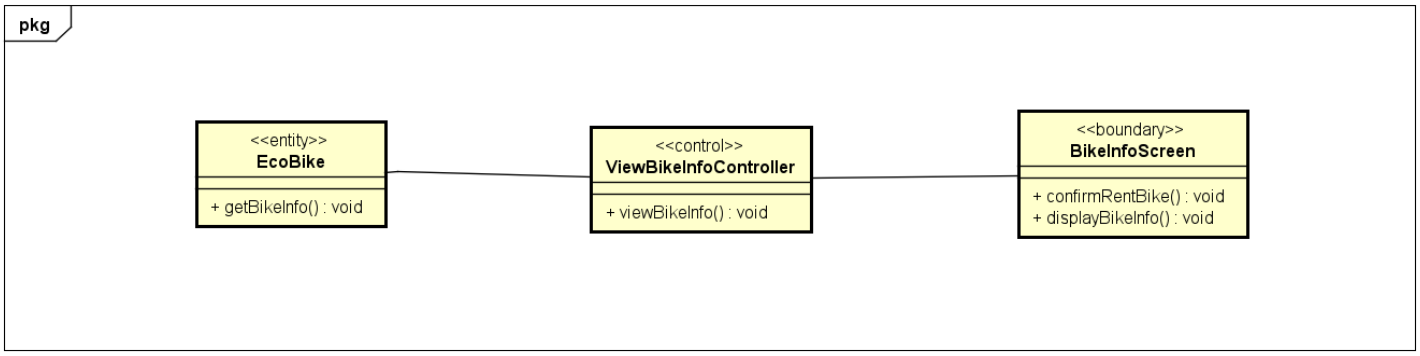
UC: Rental Bike



UC: Return Bike



UC: View Bike Information



3.4 Unified Analysis Class Diagram

3.5 Security Software Architecture

<Describe the software components and configuration supporting the security and privacy of the system. Specify the architecture for (1) authentication to validate user identity before allowing access to the system;(2) authorization of users to perform functional activity once logged into the system, (3) encryption protocol to support the business risks and the nature of information, and (4) logging and auditing design, if required.>

