

**SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES**

*A Project report submitted in partial fulfilment of 7th semester in degree Of*

BACHELOR OF ENGINEERING

IN

**ELECTRONICS AND COMMUNICATION ENGINEERING**

***Submitted By***

**Team ID: PNT2022TMID33576**

|  |  |  |
| --- | --- | --- |
| **Team Members:** |  | |
| **Team Leader** | Preethi T | 922519106115 | |
| **Team Member 01** | Keerthini R | 922519106077 |
| **Team Member 02** | Keshavarthini A | 922519106078 |
| **Team Member 03** | Mohana M | 922519106092 |

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**



**Project Report Format**

1. **INTRODUCTION**
   1. Project Overview
   2. Purpose
2. **LITERATURE SURVEY**
   1. Existing problem
   2. References
   3. Problem Statement Definition
3. **IDEATION & PROPOSED SOLUTION**
   1. Empathy Map Canvas
   2. Ideation & Brainstorming
   3. Proposed Solution
   4. Problem Solution fit
4. **REQUIREMENT ANALYSIS**
   1. Functional requirement
   2. Non-Functional requirements
5. **PROJECT DESIGN**
   1. Data Flow Diagrams
   2. Solution & Technical Architecture
   3. User Stories
6. **PROJECT PLANNING & SCHEDULING**
   1. Sprint Planning & Estimation
   2. Sprint Delivery Schedule
   3. Reports from JIRA
7. **CODING & SOLUTIONING (Explain the features added in the project along with code)**
   1. Feature 1
   2. Feature 2
   3. Database Schema (if Applicable)
8. **TESTING**
   1. Test Cases
   2. User Acceptance Testing
9. **RESULTS**
   1. Performance Metrics
10. **ADVANTAGES & DISADVANTAGES**
11. **CONCLUSION**
12. **FUTURE SCOPE**
13. **APPENDIX**

Source Code

GitHub & Project Demo Link

**INTRODUCTION :**

The Internet of Things (IoT) is a concept in which surrounding objects are connected through wired and wireless networks without user intervention. In the field of IoT, the objects communicate and exchange information to provide advanced intelligent services for users. This project deals with the problem of waste management in smart cities, where the garbage collection system is not optimized. This project enables the organizations to meet their needs of smart garbage management systems. This system allows the user to know the fill level of each trash bin in a city and send alerts to the authorized person. The person go to the particular location with the help of GPS and the waste will be disposed without affecting the environment. It also reduce the unwanted routes of the truck and reduce the fuel consumption.

* **Project Overview:**

Trash bins play a vital role in human life. In metropolitan cities mostly its condition are overflowing due to improper waste dumping, collection and management, which leads in bad odour and unhygienic health condition, thus inherently results in atmospheric pollution

* **Purpose:**

In this paper, design of a Waste Bin with real time monitoring is presented and a smart waste management system is proposed using the recent technology Internet of Things (IoT) and Cloud Services. The IOT device in the bin continuously monitors the level of the bin and it communicates to the central cloud where the bins are connected. The IOT device measures the weight of the trash bin and alerts the authorized person .The cloud services can monitor the web app. The authorized person can view the location of the trash bin by sending GPS location from the device. Smart waste management system have better level of smartness compared to existing ones in metropolitan cities in a centralized manner.

**LITERATURE SURVEY:**

1. Author says ” A planning scenario for the application of geographical information systems in municipal waste collection.”

2. Author Says “Solid waste management (SWM) is the process of collecting, handling, and disposing of no longer in use solid objects that are discarded.”

3. Author says ” By proposing a smart city service for monitoring and waste collection using low-cost and open source technologies. The proposed system is further divided into five subsystems which are Smart Waste System, Local Station, Smart Monitoring and Controlling, Smart Truck System and Smart Monitoring and Controlling Interface ”.

* **Existing problem :**

Poor waste management -ranging from non-existing collection systems to ineffective disposal-**cause air pollution,water and solid contamination.**Open and unsanitary landfills contribute to contamination of drinking water and cause infection and transmit disesses.

* **References :**

1. Zamorano, M., Molero, E., Grindlay, A., Rondriquez, M.L., Hurtado, A., Calvo, and F.J.

2. L. A. Manaf, M. A. A. Samah, and N. I. M. Zukki, “Municipal solid Manag., vol. 29, no. 11, pp. 2902–2906, Nov. 2009.

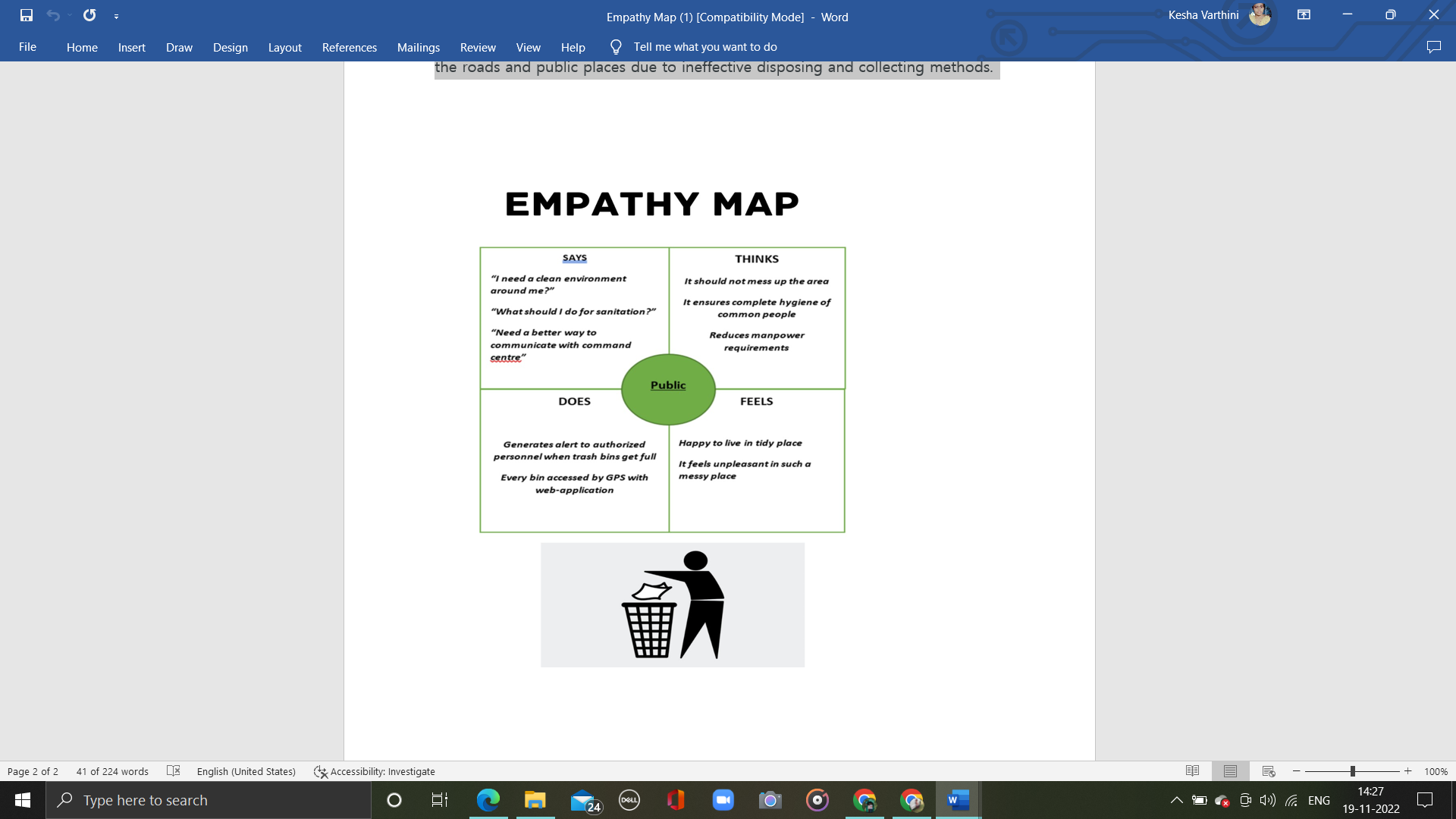
3.M. F. Omar, A. A. A. Termizi, D. Zainal, N. A. Wahap, N. M. vol. 37, no. 1, 2016.

