PROJECTREPORT

PROJECTNAME :Smart Waste Management System For Metropolitan Cities

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1. INTRODUCTION

1.1 ProjectOverview:

The solid waste is increasing in urban and rural areas as the population is increasing and wastemanagement hasbecomea global concern. Inimplementingthesmart citiesthegreat challengeishowto manage waste with low cost and high performance. Waste has a negative impact on the quality ofsociety which smart cities aim to improve. The process of collecting wastes, separating it, andtransporting the containers daily and quickly to avoid any prospect of a spread of diseases is a complexprocess. The Internet and its applications have become an integral part of today's human lifestyle. It hasbecomeanessentialtoolinevery aspect.Duetothetremendous demandandnecessity,researchers wentbeyond connecting just computers into the web. With the help of IOT, garbage in the cities can becollected on monitoring the bin level, to prevent overflow of the garbage which negatively impacts theenvironmentandtoavoid or postponegarbage collection schedulesincase oflowgarbage levels.

1.2 Purpose:

We amalgamate technology along with waste management in order to effectively create a safe and ahygienic environment.Smart waste managementis about using technology and datato create a moreefficient waste industry. Based on IoT (Internet of Things) technology, smart waste management aims tooptimize resource allocation, reduce running costs, and increase the sustainability of waste services. Thismakesitpossibletoplanmoreefficientroutesforthetrashcollectorswhoemptythebins,butalsolowersthe chance of any bin being full for over a week. A good level of coordination exists between the garbagecollectors and the information supplied via technology. This makes them well aware of the existing garbagelevel and instigate them whenever the bins reach the threshold level. They are sent with alert messages sothat they can collect the garbage on time without littering the surrounding area. The fill patterns of specificcontainers can be identified by historical data and managed accordingly in the long term. Thus, smart wastemanagement provides us with the most optimal way of managing the waste in an efficient manner usingtechnology.

2.LITERATURESURVEY:

2.1 Existingproblem:

Wastemanagementhas becomeanalarming challengeinlocaltownsandcitiesacrosstheworld. Often the local area bins are overflowing and the municipalities are not aware of it. This affects the residentsof that particular area in numerous ways starting from bad odor to unhygienic and unsafe surroundings. Poorwaste management - ranging from non-existing collection systems to ineffective disposal - causes airpollution, water and soil contamination. Open and unsanitary areas contribute to contain viruses and bacteria(i.e., salmonella and e-coli), which are a risk to human health.mination of drinking water and can causeinfection and transmit diseases. Toxic components such as Persistent Organic Pollutants (POPs) poseparticularly significant risks to human health and the environment as they accumulate through the food chain.Animalseatingcontaminatedplantshavehigher dosesofcontaminantsthan iftheywere directly exposed. Precipitation or surface water seeping through waste will absorb hazardous components from landfills,agricultural areas, feedlots, etc. and carry them into surface and groundwater. Contaminated groundwateralso poses a great health risk, as it is often used for drinking, bathing and recreation, as well as inagriculturalandindustrialactivities.Landfillsandwastetransferstationscanattractvarious pests(insects,rodents,gulls,etc.)thatlook for foodfromwaste.These pestscanspreaddiseasesthrough

2.2 References:

LITERATURE SURVEY: A number of researches and reviews have been done over the past fewdecadesonthetopicof‘SMARTWASTEMANAGEMENT FORMETROPOLITANCITIES’.Afewnotableofthem aregivenbelow.

PAPER1

AUTHORS: MohammadAazam,MarcSt-Hilaire,Chung-HorngLung,IoannisLambadaris

YEAR:2016

DESCRIPTION:

Mohammad Aazam et al proposed Cloud SWAM, in which each bin is equipped with sensors to notify itswaste level. Different bins for each category of waste, namely: organic, plastic/paper/bottle, and metal. Inthis way, each type of waste is already separated and through the status, it is known how much of waste iscollected and of what type. The availability of data stored in the cloud can be useful for different entitiesand stakeholders in different ways. Analysis and planning can start from as soon as waste starts gatheringand up to when recycling and import/export related matters are conducted. The system Cloud SWAMprovides Timely waste collection. Timely and efficient way of collecting waste leads to better health,hygiene,anddisposal.Thesystemprovidestheshortestpathtothe locationofwaste bins.Sothecollectorscanplan abetterand fuel efficientroute.

PAPER2

AUTHORS: Dr. N.SathishKumar,B.Vijayalakshmi,R.JeniferPrarthana,A.Shankar

DESCRIPTION:

Designed a smart dustbin in which the dustbin gets blocked when it reaches a threshold value. Theultrasonicsensormeasuresthewaste volume.Themicrocontrollerreadsthedatafromthesensor andalertsthe server. For the verification process RFID tag (ID card of the cleaner) interrupts the RFID reader, theultrasonic sensor checks the status of the dustbin and sends it to the web server. An android application isusedto viewthealertsandstatus at theserverend.

PAPER3

AUTHORS: BelalChowdhuryandMorshedU.Chowdhury

DESCRIPTION:

Designed a five layer architecture for RFID and sensor based waste management systems. The layers arenamed as physical layer, middleware layer, process layer, data access layer and user interface layer. ThephysicallayerconsistsoftheactualRFIDhardwarecomponentsanditincludesRFIDwastetag, readerandantennas. Middleware layer is act as the interface between the RFID reader, load cell sensor and wastemanagement service providers (i.e., waste collectors, and municipalities) IT system. The important elementof RFID and load cell sensor systems is the middleware layer , which is viewed as the central nervoussystem from the waste management system perspective. This layer enables waste management serviceprovider's (e.g., waste collector) a quick connectivity with RFID readers and load cell sensors and also thelayer lowers the volume of information that waste management system applications need to process, bygrouping and filtering raw RFID and load cell data from readers and sensors respectively. An application-level interface is provided by a middleware layer for managing RFID readers, and load cell sensors forprocessinglargevolumes ofwastedatafortheirapplications.

PAPER4

AUTHORS: MohdHelmyAbdWahab,Aeslina AbdulKadir,MohdRazaliTomariandMohamadHairolJabbar

YEAR:

2014DESCRIPT

ION:

Proposed a Smart Recycle Bin that caters for recycling glass, paper, aluminum can and plastic products. Itautomatically evaluates the value of the wastes thrown accordingly and provides a 3R card. The recyclesystem enables collection of points for performing a disposal activity into designated recycle bins. Such asystemencourages recyclingactivitiesbyallowingthepointstoberedeemablefor productsorservices.Thesystemrecordsthedatarelated to thedisposal

activities,disposedmaterial,identificationoftheuser andpointscollectedbytheuser.Theuser hastotouchhis card to the specified RFID reader at the recycle bin. Recycle bin doors open and the user puts waste oneby one. A microcontroller processes information about his user ID and number of wastes and sends it to adatabase server. The database server calculates the user points and updates it. The system provides userloginto an onlinesystemto check his total points.