4 Detailed Design

4.1 User Interface Design

<Suppose that you design a Graphical User Interface (GUI)>

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

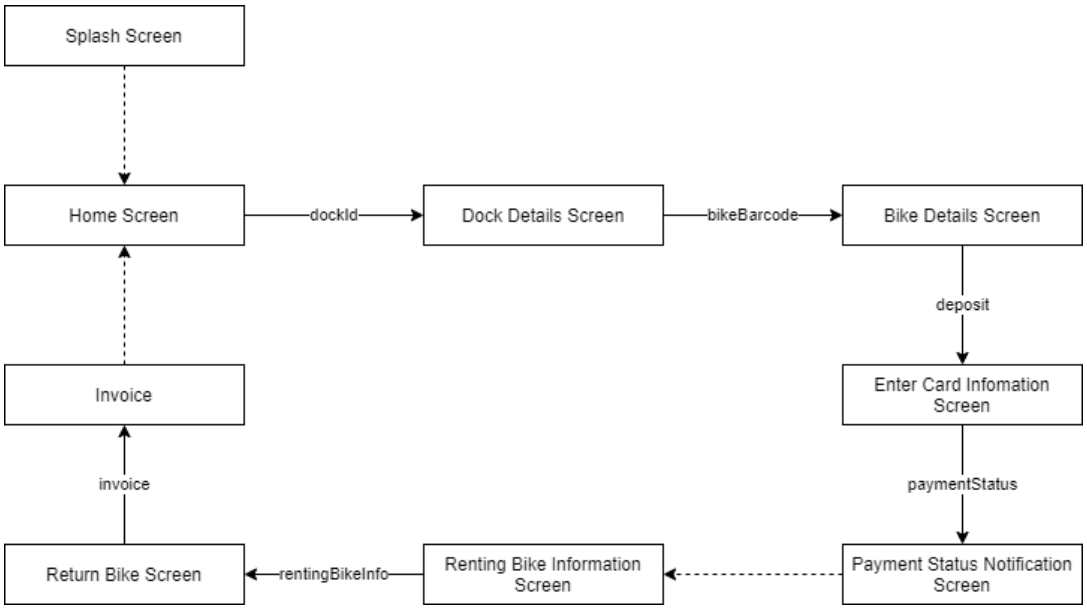
Direct input from the keyboard

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

Error

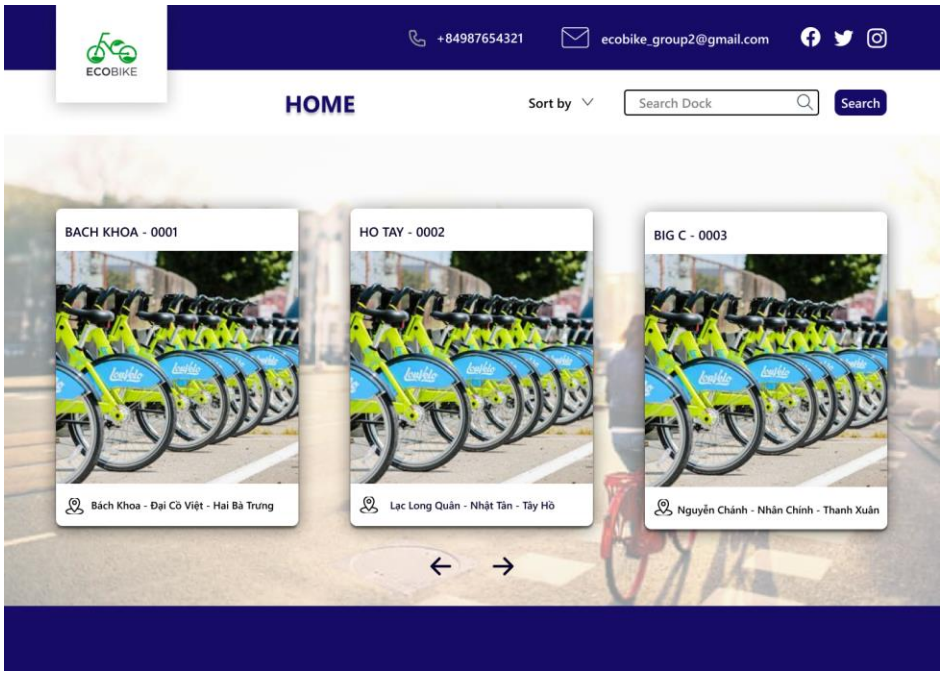
A message will be given to notify the users what is the problem.

4.1.2 Screen Transition Diagrams



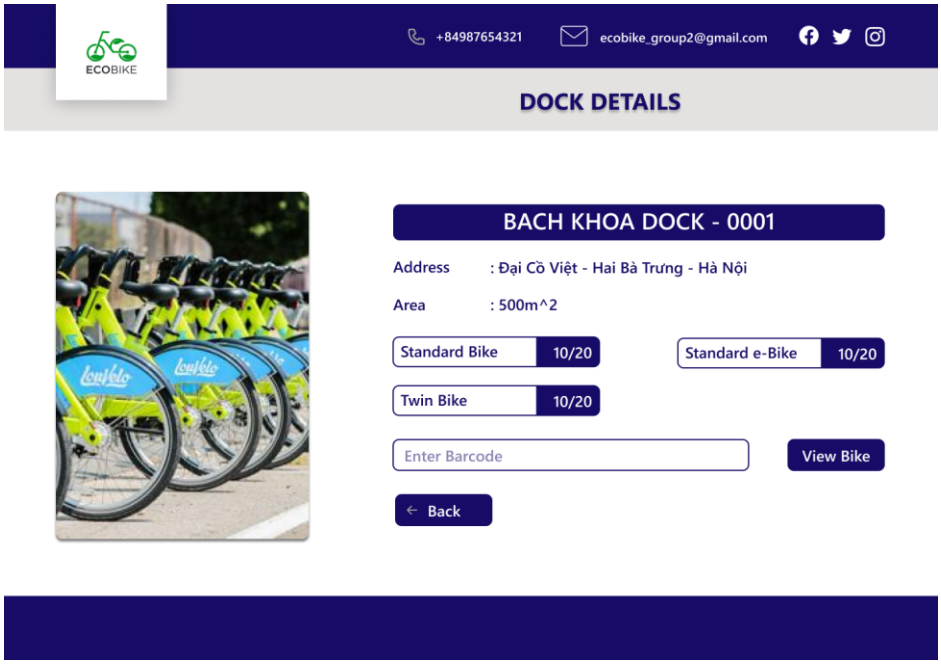
4.1.3 Screen Specifications

EcoBikeRental Software		Date of creation	Approved by	Reviewed by	Personal in charge
Screen Specification	Home screen	08/11/2021		Vũ Văn Long	Trần Xuân Trường



