SIE 454A/554A
E-Bike System

Systems Engineering Report
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1. Abstract/Executive Summary

The purpose of this project is to create an E-bike system that focused on people who wants to own an E-bike through an application, or a website, with full safety and successful services. The system allows the owners to own an E-bike through the company website. Also, the system allows the biker to register their E-bike through either the website of the mobile application once downloaded on their mobile phones. The main goal of this project is that the biker/owner can own an E-bike quickly, Also, we need to make sure that all of user's information are securely locked so that no one can access their information.

2. Introduction and Motivation

This project allows people to own an E-bike. Also, the system allows the biker to register their E-bike through the mobile application, when the biker logs in through the mobile application the biker selects register E-Bike, the system asks the biker to enter or scan their E-bike's product code, the E-bike company registrar confirms e-bike product code with biker ownership, the system displays a successfully connected confirmation on the mobile application. The system tracks overall usage and quality of the E-Bike, when the biker begins to ride their E-Bike, the E-Bike company registrar activates usage tracking on the biker's E-Bike, the system tracking up-to-date measures of the E-Bike's battery life, safety controls, location and statistics. It makes it easier for those who wants to own an E-Bike with full safety controls and successful services.

3. Problem to be solved
3.1 Problem Statement

The purpose of this project is to create an application and a website that allows people to own an E-bike. Also, the system allows the biker to register their E-bike through the mobile application, the user must have a smartphone so he/she can log in through the mobile application the biker selects register E-Bike, the system asks the biker to enter or scan their E-bike's product code, the E-bike company registrar confirms e-bike product code with biker ownership, the system displays a successfully connected confirmation on the mobile application. The system tracks overall usage and quality of the E-Bike, when the biker begins to ride their E-Bike, the E-Bike company registrar activates usage tracking on the biker's E-Bike, the system tracking up-to-date measures of the E-Bike's battery life, safety controls, location and statistics.

3.2 System Definition and Boundaries

The mobile application will begin when the Biker create an account, the E-Bike company registrar asks for an email address and password. The Biker enters all the information requested and selects create account. The E-Bike Company Registrar displays a message that the system sent a confirmation link to the Biker's email. The Biker selects Purchase E-Bike the registrar redirects Biker to enter credit card information and delivery address. The Biker enter information and clicks Submit Order. The system displays the order confirmation message.

The system display's battery life, location E-Bike was ridden, safety control measures, and usage statistics.

4. Concepts of Operations

4.1 Stakeholders

Table 1 Stakeholder Analysis

Category	Stakeholders	Role/Interest	Needs
Member	Yasmeen Kullab	To be responsible for the development and implementation of the project	System Requirements Performance Requirements Functional Requirements
Project Sponsors	E-Bike Company Registrar	The owners of the application and the website.	The system meets the desired requirements
Users	Biker	The one who will own the E-Bike	Install the application and put correct information.
External	Bank	A system which takes care of the payment transactions	Correct Account details, Security

4.2 System Use Cases

Use Case: **CreateAccount**
ID: Y
Brief Description: Biker create account by entering his email and password through the company website.
Primary Actor: Biker
Secondary Actors: None
Precondition: None
Main Flow: a. Use case begins when the biker clicks on "Create Account" through the Website b. The E-Bike company system asks for an email address and password.

c. The biker enters all the information requested and select Create Account on the CreateAccount tab d. The E-Bike company system displays a message that the system sent a confirmation link to the Biker's email. f. The use case ends.
PostCondition: The Biker creates an own account.
Alternative Flow: None

Use Case: **PurchaseEBike**
ID: Y
Brief Description: The system allows the biker to purchase an E-bike through the company website.
Primary Actor: Biker
Secondary Actors: None
Precondition: The Biker creates an account
Main Flow: a. Use case begins when the Biker selects "Purchase E-Bike" on the Website b. The system displays Payment for Biker to enter credit card information and delivery address c. The Biker enter information and clicks "Submit Order" d. The system displays the order confirmation message e. The use case ends
PostCondition: Biker purchases the Bike through the E-Bike Company
Alternative Flow: None

Use Case: **RegisterEBike**
ID: Y
Brief Description: The system allows the Biker to register their E-Bike through the mobile application
Primary Actor: Biker
Secondary Actors: E-BikeCompanyRegistrar

Precondition: Biker has the mobile application installed

Main Flow:
    a. Use case begins when the Biker logs in through the Application on the mobile application
    b. The Biker selects "Register E-Bike"
    c. The system asks the Biker to enter or scan their E-Bike's product code on the Registration
    d. The E-BikeCompanyRegistrar confirms E-Bike product code with Biker ownership
    e. The system displays a "successfully connected" confirmation on the Application
    f. The use case ends