* **Problem Statement Definition :**

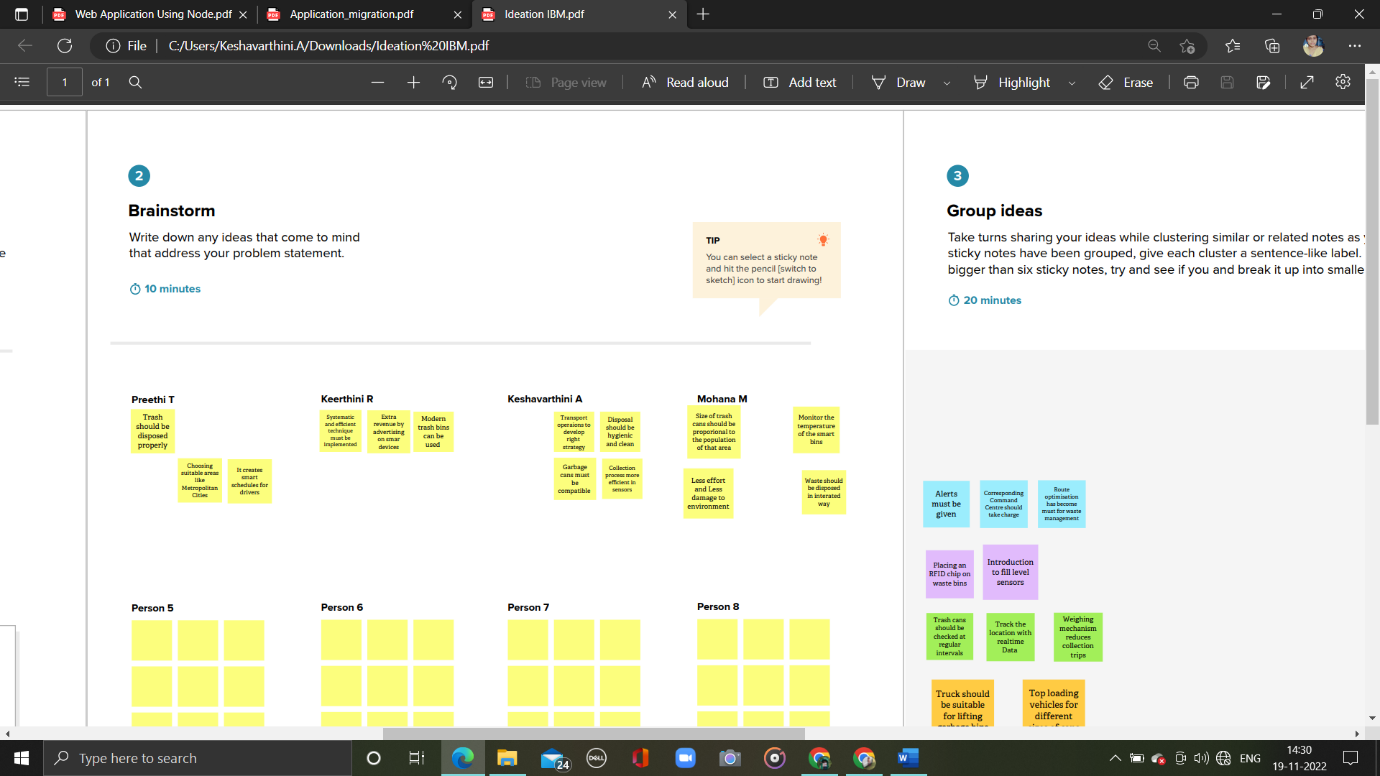
Across the globe, cities are generating ever-greater volumes of waste. According to the [World Bank](https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management), cities produced just over two billion tons of solid waste in 2016. Yet, thanks to population growth and rapid urbanization, this is likely to increase by 70%, reaching 3.4 billion tons in 2050. This has major implications for urban centers in the US and abroad. We throw this away at home or wherever we are, usually in trash cans either inside or out on the street. But, where do people leave their litter when they aren’t home and the trash cans on the street are full? You guessed it, on the street itself. Municipalities have a hard time keeping up with these outdoor bins, because it is very difficult to figure out when to empty them or whether they are full or not at all With the existing methods of collecting and disposal, it is near impossible to manage such amount of waste in the future as around 30% of waste end up on the roads and public places due to ineffective disposing and collecting methods.

