**A NEW HINT TO TRANSPORTATION-ANALYSIS OF THE NYC BIKE SHARE SYSTEM**

A project report submitted in partial fulfillment of the requirements of the award of the degree of

Bachelor of Technology in

Computer Science and Engineering

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**ENGINEERING**

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# INTRODUCTION

* 1. **PROJECT OVERVIEW**

Bike share programs have risen in popularity in recent years and have been promoted as a lower carbon alternative to other forms of transit. Interest in bicycle sharing has been growing exponentially over the past decade, resulting in a proliferation of bike share systems in 712 cities across the world, encompassing 806,000 bicycles and 37,500 stations (Shaheen et al., 2014).

This can be largely attributed to the successful incorporation of information technology in docking stations and mobile devices as well as improved logistics such as bicycle rebalancing to ensure responsive supply management. Cities often hope bike sharing will bring many beneﬁts such as extending the reach of transit, substituting motorized trips, and encourage non-cyclists to try cycling (Shahen et al., 2014).

The premise of bicycle sharing is that it is a short-term bike rental system, based on varying timed memberships. Members of the bike share network have access to stations, comprised of a pay-station and multiple bike docks, across the system where bikes can be checked out from one station and returned to another ne nearest to their destination.

The appeal of membership is 24/7 access to an automated bike rental network and utility of bikes in completing “last-kilometer connections” (Shaheen et al., 2014) without the worry of storage or maintenance. The price system is set to encourage shorter trips (less than 30 minutes in time), with additional fees for any time used over that maximum.

There is evidence that bike share users switch to bike share from motorized transport, such as bus and auto (Shaheen et al., 2014), creating the potential for signiﬁcant reductions in transportation related greenhouse gas or CO2e emissions.

However, there is signiﬁcant heterogeneity between different cities (Shaheen et al., 2014), showing that there is not a guaranteed CO2e reduction beneﬁt from instituting bike share, especially if the trips would not have been made otherwise or are substituting walking and private bicycle trips.

# PURPOSE

Many bike share systems make available their trip data for those who want to understand how their systems are used.

The bike share system in New York City, Citi Bike, is one of them, but they don’t provide much more than the data. I’ve got some experience in obtaining and preparing their data for visualization, so in this article I will show you how to get started with this rich data source.

In the Before Times I commuted from suburban New Jersey to my job as a Product Manager in New York City at an office, now shuttered, ab';ove Penn Station. To get around in the City at lunch or after work I often relied on Citi Bike, New York’s bike share system.

I found I could get to destinations in midtown and even further afield faster than walking and cheaper than the bus or subway. When I discovered that Citi Bike made trip data publicly available I thought that it might provide an interesting use case for the data preparation product that I managed.

The trip data files contain one record for each ride, around two million records per month, depending on the season. It’s a traditional bike share system with fixed stations where a user picks up a bike at one dock, using a key fob or a code, and returns it at another.

Using the large table graphic, the moderator was able to show participants images of the kiosk, membership key, smart phone apps, and more.

The features section allowed DOT to solicit participant options on the usefulness of these features, and collect suggestions for additional features.

Sites must have unrestricted, 24/7 public access.

* Sites should ensure maximum visibility and access.
* Sites must not impede the use of any existing .

1. **LITERATURE SURVEY**
   1. **EXISTING PROBLEM**

Bike sharing is an emerging industry and it is very popular in western countries, while people have tried to start the same in India, we will look into some of the stats regarding how many people use bike sharing systems. According to Wikipedia by August 2014 only 600 cities in the world had bike sharing systems and most of them were in western countries with a fleet of about 500000 bicycles with them. There is a sharp

increase in Next Bike Cog Bike Share are some of the leading Bike Sharing systems that are currently in operation in the world.

While considering Indian perspective in the Bike Share industry, India has not yet adapted the application of this emerging industry. Currently there are a few bike share

systems.

# REFERENCE

**Burrows; et al. (1999). Gotham. Oxford Press. ISBN 0-19-511634-8.**

# Koeppel, Gerard (2015). City on a Grid: How New York Became New York. Boston: Da Capo Press. ISBN 978-0-306-82284-1.

**"Gloriﬁcation! The Cities Celebrate the Work That Makes Them One". Brookly n Daily Eagle. May 24, 1883. p. 12. Retrieved June 26, 2019 – via Brooklyn Public Library; newspapers.com open access.**

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# U.S. Census Bureau, American Community Survey 2006, Table S0802.

**Metropolitan Transportation Authority. "The MTA Network". Retrieved July 15, 2016.**

# Bureau of Transportation Statistics, U.S. Department of Transportation (2001). "Highlights of the 2001 National Household Travel Survey ". Archived from the original on October 2, 2006. Retrieved May 21, 2006.

**Bellafante, Ginia (July 12, 2019). "New York Was Supposedly Getting Better for Cyclists. What Happened?". The New York Times. ISSN 0362-4331. Retrieved November 5, 2019.**

