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## 1. INTRODUCTION

Today, efficient management and handling of waste are of great importance. According to a survey more than 3 billion tonnes of waste are handled each year among which, around 90 million tonnes are hazardous. Waste prevention, recycling, reuse and disposal are the three principles laid down for waste management. Sorting is performed for efficient recycling and reuse of the waste materials. Different waste items contain recyclable and reusable materials having economic value. Hence, sorting them at the earliest has advantages. Moreover, it also ensures the quality of the collected waste with no contamination. It also avoids potential hazards. Transporting them to the sorting facilities could be another overhead to cost if not performed early.

Lastly they might end up as landfills, if left undetected. Despite that the early sorting could be beneficial, we need to reason out for the sorting process. Also, care should be taken about any possibilities of hazards during this process.

Despite their innocent appearance, dustbins occupy a critical position in any narrative of waste management. Being situated at the interface of private lives and household practices, on the one hand, and public health and environmental management on the other, dustbin technologies provide a revealing indicator of waste-relationships within society. From the standard black dustbin to multi-colored recycling bins, each contributing to the specification of new types of waste and the re-configuring of waste management activity on the part of households, local authorities, and a range of commercial organizations.

Our historical approach allows us to make sense of the emerging tensions in the world of waste management, and to speculate on the future of the bin and its part in constructing and mediating what seem to be increasingly complex relationships between households and the wider social and natural environment.

### 1.1 OBJECTIVE

Imagine if your trash bin not only collected garbage, but helped better manage the waste you produce. This is what we're trying to do by placing monitoring sensors on recycling bins that send out an alert when full to help its residents reduce household waste and increase recycling.

The Internet of Things (IoT) is now being used to aid waste management companies and sanitation departments in tracking waste and recycling volumes. With Internet-connected sensors embedded in the bins, collection frequency is determined by bin capacity alone rather than fixed collection schedules.

The main objective of our project is to **develop a system that can do intelligent waste collection and handling** by monitoring the current trash level of dustbin and sending these data to our Cloud Servers. The Cloud Servers then visualizes the locations of SmartBins with their respective fill level. Thus, the collectors can monitor trash-level and location of dustbins falling under their service zone, so that they can plan-ahead of time. This will ensure that the collector knows when a dustbin needs to be emptied and what could be the best route to pick the trashes from all the dustbins.

Waste management companies must address environmental concerns while also improving efficiency and reducing costs from initial collection to processing and landfill management. The use of sensors can help in all these areas, automating tasks such as monitoring and sorting waste. Sensors and lights indicates when trash and recycling bins are full and can result in substantial cost savings, since garbage collectors don't have to waste time checking all bins when some may only be partially full. So, our proposed system tries to minimize those situations and collects stuffs from the dustbins of the locality, in a timely fashion.

## 1.2 FEATURES

We have developed a solution to facilitate waste handling and collection process easily. A waste bin needs to be emptied /collected by the local trash-collectors many times in a week to ensure that there are no overflows and is useable. Our system attempts to do intelligent waste collection and handling. It empowers just-in-time collection, cutting down the unnecessary collection redundancy. Through this, the collectors will be informed when to empty & collect stuffs from the dustbins of the locality, in a timely fashion.

We're employing a sensor to measure trash-level of the dustbin, based on that our device will notify the collector through an SMS, that a dustbin has become full and needs to be collected quickly. SMS system will make use of a GSM transceiver component.

We offer a cloud-based interface to the collectors to monitor trash-level and location of dustbins falling under their service zone, so that they can plan-ahead of time. This will ensure that the collector knows when a dustbin needs to be emptied, if neglected and the level is full then an SMS will be sent to the collector, notifying an urgent/priority handling of that particular dustbin.

This system comprises maintenance and management of waste management system in a whole new way.

This could be an initiative with **Swachh Bharat Abhiyaan** for cleaning India.



## 2. ANALYSIS

### 2.1 EXISITING SYSTEM

One common problem with dustbins is odour, caused by the leakage of various items while they sit in the dustbin. Often, odour passes through garbage bags and bin liners, and it can cause dustbins to smell distinctly unpleasant after an extended period of time.

The generation of waste and the collection, processing, transport and disposal of waste—the process of ‘waste management’—is important for both the health of the public and aesthetic and environmental reasons. Waste is anything discarded by an individual, household or organization. As a result waste is a complex mixture of different substances, only some of which are intrinsically hazardous to health. The potential health effects of both waste itself and the consequences of managing it have been the subject of a vast body of research. The inherent latency of diseases and migration of populations are often ignored. Waste management workers have been shown to have increased incidence of accidents. The health impacts of new waste management technologies and the increasing use of recycling and composting will require assessment and monitoring.

The current major methods of waste management are:

- Recycling—the recovery of materials from products after they have been used by consumers.
- Composting—an aerobic, biological process of degradation of biodegradable organic matter.
- Sewage treatment—a process of treating raw sewage to produce a non-toxic liquid effluent which is discharged to rivers or sea and a semi-solid sludge, which is used as a soil amendment on land, incinerated or disposed of in land fill.
- Incineration—a process of combustion designed to recover energy and reduce the volume of waste going to disposal.
- Landfill—the deposition of waste in a specially designated area, which in modern sites consists of a pre-constructed ‘cell’ lined with an impermeable layer (man-made or natural) and with controls to minimize emissions.

## 2.2 PROPOSED SYSTEM

Our innovative solution to facilitate waste handling and collection process efficiently. A smart bin needs to be collected by waste collectors in a fixed period of times during a week to ensure that there are no overflows and is odourless. Our SmartBin attempts to do intelligent waste management. It empowers just-in-time collection, tearing down the unnecessary collection redundancy. Through this, the collectors will be informed when to empty & collect waste from the dustbins of the locality, in a timely fashion.

The SmartBin we've developed makes use of a sensor to measure trash-level waste inside it, based on that our device will notify the collector through short messaging service, alerting that a dustbin has become full and needs to be collected immediately. SMS system will make use of a GSM transceiver component.

We provide with a cloud-based interface to the collectors to monitor trash-level and exact location of SmartBins falling under their service zone, so that they can prepare well ahead of time. This will ensure that the collector knows when a SmartBin needs to be emptied, if avoided and the level is full then an SMS will be sent to the collector, notifying a priority handling of that particular dustbin.

### How does it work?



#### 1) Fill Level Measurement

Small battery powered sensors monitor each container's fill level in real time. The sensors are firmly attached and hidden away out of sight inside the container.



#### 2) Analysis and Monitoring

The Data from each container are sent over wireless cellular networks to the SmartBin Cloud or servers for analysis and then stored into azure cloud platform for further processing. The devices connected through our cloud services will get the current status and time to empty the bin.



#### 3) Route Planning and Optimization

You can automatically provide a list of containers with their locations and routes. Our team will share your route information and when your trash need to be emptied.

### 3. SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

SDLC is the acronym of Software Development Life Cycle. It is also called as Software development process. The software development life cycle (SDLC) is a framework defining tasks performed at each step in the software development process. ISO/IEC 12207 is an international standard for software life-cycle processes. It aims to be the standard that defines all the tasks required for developing and maintaining software.

SDLC is a process followed for a software project, within a software organization. It consists of a detailed plan describing how to develop, maintain, replace and alter or enhance specific software. The life cycle defines a methodology for improving the quality of software and the overall development process.

#### 3.1 WATERFALL MODEL

The Waterfall Model was first Process Model to be introduced. It is also referred to as a linear-sequential life cycle model. Waterfall model is the earliest SDLC approach that was used for software development. The waterfall Model illustrates the software development process in a linear sequential flow; hence it is also referred to as a linear-sequential life cycle model. This means that any phase in the development process begins only if the previous phase is complete. In waterfall model phases do not overlap.

##### 3.1.1 WATERFALL MODEL DESIGN

Waterfall approach was first SDLC Model to be used widely in Software Engineering to ensure success of the project. In "The Waterfall" approach, the whole process of software development is divided into separate phases. In Waterfall model, typically, the outcome of one phase acts as the input for the next phase sequentially.

The distinct phases of a typical Waterfall Model is shown below in figure 4.1, where each of the phases have a set of activities to be done to achieve that phase's objective. And the output of the phases acts as the input for successive phases.

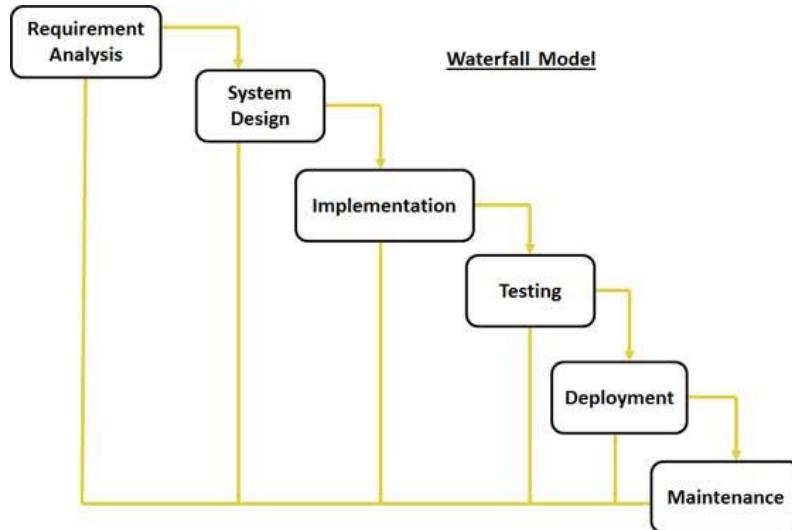


fig 4.1: The Waterfall Model

The sequential phases in Waterfall model are:

- **Requirement Gathering and analysis:** All possible requirements of the system to be developed are captured in this phase and documented in a requirement specification document
- **System Design:** The requirement specifications from first phase are studied in this phase and system design is prepared. System Design helps in specifying hardware and system requirements and also helps in defining overall system architecture.
- **Implementation:** With inputs from system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality which is referred to as Unit Testing.
- **Integration and Testing:** All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.
- **Deployment of system:** Once the functional and non-functional testing is done, the product is deployed in the customer environment or released into the market.
- **Maintenance:** There are some issues which come up in the client environment. To fix those issues patches are released. Also to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment.

All these phases are cascaded to each other in which progress is seen as flowing steadily downwards (like a waterfall) through the phases. The next phase is started only after the defined set of goals are achieved for previous phase and it is signed off, so the name "Waterfall Model". In this model phases do not overlap.

### 3.1.2 WATERFALL MODEL APPLICATION

Every software developed is different and requires a suitable SDLC approach to be followed based on the internal and external factors. Some situations where the use of Waterfall model is most appropriate are:

- Requirements are very well documented, clear and fixed
- Product definition is stable
- Technology is understood and is not dynamic
- There are no ambiguous requirements
- Ample resources with required expertise are available to support the product
- The project is short

### 3.1.3 WATERFALL PROS AND CONS

The advantage of waterfall development is that it allows for departmentalization and control. A schedule can be set with deadlines for each stage of development and a product can proceed through the development process model phases one by one. Development moves from concept, through design, implementation, testing, installation, troubleshooting, and ends up at operation and maintenance. Each phase of development proceeds in strict order. The disadvantage of waterfall development is that it does not allow for much reflection or revision. Once an application is in the testing stage, it is very difficult to go back and change something that was not well documented or thought upon in the concept stage.

PROS	CONS
<ul style="list-style-type: none"> <li>▪ Simple and easy to understand and use.</li> <li>▪ Easy to manage due to the rigidity of the model – each phase has specific deliverables and a review process.</li> <li>▪ Phases are processed and completed one at a time.</li> <li>▪ Works well for smaller projects where requirements are very well understood.</li> <li>▪ Clearly defined stages.</li> <li>▪ Well-understood milestones.</li> <li>▪ Easy to arrange tasks.</li> <li>▪ Process and results are well documented</li> </ul>	<ul style="list-style-type: none"> <li>▪ No working software is produced until late during the life cycle.</li> <li>▪ High amounts of risk and uncertainty.</li> <li>▪ Not a good model for complex and object-oriented projects.</li> <li>▪ Poor model for long and ongoing projects.</li> <li>▪ Not suitable for the projects where requirements are at a moderate to high risk of changing. So risk and uncertainty is high with this process model.</li> <li>▪ It is difficult to measure progress within stages.</li> </ul>

## 4. SCHEDULING

### 4.1 INTRODUCTION

Before any activity begins related to the work of a project, every project requires an advanced, accurate time estimate. Without an accurate estimate, no project can be completed within the budget and the target completion date.

Developing an estimate is a complex task. If the project is large and has many stakeholders, things can be more complex. Therefore, there have been many initiatives to come up with different techniques for estimation phase of the project in order to make the estimation more accurate.

To build complex software systems, many engineering tasks need to occur in parallel with one another to complete the project on time. The output from one task often determines when another may begin. Software engineers need to build activity networks that take these task interdependencies into account. Managers find that it is difficult to ensure that a team is working on the most appropriate tasks without building a detailed schedule and sticking to it. This requires that tasks are assigned to people, milestones are created, resources are allocated for each task, and progress is tracked.

Root Causes for Late Software:

- Unrealistic deadline established outside the team
- Changing customer requirements not reflected in schedule changes
- Underestimating the resources required to complete the project
- Risks that were not considered when project began
- Technical difficulties that complete not have been predicted in advance
- Human difficulties that complete not have been predicted in advance
- Miscommunication among project staff resulting in delays
- Failure by project management to recognize project failing behind schedule and failure to take corrective action to correct problems

### Project Scheduling Perspectives:

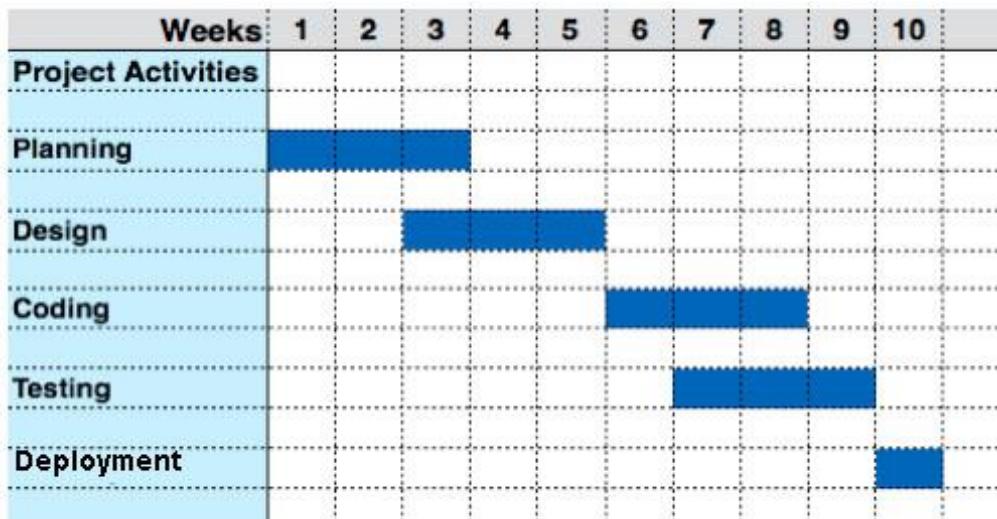
- Project scheduling is an activity that distributes estimated effort across the planned project duration by allocating the effort to specific software engineering tasks.
- One view is that the end-date for the software release is set externally and that the software organization is constrained to distribute effort in the prescribed time frame.