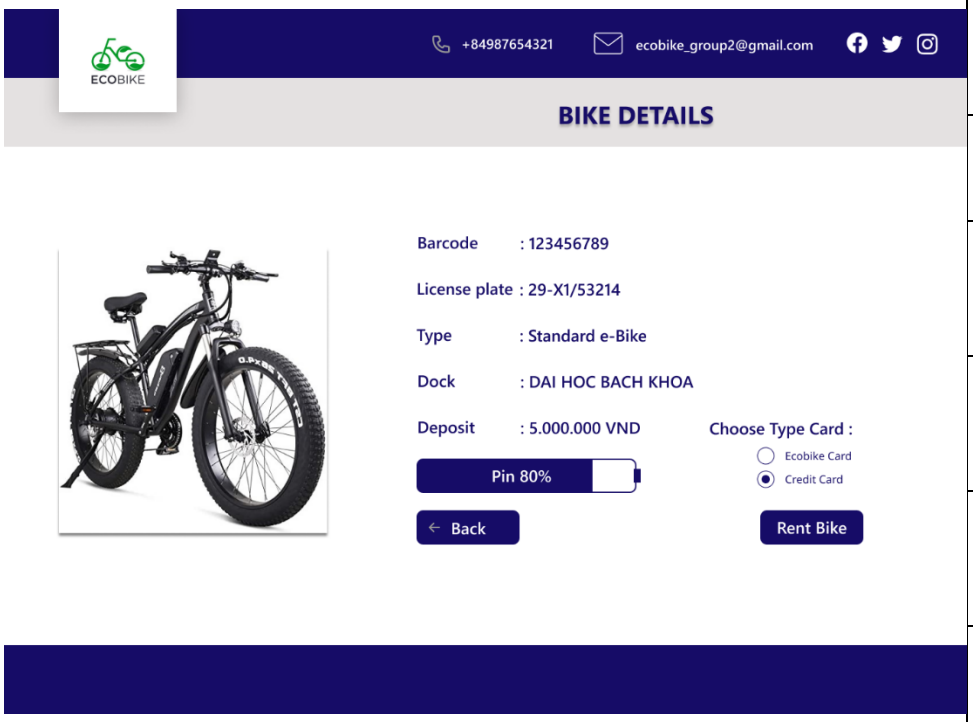
Control	Operation	Function
Area of displaying the contact information	Initial	Display the contact information such as phone number, mail, Facebook page…
Area of searching dock	Initial	Searching a dock
Area of displaying the list of docks	Initial	Displaying the list of docks
'Sort by' drop	Choose from 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.

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



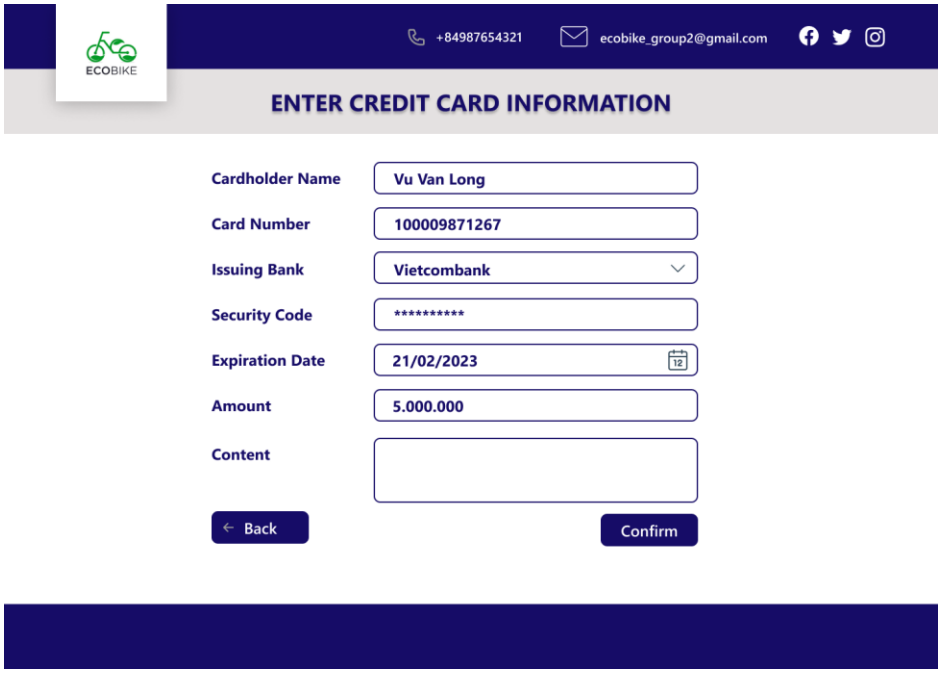
Control	Operation	Function
Area of displaying the contact information	Initial	Display the contact information such as phone number, mail, Facebook page…
Area of displaying the title	Initial	Display the title: DOCK DETAILS
Area of displaying the dock details	Initial	Display a dock details screen
Box of 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