PAPER5

AUTHORS: FachminFolianto,YongShengLowand WaiLeong Yeow

YEAR:2015

DESCRIPTION:

ProposedSmartbinsystemhas 3–tierarchitecture.Theultrasonicsensorinstalledinevery Smartbinsensesbin fullness and reports readings and sensor statuses. The sensor reading is transmitted to the gateway nodwhich is installed in every sensor cluster. It forwards the information to the backend server. The analyticsmodule in the back end server analyzes data collected by the bin sub system. The analytics moduleprocesses fullness readings, compares against predefined rules, and generates events upon exceedingthreshold. The bin sub-system sends information to the workstation and it shows meaningful information tousersthrough agraphical userinterface.

PAPER6

AUTHORS: Keerthana betal.

YEAR:2017

Designed an internet of bins for trash management in India. The smart TRASH management systemusing sensor, microcontroller and other modules ensures emptying of dustbins appropriately when thegarbagelevelreaches itsmaximum.Two thresholdlimitsare setforthebinsandanalertmessageissenttothevan that collectsthetrashifthewasteamount reaches these thresholds. The system further allows the people to drop down the trash bags into the bins till itreaches the threshold limit .It waits for the acknowledgment from the van to clear off the bin and if theacknowledgment is notreceivedit is sentagainwhenitreachesthethresholdlimitandthebingetslocked.When the bin gets locked it displays the message “Overloaded”. Then the dustbin will be monitored for aspecific time and when not cleared within a certain time limit, then a message will be sent to the higherauthoritywhocantakeappropriateaction.

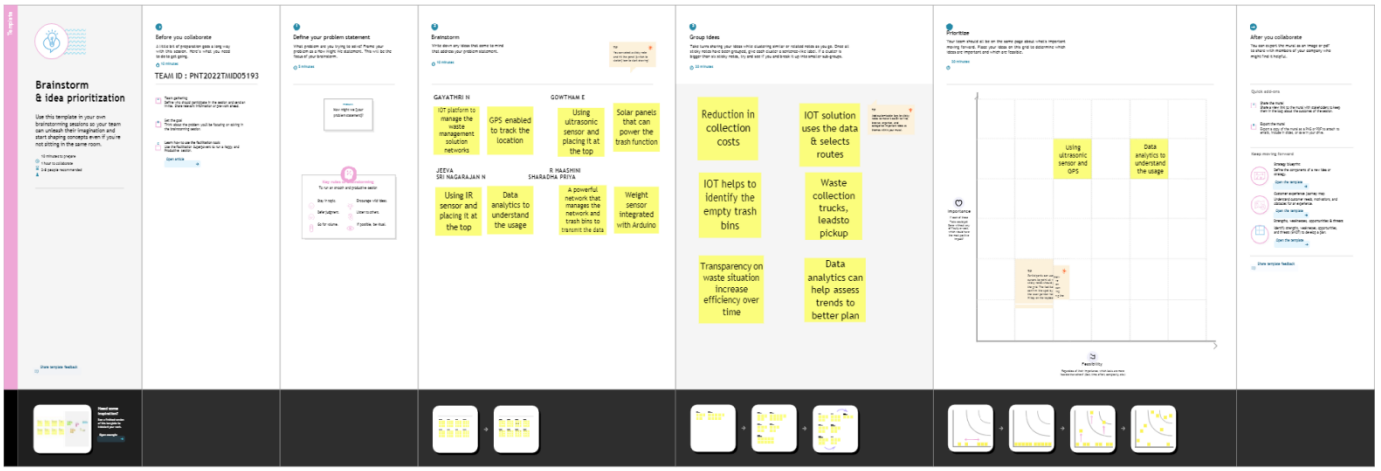
2.3 ProblemStatementDefinition:

Problem Statement (PS)	I am (Customer)	I'mtryingto	But	Because	Whichmakes mefeel
PS-1	Municipal corporation authority	Get notified whenthe trash cans arefulland be made aware of wherethefull cans arelocated.	Don't have the facilities atthe moment	There isno toolavailable todetermine thelevelof bins.	Frustrated
PS-2	Individual working for aprivatelimite dcorporation	Getridofthe example of asurplus ofwaste	The trashca ns arealwa ys filled	Ioccupya metropolitan city which isinvariably crowded	Worried