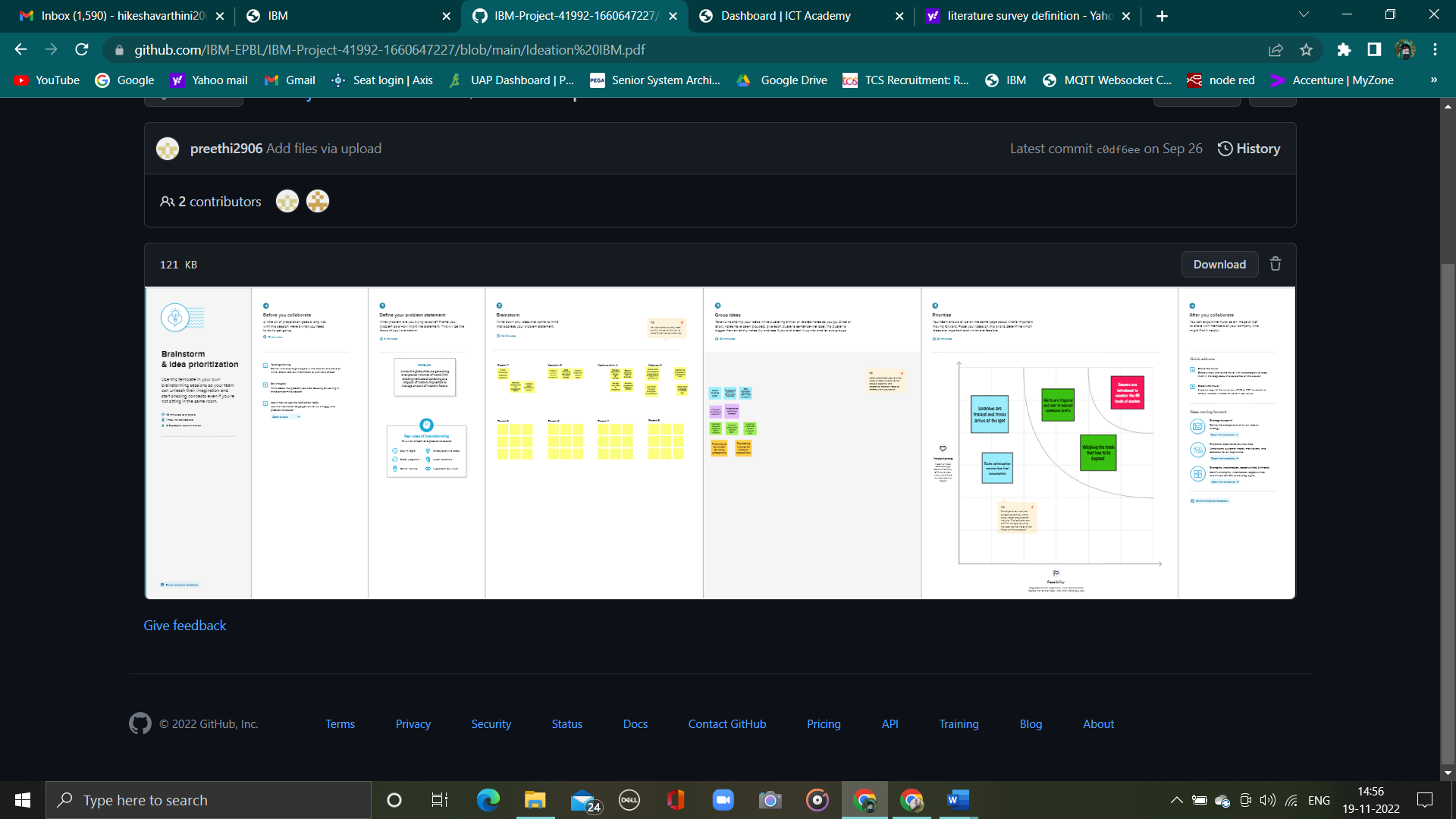
**IDEATION & PROPOSED SOLUTION:**

* **Empathy Map Canvas:**

****

* **Ideation & Brainstorming:**

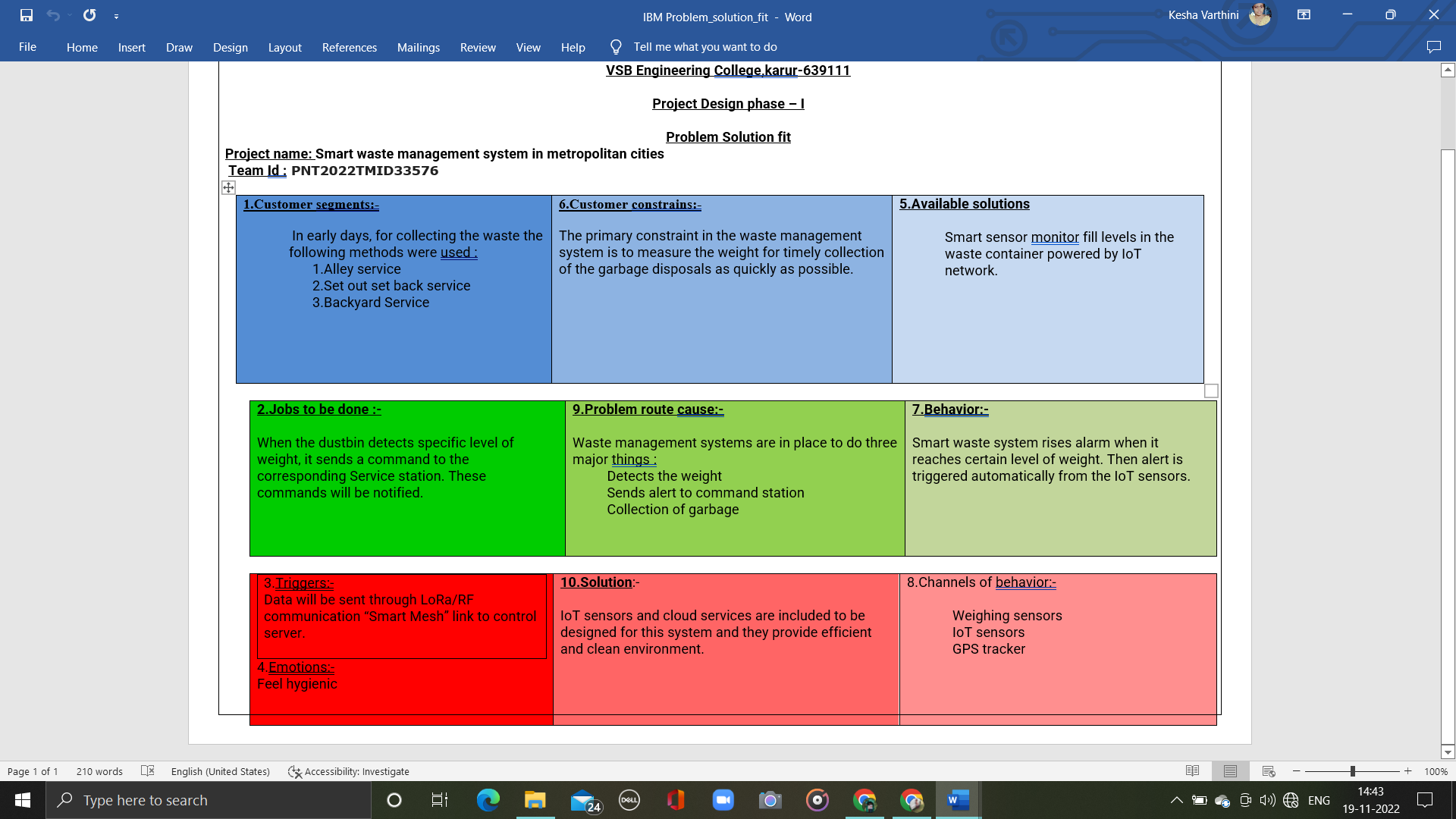
****

****

**Proposed Solution:**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Parameter** | **Description** |
| 1 | Problem Statement (Problem to be  solved) | Across the globe, cities are generating ever-greater volumes of waste. With existing methods of collecting and disposal of waste is impossible to manage amount of waste in future. |
| 2 | Idea / Solution description | Smart and monitoring system to clear dumpsters in an organized manner |
| 3 | Novelty / Uniqueness | To produce alert to the corresponding authority |
| 4 | Social Impact / Customer Satisfaction | Eco-friendly environment for a healthy living |
| 5 | Business Model (Revenue Model) | Timely pickup of waste |
| 6 | Scalability of the Solution | Over the Metropolitan cities for 24x7 |