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



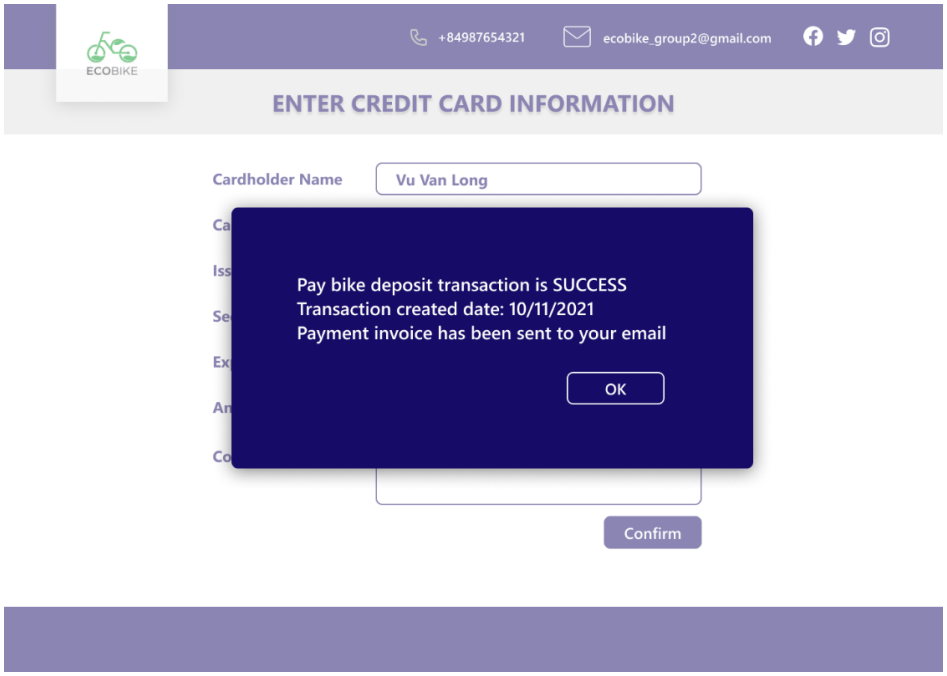
Control	Operation	Function
Area of displaying the contact information	Initial	Display the contact information such as mail, Facebook page…
Area of displaying the title	Initial	Display the title BIKE DETAILS
Area of displaying the bike details	Initial	Display the bike details
Box of displaying the pin 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

EcoBikeRental Software		Date of creation	Approved by	Reviewed by	Personal in charge
Screen Specification	Credit card information screen	09/11/2021		Vũ Văn Long	Trần Xuân Trường



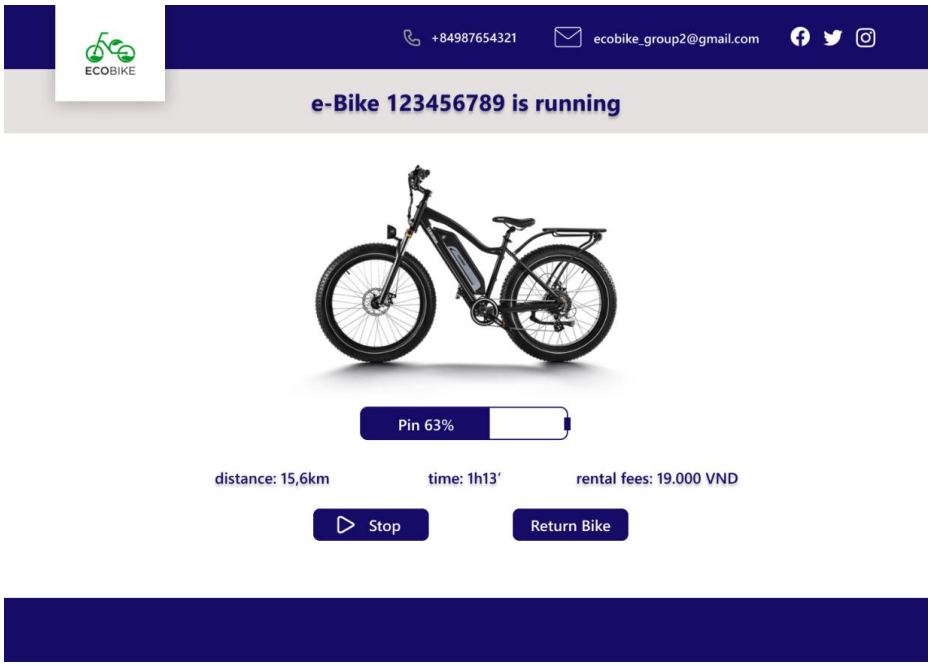
Control	Operation	Function
Area of displaying the contact information	Initial	Display the contact information such as phone number, mail, Facebook page…
Area of displaying the title	Initial	Display the title ENTER CREDIT CARD INFORMATION
Area of displaying the card information	Initial	Display the card 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