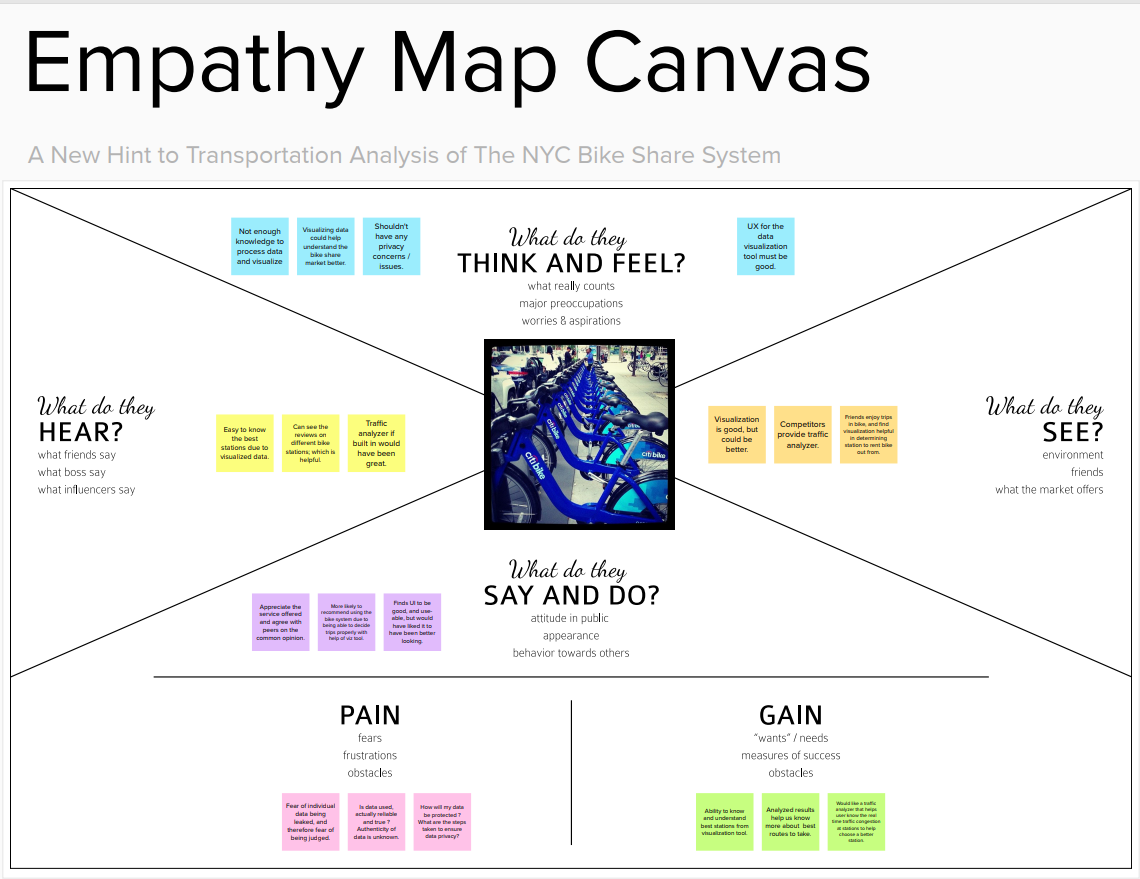
# PROBLEM STATEMENT DEFINITION

* + 1. The government needs a way to analyze the NYC bike share system so that they can enhance the system and give residents and visitors a fun, safe, affordable and convenient alternative to walking, taxis, buses etc.
    2. The goal of this analysis is to create an operating report of Citi Bike for the year

2018.

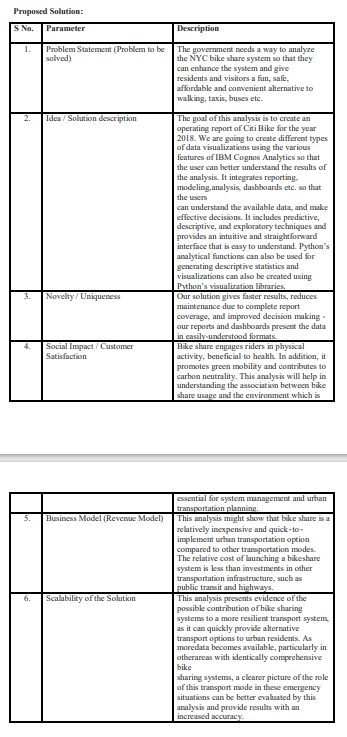
* + 1. Citi Bike oﬃcials are pushing to make the program more robust and to broaden its reach. Financial viability increases with such larger bike-sharing programs. This could be seen by analyzing the total number of trips.
    2. The top bikes used with respect to trip duration could be found by this analysis so that more of these bikes can be produced and more users can be attracted.
    3. With the help of this analysis, the top 10 Start station names with respect to customer age group could be found so that the government can broaden the bike sharing system by increasing the number of bikes in those stations to make them readily available to all the potential users.
    4. The gender of the customer as well as the subscriber could be assessed and the number of bikes used by respective age groups could also be computed.