**Problem Solution fit:**

****

**REQUIREMENT ANALYSIS:**

**Functional requirement:**

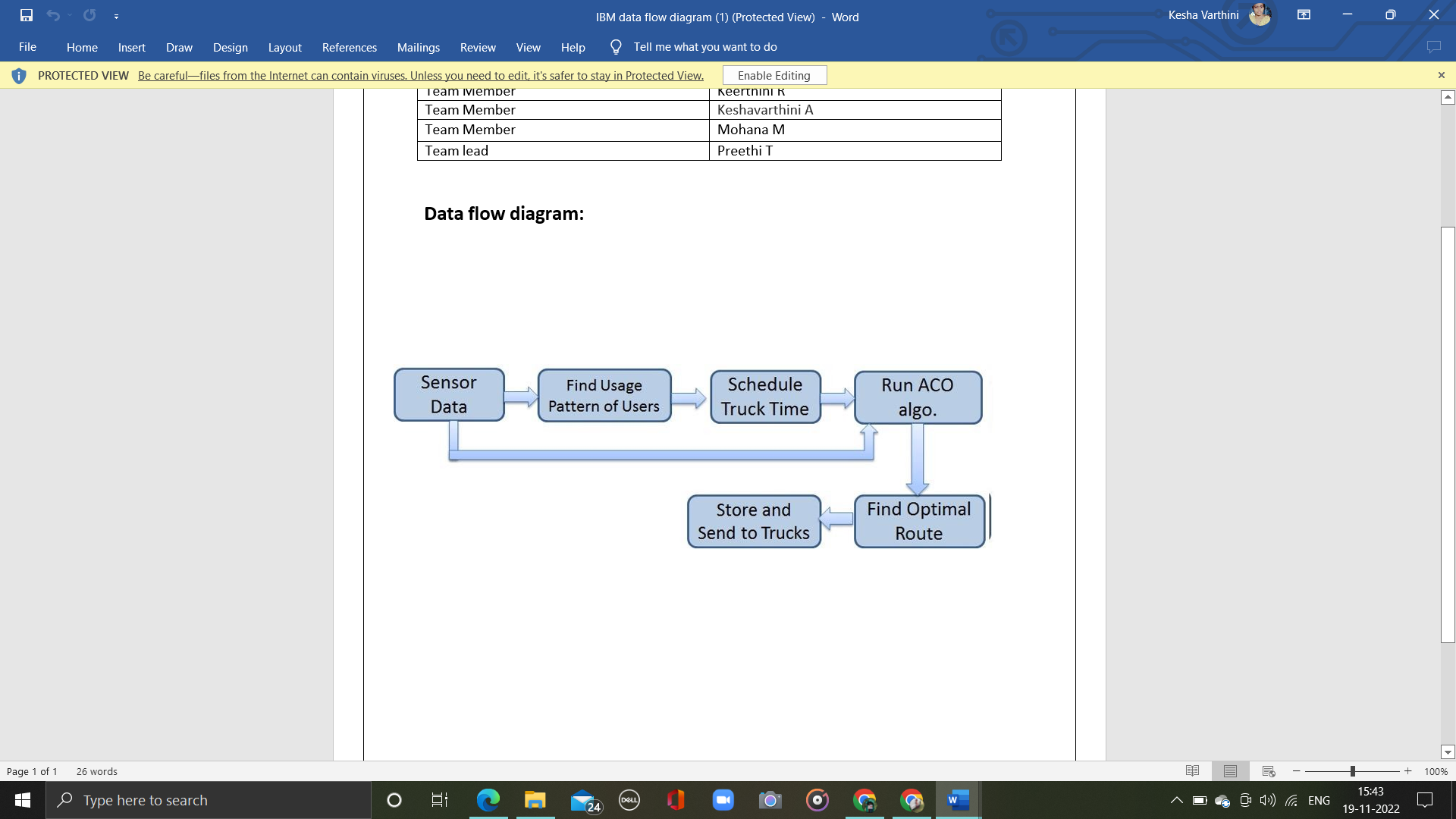
|  |  |  |
| --- | --- | --- |
| **S.no** | **Functional Requirement (Epic)** | **Sub Requirement (Story / Sub-Task)** |
| 1 | Detailed bin inventory | All monitored bins and stands can be seen on the map, and you can visit them at any time via the Street View feature from Google.  Bins or stands are visible on the map as green, orange or red circles.  You can see bin details in the Dashboard – capacity,  waste type, last measurement, GPS location and collection schedule or pick recognition. |
| 2 | Real time bin monitoring | The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors.  In addition to the % of fill-level, based on the historical data, the tool predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software..  Sensors recognize picks as well; so you can check when the bin was last collected.  With real-time data and predictions, you can eliminate  the overflowing bins and stop collecting half-empty ones. |
| 3 | Expensive bins. | We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs.  The tool considers the average distance depo-bin- discharge in the area. The tool assigns bin a rating  (1-10) and calculates distance from depo-bin discharge |
| 4 | Adjust bin distribution | Ensure the most optimal distribution of bins. Identify areas with either dense or sparse bin distribution.  Make sure all trash types are represented within a stand.  Based on the historical data, you can adjust bin capacity or location where necessary. |
| 5 | Eliminate unefficient picks.s | Eliminate the collection of half-empty bins. The sensors recognize picks.  By using real-time data on fill-levels and pick  recognition, we can show you how full the bins you collect are. The report shows how full the bin was when picked.  You immediately see any inefficient picks below 80% full. |
| 6 | Plan waste collection routes. | The tool semi-automates waste collection route planning. Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection.  You can compare planned vs. executed routes to identify any inconsistencies. |

**Non-Functional requirements:**

|  |  |  |
| --- | --- | --- |
| S.No | **Non-Functional Requirement** | **Description** |
| 1 | **Usability** | IoT device verifies that usability is a special and important perspective to analyze user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users’ product usability can indeed help  designers better understand users’ potential needs in waste management, behavior and experience |
| 2 | **Security** | Use a reusable bottles Use reusable grocery bags  Purchase wisely and recycle  Avoid single use food and drink containers. |
| 3 | **Reliability** | Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend  their time more efficiently, taking care of bins that need servicing. |
| 4 | **Performance** | The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks ( (NB-IoT,GPRS), the sensors send the data to Sensoneo’s Smart Waste Management Software System, a powerful cloud-based platform, for data- driven daily operations, available also as a waste management app.  Customers are hence provided data-driven decision making, and optimization of waste collection routes, frequencies, and vehicle loads resulting in route  reduction by at least 30%. |
| 5 | **Availability** | By developing & deploying resilient hardware and  beautiful software we empower cities, businesses, and countries to manage waste smarter. |
| 6 | **Scalability** | Using smart waste bins reduce the number of bins inside town , cities coz we able to monitor the  garbage 24/7 more cost effect and scalability when we moves to smarter. |