EcoBikeRental Software		Date of creation	Approved by	Reviewed by	Personal in charge
Screen Specification	**Notification success**	**09/11/2021**		**Vũ Văn Long**	**Trần Xuân Trường**



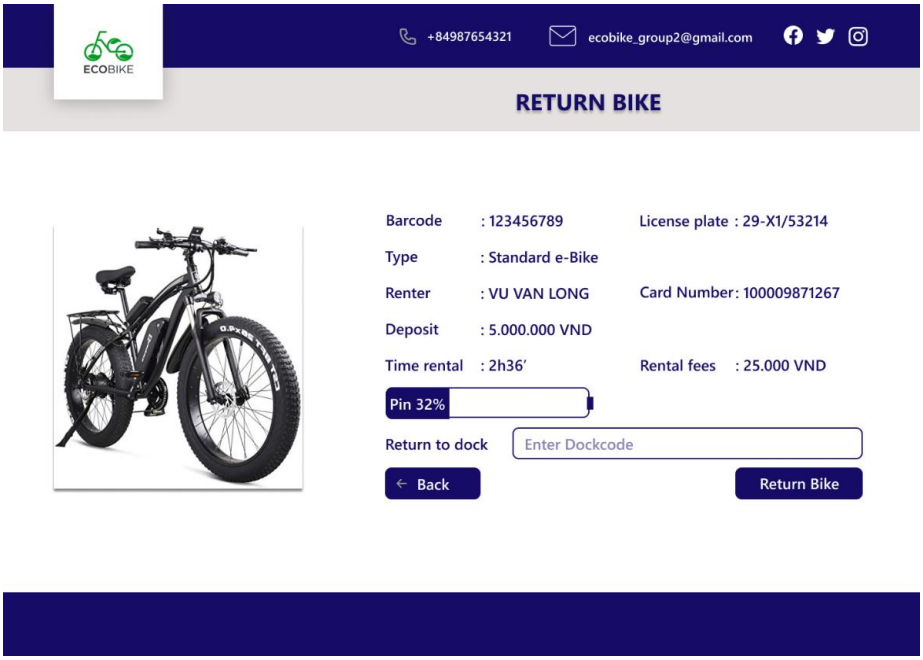
Control	Operation	Function
Area of displaying the notification of payment transaction		Displaying the notification of payment transaction, display successful transaction or error transaction, if transaction has error, display the detailed error.
'OK' button	Click	If the payment transaction is successful, display next screen. If not, display the current screen.

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



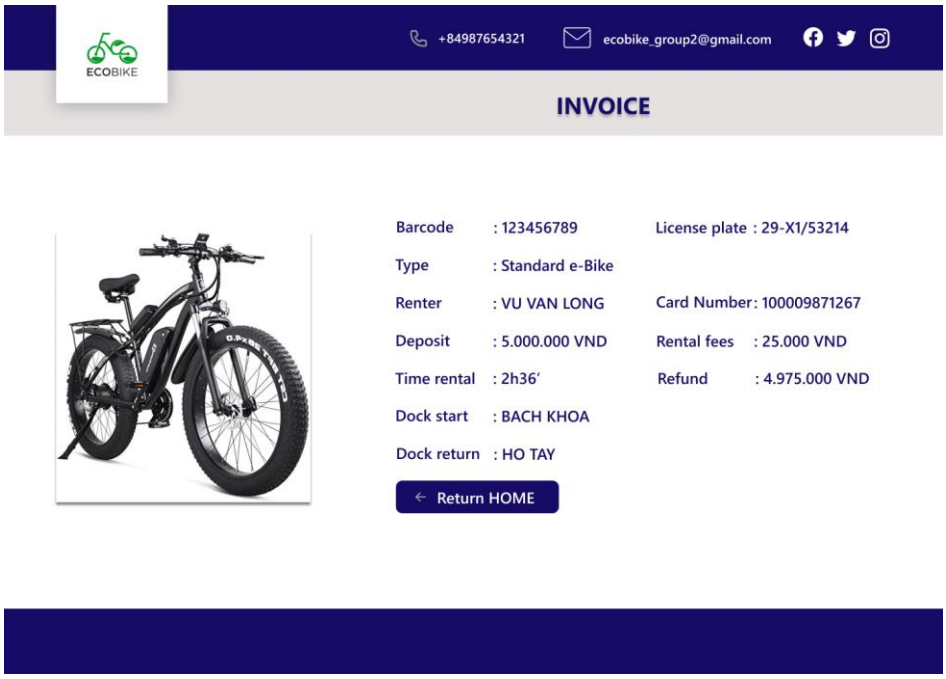
Control	Operation	Function
Area of displaying the contact information	Initial	Display the contact information such as phone number, mail, Facebook page…
Area of displaying the title	Initial	Display the title
Area of displaying the bike state details	Initial	Display the bike current state details that 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