# IDEATION & PROPOSED SOLUTION

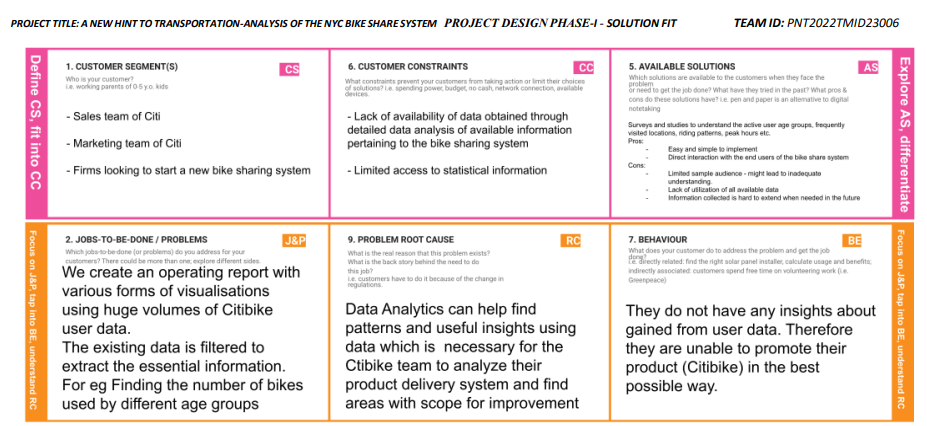
* 1. **EMPATHY MAP CANVAS**

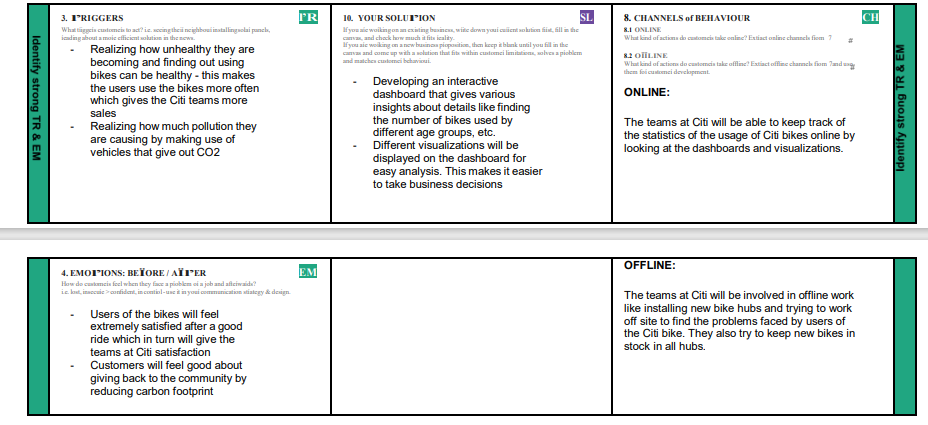
# IDEATION AND BRAINSTORMING

* 1. **PROPOSED SOLUTION**

****

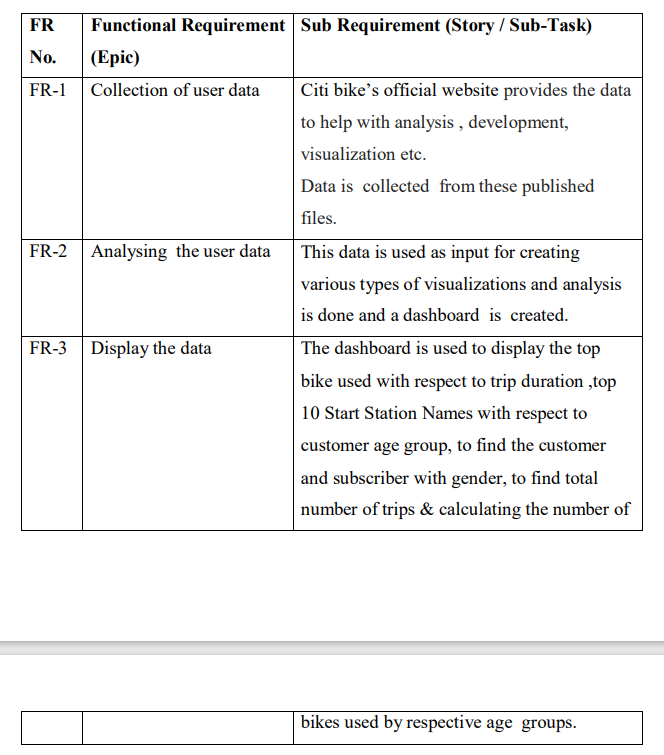
# PROBLE SOLUTION FIT

****



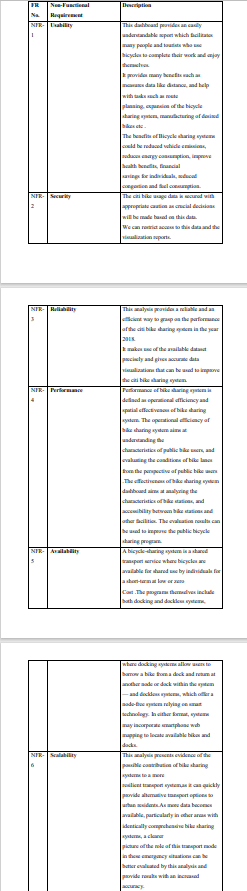
1. **REQUIREMENT ANALYSIS**

# FUNCTIONAL REQUIREMENT

Following are the functional requirement of the proposed solution

# NONFUNCTIONAL REQUIREMENT

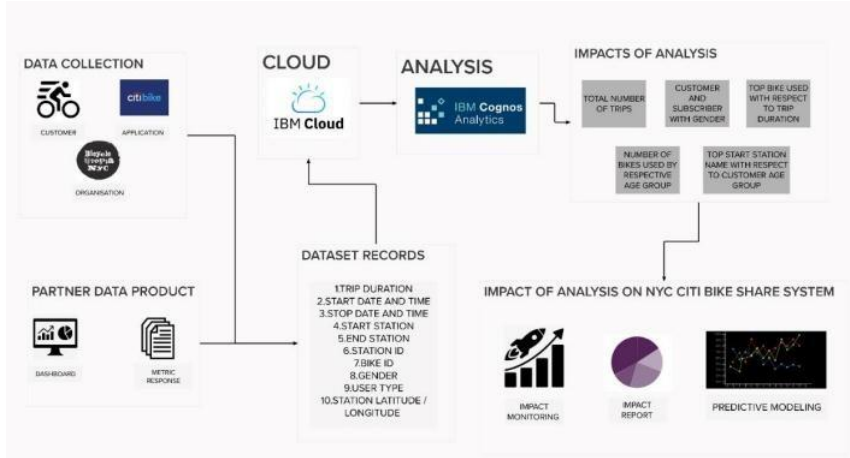
Following are the nonfunctional requirement of the proposed solution