## 4.2 GANTT CHART

A Gantt chart, commonly used in project management, is one of the most popular and useful ways of showing activities (tasks or events) displayed against time. On the left of the chart is a list of the activities and along the top is a suitable time scale. Each activity is represented by a bar; the position and length of the bar reflects the start date, duration and end date of the activity.

This allows you to see at a glance:

- What the various activities are
- When each activity begins and ends
- How long each activity is scheduled to last
- Where activities overlap with other activities, and by how much
- The start and end date of the whole project



### 4.3 PROJECT EVALUATION AND REVIEW TECHNIQUE (PERT)

At the core, PERT is all about management probabilities. Therefore, PERT involves many simple statistical methods as well. Sometimes, people categorize and put PERT and CPM together. Although CPM (Critical Path Method) shares some characteristics with PERT, PERT has a different focus. Same as most of other estimation techniques, PERT also breaks down the tasks into detailed activities.

Then, a Gantt chart will be prepared illustrating the interdependencies among the activities. Then, a *network* of activities and their interdependencies are drawn in an illustrative manner.

In this map, a *node* represents each event. The activities are represented as arrows and they are drawn from one event to another, based on the sequence.

Next, the Earliest Time (TE) and the Latest Time (TL) are figured for each activity and identify the slack time for each activity.

When it comes to deriving the estimates, the PERT model takes a statistical route to do that. We will cover more on this in the next two sections.

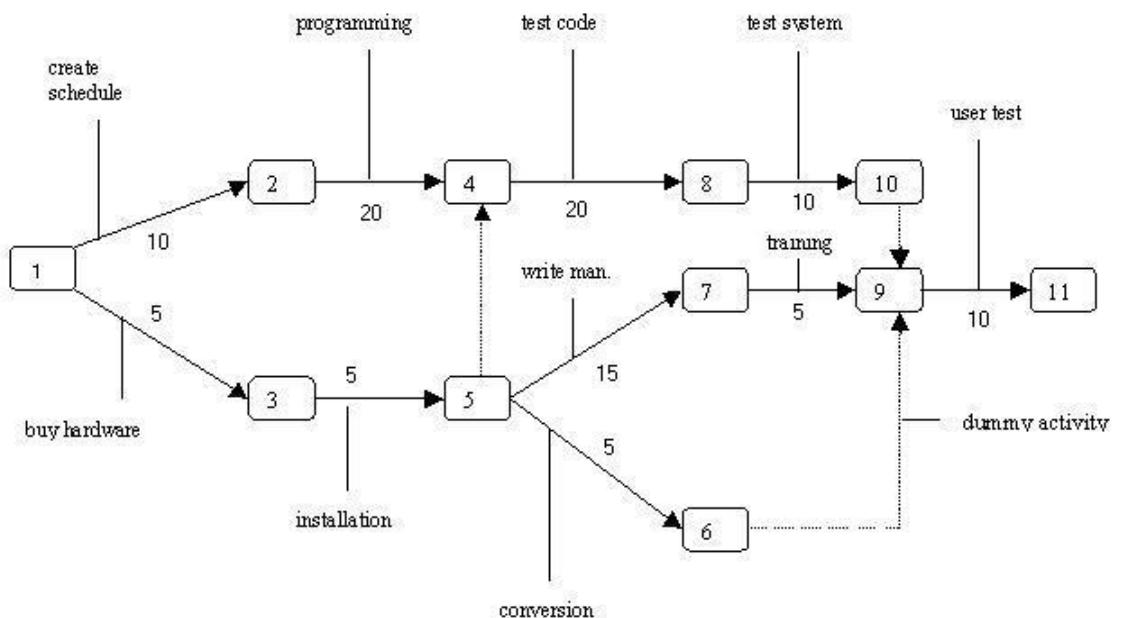


Fig. 1:  
PERT Chart

- \* Numbered rectangles are nodes and represent events or milestones.
- \* Directional arrows represent dependent tasks that must be completed sequentially.
- \* Diverging arrow directions (e.g. 1-2 & 1-3) indicate possibly concurrent tasks.
- \* Dotted lines indicate dependent tasks that do not require resources.

## 5. REQUIREMENT ENGINEERING

To be used efficiently, all computer software needs certain hardware components or other software resources to be present on a computer. These prerequisites are known as system requirements and are often used as a guideline as opposed to an absolute rule. Most software defines two sets of system requirements: minimum and recommended. With increasing demand for higher processing power and resources in newer versions of software, system requirements tend to increase over time.

The following are the list of hardware components that we've used:

1. Arduino UNO
2. GSM Modem Module SIM 900A
3. HC-SR04 Ultrasonic Sensor
4. Smartphones capable of running Android and/or Windows applications.

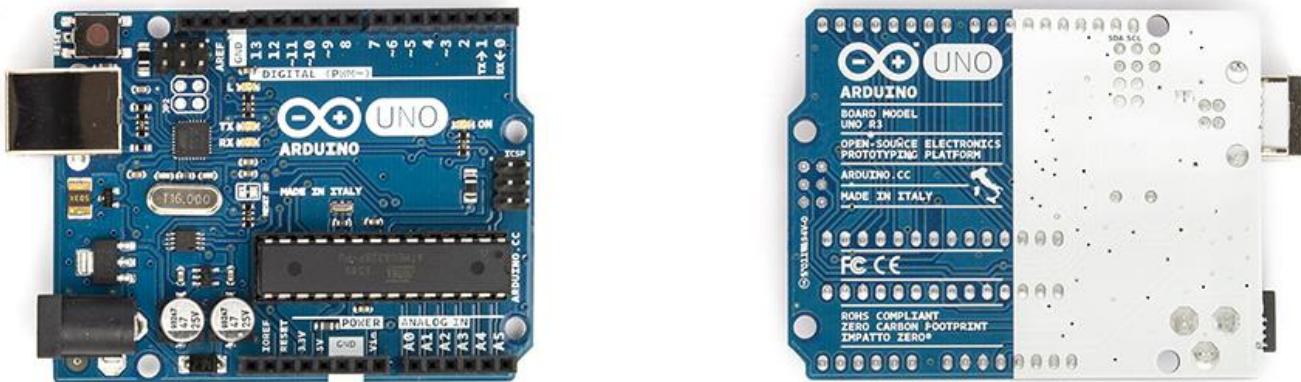
### 5.1 ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Revision 3 of the board has the following new features:

- 1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

*UNO* means one in Italian and is named to mark the release of Arduino 1.0. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform;



## Features

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

## Power

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1 mm centre-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- VIN: The input voltage to the Arduino board when it's using an external power source
- 5V: This pin outputs a regulated 5V from the regulator on the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50mA.
- GND: Ground pins.

## Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

## Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the `analogWrite()` function.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- The Uno has 6 analog inputs, labelled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values).

There are a couple of other pins on the board:

- AREF: Reference voltage for the analog inputs. Used with `analogReference()`.
- Reset: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

## Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which

is available on digital pins 0 (RX) and 1 (TX). On Windows, **a.inf** file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.

## Programming

The Arduino Uno can be programmed with the Arduino software. Select "Arduino Uno" from the Tools > Board menu (according to the microcontroller on your board). The ATmega328 on the Arduino Uno comes pre-burned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

## USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

## Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

## Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment.

## 5.2 GSM MODEM MODULE SIM900A

SIM900A Modem is built with Dual Band GSM/GPRS based SIM900A modem from SIMCOM. It works on frequencies 900/ 1800 MHz SIM900A can search these two bands automatically. The frequency bands can also be set by AT Commands. The baud rate is configurable from 1200-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS.

SIM900A is an ultra-compact and reliable wireless module. This is a complete GSM/GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core, allowing you to benefit from small dimensions and cost-effective solutions.



### Features

- GPRS multi-slot class 10/8
- GPRS mobile station class B
- Compliant to GSM phase 2/2+
- Class 4 (2 W @850/ 900 MHz)
- Class 1 (1 W @ 1800/1900MHz)
- Control via AT commands (GSM 07.07, 07.05 and SIMCOM enhanced AT Commands)
- Low power consumption: 1.5mA(sleep mode)
- Operation temperature: -40°C to +80 °C

**Specifications for GPRS**

- GPRS class 10
- Max. 85.6 kbps (downlink)
- Max. 42.8 kbps (uplink)
- PBCCH (Support packet Switched Broadcast Control Channel) support
- Coding schemes CS 1, 2, 3, 4

**Specifications for SMS via GSM/GPRS**

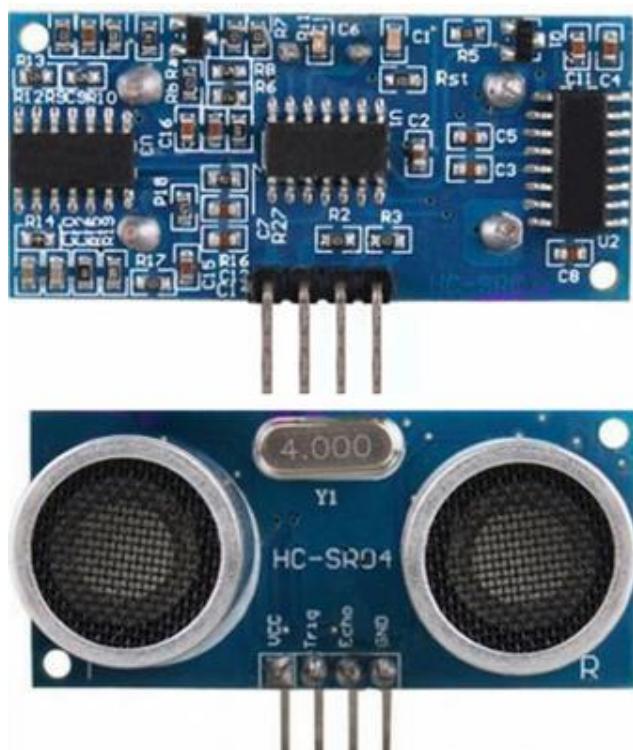
- Point to point MO and MT
- SMS cell broadcast
- Text and PDU mode

**Software features**

- 0710 MUX protocol
- Embedded TCP/UDP protocol
- FTP/HTTP
- FOTA
- MMS
- Embedded AT
- AT cellular command interface

### 5.3 HC-SR04 ULTRASONIC SENSOR

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. From 2cm to 400 cm or 1" to 13 feet. Its operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.



#### Features

- Power Supply :+5V DC
- Quiescent Current : < 2mA
- Working Current: 15mA
- Effectual Angle: < 15°
- Ranging Distance : 2cm – 400 cm/1" - 13ft
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm

## Connector PINS

- VCC: +5VDC
- Trig: Trigger input of Sensor
- Echo: Echo output of Sensor
- GND: Ground

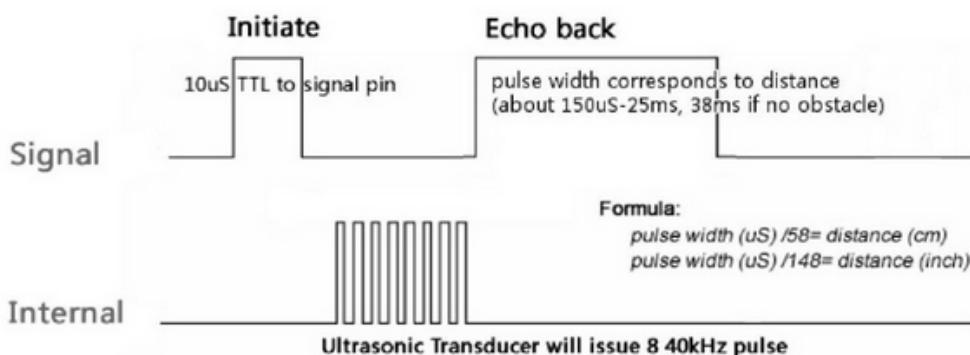
## Specification and Limitation

Parameter	Min	Typical	Max	Unit
Operating Voltage	4.50	5.0	5.5	V
Quiescent Current	1.5	2	2.5	mA
Working Current	10	15	20	mA
Ultrasonic Frequency	-	40	-	kHz

## Operation

The timing diagram of HC-SR04 is shown. To start measurement, Trig of SR04 must receive a pulse of high (5V) for at least 10us, this will initiate the sensor will transmit out 8 cycle of ultrasonic burst at 40kHz and wait for the reflected ultrasonic burst. When the sensor detected ultrasonic from receiver, it will set the Echo pin to high (5V) and delay for a period (width) which proportion to distance. To obtain the distance, measure the width (Ton) of Echo pin.

- Time = Width of Echo pulse, in micro second
- Distance in centimetres = Time / 58
- Distance in inches = Time / 148
- Or you can utilize the speed of sound, which is 340m/s



## 6. TECHNOLOGIES USED

### 6.1 ANDROID OPEN SOURCE PROJECT (AOSP) – PLATFORM

Android is a mobile operating system based on the Linux kernel and currently developed by Google. With a user interface based on direct manipulation, Android is designed primarily for touchscreen mobile devices such as smartphones and tablet computers, with specialized user interfaces for televisions (Android TV), cars (Android Auto), and wrist watches (Android Wear). The OS uses touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching, and reverse pinching to manipulate on-screen objects, and a virtual keyboard. Despite being primarily designed for touchscreen input, it also has been used in game consoles, digital cameras, regular PCs and other electronics.



### 6.2 ANDROID SOFTWARE DEVELOPMENT KIT (SDK)

The Android software development kit (SDK) includes a comprehensive set of development tools. These include a debugger, libraries, a handset emulator based on QEMU, documentation, sample code, and tutorials. Currently supported development platforms include computers running Linux (any modern desktop Linux distribution), Mac OS X 10.5.8 or later, and Windows XP or later. As of March 2015, the SDK is not available on Android itself, but the software development is possible by using specialized Android applications.

## 6.3 ANDROID STUDIO

Android Studio is an integrated development environment (IDE) for developing on the Android platform. It was announced on May 16, 2013 at the Google I/O conference by Google's Product Manager, Katherine Chou. Android Studio is freely available under the Apache License 2.0.