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 pin of the bike after renting	Initial	Display the remain pin of the bike after renting if the bike is Standard 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

EcoBikeRental Software		Date of creation	Approved by	Reviewed by	Personal 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
'Return HOME' area	Initial	Return the HOME screen

Define the field attributes

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

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	Numeral	White	Center
Address	100	String	Blue	Left-justified
Area	5	Numeral	Blue	Left-justified
Enter barcode area	10	Numeral	Box	Left-justified
Bike name	50	String	Blue	Left-justified

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

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

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	

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

Screen name	**Return bike screen**			
Item name	**Number of digits (bytes)**	**Type**	**Field attribute**	**Remarks**
Barcode	10	Numeral	Blue	Center

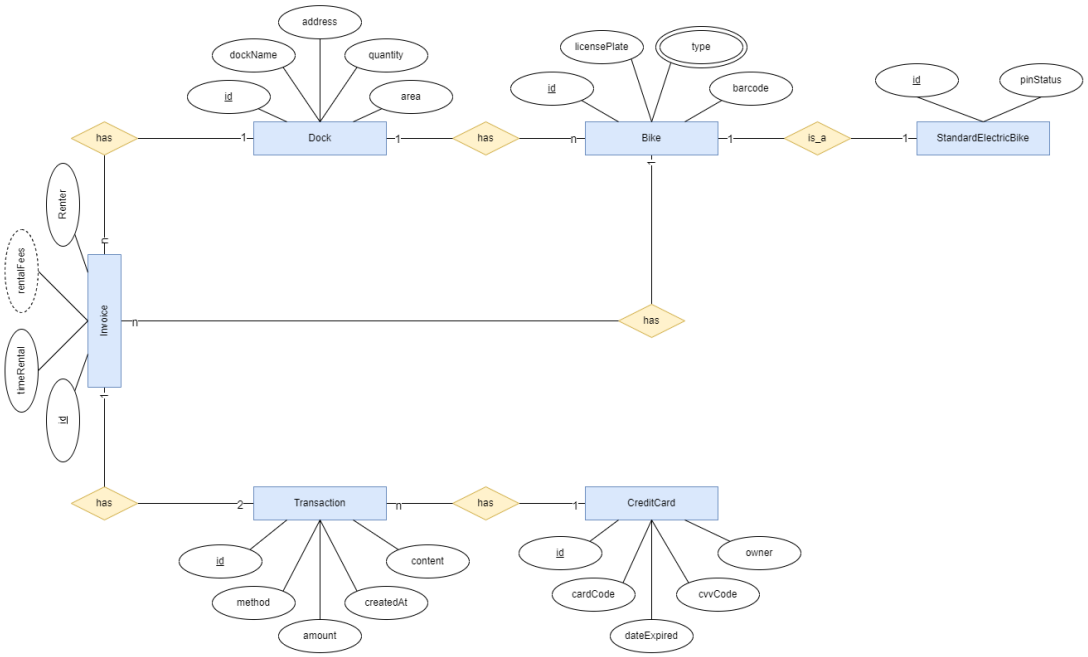
License plate	20	String	Blue	Right-justified
Type	50	String	Blue	Center
Renter	50	String	Blue	Center
Card Number	20	Numeral	Blue	Right-justified
Deposit	10	Numeral	Blue	Center
Time rental	10	String	Blue	Center
Rental fees	10	Numeral	Blue	Right justified
Return to dock	5	Numeral	Box	Right justified