**PROJECT DESIGN:**

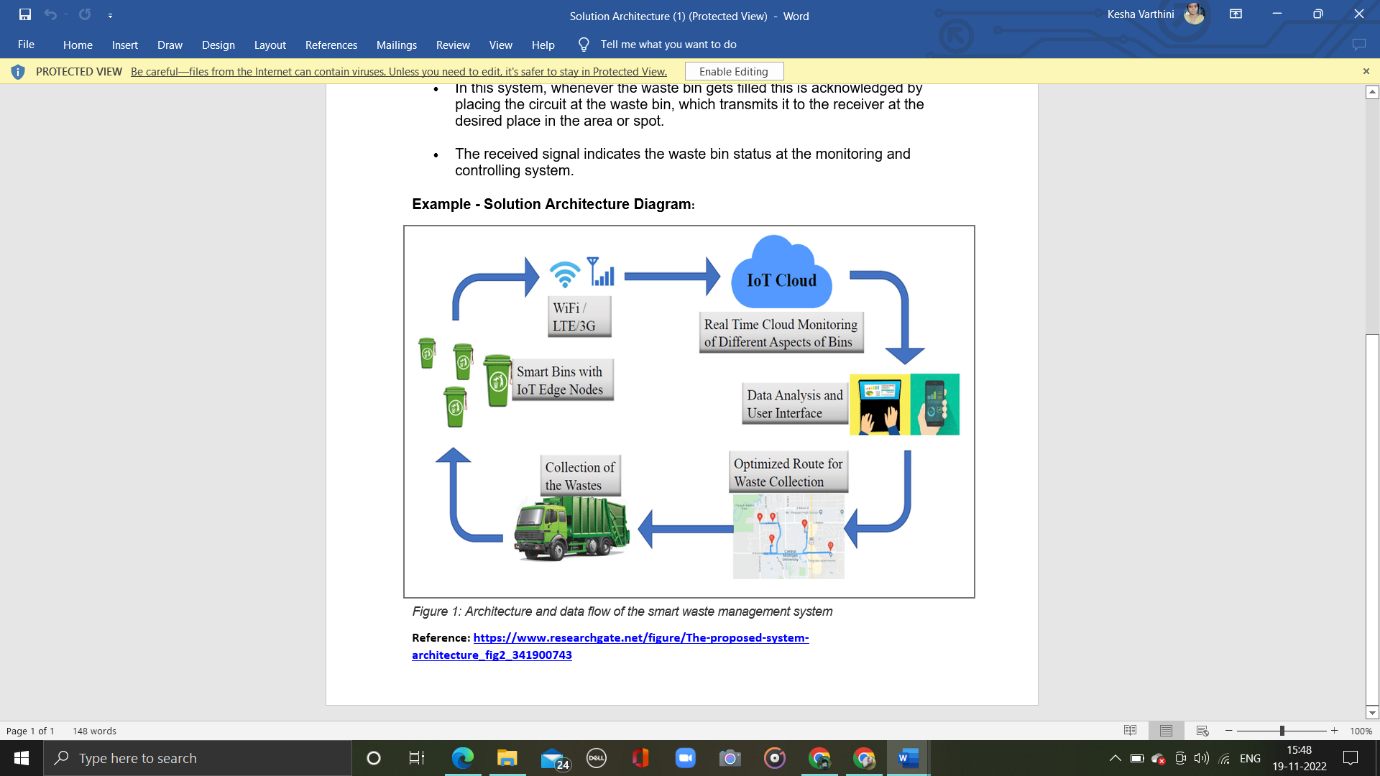
**Data Flow Diagrams:**

****

**Solution Architecture:**

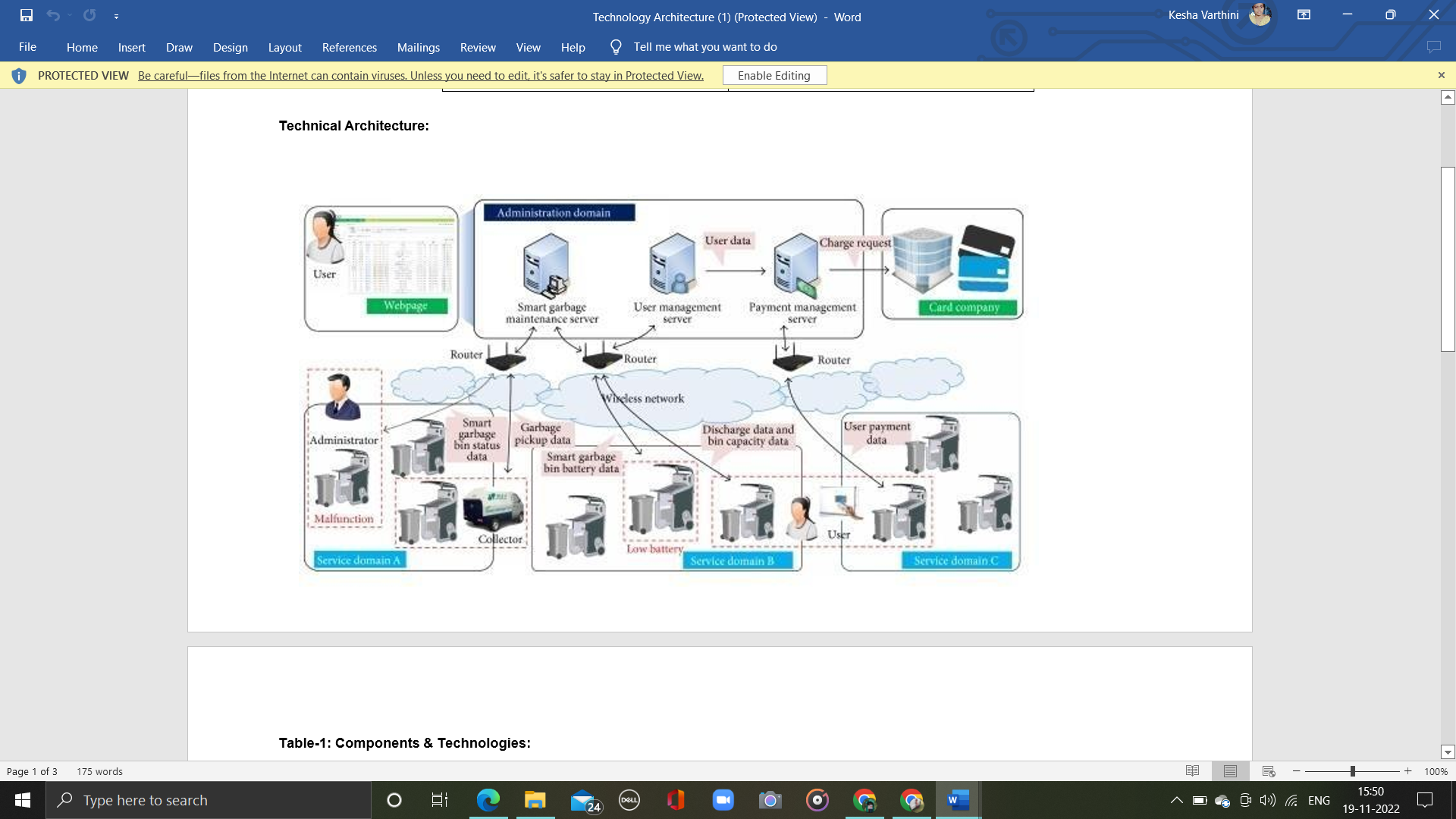
Solution architecture is a complex process – with many sub-processes – that bridges the gap between environmental problems and technology solutions. Its goals are to:

* Find the best tech solution to solve existing business problems.
* The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT.
* In this system, whenever the waste bin gets filled this is acknowledged by placing the circuit at the waste bin, which transmits it to the receiver at the desired place in the area or spot.
* The received signal indicates the waste bin status at the monitoring and controlling system.



**Reference:** [**https://www.researchgate.net/figure/The-proposed-system-architecture\_fig2\_341900743**](https://www.researchgate.net/figure/The-proposed-system-architecture_fig2_341900743)

**Technical Architecture:**

****

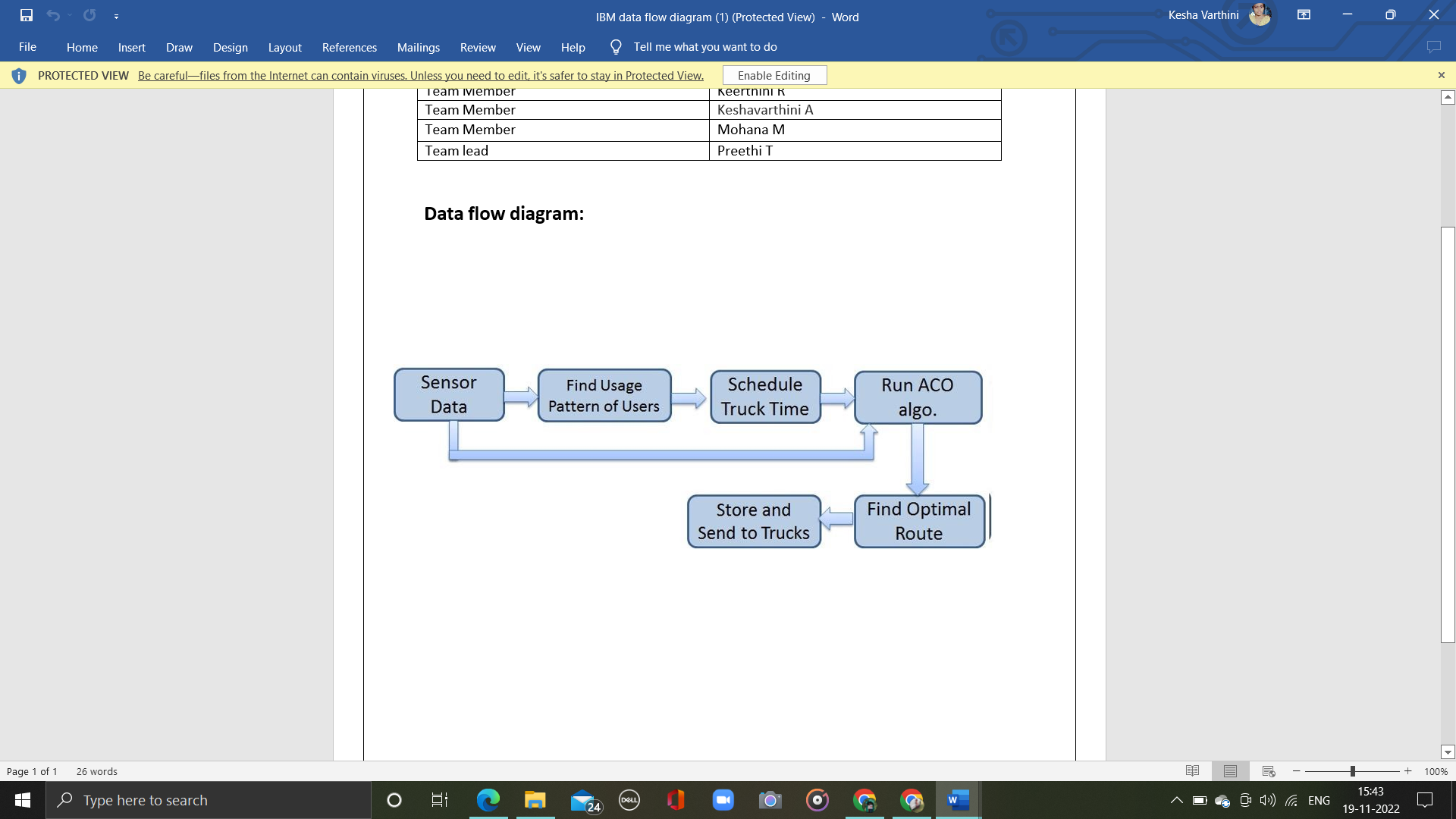
**Table-1: Components & Technologies:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Component** | **Description** | **Technology** |
| 1 | User Interface | Mobile Application | HTML, CSS, JavaScript. |
| 2 | Application Logic | Logic for a process in the application | Java |
| 3 | Database | Data Type, Configurations etc. | MySQL |
| 4 | Cloud Database | Database Service on Cloud | IBM Cloud |
| 5 | File Storage | File storage requirements | Local Filesystem and IBM cloud |
| 6 | Infrastructure (Server / Cloud) | Application Deployment on cloud Local Server Configuration | Local and Cloud Foundry |