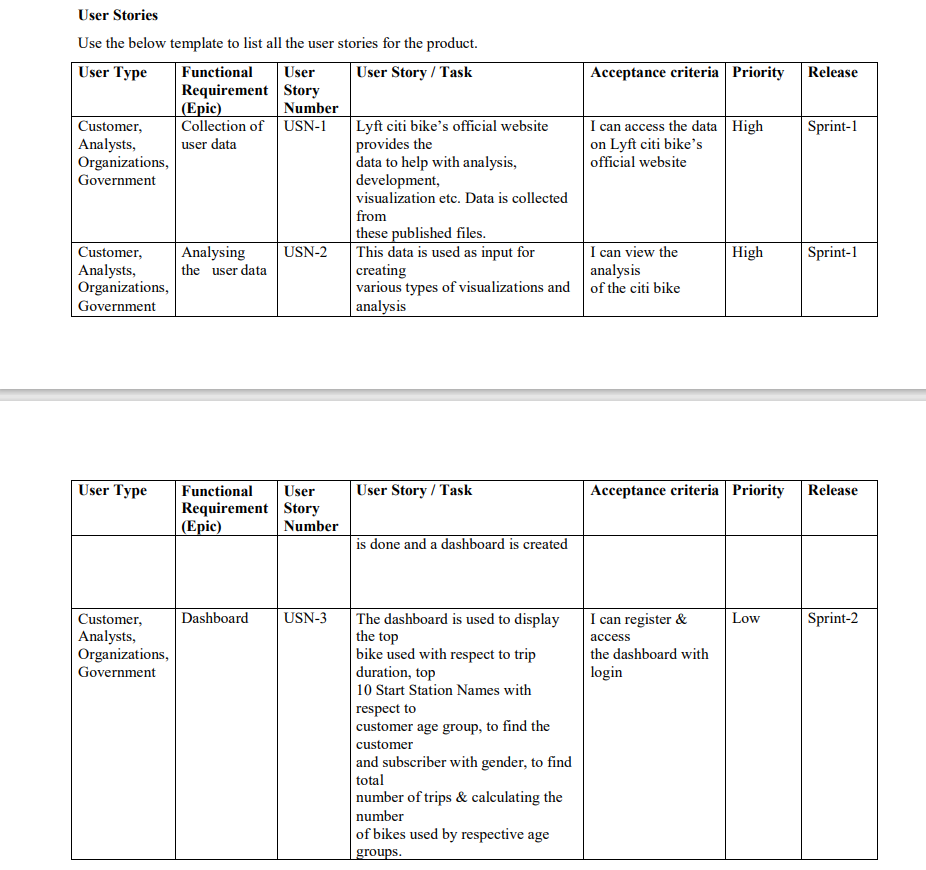
# PROJECT DESIGN

A data ﬂow diagram is traditional visual representation of the information ﬂow with in a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how enters and leaves the system, what changes the information and when data is stored.

# DATA FLOW DIAGRAM



**5.2 USER STORIES**

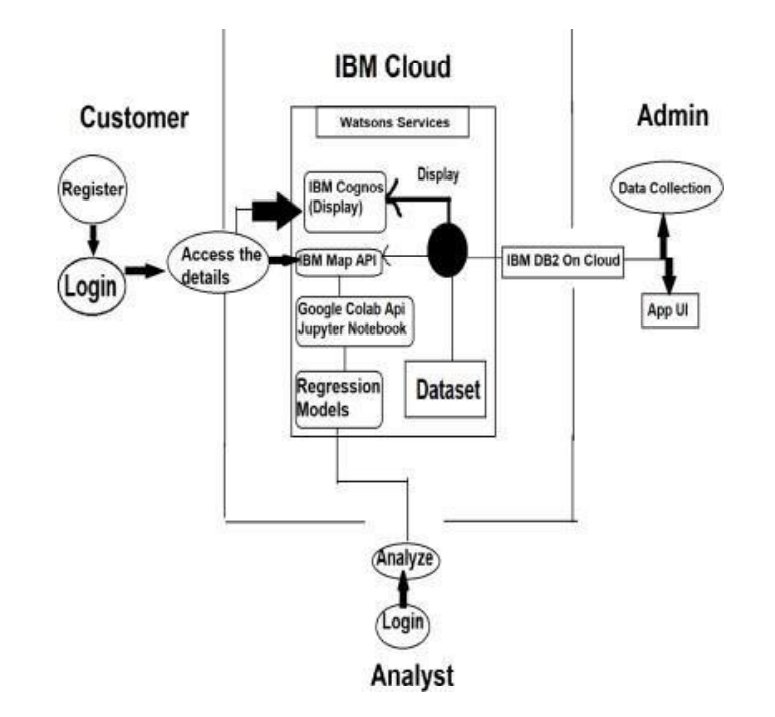
****

* 1. **SOLUTION AND TECHNICAL ARCHITECTURE**

# SOLUTION ARCHITECTURE

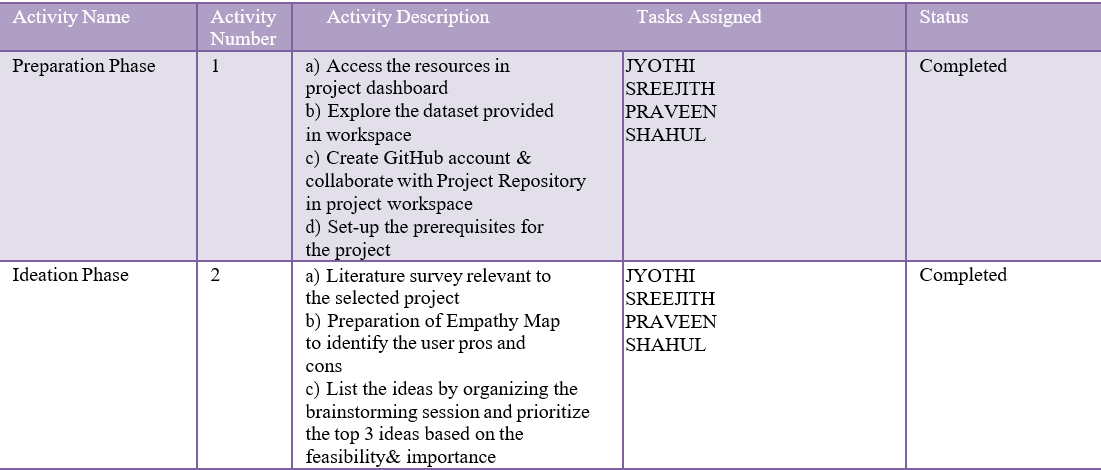
**TECHNICAL ARCHITECTURE**

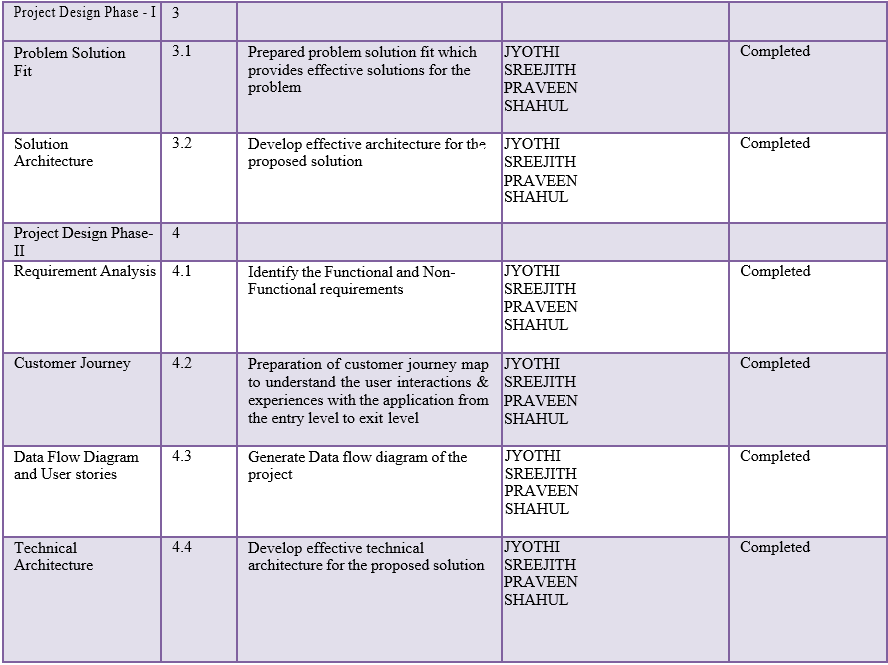
The Deliverable shall include the architectural diagram as below