PostCondition: The E-Bike is registered into the system
Alternative Flow: None

Use Case: **TrackUsage**
ID: Y
Brief Description: The system tracks overall usage and quality of the E-Bike
Primary Actor: Biker
Secondary Actors: E-BikeCompanyRegistrar
Precondition: The Biker has their E-Bike. Registered
Main Flow: a. Use case begins when the Biker begins to ride their E-Bike. b. The E-BikeCompanyRegistrar activates usage tracking on the Biker's E-Bike through the Usage c. The system begins tracking up-to-date measures of the E-Bike's battery life, safety controls, location, and statistics. d. The use case ends
PostCondition: The system has data of E-Bike usage
Alternative Flow: None

Use Case: **AutoLockBike**
ID: Y
Brief Description: The system automatically locks E-Bike after a ride.

Primary Actor: Biker
Secondary Actors: BikeSensor
Precondition: The E-Bike is in use and/or signed in on the Application
Main Flow: a.   The use case begins when the Biker turns off E-Bike power or signs off of Application b.   The BikeSensor detects the change in the E-Bike power and/or the status from the Application c.   The system automatically locks the E-Bike. d.   The use case ends.
PostCondition: E-Bike is locked.
Alternative Flow: None

Use Case: **FingerPrintAccess**
ID: Y
Brief Description: The system allows the Biker to access the Application and E-Bike by their fingerprint.
Primary Actor: Biker
Secondary Actors: IdentificationConfirmer
Precondition: mobile phone has a fingerprint sensor
Main Flow: a.   The use case begins when the Biker signs on the Application or turns on E-Bike b.   The system asks the Biker to place their fingerprint on their mobile phone sensor. c.   The IdentificationConfirmer confirms identity of Biker. d.   The systems grant access to Biker if the identification process is successful. e.   The use case ends.
PostCondition: E-Bike is unlocked.
Alternative Flow: None.

Use Case: **DisplayTirePressureAlert**

| |
|---|
| ID: Y |
| Brief Description: The system alerts the Biker of tire-pressure if under or over normal rate. |
| Primary Actor: Biker |
| Secondary Actors: BikeSensor |
| Precondition: Tire-pressure is not in normal rate. |
| Main Flow:
a.   The use case begins when the Biker turns on E-Bike or signs on through the Application
b.   The BikeSensor detects tire-pressure rate.
c.   The system displays an alert message saying "TPM malfunction"
d.   The use case ends. |
| PostCondition: Tire pressure alert is displayed. |
| Alternative Flow: None. |

4.3 Needs list
- Provide the capability for the biker to create account.
- Provide the capability for the biker to purchase an E-Bike.
- Provide the capability for the biker to register an E-Bike.
- Provide speed service and give the option of auto cruise speed control.
- Notify the biker if there's anything wrong in the E-Bike.
- Automatically lock E-Bike when turned off.

4.4 System Functions
- The system must let the Biker creates an own account.
- The system must allow the biker to purchase E-Bike through the company website.
- The system must allow the Biker to register their E-Bike through the company website or mobile application.
- The system must track overall usage and quality of the E-Bike.
- The system must automatically lock E-Bike when turned off.
- The system must be connected to the mobile application at all times when using E-Bike