Based on JetBrains' IntelliJ IDEA software, Android Studio is designed specifically for Android development. It is available for download on Windows, Mac OS X and Linux and replaced Eclipse Android Development Tools (ADT) as Google's primary IDE for native Android application development.

### Features

- Live Layout: WYSIWYG Editor - Live Coding - Real-time App Rendering.
- Gradle-based build support
- Android-specific refactoring and quick fixes
- Lint tools to catch performance, usability, version compatibility and other problems
- ProGuard and app-signing capabilities
- Template-based wizards to create common Android designs and components
- A rich layout editor that allows users to drag-and-drop UI components, option to preview layouts on multiple screen configurations
- Support for building Android Wear apps
- Built-in support for Google Cloud Platform, enabling integration with Google Cloud Messaging and App Engine

## 6.4 MICROSOFT AZURE

Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed datacentres. It provides both PaaS and IaaS services and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems. Azure was released on 1 February 2010.

Scaling and reliability are controlled by the Microsoft Azure Fabric Controller so the services and environment do not crash if one of the servers crashes within the Microsoft data centre and provides the management of the user's web application like memory resources and load balancing.

Azure provides an API built on REST, HTTP, and XML that allows a developer to interact with the services provided by Microsoft Azure. Microsoft also provides a client-side managed class library which encapsulates the functions of interacting with the services. It also integrates with Microsoft Visual Studio, Git, and Eclipse.

## Features

*Infrastructure Services* - Provision Windows and Linux Virtual Machines and applications in minutes. Microsoft's hybrid consistency enables you to use the same VMs and management tools in Azure that you use on-premises.

*Develop Modern Applications* - Azure provides features to build and deploy a wide variety of applications – including web, mobile, media and line-of-business solutions. Built-in AutoScale features enable you to dynamically scale up and down to meet any needs.

*Insights from Data* - Azure provides managed SQL and NoSQL data services, and built-in support for analyzing and helping you gain insights from your data. Leverage the full power of SQL Server in the cloud as well as use HDInsight to build Hadoop clusters to analyze data.

*Identity and Access Management* - Windows Azure Active Directory is a comprehensive identity and access management cloud solution.

## 6.4 MICROSOFT VISUAL STUDIO

Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web applications and web services. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silverlight. It can produce both native code and managed code.

Visual Studio supports different programming languages and allows the code editor and debugger to support (to varying degrees) nearly any programming language, provided a language-specific service exists. Built-in languages include C, C++ and C++/CLI (via Visual C++), VB.NET (via Visual Basic .NET), C# (via Visual C#), and F# (as of Visual Studio 2010).

## 6.5 AZURE SQL DATABASE

Microsoft Azure SQL Database is a cloud-based service from Microsoft offering data-storage capabilities as a part of the Azure Services Platform. Unlike similar cloud-based databases, SQL Database allows users to make relational queries against stored data, which can either be structured or semi-structured, or even unstructured documents. SQL Database features querying data, search, data analysis and data synchronization. SQL Database uses a special version of Microsoft SQL Server as its backend. It exposes a subset of the full SQL Server functionality, including only a subset of the data types — including string, numeric, date and boolean. It uses an XML-based format for data transfer.

## 7. SYSTEM ENGINEERING

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Systems design could be seen as the application of systems theory to product development. There is some overlap with the disciplines of systems analysis, systems architecture and systems engineering.

### 7.1 ARCHITECTURAL DESIGN

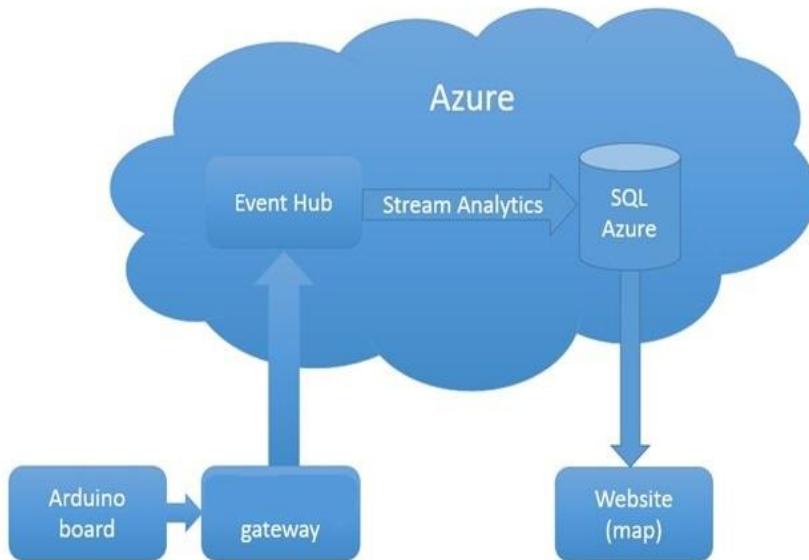
**Software architecture** is the high level structure of a software system, the discipline of creating such structures, and the documentation of these structures. It is the set of structures needed to reason about the software system, and comprises the software elements, the relations between them, and the properties of both elements and relations

**IEEE 1471** is a superseded IEEE Standard for describing the architecture of a "software-intensive system", also known as software architecture.

According to **IEEE 1471**, an architectural description can be used for the following:

- Expression of the system and its evolution
- Communication among the system stakeholders
- Evaluation and comparison of architectures in a consistent manner
- Planning, managing, and executing the activities of system development
- Expression of the persistent characteristics and supporting principles of a system to guide acceptable change
- Verification of a system implementation's compliance with an architectural description

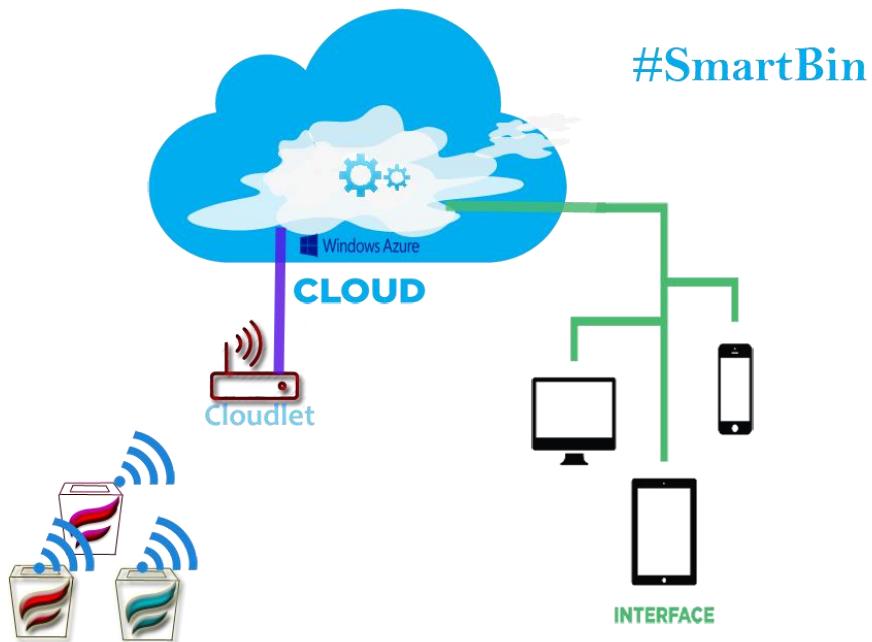
Figure 7.1 below shows the basic architecture of our system in which an Arduino UNO board is interfacing with a gateway through GSM transceiver and sends the data to Azure Cloud service. And from there the data is being visualized in our Web App and mobile apps.



**Figure # 7.1: Architecture of the connection between Arduino and Azure**

The Event Hub waits for the update event from the gateway and then streams updated data into the SQL Azure or more generally termed as Azure SQL databases. Now as all of our data is in cloud, we use this data to show the locations and fill levels of trash in our SmartBin. We provide a cloud-based interface to the collectors as well as the users, to monitor trash-level and exact location of SmartBins falling under their service zone, so that they can prepare well ahead of time.

Figure 7.2 shows our overall project architecture and displays how our SmartBins are connected with the cloud services, leading to the formation of an **Internet of SmartBins** with the client side interfaces.



**Figure #7.2: Our project architecture as internet of SmartBins**

## 7.2 LOGICAL DESIGN

### E-R Diagram (Entity-Relationship Diagram)

An Entity Relationship(ER) diagram is a specialized graphic that illustrates the relationships between entities in a database. ER diagram often use symbols to represent three different types of information. Boxes are commonly used to represent entities. Diamonds are normally used to represent relationships and ovals are used to represent attributes.

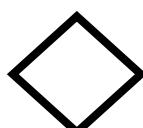
ER diagram are used to organise data as a relation, normalizing relations and finally obtaining a relational database model.

Elements of an ER diagram are:

- **ENTITY:** This specifies the real life objects and is represented as:



- **RELATIONSHIPS:** These connect entities and establish meaningful dependencies between them and are represented by :



- **ATTRIBUTES:** They specify the properties of entities and are represented by



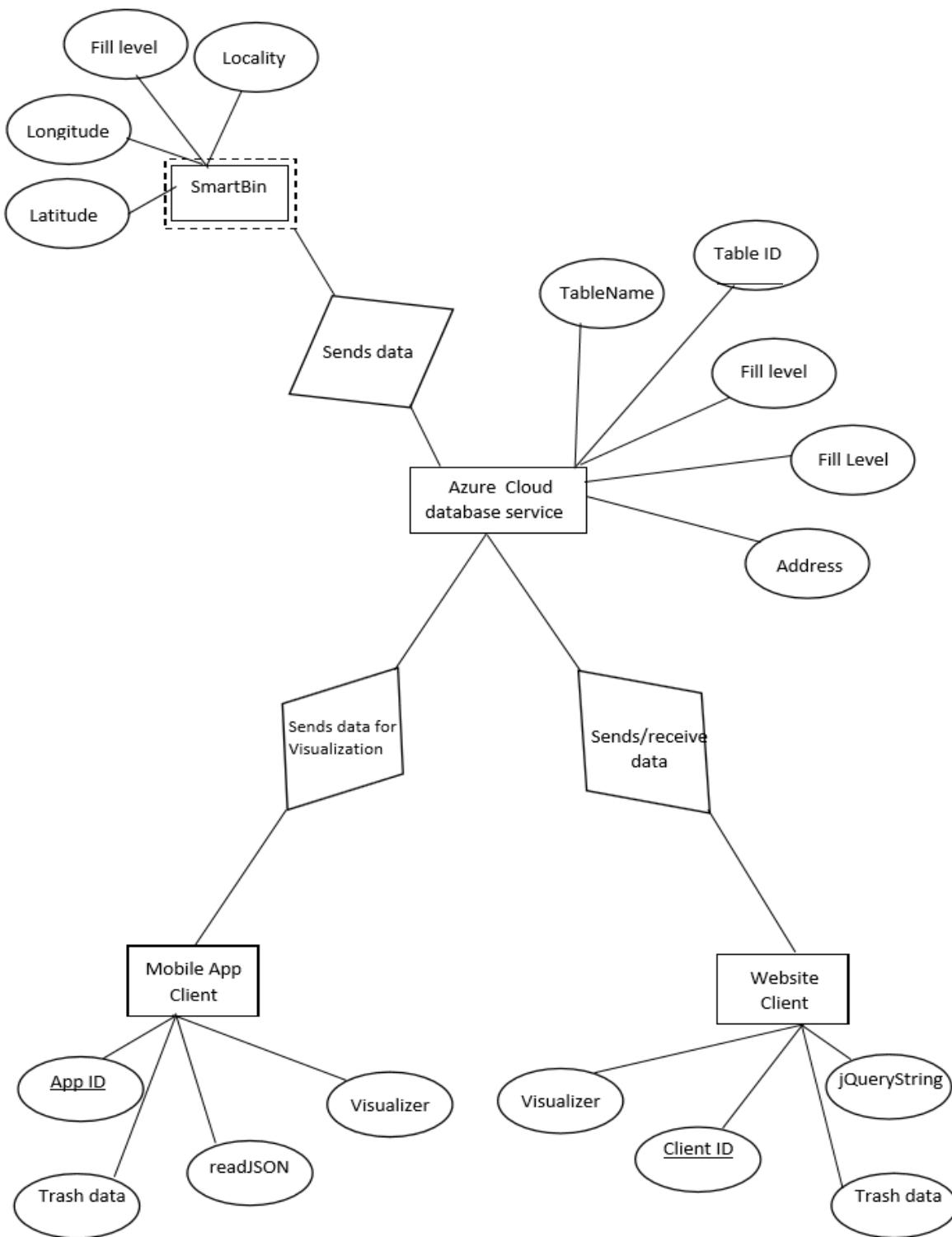


Figure 7.3: Entity-Relationship Diagram of SmartBin system

## Data Flow Diagram

The Physical Dataflow Diagram shows the actual implementation and movement of data between people, departments, and workstations. Each component of a DFD is labelled with a descriptive name. Process names are further numbered that will be used for identification purposes.

The number assigned to a specific process does not correspond to the sequence of processes. It is strictly for identification purposes. A data flow diagram allows parallel activities i.e., a number of data flows coming out from the source and going into the destination.

### NOTATIONS:

- Data-Flows show the movement of data in a specific direction from the source to the destination.  
It represents a packet of data.

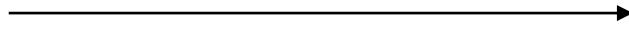


Fig: Data Flow

- Processes show the operations performed on the data, which transform it from input to output.

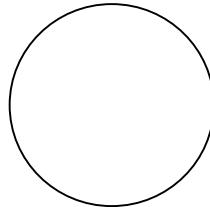


Fig: Process

- Sources and destinations of data, which may be people, programs, organisations, or other entities interacting with the system, but are outside its boundary.

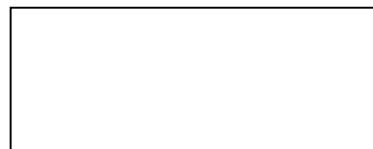


Fig: External Entity

- Data stores are placed where data are stored such as files and tables.
- 
- 

Fig: Data Source

- The output symbol is used when a hard copy is produced.