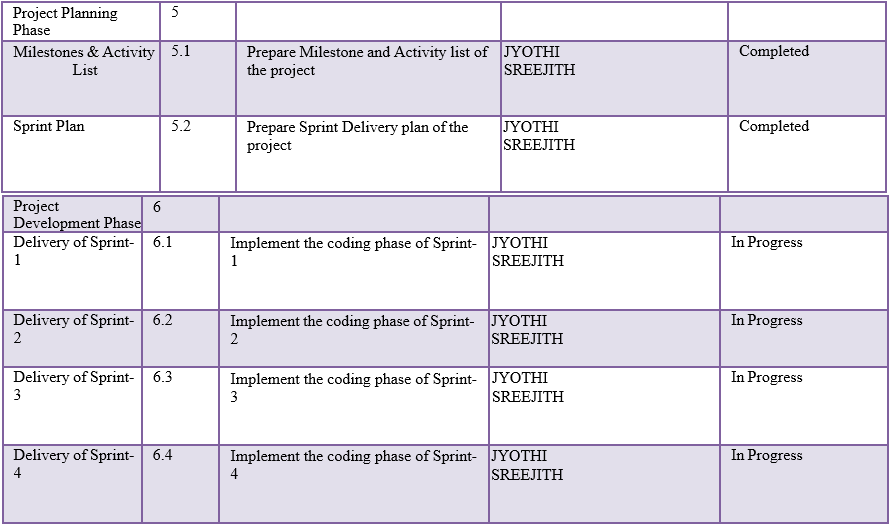


# 6 . PROJECT PLANNING AND SCHEDULING

* 1. **SPRINT PLANNING AND ESTIMATION**

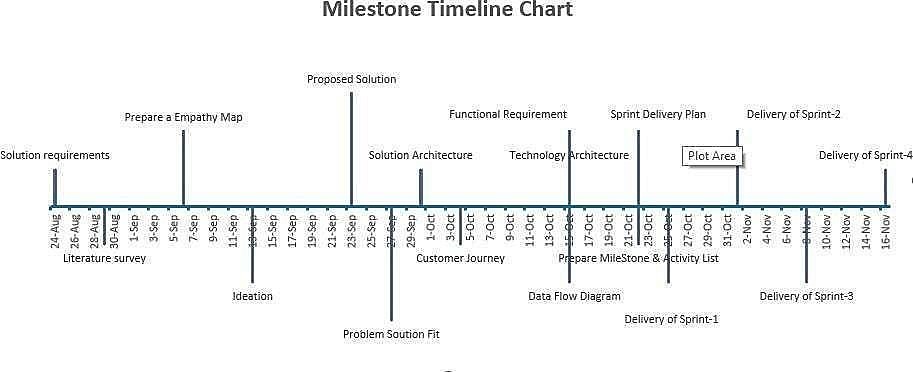
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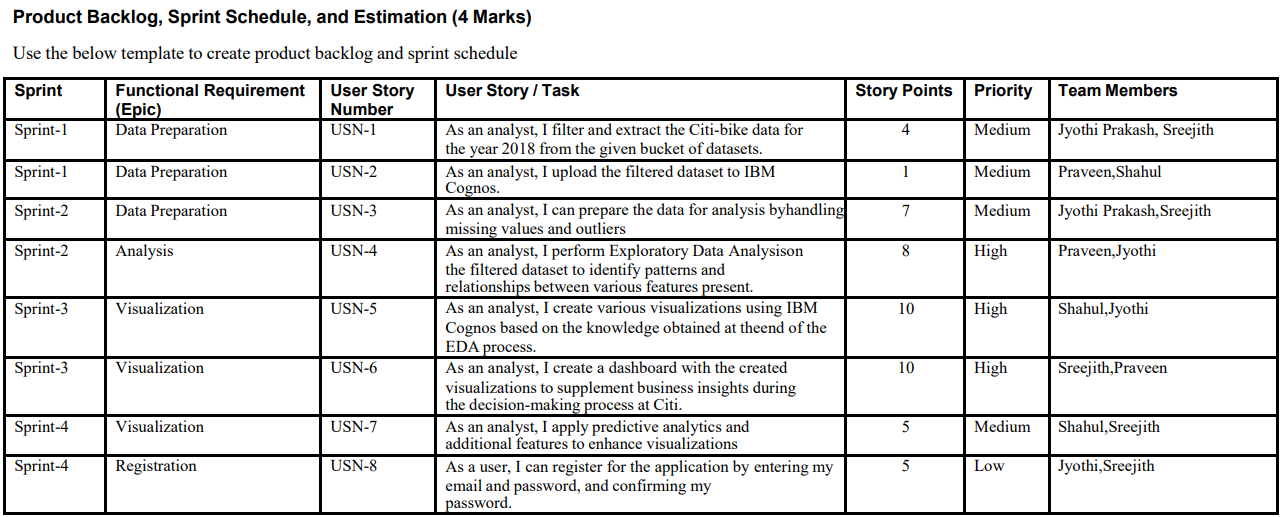


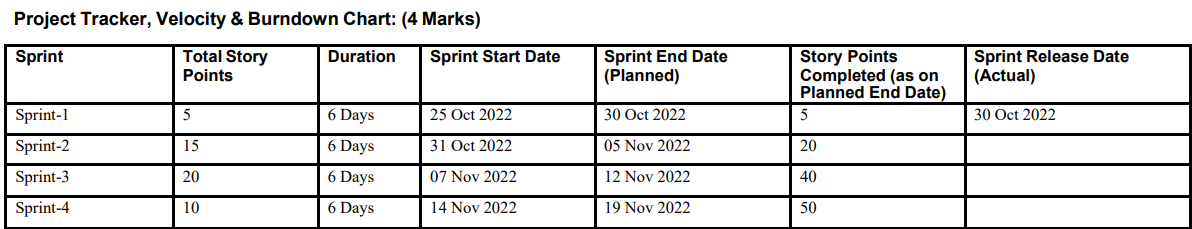
# Milestone Timeline Chart:

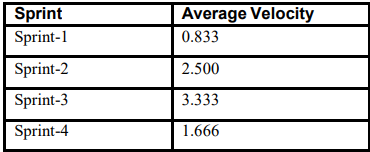
A milestone schedule, or milestone chart, is a timeline that uses milestones to divide a project schedule into major phases. Due to its simplicity, it's used when project

managers or sponsors need to share an overview of the project schedule with stakeholders or team members without going over every detail.