4.5 System Function Block Diagram (FBD)

Figure 1 Function Block Diagram (FBD)
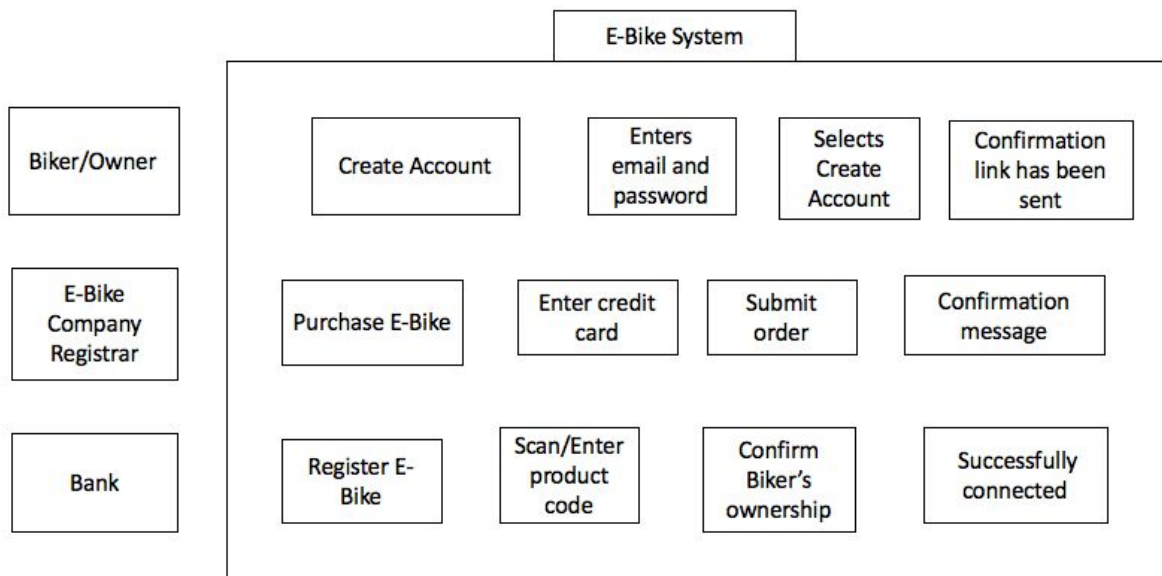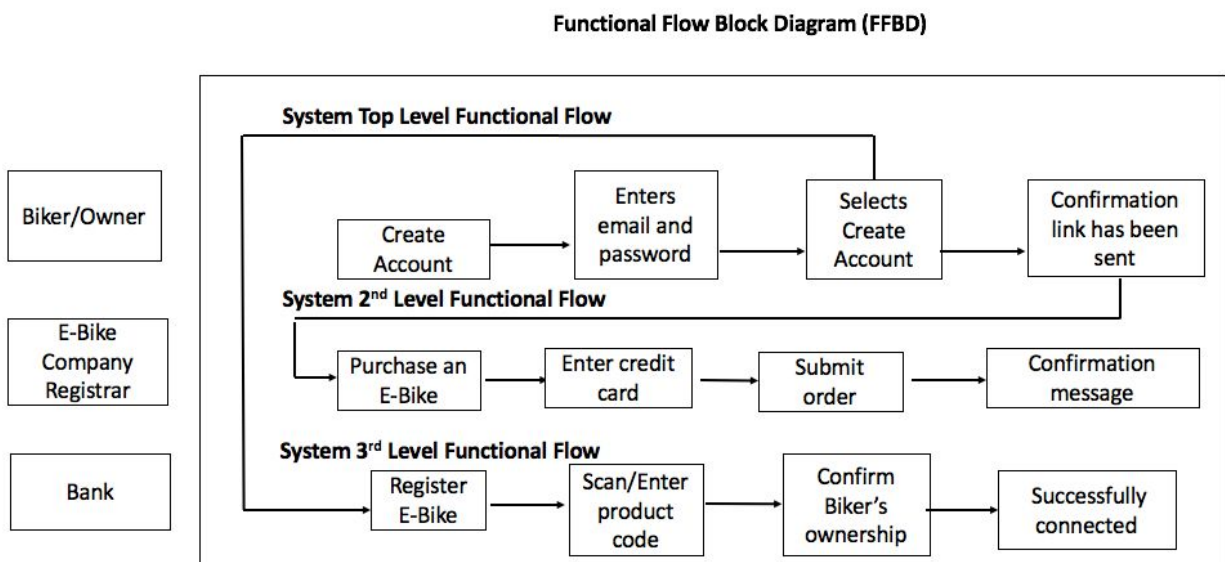
5. System Detail Design

5.1 Functional Flow Block Diagram (FFBD)
The following diagram shows how the system flows up to 3rd level.

Figure 2 Functional Flow Block Diagram (FFBD)

5.2 System Interfaces
Interface Requirements:

5.2.1 App Interface: The app interface shall provide the capability for the biker to CreateAccount including email and password through the company website.
5.2.2 Web interface: The web interface shall provide the capability for the biker to PurchaseEBike through the company website.
5.2.3 App interface: The app interface shall provide the capability for the biker to RegisterEBike through the mobile app.
5.2.4 App interface: The app interface shall DisplayUsage and data on the mobile app.

5.3 System Requirements

5.3.1 Functional Requirements

5.3.1 The system shall provide the capability for the biker to CreateAccount including email and password through the company website.