**Table-2: Application Characteristics:**

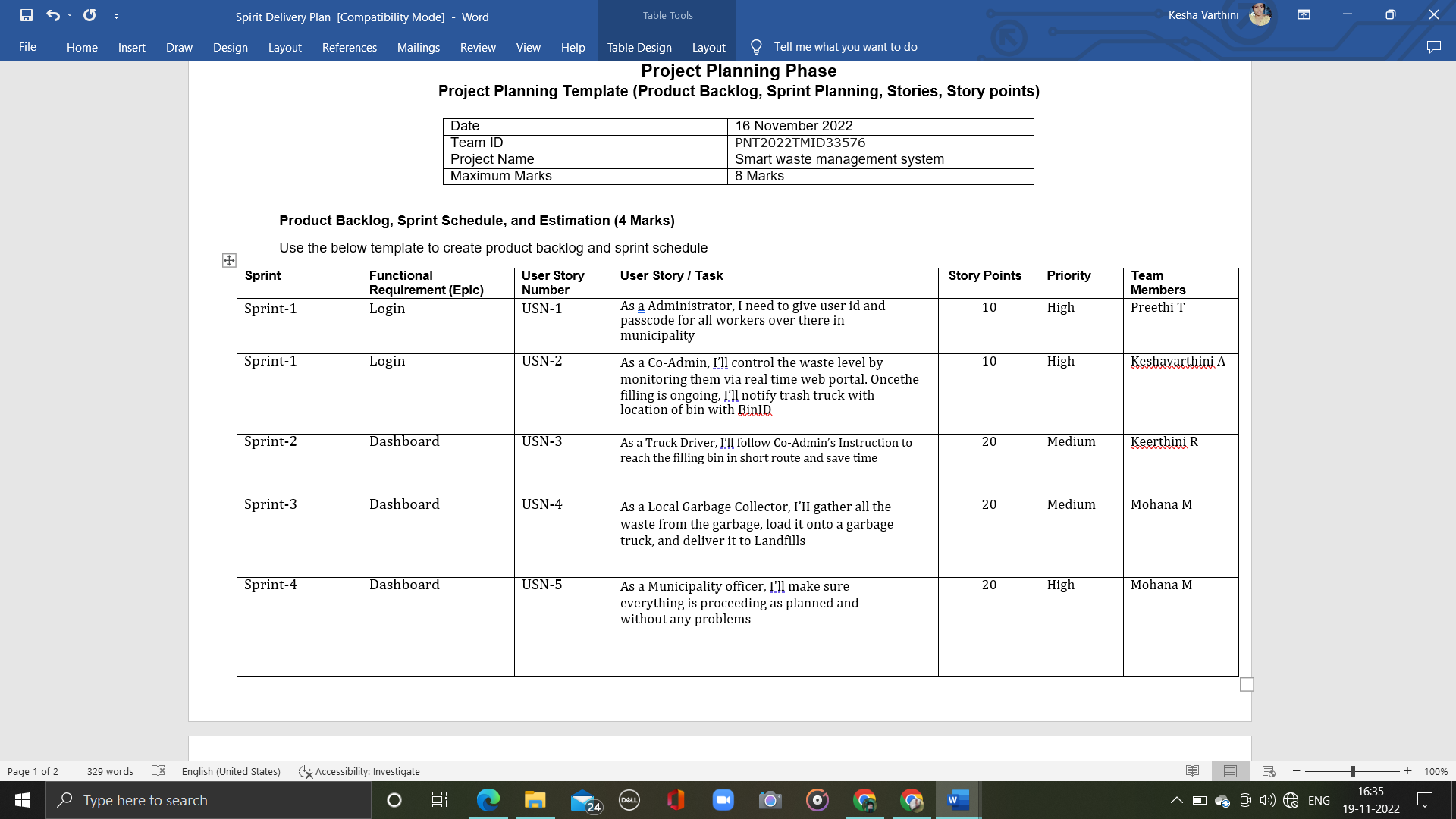
|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Characteristics** | **Description** | **Technology** |
| 1 | Open-Source Frameworks | GitHub | Internet hosting service |
| 2 | Security Implementations | Application security: Veracode  Firewall: cisco | Network automation |
| 3 | Scalable Architecture | It provides the room for expansion more database  of smart bins added additionally can be updated. | Cloud storage |
| 4 | Availability | As the system control is connected to web server it  is available 24\*7 and can be accessed whenever  needed. | Server |
| 5 | Performance | Performance is high it uses 5mb caches | Wireless Sensor Network |