# SPRINT DELIVERY SCHEDULE

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****

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1. **CODING & SOLUTIONING (Explain the features added in the project along with code)**

# FEATURE

People use bike-share for various reasons. Some who would otherwise use their own bicycle have concerns about theft or vandalism, parking or storage, and maintenanc**e.**

The Citi Bike System Data page describes the information provided. The speciﬁc information for each ride is:

♢ Trip Duration (seconds)

♢ Start Time and Date

♢ Stop Time and Date

♢ Start Station Name

♢ End Station Name

♢ Station ID

♢ Station Lat/Long

♢ Bike ID

♢ User Type (Customer = 24-hour pass or single ride user; Subscriber = Annual Member)

♢ Gender (Zero=unknown; 1=male; 2=female)

♢ Year of Birth

# FEATURE

**EASY INSTALLATION**

♢ Stations install in under an hour

♢ Solar powered and wireless

♢ No digging or roadwork required

# BUSINESS PLAN

♢ NYC Bike share pays for all system costs- revenues from users and sponsorship

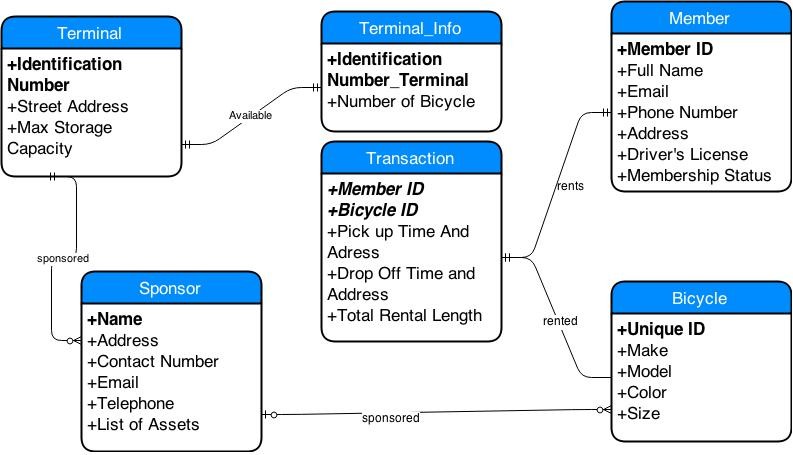
♢ Sponsorship in NYC is highly valued

♢ Proﬁt split 50/50 between NYC Bike Share and the City

♢ Bike Share in NYC will help spread the word about safe, respectful cycling

# DATABASE SCHEMA

The database schema is the structure of a database described in a formal language supported by the database management system. The term "schema" refers to the organization of data as a blueprint of how the database is constructed.



# 8.TESTING

Testing is the process of evaluating and verifying that a software product or application does what it is supposed to do. The beneﬁts of testing include preventing bugs, reducing development costs and improving performance.

# 8.1 TEST CASES

Test case includes information such as test steps, expected results and data while a test scenario only includes the functionality to be tested.

♢ UI Test Cases for Bike

♢ Positive Test Cases for Bike

♢ Negative Test Cases for Bike

# UI Test Cases for Bike

♢ Verify that design and dimension of the application are as per the speciﬁcations.

♢ Verify that the different colors used in the bike are of the correct shades as per the speciﬁcations.

♢ Verify that the weight of the bike is as per the speciﬁcations.

♢ Check the material used in different parts of the bike – outer body, tires, seat, etc.

# Positive Test Cases for Bike

♢ Check if the bike is of type electric start, manual start or both.

♢ Verify that the bike starts smoothly using the available options.

♢ Check the amount of force to kick-start the bike.

♢ Verify that bike runs smoothly and attain desired speed when accelerated.

♢ Verify that the maximum speed attained by bike is as per the speciﬁcation.

# Negative Test Cases for Bike

♢ Check if the bike starts when fuel other than prescribed fuel is ﬁlled in the bike.

♢ Check the condition of the bike when tires are ﬁlled with pressure less or more than speciﬁed.

♢ Check the condition of the bike when both the tires have different air pressure.

♢ Check the bike’s condition when it is ridden at high speed on ﬁrst gear only.

# 8.2 USER ACCEPTANCE TESTING

User Acceptance Testing (UAT), which is performed on most UIT projects, sometimes called beta testing or end-user testing, is a phase of software development in which the software is tested in the "real world" by the intended audience or business representative.

♢ Before product goes live.

♢ Done by end users.

♢ Fix usability issue.

♢ Ensures viable product.

# UAT test cases will look like this:

♢ Are testers ﬁlling out the correct information in bike?

♢ Do they understand what’s happening when being redirected to the in bike system?

# 9.RESULTS

**9.1 PERFORMANCE METRICS**

The main metrics are used to judge the performance of bikeshare systems: average number of daily uses per bike and average daily trips per resident (of the coverage area). These two metrics tend to have an inverse relationship.

A system with a low number of bikes could have high per-bike usage because demand is high, but fail to meet that demand and therefore have a lower number of trips per resident. On the other hand, a system could have a high number of trips per resident but also a very high number of bikes, and therefore a low number of trips per bike.

Both of these extremes are ineﬃcient; a sustainable system should ﬁnd a balance of having just enough bikes to satisfy demand with around 4 daily trips per bike share system.

# Average daily trips per bike

Target: 4-8 daily uses per bike

Turnover is critical to a successful bikeshare system, and this metric gets at how eﬃciently the bikes are being used. Fewer than four daily uses per bike can result in ﬁnancial unsustainability for the operator (i.e., user fees not able to cover cost to operate each bike), while more than eight daily uses can indicate limited bike availability, especially during peak hours. New York City (6.4), Barcelona (6.4), Mexico City (5.4), and Guangzhou (5.0) showed solid daily usage numbers in 2017.