5.3.2 The system shall provide the capability for the biker to PurchaseEBike through the company website.

5.3.3 The system shall provide the capability for the biker to RegisterEBike through the mobile app.

5.3.4 The system shall TrackUsage and data of the bike.

5.3.5 The system shall DisplayUsage and data on the mobile app.

5.3.6 The system shall AutoLockBike once the biker signs out of the system.
5.3.7 The system shall allow the biker to place an EmergencyCall in case of urgent situations.
5.3.8 The system shall DisplayRealTimeLocation of the bike when the biker uses the (Find My Bike) feature
5.3.9 The system shall allow the Biker to get FingerprintAccess to the bike.
5.3.10 The system shall detect biker's real-time heartbeats and DisplayHeartRate
5.3.11 The system shall allow the biker to Edit/DeleteProfileOnWeb information on the company website.
5.3.12 The system shall allow the biker to ChangeRideMode from the mobile application.
5.3.13 The system shall detect helmet and DisplayHelmetAlert if biker is not wearing a helmet when beginning the ride.
5.3.14 The system shall DisplayRideOverview on the mobile application after each ride for the biker.
5.3.15 The system shall detect tire's condition and DisplayTirePressureAlert if pressure is under or over normal rate.

5.3.2 Performance Requirements

5.3.2.1 The system shall allow the bike a maximum speed limit of 45 mph
5.3.2.2 The system shall give the option of auto cruise speed control
5.3.2.3 System Security: The app shall encrypt all the important information.

5.3.2.4 The system shall notify the biker if there's a malfunction in the tires.

5.3.3 Standards Requirements

5.3.3.1 Bank Account: The user shall have an existing bank account to be able to do the payment.

5.3.3.2 Valid Email Address: The Biker shall have a valid email address for verification and to allow access back into the account if the user forgets their password.

5.3.3.3 Available Storage space; the user shall have enough storage in their mobile to install and download the app.

5.3.3.4 Valid Phone Number: The biker shall have a valid phone number for verifications.

5.4 System Architecture

The diagram below shows the architecture flow of the system. This diagram branches into three levels, a system, three subsystems, and their components. The diagram below shows how those systems and components are structured.

Figure 3 System Architecture Diagram
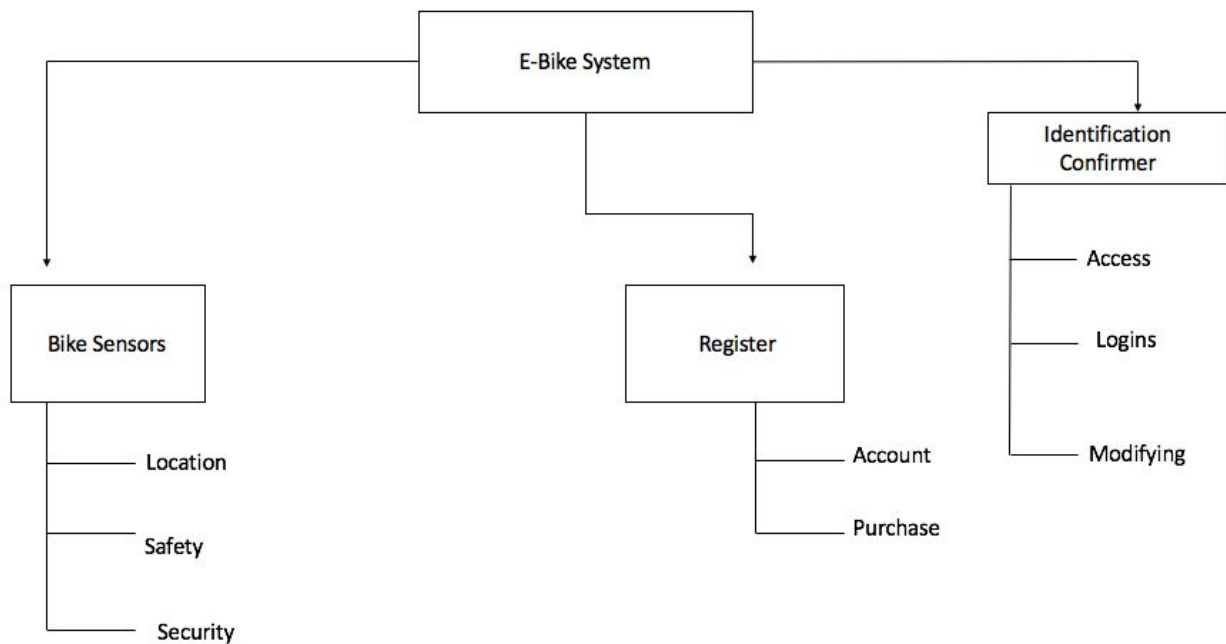
5.5 Subsystem Requirements

Table 2 Requirements Flow Down Table

Requirment Number	Subsystem		VM
5.2.1	Register	Direct	T/D/I
5.2.2	Register	Direct	T/D/I
5.2.3	Register	Direct	T/D/I
5.2.4	Bike Sensors	Direct	T/D/I
5.3.2.1	Bike Sensors	Direct	T/D
5.3.2.2	Bike Sensors	Direct	T/D
5.3.2.3	Bike Sensors	Direct	T/D
5.3.2.4	Bike Sensors	Direct	T/D
5.3.3.1	Identification Confirmer	Direct	T/D
5.3.3.2	identification Confirmer	Direct	T/D/I
5.3.3.3	Register / Identification Confirmer	Direct	T/D
5.3.3.4	Register / Identification Confirmer	Direct	T/D/I

5.6 System Environment

This application's minimum viable product supports English speakers in the United States of America. The app is easy to carry around on a mobile device. The app will be available on iOS and Android platforms.