3.IDEATION&PROPOSEDSOLUTION

3.1 EmpathyMapCanvas

3.2 Ideation&Brainstorming

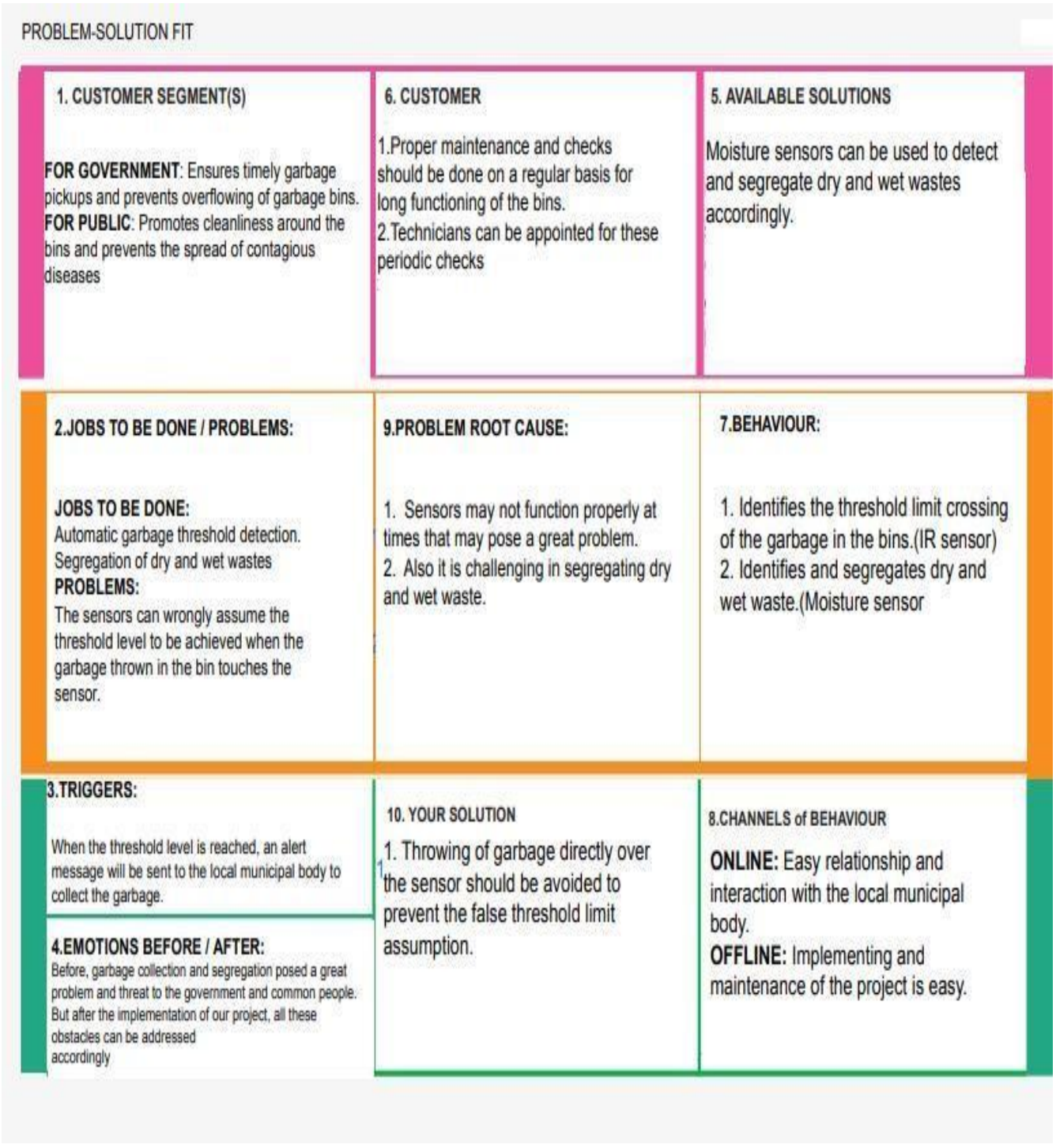


3.3 ProposedSolution

S.No	Parameter	Description
1.	Problem Statement (Problem tobesolved)	✓ Themanualmonitoringofwastesin trash cans is a laborious operationthatrequiresadditionaltime,money,andhuman labor ✓ Unsafe trash disposal is generatingproblemsforpeople. ✓ Badodorallaroundtheplace from uncollected trashorrubbish.
2.	Idea/Solution description	✓ Thisprocedureusesa cloud connectionandnon-biodegradablewastes and an ultrasonic sensor todetermine the level of a rubbishcontainer ✓ Bydevelopinganapp,thecompanyof a certain neighborhood inside alarge metropolis will be able tocheckthetrashcanstoseeifthey are fullornot.
3.	Novelty/Uniqueness	✓ Incontrast tothetraditionalways forcollectingtrash cans,thisstrategy instructs us to utilize thetransportationonlywhennecessary. ✓ Keepinganeyeonthetrashcans easier andlesslabor-intensiveforhumans.
4.	Social Impact / CustomerSatisfaction	✓ Peoplecanexperiencea cleanatmosphere. ✓ Reduces the amount of laborrequired from humans forwaste disposal. ✓ For a municipal corporation tomonitorthecleanliness ofdifferent areasofthe city, thisproposalwillbe quitehelpful.
5.	BusinessModel(RevenueModel)	✓ By cuttingbackonunneeded transportationcosts topointlesslocations, thislowers a significant amount offuel costsforcitybusinesses ✓ Thisinitiativeintendsto assist municipalcor

		poration. ✓ Provideasanitary atmosphere.

3.4 ProblemSolutionfit



\4.REQUIREMENTANALYSIS

4.1 Functionalrequirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	**Fitting IoT device in the trashcans.**	The IoT device need to be fixed in the dustbin with Water proof safety. The IoT device consists Ultrasonic sensor, IR sensor, Weight sensor. To send data to the cloud GPRS/GSM is used.
FR-2	**Bin monitoring**	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, lastmeasurement, GPS location and collection schedule or pick recognition.
FR-3	**Predictions for bin fulness**	It is a 24×7 monitoring system is designed for monitoring the dumpster. If either of the containers is full then an alert message is sent from the dustbin to employees and the cloud. In turn, employees can clear the corresponding dumpster. The bin has Sensors that can 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.
FR-4	**Plan waste collection routes**	Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond andschedule waste collection. You can compare planned vs. executed routes to identify any inconsistencies.

4.2 Non-Functionalrequirements

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	A smart solution has been proposed to make the waste by sorting more simple and accurate and improve the user experience, usability, and satisfaction. It aims to optimize ease of use while offering maximum functionality.
NFR-2	**Security**	Building and deploying IoT-based smart waste management in cities can be a complex,time consuming and resource-intensive process. Many municipal IT departments will not have the resources or in-house skills to support such a project internally.
NFR-3	**Reliability**	Smart waste management is also about creating better working conditions for waste collectors and drivers. Operates in a defined environment without failure resulting in less manpower, emissions, fuel use and traffic congestion.
NFR-4	**Performance**	The system will provide accurate reports, thus increasing the efficiency of the system. The real-time monitoring of the garbage level with the help of sensors and wireless communication will reduce the total number of trips required of Garbage collecting truck. This will reduce the total expenditure associated with the garbage collection.
NFR-5	**Availability**	Another purpose of this project is to make the proposed waste management system as cheap as possible. By this we empower cities,businesses, and countries to manage waste smarter.
NFR-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.

5.PROJECTDESIGN

5.1 DataFlowDiagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the informationflows within a system. A neat and clear DFD can depict the right amount of the systemrequirementgraphically.