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

<E-R Diagram image and description of entities and relationships>

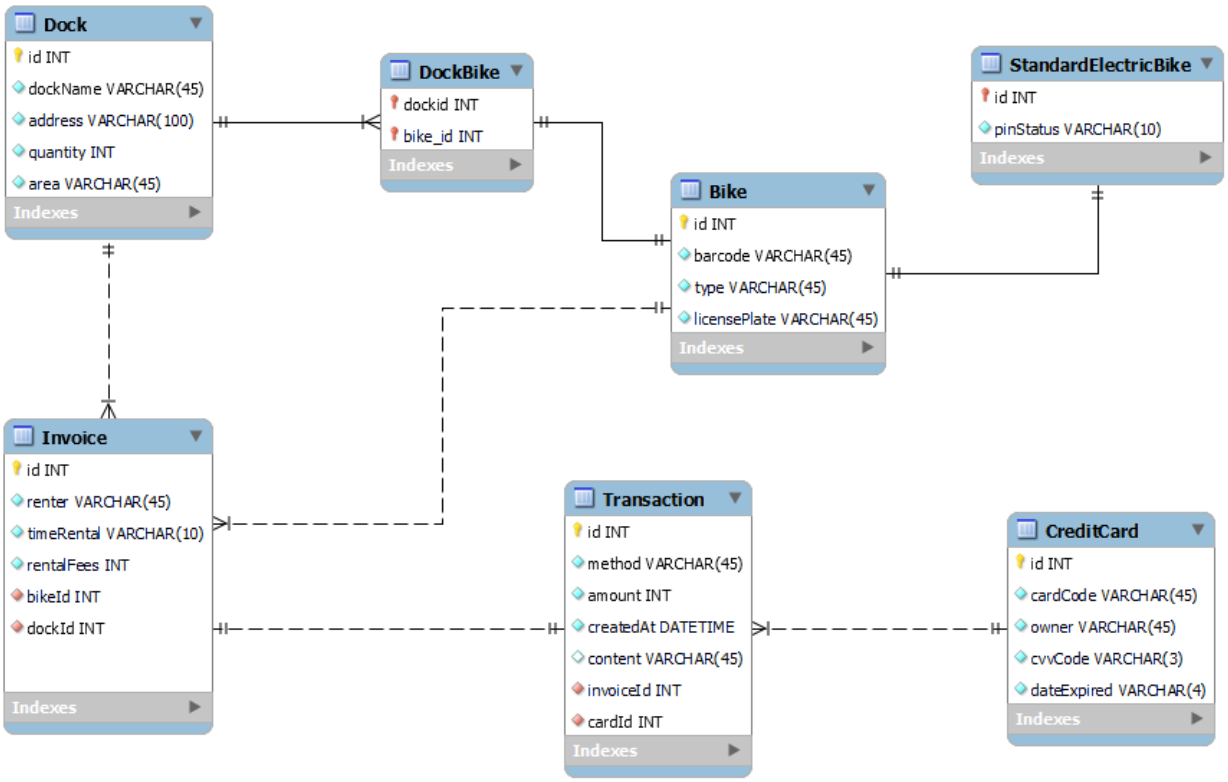


4.2.2 Database Design

4.2.2.1 Database Management Systems

<Specify what is the decision of Database Management System (DBMS) and give some description of the DBMS>

4.2.2.2 Logical Data Model



4.2.2.3 Physical Data Model

- Dock

#	PK	FK	Dock	Data Type	Mandatory	Description
1	x		id	Integer	Yes	ID of dock
2			dockName	VARCHAR(45)	Yes	Name of dock
3			address	VARCHAR(45)	Yes	Address of dock
4			quantity	Integer	Yes	Quantity of bikes at the dock
5			area	VARCHAR(45)	Yes	Area of dock

- DockBike

#	PK	FK	DockBike	Data Type	Mandatory	Description
1	x	x	dockId	Integer	Yes	ID of dock
2	x	x	bikeId	Integer	Yes	ID of bike

- Bike

#	PK	FK	Bike	Data Type	Mandatory	Description
1	x		id	Integer	Yes	ID of bike
2			barcode	VARCHAR(45)	Yes	Barcode of bike
3			type	VARCHAR(45)	Yes	Type of bike: standard bike, standard e-bike, twin bike
4			licensePlate	VARCHAR(45)	Yes	License plate of bike

- CreditCard

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	x		id	Integer	Yes	ID
2			cardCode	VARCHAR(45)	Yes	Card code
3			owner	VARCHAR(45)	Yes	Cardholder
4			cvvCode	VARCHAR(3)	Yes	CVV code
5			dateExpired	VARCHAR(4)	Yes	Expiration date

- Invoice

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	x		id	Integer	Yes	ID
2			renter	VARCHAR(45)	Yes	Name of renter
3			timeRental	VARCHAR(10)	Yes	Rental time
4			rentalFees	Integer	Yes	Rental fees
5		x	bikeId	Integer	Yes	ID of the bike
6		x	dockId	Integer	Yes	ID of the dock