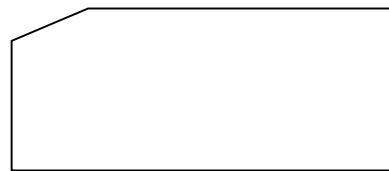


Fig: Output

Data Flow Diagram:

Context Level (0-Level):

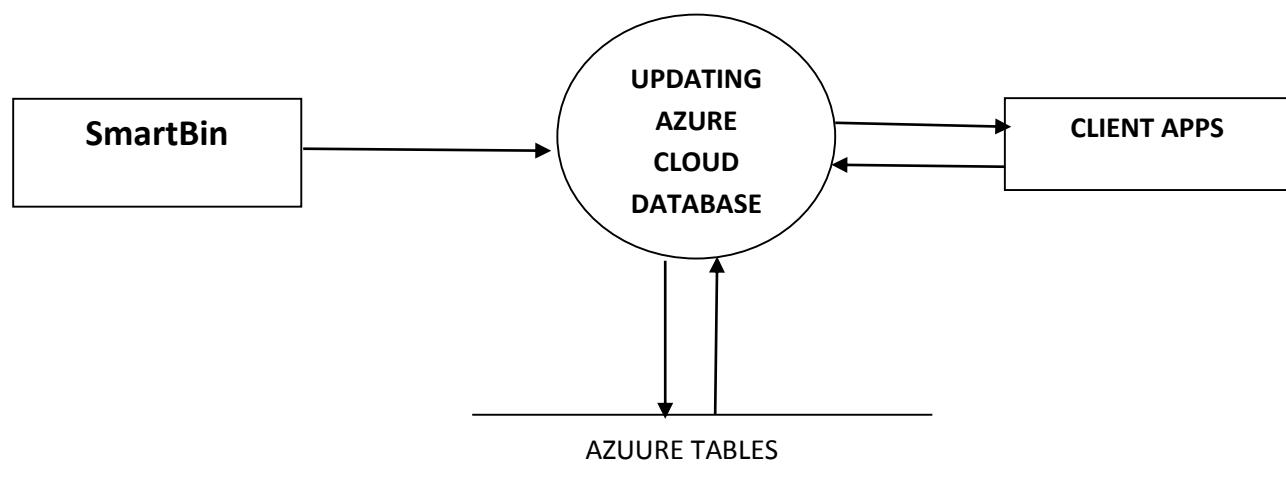


Figure: Abstract Physical Dataflow Diagram

## Level 1:

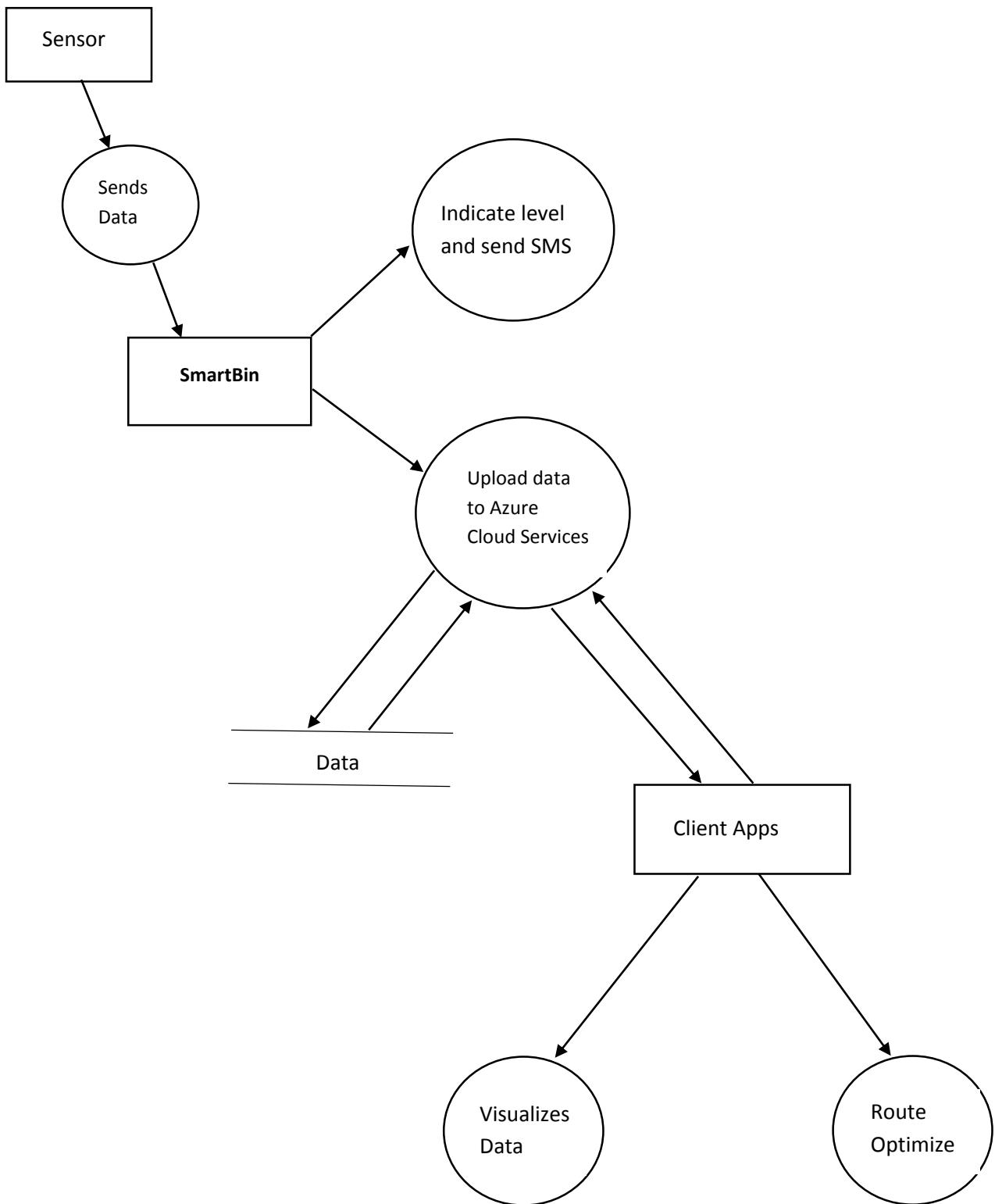


Figure: The Physical Dataflow Diagram of SmartBin

### 7.3 PHYSICAL DESIGN

In integrated circuit design, physical design is a step in the standard design cycle which follows after the circuit design. At this step, circuit representations of the components (devices and interconnects) of the design are converted into geometric representations of shapes which, when manufactured in the corresponding layers of materials, will ensure the required functioning of the components. This geometric representation is called integrated circuit layout.

So here is the basic physical design and the connection between different component in the below figure 7.3.

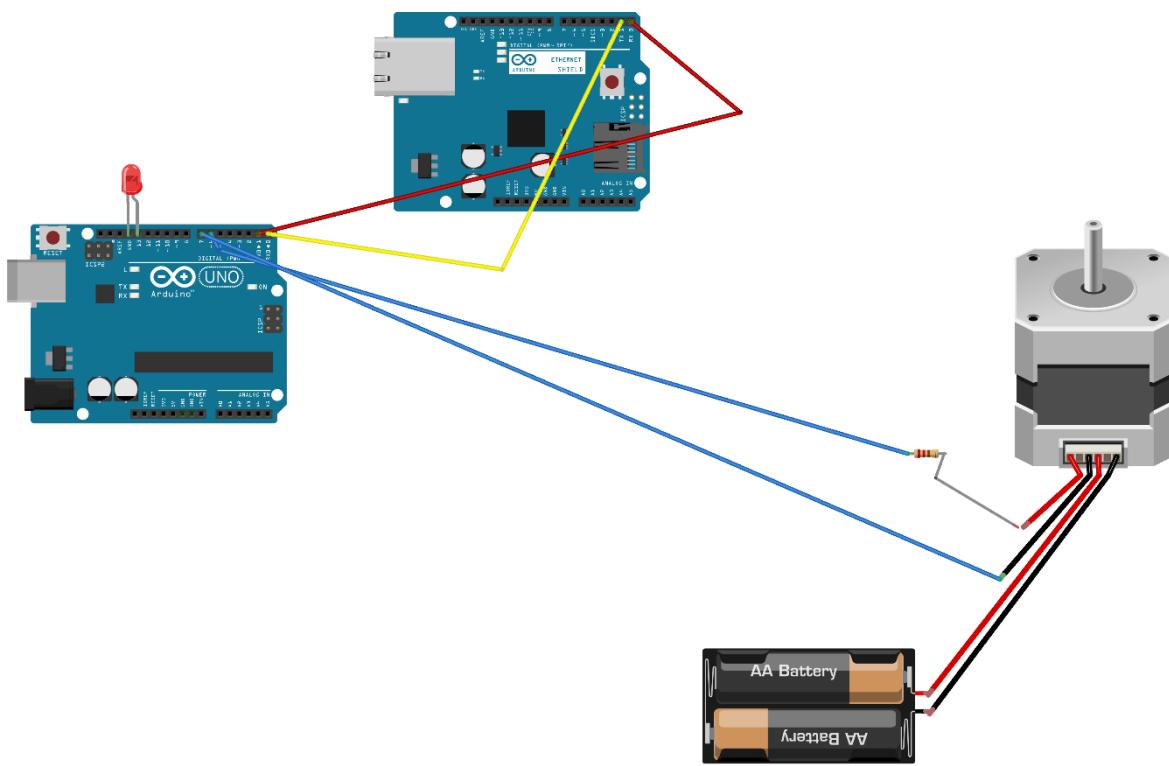
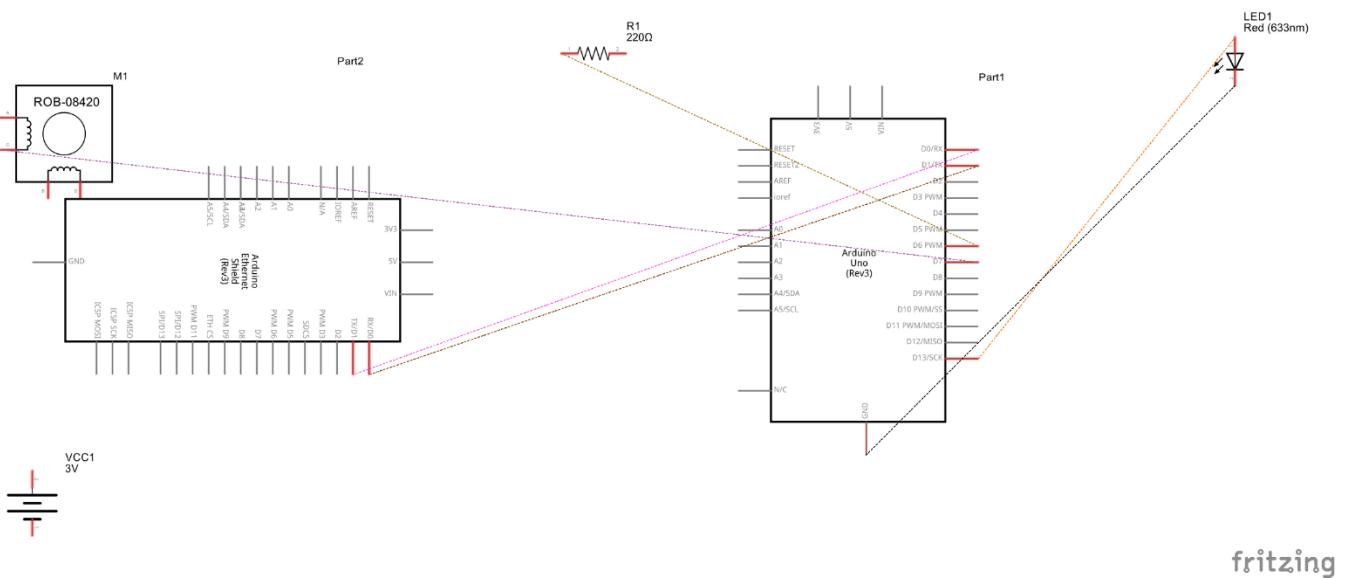


Figure 7.3: Physical connection layout of Arduino board, GSM module, sensor motor and external power source  
(designed in fritzing design software)

The circuit diagram of the physical connection is as follows:



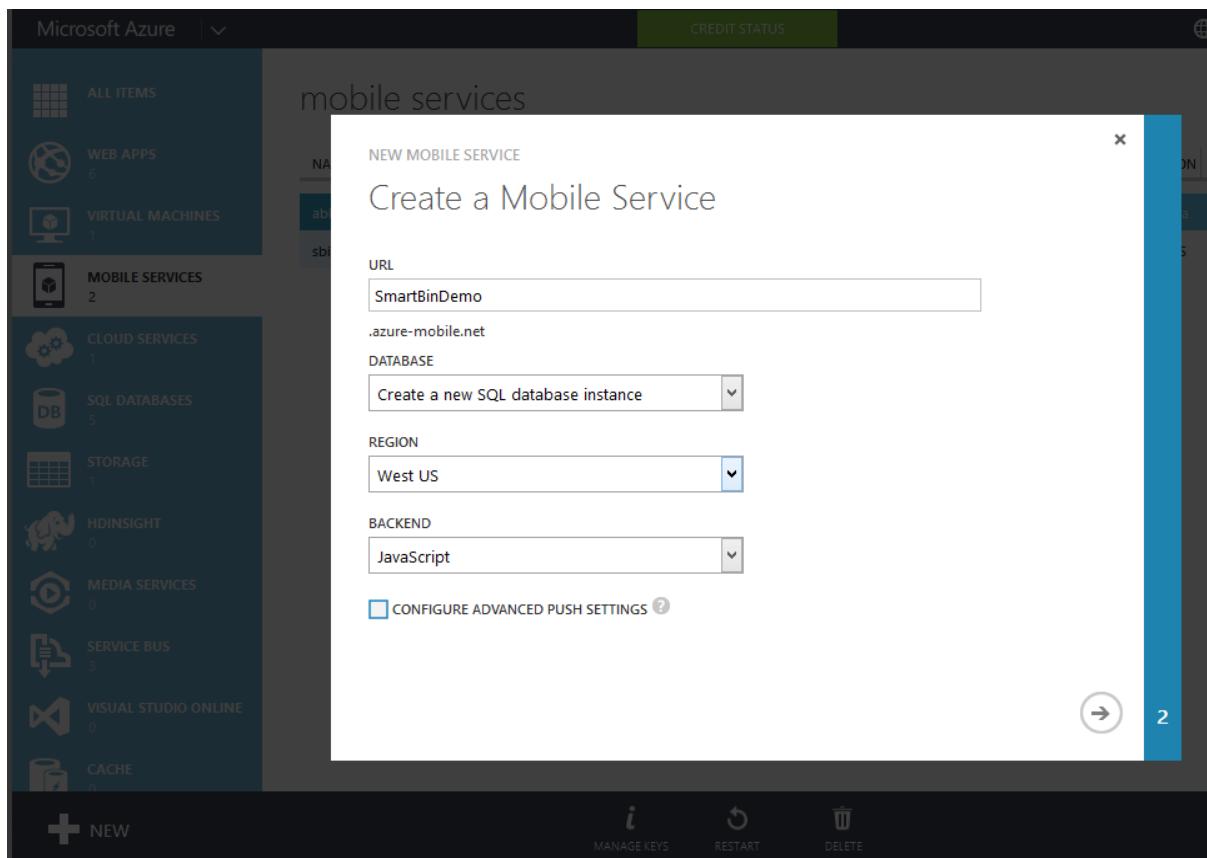
## 7.4 DATABASE DESIGN:

We are using Azure Mobile Services to connect our Arduino Uno device to the Cloud which is the very basic component of our SmartBins .Azure Mobile Services, as its name implies, is intended to provide a scalable and secure backend for mobile applications running on any platform.