**User Stories:**

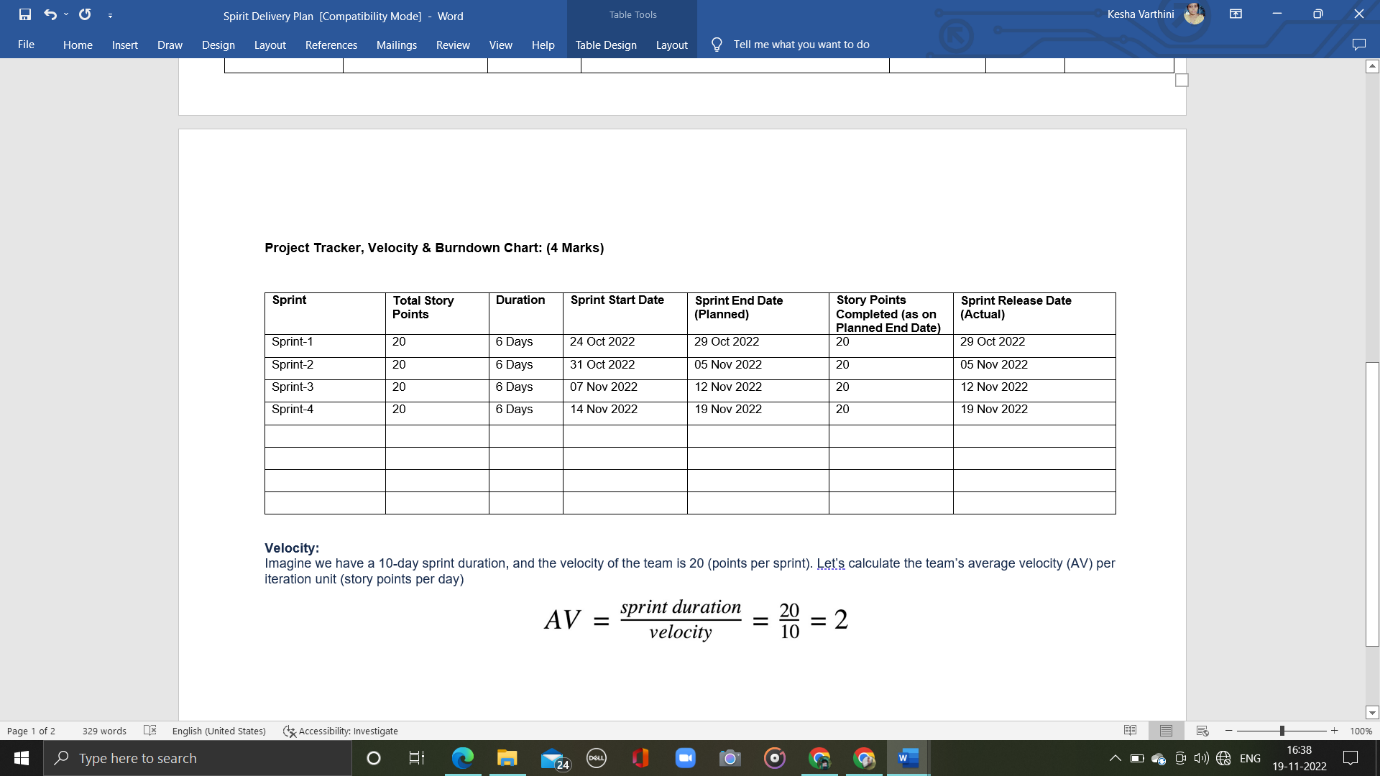
****

**PROJECT PLANNING & SCHEDULING:**

* **Sprint Planning & Estimation:**

****

* **Sprint Delivery Schedule:**

****

**Velocity:**

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let’s calculate the team’s average velocity (AV) per iteration unit (story points per day)



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

**Feature 1:**

Index.html

<!DOCTYPE html>  
<html>  
  
<head>  
  <link rel="stylesheet" href="<https://cdn.jsdelivr.net/npm/bootstrap@4.3.1/dist/css/bootstrap.min.css>" integrity="sha384-ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T" crossorigin="anonymous">  
<meta charset="utf-8">  
<meta name="viewport" content="width=device-width">  
<title>Garbage Management System</title>  
<link rel="icon" type="image/x-icon" href="/Images/DUMPSTER.png">  
<link href="style.css" rel="stylesheet" type="text/css" />  
<script src="<https://www.gstatic.com/firebasejs/8.10.1/firebase-app.js>"></script>  
<script src="<https://www.gstatic.com/firebasejs/8.10.1/firebase-database.js>"></script>  
  
<script>  
var firebaseConfig =  
{  
apiKey: "AIzaSyB9ysbnaWc3IyeCioh-aJQT\_UCMd5CBFeU",  
authDomain: "[fir-test-923b4.firebaseapp.com](http://fir-test-923b4.firebaseapp.com/)",  
databaseURL: "[https://fir-test-923b4-default-rtdb.firebaseio.com](https://fir-test-923b4-default-rtdb.firebaseio.com/)",  
projectId: "fir-test-923b4",  
storageBucket: "[fir-test-923b4.appspot.com](http://fir-test-923b4.appspot.com/)",  
messagingSenderId: "943542145393",  
appId: "1:943542145393:web:9b5ec7593e6a3cbd7966d0",  
measurementId: "G-BN7JNX1Q7B"  
};  
firebase.initializeApp(firebaseConfig)  
</script>  
<script defer src="database.js"></script>  
</head>  
  
<body style="background-color:#1F1B24;">  
<script src="map.js"></script>  
  
  
<div id="map\_container">  
<h1 id="live\_location\_heading" >LIVE LOCATION</h1>  
<div id="map"></div>  
<div id="alert\_msg">ALERT MESSAGE!</div>  
    </div>  
</div>  
<center><a href="<https://goo.gl/maps/G9XET5mzSw1ynHQ18>"  
  type="button" class="btn btn-dark">DUMPSTER</a></center>  
     
<script  
src="<https://maps.googleapis.com/maps/api/js?key=AIzaSyBBLyWj-3FWtCbCXGW3ysEiI2fDfrv2v0Q&callback=myMap>"></script></div>  
</body>  
  
</html>

Map.js

const database = firebase.database();  
  
function myMap()  
{  
var ref1 = firebase.database().ref();  
  
ref1.on("value", function(snapshot)  
{  
   snapshot.forEach(function (childSnapshot) {  
       var value = childSnapshot.val();  
const latitude = value.latitude;  
const longitude = value.longitude;  
  
var latlong = { lat: latitude, lng: longitude}  
var mapProp =  
{  
center: new google.maps.LatLng(latlong),  
zoom: 10,  
};  
var map = new google.maps.Map(document.getElementById("map"), mapProp);  
  
var marker = new google.maps.Marker({ position: latlong });  
marker.setMap(map);  
   });  
}, function (error) {  
   console.log("Error: " + error.code);  
});  
  
}

REPLIX.NIX.TXT

{ pkgs }: {  
  deps = [  
    pkgs.nodePackages.vscode-langservers-extracted  
    pkgs.nodePackages.typescript-language-server  
  ];  
}

**STYLE.CSS**

html, body  
{  
    height: 100%;  
margin: 0px;  
padding:0px;  
}  
#container  
{  
display: flex;  
flex-direction: row;  
height: 100%;  
width: 100%;  
position: relative;  
}  
#logo\_container  
{  
height: 100%;  
width: 12%;  
background-color: #C5C6D0;  
display: flex;  
flex-direction: column;  
vertical-align: text-bottom;  
}  
.logo  
{  
width:70%;  
margin: 5% 15%;  
  
/\* border-radius: 50%; \*/  
}  
#logo\_3  
{  
vertical-align: text-bottom;  
  
}  
#data\_container  
{  
height: 100%;  
width: 20%;  
margin-left: 1%;  
margin-right: 1%;  
display: flex;  
flex-direction: column;  
}  
#data\_status  
{  
height:60%;  
width:8%;  
margin:7%;  
background-color: #691F6E;  
display: flex;  
flex-direction: column;  
border-radius:20px;  
}  
#load\_status  
{  
background-image: url("/Images/KG.png");  
background-repeat: no-repeat;  
background-size:     170px;  
background-position: left center;  
}  
#cap\_status  
{  
background-image: url("/Images/dust.png");  
background-repeat: no-repeat;  
background-size: 150px;  
background-position: left center;  
}  
.status  
{  
width: 80%;  
height: 40%;  
margin:5% 10%;  
background-color:#185adc;  
border-radius:20px;  
display: flex;  
  justify-content: center;  
  align-items: center;  
color: white;  
font-size: 60px;  
     