# Average daily trips per 1,000 residents (in service area)

Target: city-generated, improvement over time

This is a metric of market penetration, that is, how many people in the service area are using the system. A high number of uses spread across residents in the service area is key the increasing bicycle mode share, decreasing vehicle and transit network congestion, and promoting safe, clean, healthy modes of transport.

Trips per 1,000 residents should be monitored as the system matures, with the goal of increasing market penetration over time (a more prescriptive target for annual improvement in market penetration could be created from baseline trip numbers). An increase in trips per 1,000 residents indicates more trips being taken by bike, and can help to evaluate progress toward citywide mode shift goals.

# 10. ADVANTAGES AND DISADVANTAGES

**ADVANTAGES**

# Convenient Mode of Transportation

The most common beneﬁt of this program is its accessibility. If you are fond of cycling, you will ﬁnd this method helpful as there are numerous systems just about everywhere for you to use. Bigger cities are supporting the use of bike-sharing. This is why it is common to ﬁnd bike- sharing systems in downtown areas. Driving a car through congested avenues can be frustrating and irritating. This makes bike sharing very convenient.

# Healthy Method for Traveling

Wellness, ﬁtness, and health are an essential part of your life. You should care about what you consume and what your daily activity is. Bike-sharing systems can help and encourage you to live a better and healthier life. They help you stay in shape even when you are away from home vacationing.

# Environmental Beneﬁts

Maintaining a clean environment is as important as maintaining your health. Living in a heavily polluted environment can cause various health issues. Bikes do not release greenhouse gases, unlike buses and cars. So, if you are renting a bike from a bike-sharing system, you reduce the carbon footprint and take measures to keep your environment safe.

# DISADVANTAGES

1. **Congestion in the Users of Bike Sharing**

As bike-sharing systems can help you travel throughout the city, they do not exist in inﬁnite numbers. Waiting can be annoying if the bike is not available. You may face this problem during peak hours.

# A Helmet is a Requirement

When you are planning to ride a bike, you need to keep safety measures in your mind. Therefore, wearing a helmet is essential. Some bike sharing systems may require you to use a helmet but might not provide them for you. Sometimes you will need to bring your own which can be a hassle.

# Bikes Are Not Clean

Shared bikes can be unhygienic as many people have probably used it before you. The seat and handlebars are a particularly high-traﬃc area for germs, so cleanliness is always a concern.

# CONCLUSION

Bicycle sharing systems can be the new boom in India, with use of various prediction models the ease of operations will be increased. The four algorithms are applied on the bikeshare dataset for predicting the count of bicycles that will be rented per hour. We got some good results and accuracy with random forest and by using Tune RF function with the original random forest algorithm. The accuracy and performance has been compared between the models using Root Mean Squared Logarithmic Error (RMSLE).

If these systems include the use of analytics the probability of building a successful system will increase.

# FUTURE SCOPE

One aspect of the data that I did not explore in great detail is the intra-day variation in usage of the system. This is also a key aspect that bike share system operators are interested in because knowing the variation in demand on an hourly basis is another very useful metric for identifying the times of the day when the need for artiﬁcial rebalancing is maximum.

Additionally, this work will feed into a larger study calculating the life cycle environmental impacts of a bikeshare system and its ability to substitute other modes of transit with the aim of reducing the overall Greenhouse gas (GHG) emissions due to transportation.

# APPENDIX

**Research Methodology and Framework Methodology and Data Sources**

Using spatial data primarily from the United States Census54 and New York City’s Department of Information Technology & Telecommunications,55 ridership and station activity data from New York City Department of Transportation and NYC Bike Share, LLC,56 and station location data from NYC Bike Share, LLC, this study used ArcGIS software57 to analyze and show connections between Citi Bike and public transit. Data from Divvy Bikes,58 Chicago Open Data Portal,59 Capital Bike Share,60 the District Department of Transportation,61 Hubway,62 the Massachusetts Bay Transportation Authority,63 Nice Ride,64 and MetroGIS65 allowed for comparisons in station coverage area and station density in New York City, Chicago, Washington, DC, and Minneapolis/St. Paul. Researchers conducted interviews with New York City Department Transportation and NYC Bikeshare LLC staff.

# Framework

We examine connections between New York City’s bike share program, Citi Bike, and the previously existing transportation options in New York City. After observing the system’s success in its ﬁrst year of operation, this study analyzes connections between bike share stations and from stations to transit options. New York City’s bike share system offers a solution to the “last mile”66 problem, the problem of getting riders short distances, under a mile, to and from transit stations. A key component of this “last mile” analysis came through calculating the number of Citi Bike stations with 100, 200, 500, and 1320 feet67 of subway station entrances and comparing the proximity and density of bike share stations in New York City, Washington, DC, Chicago, Boston, and Minneapolis/St. Paul.

**Source** **Code**

#cleaning\_and\_understanding\_the\_data.ipynb

import pandas as pd

import numpy as np

import seaborn as sns

import matplotlib.pyplot as plt

import plotly.express as px

from datetime import datetime

from pprint import pprint

from pydrive.auth import GoogleAuth

from pydrive.drive import GoogleDrive

from google.colab import auth

from oauth2client.client import GoogleCredentials

path = "/content/dataset.csv"

df = pd.read\_csv(path)

print(df)

df.head()

df.describe()

df.info()

df.isnull().sum()

trips\_df = pd.DataFrame()

trips\_df = temp.groupby(['start station name','end station name']).size().reset\_index(name = 'Number of Trips')

trips\_df = trips\_df.sort\_values('Number of Trips',ascending = False)

trips\_df["start station name"] = trips\_df["start station name"].astype(str)

trips\_df["end station name"] = trips\_df["end station name"].astype(str)

trips\_df["Routes"] = trips\_df["start station name"] + " to " + trips\_df["end station name"]

trips\_df = trips\_df[:50]

trips\_df = trips\_df.reset\_index()

trips\_df

px.pie(values = temp['gender'].value\_counts(),

names =temp['gender'].value\_counts().index,

title ="Gender Variation")

px.bar(x=temp["start station name"].value\_counts().index,

y=temp["start station name"].value\_counts().values,

labels={'x':'Start Station Name',"y":"Count"})

px.bar(x=temp["end station name"].value\_counts().index,

y=temp["end station name"].value\_counts().values,

labels={'x':'End Station Name',"y":"Count"})

px.bar(x=temp["Hour"].value\_counts().index,

y=temp["Hour"].value\_counts().values,

title = "Hour usage of Citi Bikes",

labels={'x':'Time',"y":"Number of people using bike"})