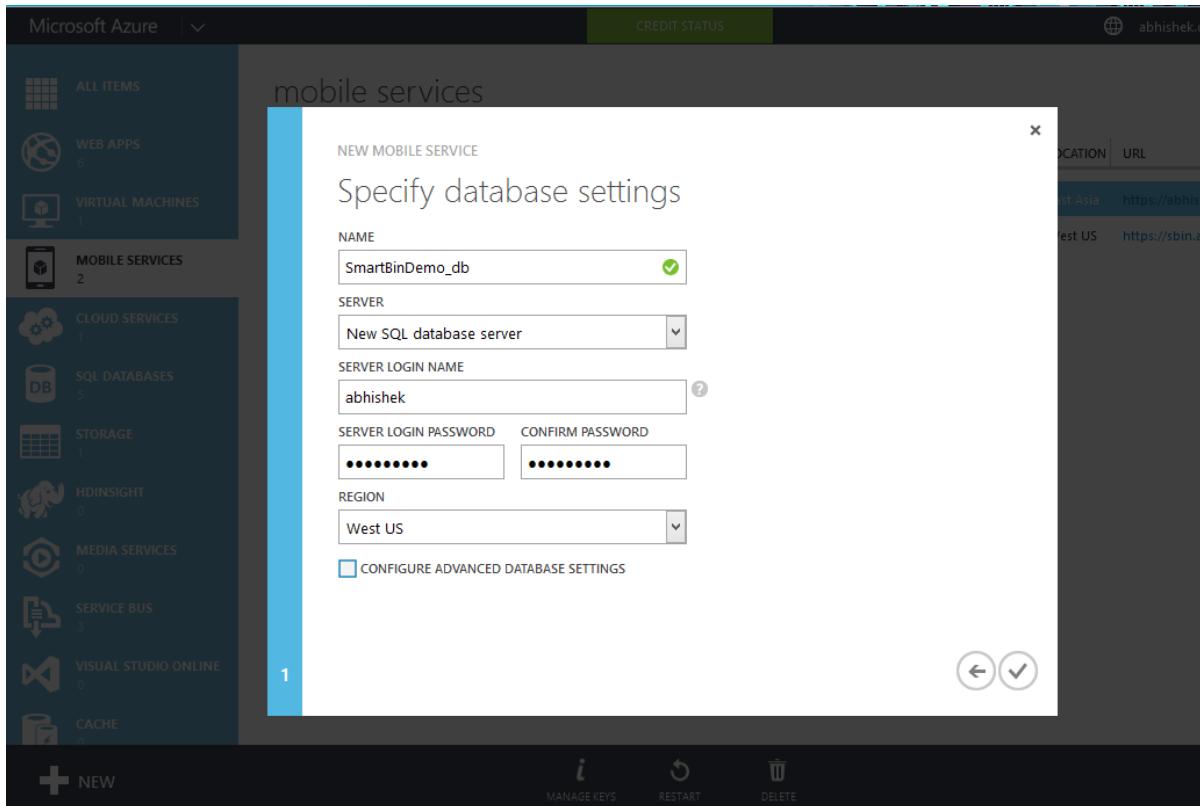
On the software side, we will use the standard Arduino IDE, which includes an Ethernet library and GSM library to easily connect to network resources.

### Creating a Mobile Service backend

Creating a Mobile Service backend couldn't be easier. Using the Web management portal, click on New, then Compute, Mobile Service, Create. We will have to choose a public URL for your service, a region where your service will be created, and the language you want to use: in our project we will use JavaScript. As part of the service, we created an Azure SQL Database that will be used to store our data.

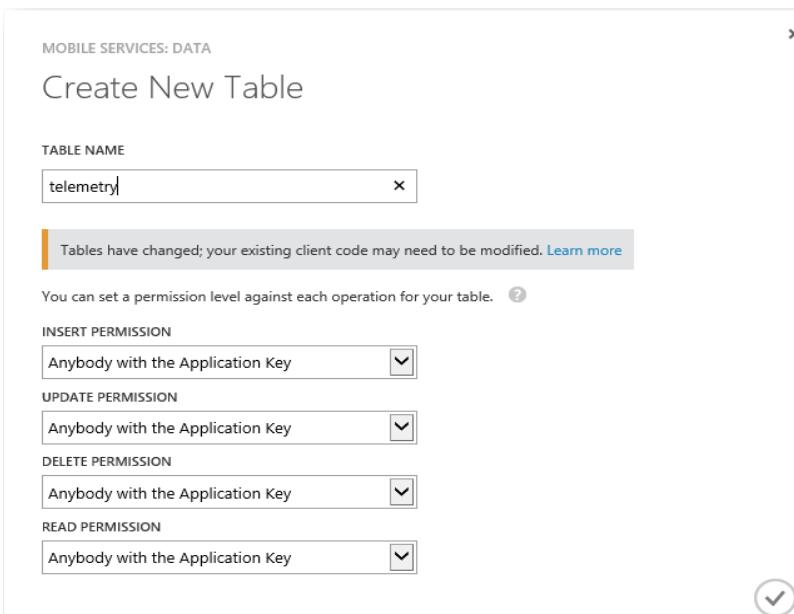


The next screen will ask you the details about database: most importantly the server that will host it.



## Creating a Table

Now that our service is created, we can add tables easily in our database. Azure Mobile Services offers a built-in NoSQL data API in the form of simple tables. Since we want to send some data from SmartBin. We create a new table. Since this is NoSQL, we don't have to specify a schema for the data as it can automatically create schemas for the table. We can give specific permissions like access to the insert/update/delete/read operations also.



Now our table and Azure Mobile services are up and ready to get sensor data. The different columns and indexes of our table are shown in the below figure.

COLUMN NAME	TYPE	INDEX
<code>id</code>	string	✓ Indexed
<code>__createdAt</code>	date	✓ Indexed
<code>__updatedAt</code>	date	
<code>__version</code>	timestamp (MSSQL)	
<code>__deleted</code>	boolean	
<code>title</code>	string	
<code>value</code>	string	
<code>lat</code>	string	
<code>lng</code>	string	

The main columns of our table are as follows:

- Id (string): Unique ID
- Title (string) : Which stores the name of locality of SmartBins
- Value (string): The current reading of sensor data
- Lat (string): latitude
- Lng (string): longitude
- `__createdAt(date)`
- `__updatedAt (date)`
- `__version ( timestamp)`

The sensor generated data is now ready to be stored in our Azure database. Let's suppose a scenario when two SmartBins located at Ranchi and Ormanjhi are sending the information about their trash

level. This data then Posted to our cloud servers and thus get saved in our jsondata table. The below is the screenshot of the data received in Azure Cloud service jsondata table.

The screenshot shows the Microsoft Azure portal interface. The top navigation bar includes 'Microsoft Azure' with a dropdown, a green 'CREDIT STATUS' button, and a user account icon with the email 'abhishek.official@live.com'. The main content area is titled 'jsondata' under the 'COSMOS DB' section. On the left, a sidebar lists various database collections: 'contact', 'Item', 'jsondata' (which is selected and highlighted in blue), 'telemetry', and 'user'. Below these are icons for 'Cloud', 'DB', 'Table', 'Event Hubs', 'File', 'Queue', and 'Table Storage'. At the bottom of the sidebar is a 'NEW' button with a plus sign. The main workspace shows a table with the following data:

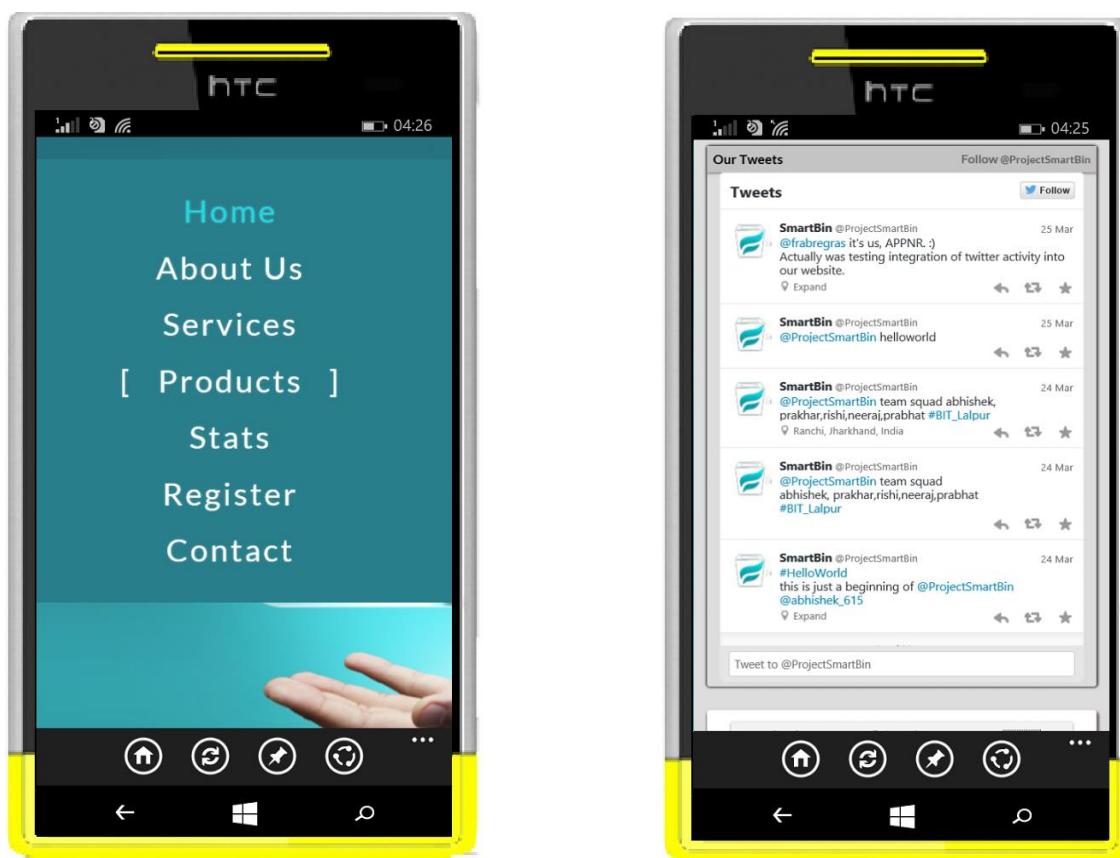
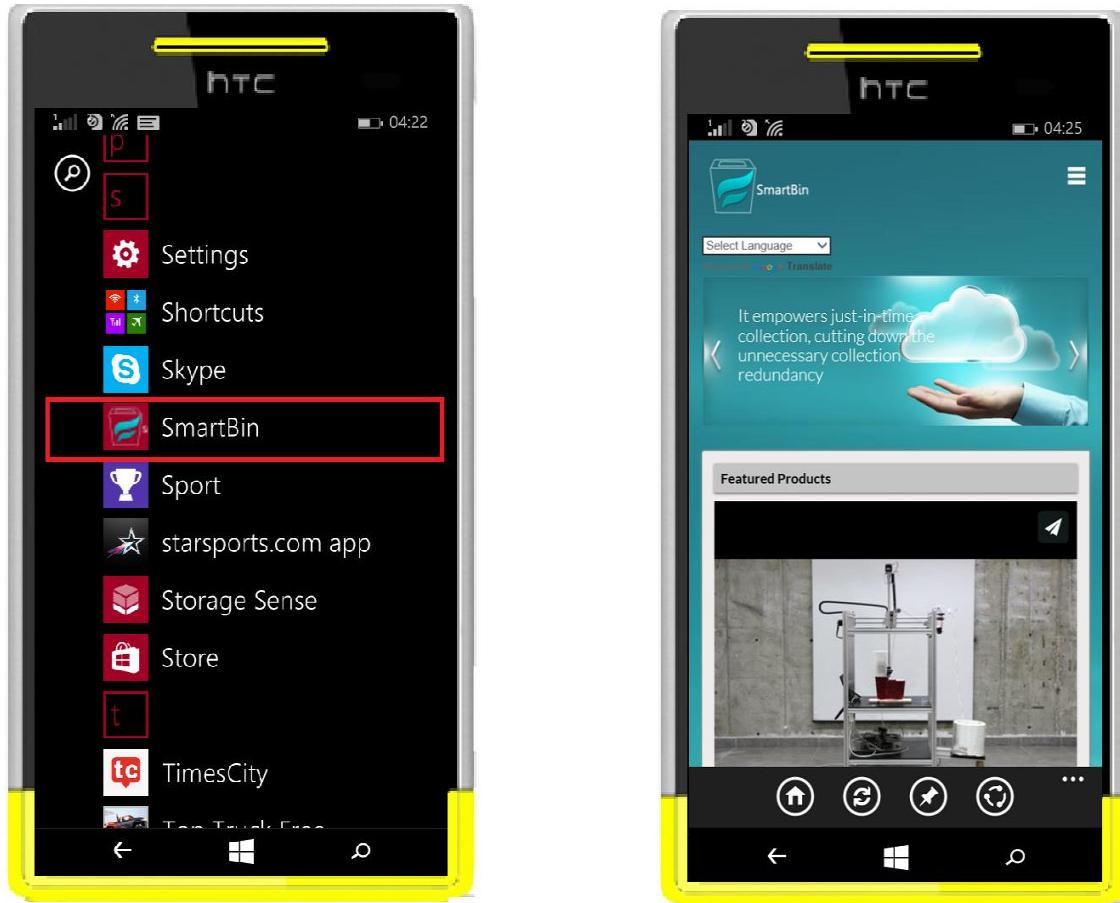
BROWSE	SCRIPT	COLUMNS	PERMISSIONS																		
<table border="1"><thead><tr><th>id</th><th>title</th><th>value</th><th>lat</th><th>long</th><th>_createdAt</th></tr></thead><tbody><tr><td>7E19DB62-FA06-4854-B2...</td><td>ranchi</td><td>50</td><td>72.098</td><td>88.00</td><td>2015-04-28T18:00:38</td></tr><tr><td>FCECF8BA-75EA-4837-9C6...</td><td>ormanjhi</td><td>39</td><td>72.01</td><td>88.55</td><td>2015-04-28T18:01:13</td></tr></tbody></table>				id	title	value	lat	long	_createdAt	7E19DB62-FA06-4854-B2...	ranchi	50	72.098	88.00	2015-04-28T18:00:38	FCECF8BA-75EA-4837-9C6...	ormanjhi	39	72.01	88.55	2015-04-28T18:01:13
id	title	value	lat	long	_createdAt																
7E19DB62-FA06-4854-B2...	ranchi	50	72.098	88.00	2015-04-28T18:00:38																
FCECF8BA-75EA-4837-9C6...	ormanjhi	39	72.01	88.55	2015-04-28T18:01:13																