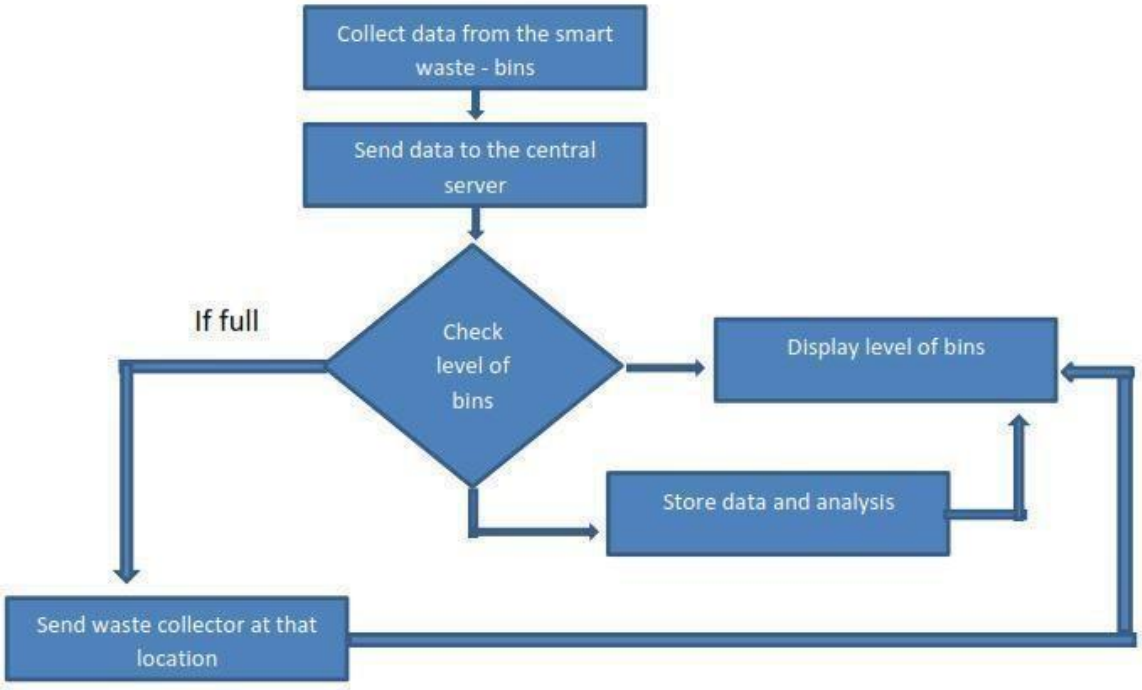
It shows how data enters and leaves the system, what changes the information, andwheredatais stored.

Asmartwastemanagementplatformusesanalytictotranslatethedatagatherinyour

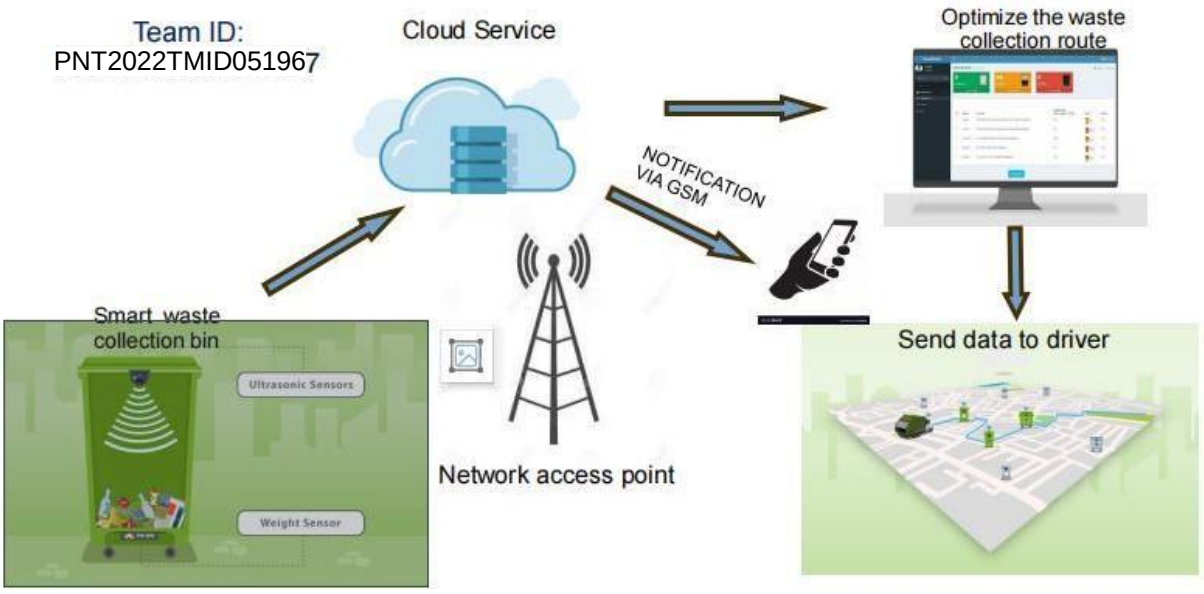
bins into actionable insights to help you improve your waste services.Youcanreceivedataonmetricsuchas:

- The first test conducted is the situation where the garbage bin is empty or itsgarbagelevelisvery low
- Then, the bin is filled with more garbage until its level has surpassed the firstthreshold value,which issetto80%thenthefirstwarning SMSisbeing sent,asdepicted
- The first notification SMS sent by the system, once the waste reaches the level of85%full
- The second notification SMS sent by thesystem, indicating thatbin is at least95%fulland thegarbageneedstobecollected immediately
- Locationspronetooverflow
- Thenumberofbinsneededtoavoidoverflowingwaste
- Thenumberofcollectionservicesthatcould besaved
- Theamount offuelthatcould besaved
- Thedriving distancethatcouldbesaved

Data flow diagram:



5.2 Solution&TechnicalArchitecture



SOLUTIONARCHITECTURE

TECHNOLOGYARCHITECTURE

Design:

• Garbageleveldetectioninbins.

• Gettingthe weightofthe garbageinthebin.

• Alertstheauthorizedpersontoemptythebinwheneverthe binsarefull.

• Garbagelevelofthebinscan bemonitoredthrough aweb App.

• We can view the location of every bin in the web application bysendingGPSlocationfromthedevice.

Softwareandsystemrequired:

• PythonIDLE

• 4GBprocessorandOS-Windows/Linux/MAC

Table-1:Components&Technologies:

S.no	Component	Description	Technology
1.	UserInterface	MobileApplication	HTML,CSS,JavaScript.
2.	ApplicationLogic	Logic fora processinthe application	Java
3.	Database	DataType,Configurationsetc.	MySQL
4.	CloudDatabase	DatabaseServiceonCloud	IBM Cloud
5.	FileStorage	Filestoragerequirements	LocalFilesystemandIBMcloud
6.	Infrastructure(Server /Cloud)	ApplicationDeploymentonCloud LocalServerConfiguration	Local andCloudFoundry

Table-2:ApplicationCharacteristic

S.no	Characteristics	Description	Technology
1.	Open-SourceFrameworks	GitHub	Internethostingservice
2.	SecurityImplementations	Applicationsecurity:VeracodeFirewall:Cisco	Networkautomation
3.	ScalableArchitecture	It provides the room for expansionmore database of smart bins addedadditionallycanbe updated.	Cloudstorage
4.	Availability	As the system control isconnectedtowebserver itisavailable 24*7andcanbe accessedwheneverneeded.	Server
5.	Performance	Performanceishighituses5mb caches	WirelessSensorNetwork