6. Verification Matrix

This matrix explains how each system level requirement will be verified and at what level the verification will occur.

Table 3 Verification Matrix

Requirement Decomposition					
Subsystems	Systems Requirements Ref	Verification Method			
		A	T	D	I
Bike Sensors Subsystem	4.3.6 The system shall Auto Lock Bike once the biker signs out of the system.	X		X	
Registration Subsystem	4.3.3 The system shall provide the capability for the biker to Register E-Bike through the mobile app.			X	
	4.3.2 The system shall provide the capability for biker to Purchase E-Bike through company website.			X	
Identification Confirmer Subsystem	4.3.9 The system shall allow the biker to get Fingerprint Access to the bike.		X		
Maintenance Subsystem	4.3.11 The system allow the biker to Edit profile on Web information on the company website				X

7. Trade Studies

The weighted average score is calculated for factors: performance, Maintenance, quality, service and support with each having weight. It describes the weighted average score is the total risk score.

Table 4 Trade – Off Analysis (Weighted Score)

		Location		Safety		Security	
Criteria	Importance Weight (%)	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Performance	30	4	1.20	2	0.60	3	0.90
Maintenance	25	4	1.00	3	0.75	3	0.75
Quality	20	2	0.80	3	0.60	2	0.40
Service & support	10	2	0.20	4	0.40	3	0.30
Overall Risk	85	NA	3.2	NA	2.35	NA	2.35

8. Risk Mitigation

The main risks for this project lies within security measures, or personal information security. In order for this project to be successful, we have to make sure that all the information is safe and secure.

The table below shows the critical risks we need to mainly focus on:

Table 5 Risk Analysis and Mitigation Plan

Rank	Description	Mitigation	Contingency
1	Malfunction in the tiers	A screen in the E-Bike to notify the biker if there's a malfunction in the tires	Allow the biker to stop the ride immediately
2	Battery low	A screen in the E-Bike to notify the biker to recharge when the bike is on 20% battery life	Allow the biker to use a portable charger we have personally tested
3	Speed above 10 mph	Test the emergency brakes if the biker approaches any object 5 feet away in a speed above 10 mph	Only allow users to use the emergency braked that we have personally tested
4	Passcode doesn't work	Reset passcode only once two-authorizing identification process is successful	Only allow the biker to do this feature
5	Application doesn't work	Test the app as much as we can	Only allow the app to be installed on phones that we personally tested

Table 6 Risk Chart

Likelihood	Consequences				
	Insignificant (Risk is easily mitigated by normal day to day process)	Minor (Delays up to 10% of schedule or additional cost)	Moderate (Delays up to 30% of schedule or additional cost)	Major (Delays up to 50% of schedule or additional cost)	Catastrophic (Project abandoned)
Almost Certain (>90%)	High	High	Extreme	Extreme	Extreme
Likely (50%-90%)	Moderate	High	High	Extreme	Extreme
Moderate (10%-50%)	Low	Moderate	High	Extreme	Extreme
Unlikely (3%-10%)	Low	Low	Moderate 4,5	High 1,2,3	Extreme
Rare (<3%)	Low	Low	Moderate	High	High

1. Malfunction in the tiers
2. Battery low
3. Speed above 10 mph
4. Passcode doesn't work
5. Application doesn't work

9. Impact

The mobile application and website will allow bikers to create and purchase an E-bike by using their full personal information. The mobile app or website can be used to register your own E-bike which only needs your important information. The mobile app and website will also be able to connect to a security system while the biker can check the location and E-Bike's battery life. The E-Bike Company Registrar will help the users and the bikers to have full service including the safety through the mobile app or website.

10. Summary

In conclusion, with the fast development of technology, we chose to design, develop and create a new an E-Bike system that focuses on people who want to own an E-Bike with full safety measures, security system, and outstanding feature services. This system allows owners to register their E-Bike through a mobile application and make use of great features for a smooth experience riding the E-Bike. All in all, our E-Bike company makes it easier for those who wants to own an E-Bike with successful services.