## 8. USER INTERFACE DESIGN

### Windows Phone App Interfaces

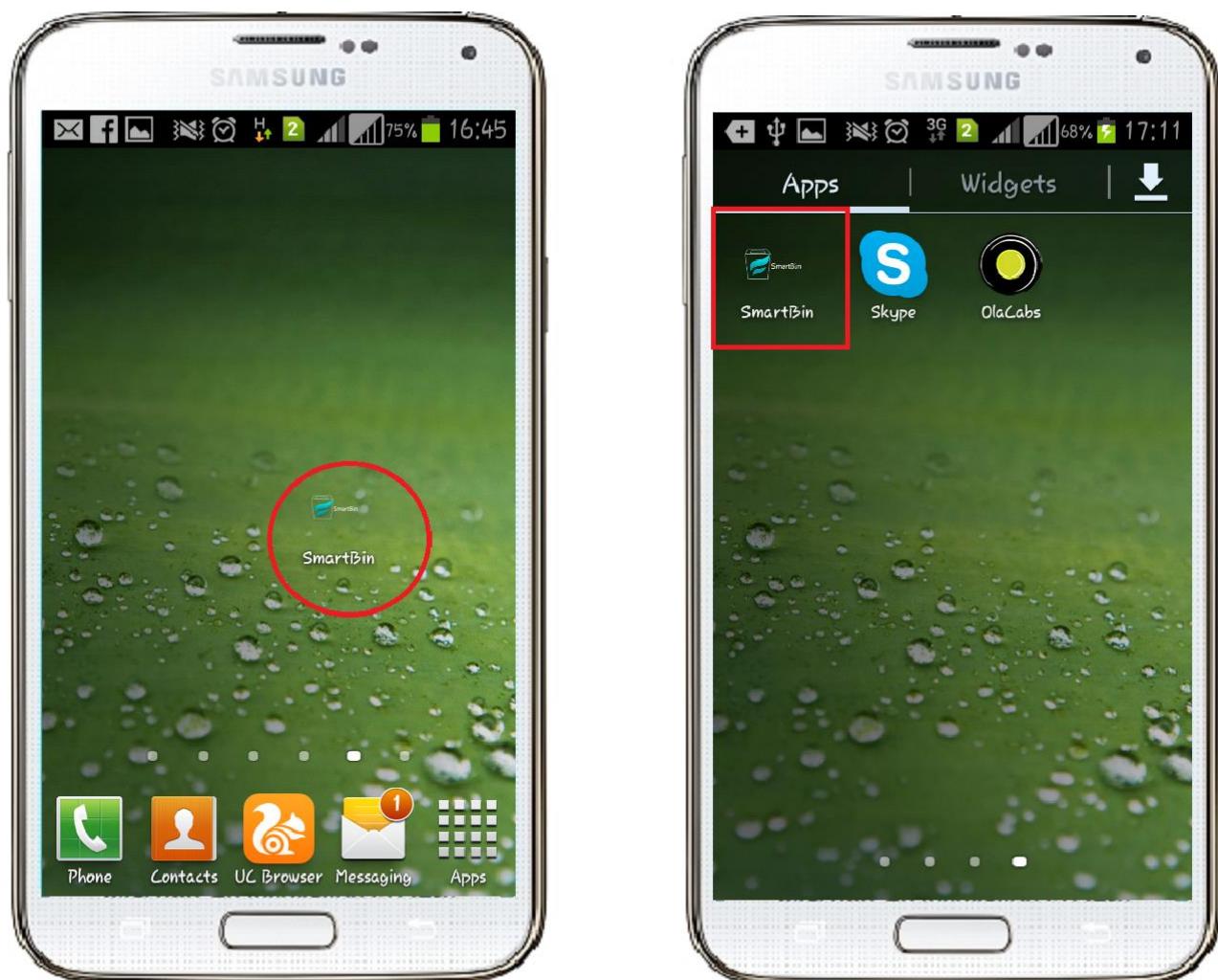
- Our App's live Tile in Start Screen of Windows Phone 8.1, Our App in app menu and App Pages

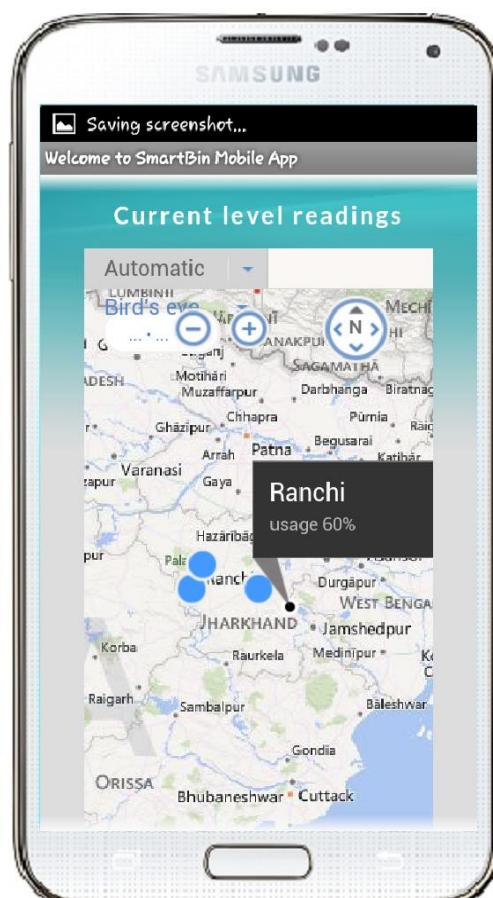
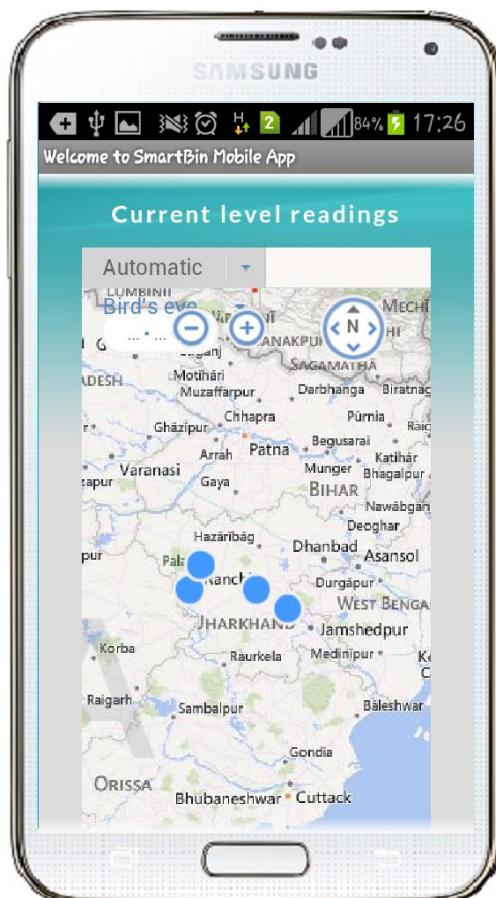
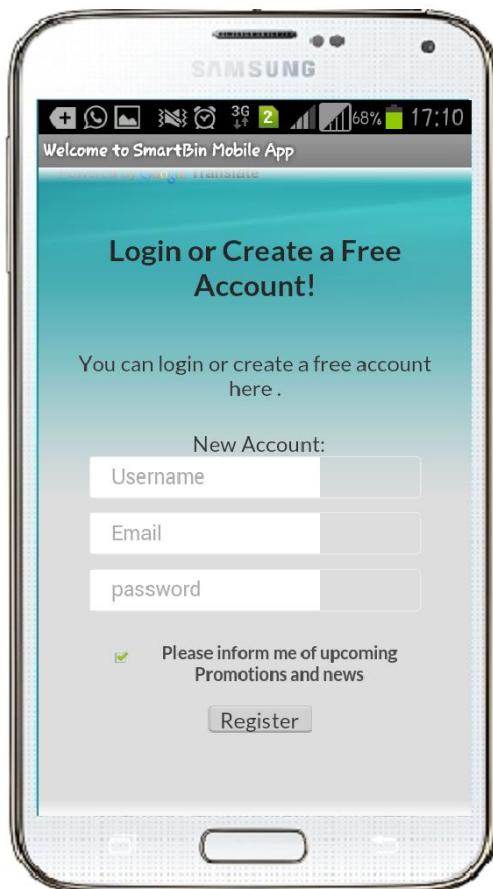
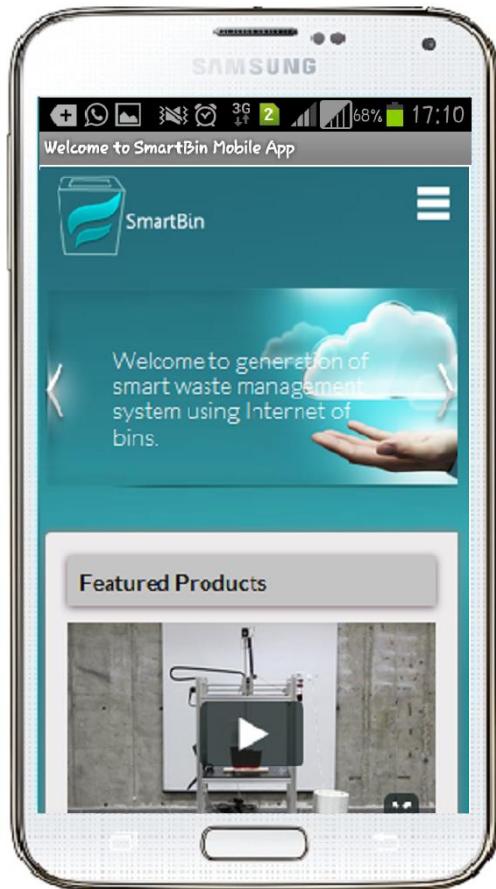




## Android Mobile App Interfaces

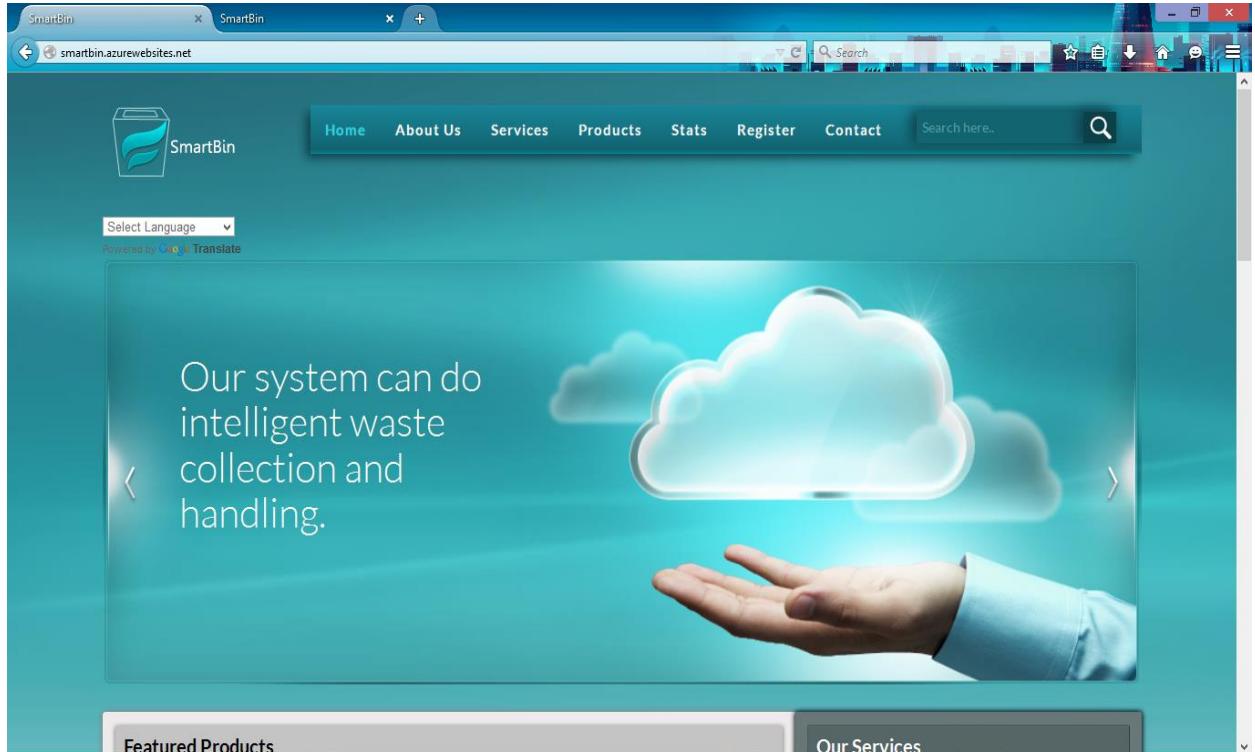
- Our App in Start Screen of Android, Our App in app menu and App Pages





## WebPages

### 1. Index.html (homepage)



**Featured Products**

**Our Services**

**SmartBin-An innovation to clean India**

We're developing a solution to facilitate waste handling and collection process easily. A waste bin needs to be emptied/collected by the local trash-collectors many times in a week to ensure that there are no overflows and is useable. Our system attempts to do intelligent waste collection and handling. It empowers just-in-time collection, cutting down the unnecessary collection redundancy. Through this, the collectors will be informed when to empty & collect stuffs from the dustbins of the locality, in a timely fashion. We're employing a sensor to measure trash-level of the dustbin, based on the level it will notify the collector through an SMS, that a dustbin has become full and needs to be collected.