- Standard e-bike:

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	x	x	id	Integer	Yes	ID, same of the ID of Bike of which type is Standard e-bike
2			pinStatus	VARCHAR(10)	Yes	Current battery percentage of e-bike

- Transaction

#	PK	FK	Column Name	Data Type	Mandatory	Description
1	x		id	Integer	Yes	ID
2			method	VARCHAR(45)	Yes	Method: pay or refund
3			amount	Integer	Yes	Amount
4			createdAt	DATETIME	Yes	Date of creation
5			content	VARCHAR(45)	No	Transaction content
6		x	invoiceID	Integer	Yes	ID of the invoice
7		x	cardId	Integer	Yes	ID of the used card

4.3 Non-Database Management System Files

<Provide the detailed description of all non-DBMS files if any and include a narrative description of the usage of each file that identifies if the file is used for input, output, or both, and if the file is a temporary file. Also provide an indication of which modules read and write the file and include file structures (refer to the data dictionary). As appropriate, the file structure information should include the following:

- *Record structures, record keys or indexes, and data elements referenced within the records*
- *Record length (fixed or maximum variable length) and blocking factors*
- *Access method (e.g., index sequential, virtual sequential, random access, etc.)*
- *Estimate of the file size or volume of data within the file, including overhead resulting from file access methods*
- *Definition of the update frequency of the file (If the file is part of an online transaction-based system, provide the estimated number of transactions per unit of time, and the statistical mean, mode, and distribution of those transactions.)*
- *Backup and recovery specifications>*

4.4 Class Design

4.4.1 General Class Diagram

4.4.2 Class Diagrams

4.4.2.1 Class Diagram for Package A

4.4.2.2 Class Diagram for Subsystem B

…

4.4.3 Class Design

4.4.3.1 Class "SampleClass1"

<SampleClass1 class image in UML>

Attribute

#	*Name*	*Data type*	*Default value*	*Description*
1				
2				

Operation

#	*Name*	*Return type*	*Description (purpose)*
1			
2			

Parameter:

- x: Default value, description
- y: Default value, description

Exception:

- AException if …
- BException if …

Method

How to use parameters / attributes

Flowchart / Sequence diagram if the method has a complex/special algorithm

State

State diagram if any

4.4.3.2 Class "SampleClass2"

…

5 Design Considerations

<Describe issues which need to be addressed or resolved before attempting to devise a complete design solution>

5.1 Goals and Guidelines

<Describe any goals, guidelines, principles, or priorities which dominate or embody the design of the system and its software.

Examples of such goals might be: an emphasis on speed versus memory use; or working, looking, or "feeling" like an existing product.

Guidelines include coding guidelines and conventions.

For each such goal or guideline, describe the reason for its desirability unless it is implicitly obvious.

Describe any design policies and/or tactics that do not have sweeping architectural implications (meaning they would not significantly affect the overall organization of the system and its high-level structures), but which nonetheless affect the details of the interface and/or implementation of various aspects of the system (e.g., choice of which specific product to use)>

5.2 Architectural Strategies

<Describe any design decisions and/or strategies that affect the overall organization of the system and its higher-level structures. These strategies should provide insight into the key abstractions and mechanisms used in the system architecture. Describe the reasoning employed for each decision and/or strategy (possibly referring to previously stated design goals and principles) and how any design goals or priorities were balanced or traded-off.

Examples of design decisions might concern (but are not limited to) things like the following:

- *Use of a particular type of product (programming language, database, library, commercial off-the-shelf (COTS) product, etc.)*
- *Reuse of existing software components to implement various parts/features of the system*
- *Future plans for extending or enhancing the software*
- *User interface paradigms (or system input and output models)*
- *Hardware and/or software interface paradigms*
- *Error detection and recovery*
- *Memory management policies*
- *External databases and/or data storage management and persistence*
- *Distributed data or control over a network*

- *Generalized approaches to control*
- *Concurrency and synchronization*
- *Communication mechanisms*
- *Management of other resources*

>

5.3 Coupling and Cohesion

<Evaluate your design and describe which levels of coupling and cohesion that your design is at. Give proofs for your assumptions. Explain if there is any special design or exceptions>

5.4 Design Principles

<Does your design follow the SOLID principles for the new requirements/changing requirements? Give proofs for your assumptions. Explain if there is any special design or exceptions>

5.5 Design Patterns

<Do you use any design patterns for your design? If yes, describe detailly why you use those design patterns? Describe in detail on the solutions and how to implement each design pattern>