  
}  
.datas  
{  
width:86%;  
margin:2.5% 7%;  
height:10%;  
   background: url(water.png);  
    background-repeat: repeat-x;  
    animation: datas 10s linear infinite;  
       
    box-shadow: 0 0 0 6px #98d7eb, 0  20px 35px rgba(0,0,0,1);  
  
}  
#map\_container  
{  
height: 100%;  
width: 100%;  
display: flex;  
flex-direction: column;  
}  
#live\_location\_heading  
{  
margin-top:10%;  
text-align: center;  
  color:  GREY;  
}  
#map  
{  
height: 70%;  
width: 90%;  
margin-left: 4%;  
margin-right:4%;  
border: 10px solid white;  
border-radius: 25px;  
}  
#alert\_msg  
{  
width:92%;  
height:20%;  
margin:4%;  
background-color:grey;  
border-radius: 20px;  
display: flex;  
  justify-content: center;  
  align-items: center;  
color: #41af7f;  
font-size: 25px;  
font-weight: bold;  
}  
.lat  
{  
margin: 0px;  
font-size:0px;  
}  
  
  
  
  
@keyframes datas{  
    0%  
    {  
        background-position: -500px 100px;  
    }  
    40%  
    {  
        background-position: 1000px -10px;  
    }  
   
    80% {  
        background-position: 2000px 40px;  
    }  
    100% {  
        background-position: 2700px 95px;  
    }  
   
}

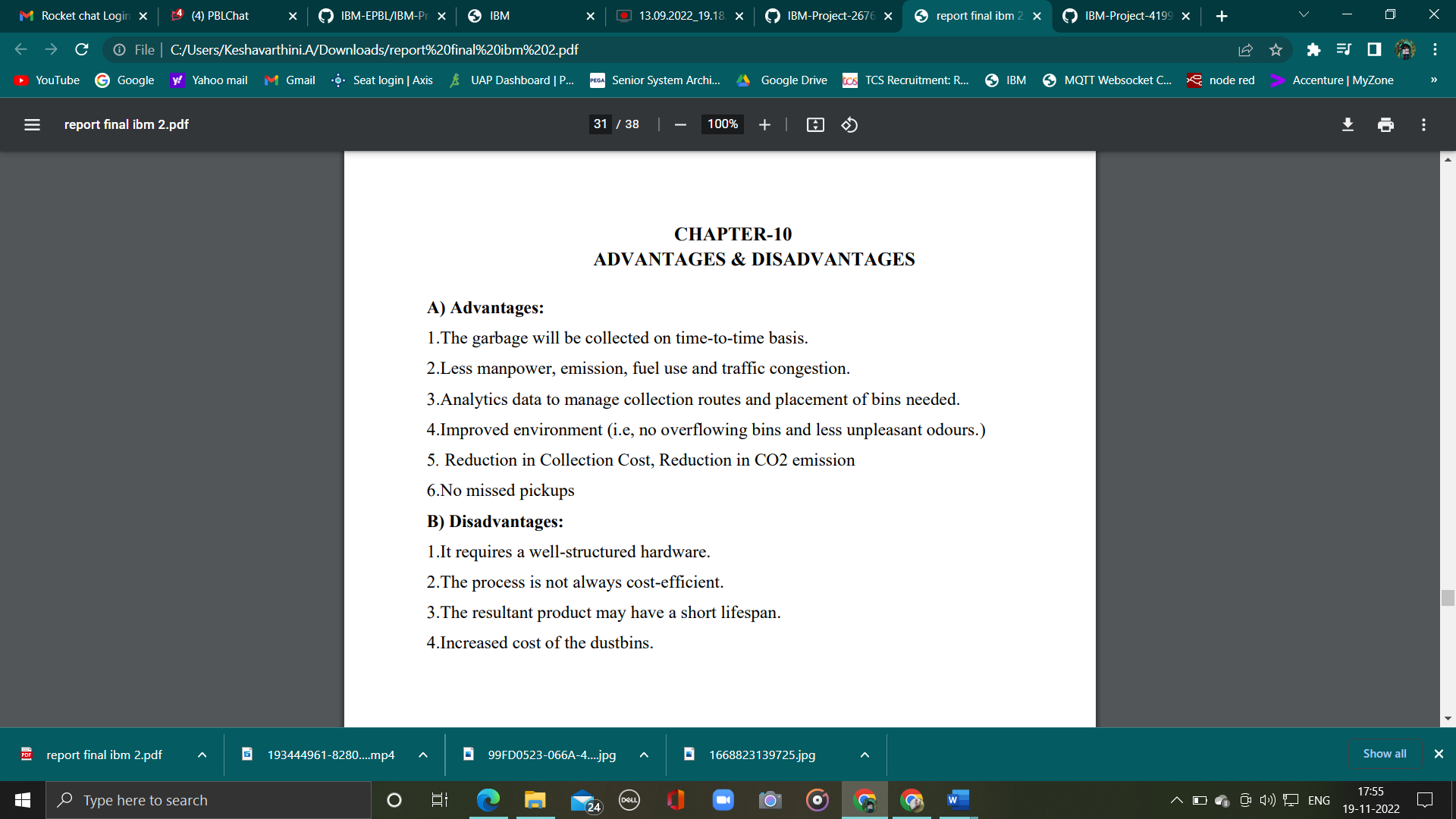
**Feature 2:**

**Database Schema (if Applicable)**

Database.js

const cap\_status = document.getElementById('cap\_status');  
const alert\_msg = document.getElementById('alert\_msg');  
  
var ref = firebase.database().ref();  
  
ref.on("value", function(snapshot)  
 {  
    snapshot.forEach(function (childSnapshot) {  
        var value = childSnapshot.val();  
  
const alert\_msg\_val = value.alert;  
const cap\_status\_val = value.distance\_status;  
  
  
alert\_msg.innerHTML= `${alert\_msg\_val}`;  
    });  
 }, function (error) {  
    console.log("Error: " + error.code);  
 });

**ADVANTAGES & DISADVANTAGES :**



**Conclusion :**

This project work is the implementation of smart waste management system using Watson IoT platform, node-red and MITAPP Inventor. This system assures the cleaning of dustbins soon when the garbage level reaches its maximum. This reduces the total number of trips of garbage collection vehicle and hence reduces the overall expenditure associated with the garbage collection. It ultimately helps to keep cleanliness in the society. Therefore, the smart Waste management system makes the garbage collection more efficient. Smart dustbins help us to reduce pollution. This project ensures waste collection on time which in turn ensures less contamination of environment, no spread of disease and a cleaner surrounding.

**FUTURE SCOPE :**

By deploying sensors, network infrastructure, and data visualization platforms, waste management will be able to generate actionable insights, to make informed decisions. Automatic garbage fill alerting system helps us to reduce the pollution. Many times, garbage dustbin is overflow and many animals like dog or cow enters inside or near the dustbin. Also, some birds are also trying to take out garbage from dustbin. This project can avoid such situations. And the message can be sent directly to the cleaning vehicle instead of the contractor’s office. Apart from this, differentiation can be made between dry trash bin and wet trash bin collecting plastic dry waste and biodegradable waste respectively. To implement this methane and smell sensors can be used. This helps in distinguishing the waste at the source and hence reducing the requirement of manpower.

**REFERENCES:**

1. [https://ijirt.org/master/publishedpaper/IJIRT155033\_PAPER.pdf](https://ijirt.org/master/publishedpaper/IJIRT155033_PAPER.pdf%20)

2. <https://dl.acm.org/doi/abs/10.1007/s11277-021-08897-z>

3[. https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=3841316](https://d.docs.live.net/dc27af65fb24f7ff/Documents/.%20https:/papers.ssrn.com/sol3/papers.cfm?abstract_id=3841316)