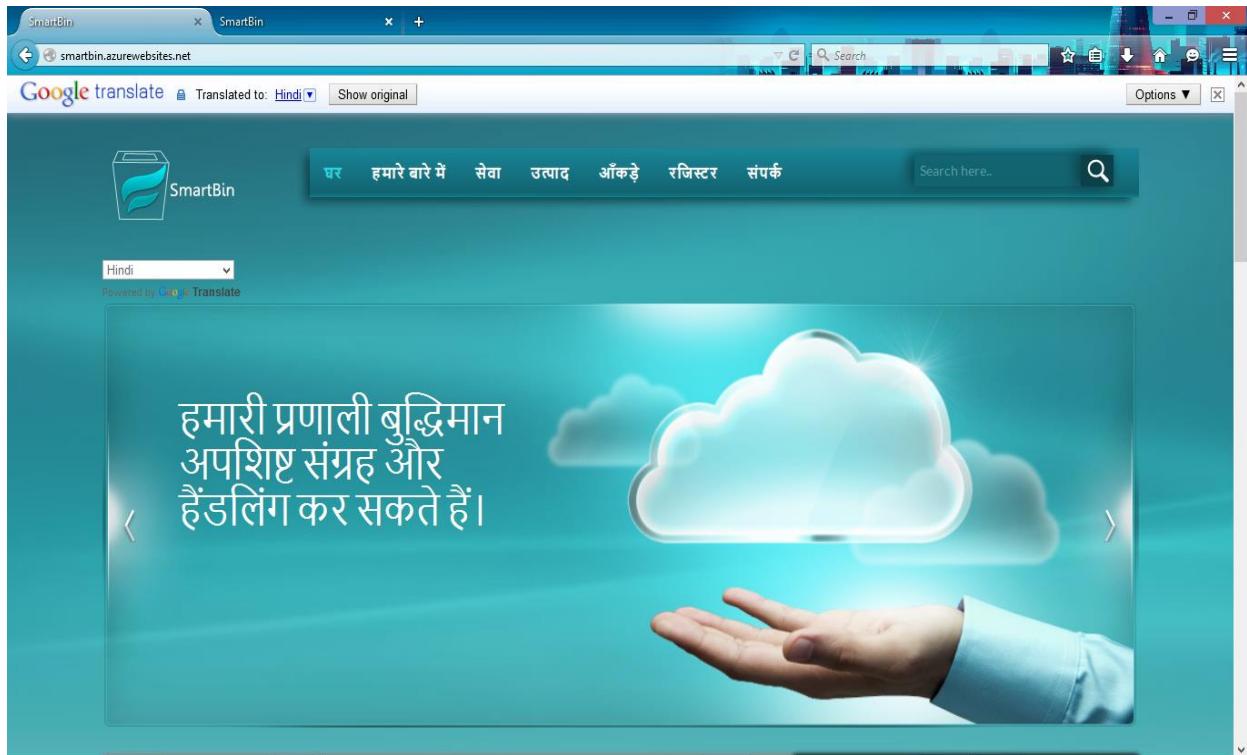
**An initiative to Smart City**

SmartBin can absolutely be helpful in MAKE IN INDIA.

[Learn More](#)

Our website automatically translates itself in language of your region and choices, here are some multilingual interfaces.

Hindi Version:



**SmartBin-एक नवीनता भारत को साफ करने के लिए**

हम आसानी से कचरे से निपटने और संग्रह की प्रक्रिया को सुविधाजनक बनाने के लिए एक समाधान विकसित कर रहे हैं। एक कचरे के हिल्डे में कोई छह कर रहे हैं कि यह सुनिश्चित करने के लिए एक सारांश में स्थानायक कचरा संग्रहकों को इब बार द्वारा एक / खाती कर दिया जाना चाहिए और useable है। हमारी प्रणाली बुद्धिमान अपशिष्ट संग्रह और हैंडलिंग ऐसा करने के लिए प्रयास करता है। यह अनावश्यक संग्रह अतिरिक्त नीचे करते, बस में सभी संग्रह से, कलेक्टरों की खाती और एक समय पर फैशन में, इलाके के कर्दे के हिल्डे से सामान इकट्ठा करने के लिए जब सुचित किया जाएगा। हम अपने डिवाइस एक कूड़ेदान पूरा ही गया है कि, एक एसएमएस के माध्यम से कलेक्टर को सूचित कर और एक ऊर्जासंगत ट्रॉसीफर का इस्तेमाल करना होगा quicklySMS प्रणाली एकत्र किए जाने की ज़रूरत है कि के आधार पर, कूड़ेदान का कचरा-स्तर को मापने के लिए एक संवेदक काम कर रहे हैं घटक।

**हमारे ब्लॉग से लोकप्रिय पोस्ट**

**शहर को साफ रखने के लिए स्मार्ट तरीका**

हाँ, बिल्कुल इस परियोजना को खच्छ हमारे शहर रखने के लिए नेतृत्व करेंगे।

10 मार्च 2015 8 टिप्पणियाँ

**हमारे ट्रीट्स**

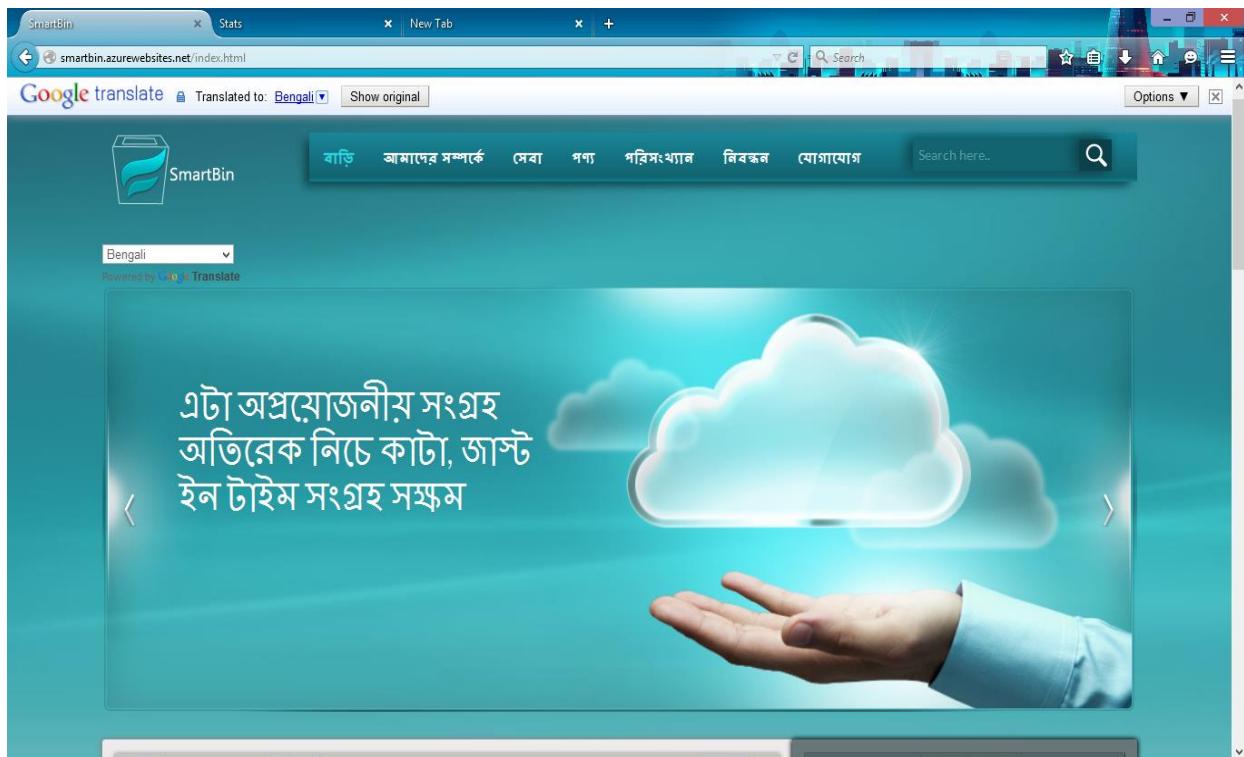
का पालन करें ProjectSmartBin

ट्रीट्स

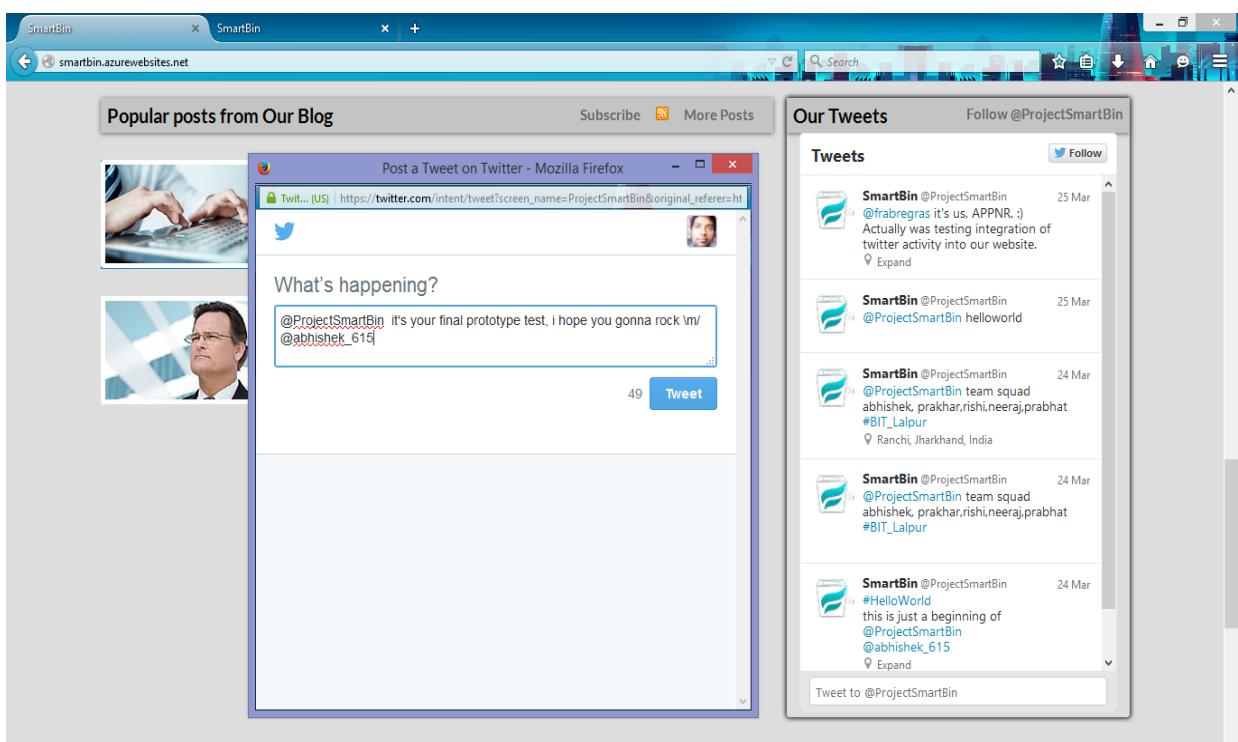
ट्रीट्स

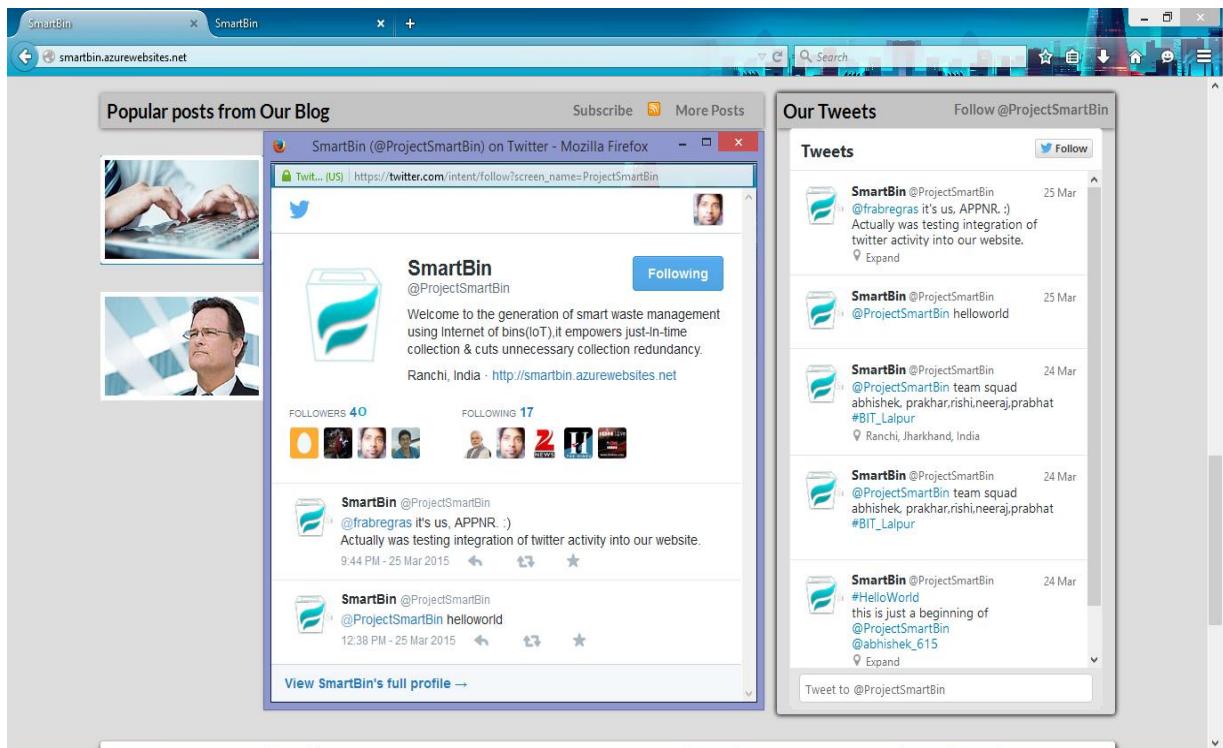
SmartBin @ ProjectSmartBin 25 Mar  
@ frabregas यह APPNR हमें है। 3 असल में हमारी वेबसाइट में ट्रिट गतिविधि के एकाकरण का परीक्षण किया गया। 9 का विस्तार करें