6.PROJECTPLANNINGANDSCHEDULING

6.1. SprintPlanningandEstimation

TITLE	DESCRIPTION	RELEASEDATE
Literature Survey andInformationGathering	Surveying on the topic ofselected project & gatheringinformationbyreferringthe,technicalpapers,researchpublicationsetc.	23SEPTEMBER2022
PrepareEmpathyMap	PrepareEmpathyMapCanvasto capture the user pains &gainsonparticularissue.	25SEPTEMBER2022
Ideation	Jot down the ideas byorganizing the brainstormingsessionandprioritizethetop3ideas based on the feasibility&importance.	27SEPTEMBER2022
ProposedSolution	Prepare your proposed solutionoftheprojectwhichincludesthenovelty,feasibilityof idea,businessmodel,socialimpact, scalabilityofsolution,etc.	28SEPTEMBER2022
ProblemSolutionFit	Prepareproblem-solutionfitdocument.	28SEPTEMBER2022
SolutionArchitecture	Preparesolution architecturedocument.	30SEPTEMBER2022
CustomerJourneyMap	Preparethecustomerjourney maps to understand the userinteractions &experienceswiththeapplication (entry toexit)	17OCTOBER2022
FunctionalRequirement	Preparethefunctional requirementfortheproject.	17OCTOBER2022
DataFlowDiagrams	Draw the data flow diagrams tounderstandtheflowofexecution oftheproject.	18OCTOBER2022
TechnologyArchitecture	Prepare thetechnologyarchitecturediagram.	18OCTOBER2022
Milestone&ActivityList	Prepare themilestones&activity listoftheproject.	29OCTOBER2022

DeliveryofSprints	Submitthecodingdevelopmento f the project and submit insprints. Sprint-1 Sprint-2 Sprint-3 Sprint-4	30October 2022 5November 2022 11November 2022 17November 2022

6.2. SprintDeliverySchedule

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority
Sprint-1	Objective	USN-1	The smart bin system will alert the nearby garbage collectors when the bin overflows.	6	High
Sprint-1	Registration	USN-2	The user(garbage collectors) can register for the application using the respective credentials provided to them.	4	Medium
Sprint-1	Designing	USN-3	Designing a circuit with sensors and arduino interface	6	High
Sprint-1	Cloud	USN-4	As an administrator, register in IBM cloud	4	Medium
Sprint-2	Code development	USN-5	Develop a code to send a message when the bin overflows using ultrasonic sensor	10	High
Sprint-2	Cloud Server	USN-6	Cloud web server is created which connects the bin and the authority who is responsible for the disposal of waste from its bin	10	High
Sprint-3	Sensor	USN-7	Detect the level of garbage using sensor and store it in the server for specific interval of time.	10	High
Sprint-3	Cloud	USN-8	Authority should allocate which garbage collector should collect the waste at particular area	10	High
Sprint-4	Communicating Medium	USN - 9	Garbage collector receives the message from the authority and goes to collect the garbage	10	High
Sprint-4	Communicating Medium	USN-10	Once the garbage is collected the particular person should intimate the completion of the task	5	Medium
Sprint -4	Cloud database	USN-11	Update the database after task completion	5	Medium

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	30 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

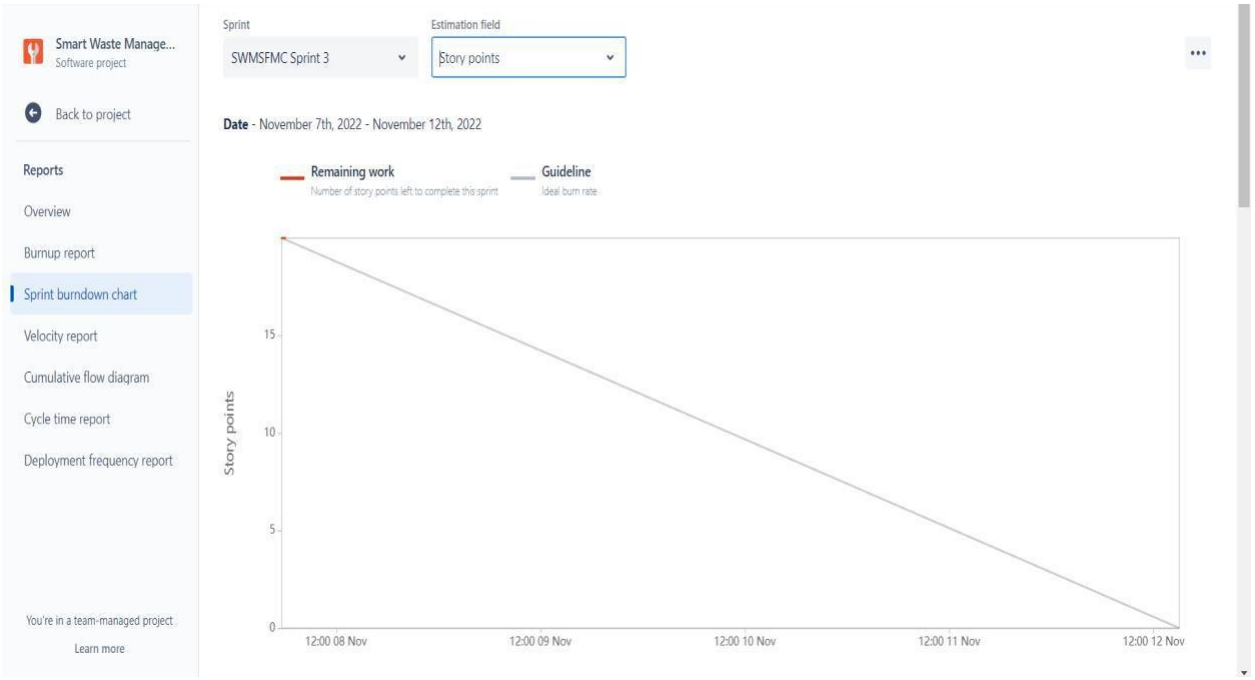
Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint).Let'scalculatetheteam'saveragevelocity(AV)periterationunit(storypointsperday)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