--------------------------------------------------------------------------------------

# index.js

const mysql = require('mysql');

const express = require('express');

const session = require('express-session');

const path = require('path');

const { dirname } = require('path');

const { request } = require('express');

// Requiring dotenv and Creating variables to store the Env values to maintain a bit of secrecy

require("dotenv").config()

const DB\_HOST = process.env.DB\_HOST

const DB\_USER = process.env.DB\_USER

const DB\_PASSWORD = process.env.DB\_PASSWORD

const DB\_DATABASE = process.env.DB\_DATABASE

const connection = mysql.createConnection({

host: DB\_HOST,

user: DB\_USER,

password: DB\_PASSWORD,

database: DB\_DATABASE

});

// Creating an express application

const app = express();

// storing the value of username for further displaying the respective user's info

let uname = '';

// setting the view engine to ejs -> as I wanted to render the user info dynamically, and have it viewed through an engine [This was the only possible way to render / pass values to HTML]

app.set('view engine', 'ejs');

app.use(session({

secret: 'secret',

resave: true,

saveUninitialized: true

}));

app.use(express.json());

app.use(express.urlencoded({ extended: true }));

app.use(express.static(path.join(\_\_dirname, 'static')));

// http://localhost:3000/

app.get('/', function(request, response) {

// Render login template

response.sendFile(path.join(\_\_dirname + '/login.html'))

})

// http://localhost:3000/auth

app.post('/auth', function(request, response) {

// Capture the input fields

let username = request.body.username;

uname = username;

let password = request.body.password;

// Ensure the input fields exist and are not empty

if (username && password) {

// Execute SQL query that'll select the account from the database based on the specified username and password

connection.query('SELECT \* FROM accounts WHERE username = ? AND password = ?',[username, password], function(error,results,fields){

// If there is an issue with the query, output the error

if (error) throw error;

// If the account exists

if (results.length > 0) {

// Authenticate the user

request.session.loggedin = true;

request.session.username = username;

// Redirect to home page

response.redirect('/home');

} else {

response.send('Incorrect Username and/or Password!');

response.end();

}

});

} else {

response.send('Please enter Username and Password!');

response.end();

}

});

// http://localhost:3000/home

app.get('/home', function(request, response) {

// If the user is loggedin

if (request.session.loggedin) {

// Creating a home page for the users to be welcomed.

response.sendFile(path.join(\_\_dirname + '/home.html'));

// // Output username

// response.send('Welcome back, ' + request.session.username + '!');

} else {

// Not logged in

response.send('Please login to view this page!');

}

//response.end();

// Uncommenting this usually led me to have errors regarding 'Can't set headers after they are sent' -> so it meant that responses were closed, and communication wasn't possible after that ?

});

// http://localhost:3000/dashboard

app.post('/dashboard', function(request, response) {

// Return the dashboard for the user if he is logged in.

if (request.session.loggedin) {

// // Return the dashboard to be viewed for the user.

// response.sendFile(path.join(\_\_dirname + '/dashboard.html'));

// Instead of sending the path and hence thereby opening the html file, we can instead render an ejs file, using the ejs view engine.

response.render('dashboard');

} else {

// Not logged in

response.send('Please login to view this page!');

}

//response.end();

});

// http://localhost:3000/info

app.post('/info', function(request, response) {

// Return the dashboard for the user if he is logged in.

if (request.session.loggedin) {

// // Return the dashboard to be viewed for the user.

// response.sendFile(path.join(\_\_dirname + '/info.html'));

// Instead of sending the file and it's path, to be displayed when accessing this route, we can actually pass the sql values as parameters to the view engine, to print them out, dynamically corresponding to the data available from the sql database.

// response.render('info', { rinzler: 'Hello Tron!'});

// console.log(uname);

connection.query('SELECT id,username,email FROM accounts WHERE username = ?',[uname], function(error,results,fields){

// Output error if there is some kind of problem with the query

if (error) throw error;

// If the account exists then perform the operations associated with it!

else {

// console.log(results);

// // This basically stores all the resulting row's fields in it.

// // In the following steps, we have to seperate the different fields (4 of them) and just show only the three fields to the user.

// // Also try to change the query so that only the three non-private fields are sent back as a result

// console.log("Id is : ",results[0].id);

// console.log("Username is : ",results[0].username);

// console.log("Email is : ",results[0].email);

response.render('info', { id: results[0].id, name: results[0].username, mail: results[0].email})

}

})

} else {

// Not logged in

response.send('Please login to view this page!');

}

//response.end();

});

// Add a port to enable the nodejs server to listen to incoming connections

// Ideally when we want to deploy our login system to a production server, we want to listen on port `80` so that we don't have to specify the port number in the URL.

app.listen(3000);

--------------------------------------------------------------------------------------

# home.html

<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="UTF-8">

<meta http-equiv="X-UA-Compatible" content="IE=edge">

<meta name="viewport" content="width=device-width, minimal-scale=1.0">

<title>Home</title>

<!-- form awesome library for adding icons to the form -->

<link rel="stylesheet" href="https://use.fontawesome.com/releases/v5.7.1/css/all.css">

<link rel="stylesheet" href="style.css" type="text/css">

</head>

<body>

<div class="login">

<!--

<h2><a href="/dashboard">Dashboard</a></h2>

<h2><a href="/info">User Info</a></h2>

-->

<form action="/dashboard" method="post">

<label for="dashboard">

<h2 class="fas fa-chart-line"></h2>

</label>

<!--

-->

<input type="submit" value="analytics">

</form>

</div>

<div class="login">

<form action="/info" method="post">

<label for="info">

<h2 class="fas fa-info"></h2>

</label>

<!--

-->

<input type="submit" value="info">

</form>

</div>

</body>

</html>

--------------------------------------------------------------------------------------

**GitHub Link**

<https://github.com/IBM-EPBL/IBM-Project-54724-1662452782>

**Project Demo Link**