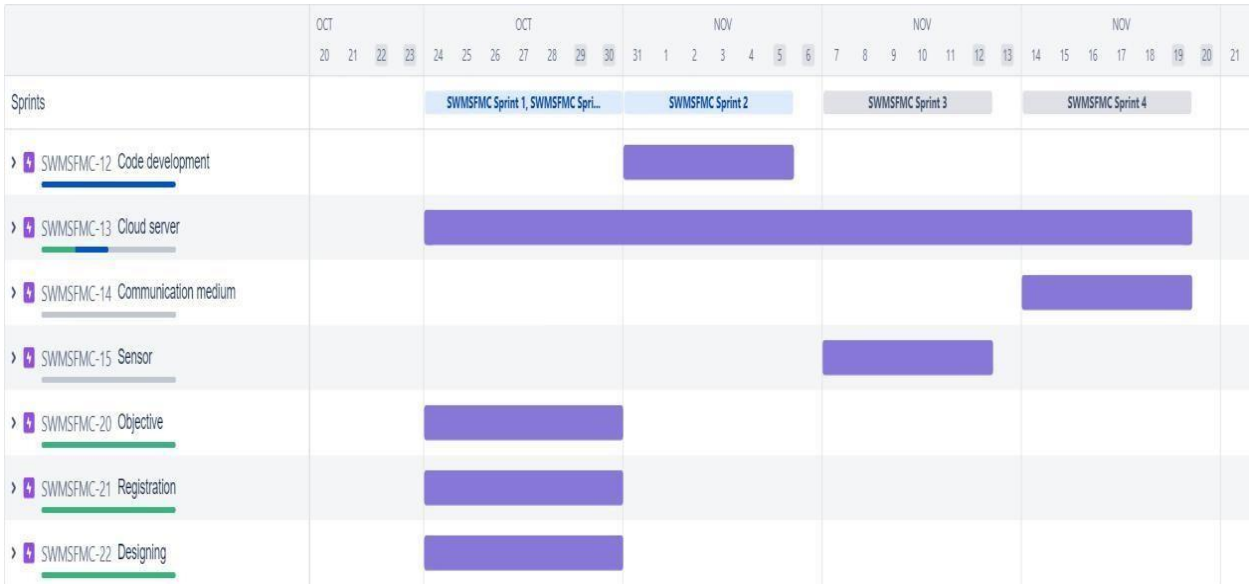
6.3ReportsfromJIRA

BURNOUTCHART

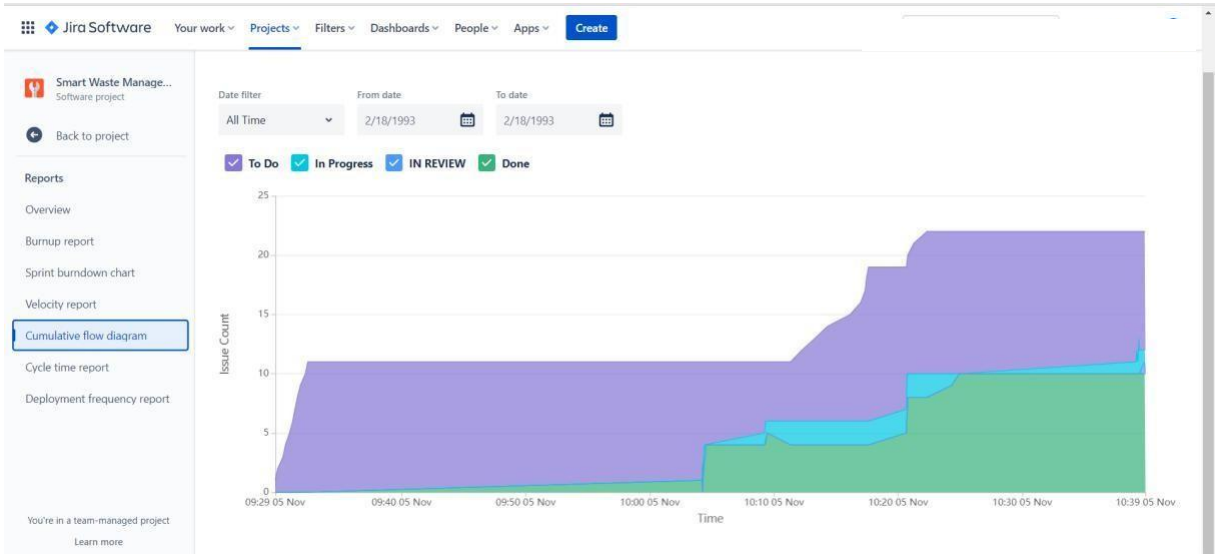


JIRA SOFTWARE

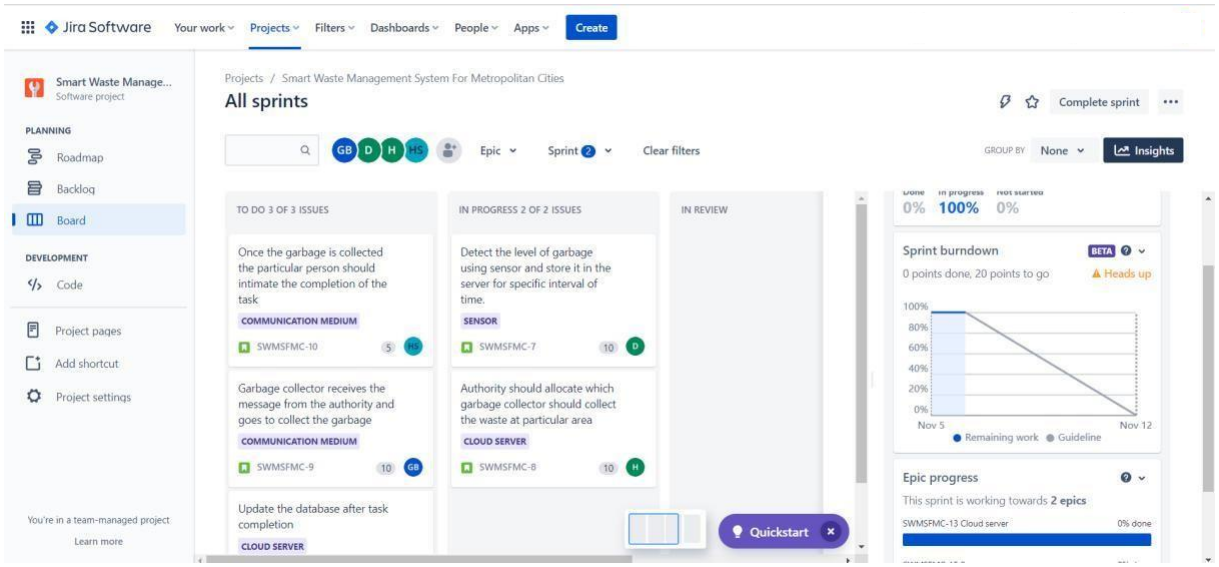
SCREENSHOTSROADMAP



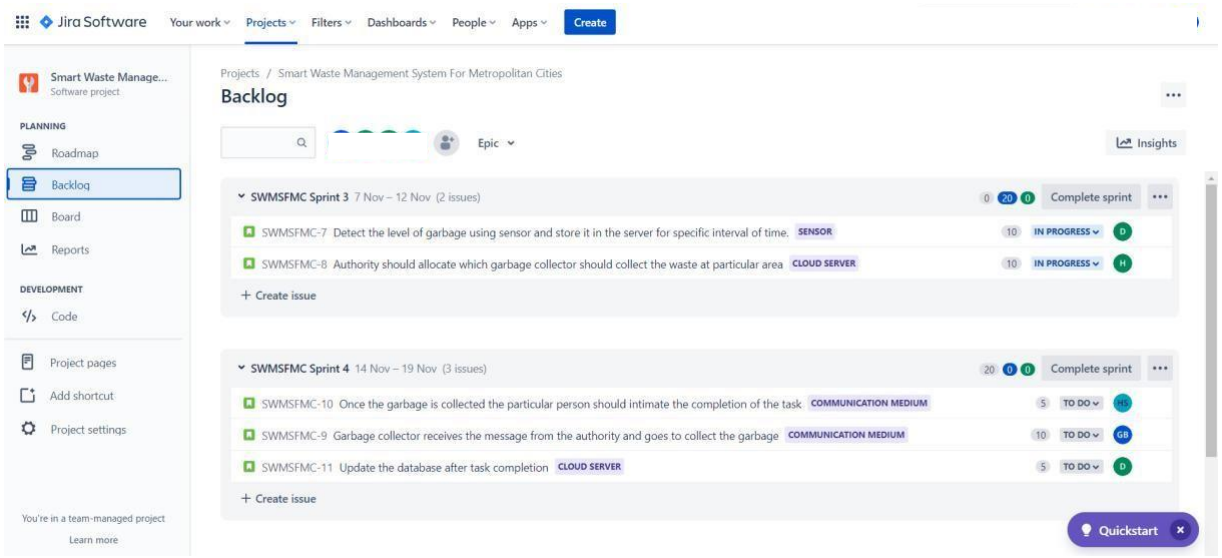
CUMULATIVEFLOWDIAGRAM



BOARDS

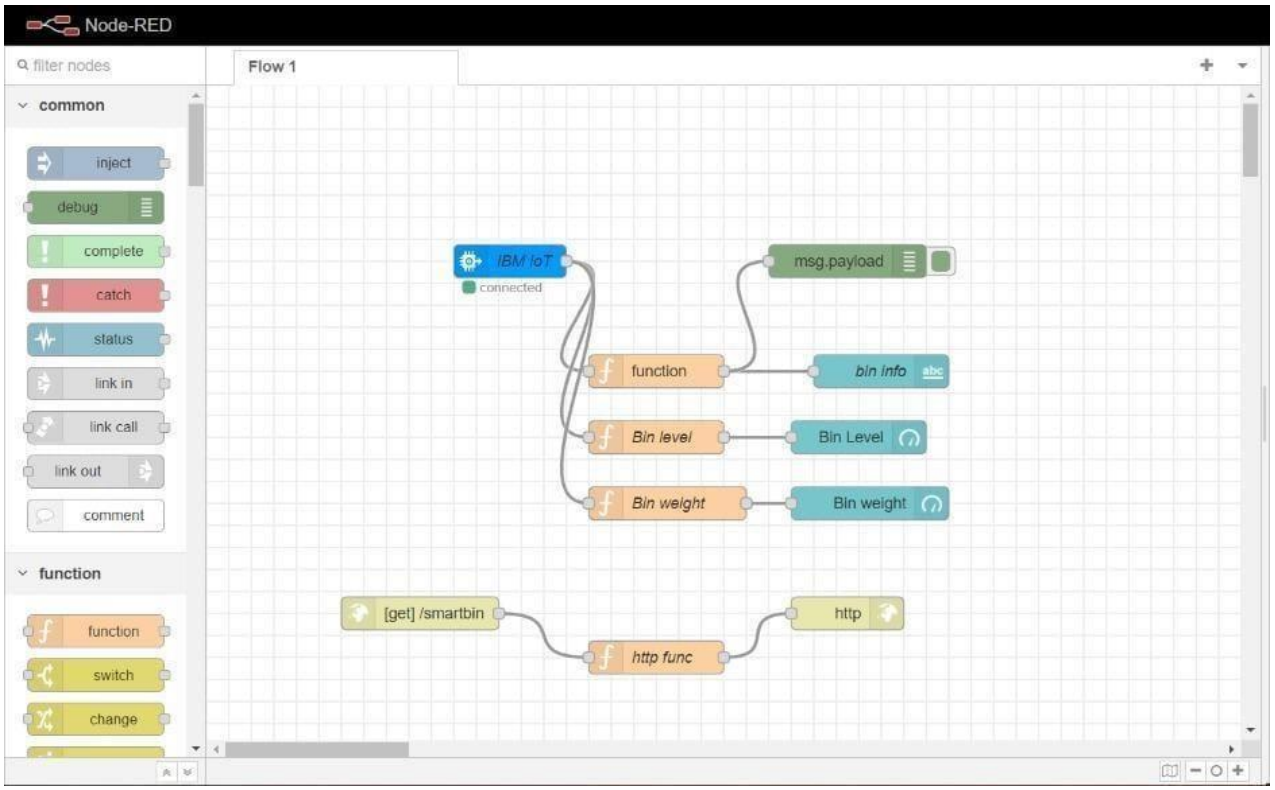


BACKLOG



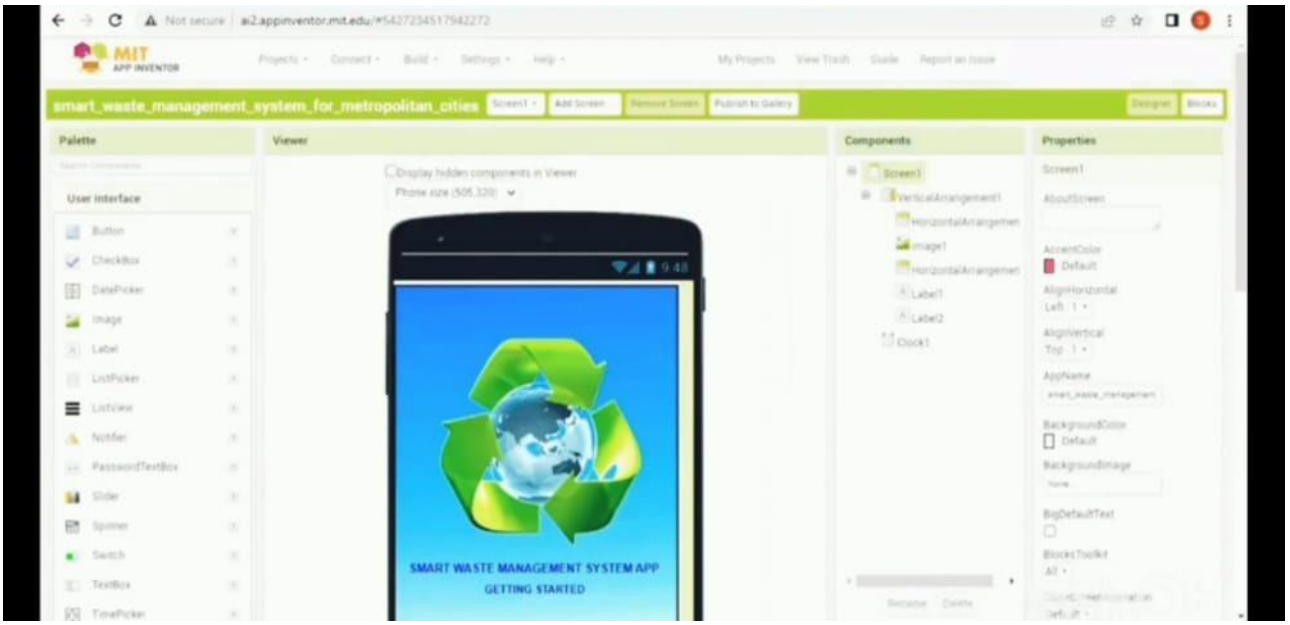
7. CODING & SOLUTIONING (Explain the features added in the projectalongwithcode)

7.1 Feature1-Node Red



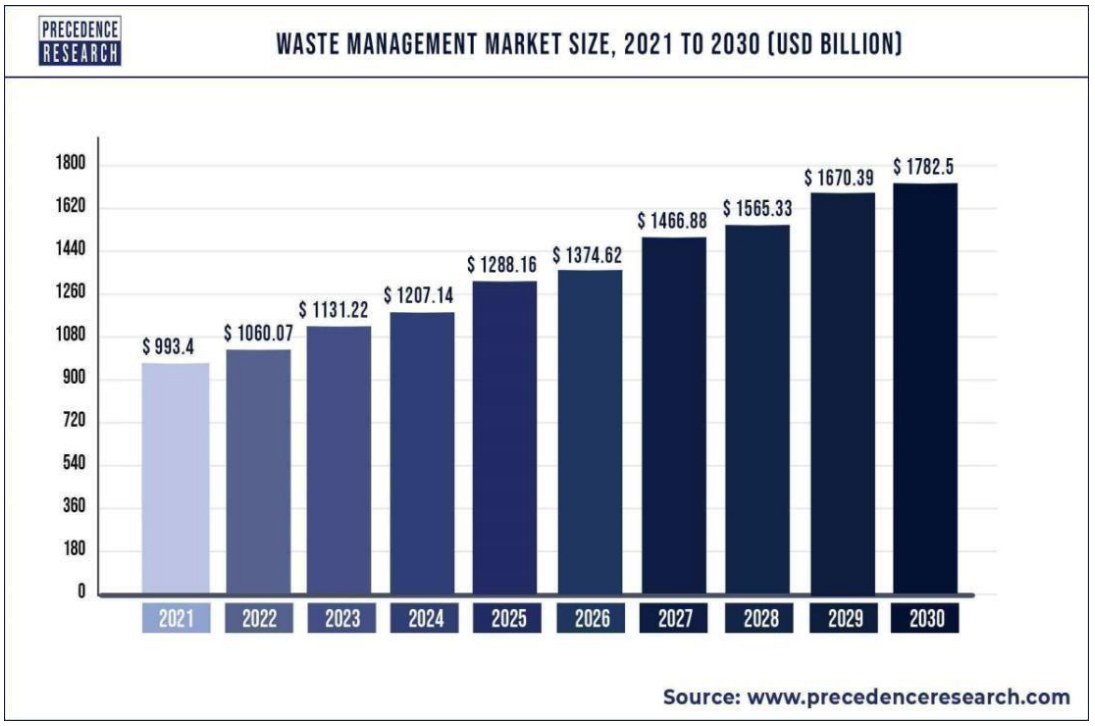
7.2 Feature2-WebUIDisplayingbindetails

7.3 Feature3-LiveupdateoncollectedData



8.RESULTS

8.1 PerformanceMetrics



9. ADVANTAGES

&DISADVANTAGES<u>ADVANTAGE</u>

<u>S:</u>

1.Reduction in Collection

Cost2.No Missed

Pickups3.ReducedOverflows

4.Waste Generation

Analysis5.CO2 Emission

Reduction**<u>DISADVANTAG</u>**

<u>ES:</u>

Systemrequiresagreaternumberofwastebinsfor separatewastecollectionas

perpopulationinthecity.Thisresultsinhighinitialcostduetoexpensivesmart dustbinscompareto other methods.

Sensornodesusedinthe dustbinshave limited memorysize.

10. CONCLUSION

A Smart Waste Management system that is more effective than the one in use now is achievable by usingsensors to monitor the filling of bins. Our conception of a "smart waste management system" focuses onmonitoringwastemanagement,offeringintelligenttechnologyforwastesystems,eliminatinghumaninterventio n, minimizing human time and effort, and producing a healthy and trash-free environment. Thesuggested approach can be implemented in smart cities where residents have busy schedules that providelittle time for garbage management. If desired, the bins might be put into place in a metropolis where asizablecontainerwould beableto holdenoughsolid trashfor asingle unit.Theprice might be high.

11. FUTURESCOPE

There are several futureworks and improvements for the proposed system, including the following:

1.Change the system of userauthentication and atom iclockof bins,whichwouldaidinprotectingthebinfromdamageortheft.

2.The concept of green points would encourage the involvement of residents or end users, making the ideasuccessful andaiding in the achievement of collaborative waste management efforts, thus fulfilling theideaofSwachhBharath.

3.Having case study or data analytics on the type and times waste is collected on different days or seasons,makingbinfillingpredictableandremovingthereliianceonelectroniccomponents,andfixingthecoortes.

4.ImprovingtheServer'sandAndroid'sgraphicalinterfaces