## Bengali Translated Version:



## Twitter API integration in index.html



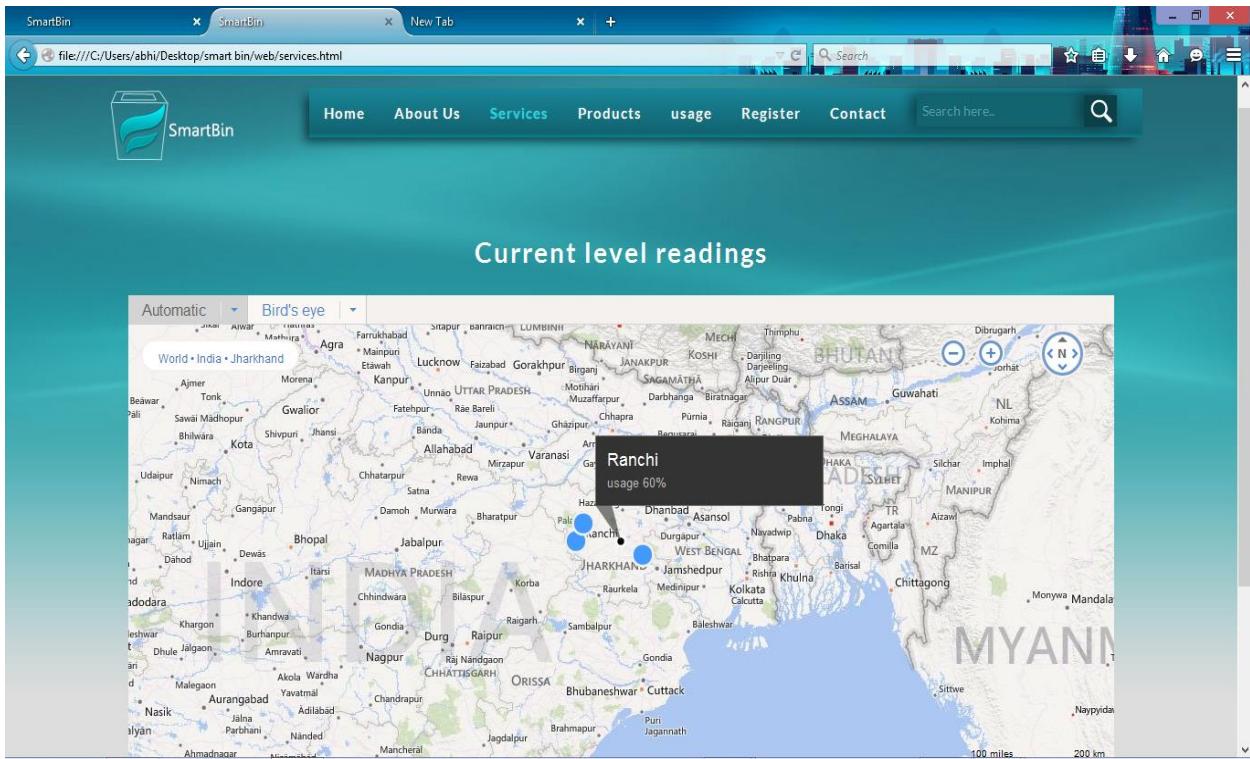


Other Different pages of our web interface:

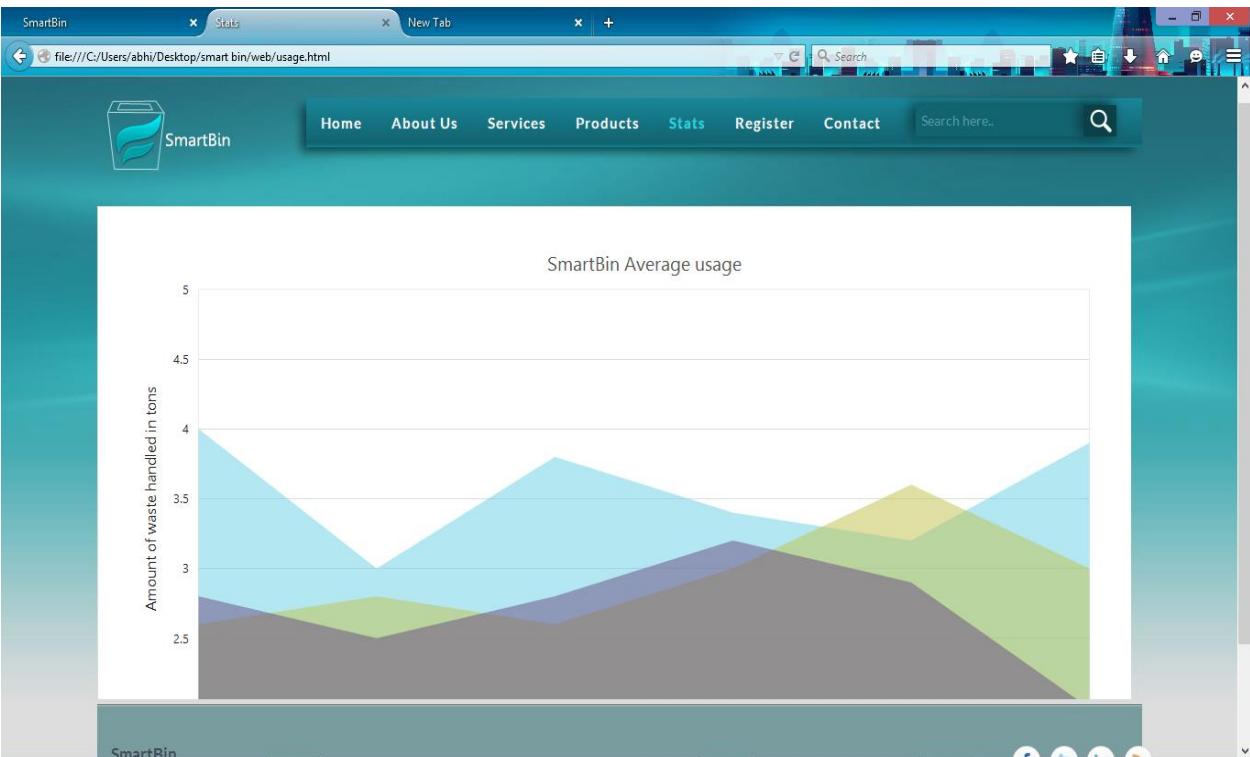
About.html:

The screenshot shows the "About Us" page of the SmartBin website. At the top, there is a navigation bar with links for Home, About Us, Services, Products, Stats, Register, Contact, and a search bar. The main content area features a large teal background image. On the left, there is a logo consisting of a blue recycling bin icon with the word "SmartBin" next to it. Below the logo is a "Select Language" dropdown menu and a "Translate" button. The title "Who We Are" is centered above a paragraph about the project. The paragraph states: "Title of The project: SmartBin- An innovative waste handling system" and "Our team is working on SmartBin". It also mentions: "We'll offer a cloud-based interface to the collectors to monitor trash-level and location of dustbins falling under their service zone, so that they can plan-ahead of time. This will ensure that the collector knows when a dustbin needs to be emptied, if neglected and the level is full then an SMS will be sent to the collector, notifying an urgent/priority handling of that particular dustbin." Two photographs of people are displayed at the bottom: a man and a woman on the left, and a group of four people on the right.

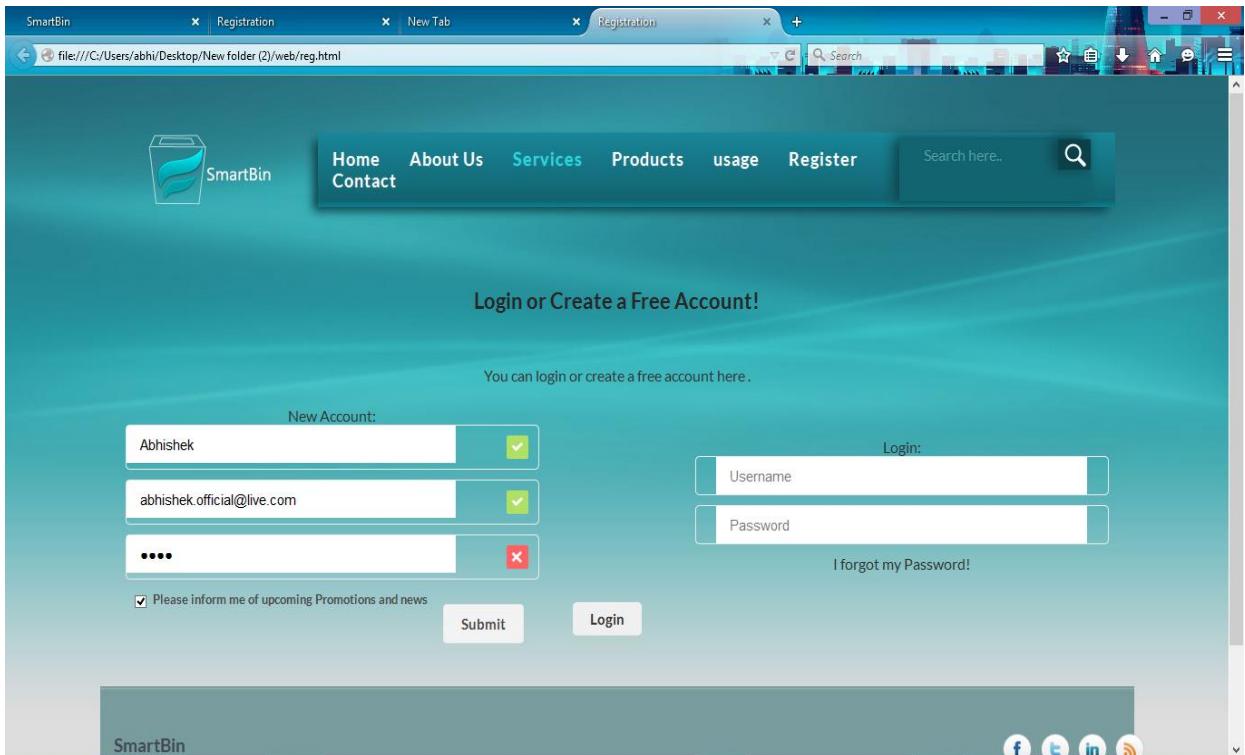
## Services.html:



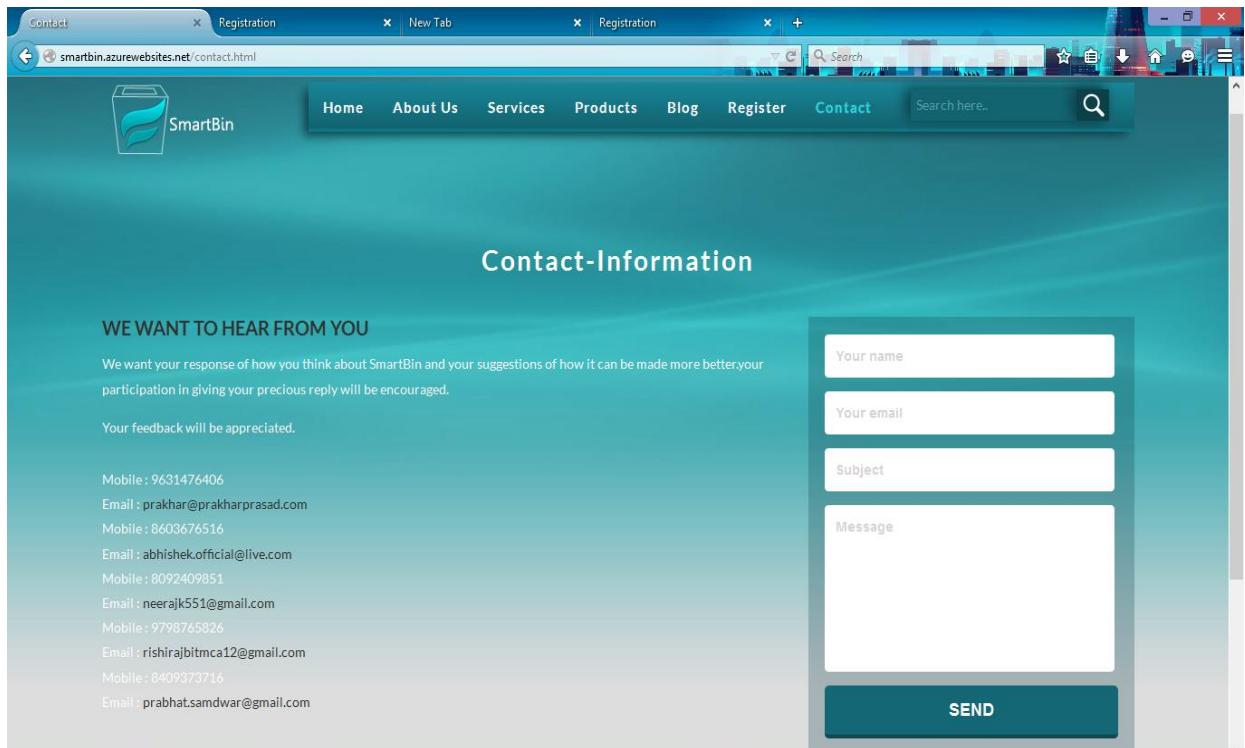
## Usage.html:



## Reg.html(register page):



## Contact.html:



## 9. IMPLEMENTATION

### Embedded C code for Arduino:

A quick overview of the different functions in the embedded C code in Arduino IDE:

- *setup()* initializes the Serial port and the Ethernet/GSM shield using the DHCP method (you should have a working DHCP server on your network).
- *loop()* reads the sensor value on line A0 and then calls the following network functions.
- *send\_request()* is where most of the work happens. A TCP connection is established to the Mobile Services endpoint, and the HTTP POST request is emitted. The headers are the same as shown in the cURL example above, e.g. the Host with the name of your endpoint, the X-ZUMO-APPLICATION key, and the JSON Content-Type. The body contains a simple JSON object with the value from the sensor.
- *wait\_response()* just blocks until some bytes are available on the connection.
- *read\_response()* will read all the response bytes, and just print the HTTP response code to the serial console for debugging.

We are using the Ethernet/GSM library to open a connection to the Azure Mobile Services endpoint and send the HTTP POST requests to store the values read from the sensor into our table.

- *server* is the address of our Mobile Services endpoint.
- *table\_name* is the name of the table we created to store data.
- *ams\_key* is our Mobile Services application key

```
// C code for sending data to Azure Mobile Services

// Azure Mobile Service address

const char *server = "https://sbin.azure-mobile.net/";

// Azure Mobile Service table name

const char *table_name = "telemetry_data";

// Azure Mobile Service Application Key

const char *ams_key = "KiqhhmysjcLvZQeThVpFKEFsVFVQvh15";

YunClient client;
```

```
char buffer[64];

/*Send HTTP POST request to the Azure Mobile Service data API */

void send_request(int Level)

{

Serial.println("\nconnecting...");

if (client.connect(server, 80)) {

Serial.print("sending ");

Serial.println(Level);

// POST URI

sprintf(buffer, "POST /tables/%s HTTP/1.1", table_name);

client.println(buffer);

// Host header

sprintf(buffer, "Host: %s", server);

client.println(buffer);

// Azure Mobile Services application key

sprintf(buffer, "X-ZUMO-APPLICATION: %s", ams_key);

client.println(buffer);

// JSON content type

client.println("Content-Type: application/json");

// POST body

sprintf(buffer, "{\"LightLevel\": %d}", lightLevel);

// Content length

client.print("Content-Length: ");

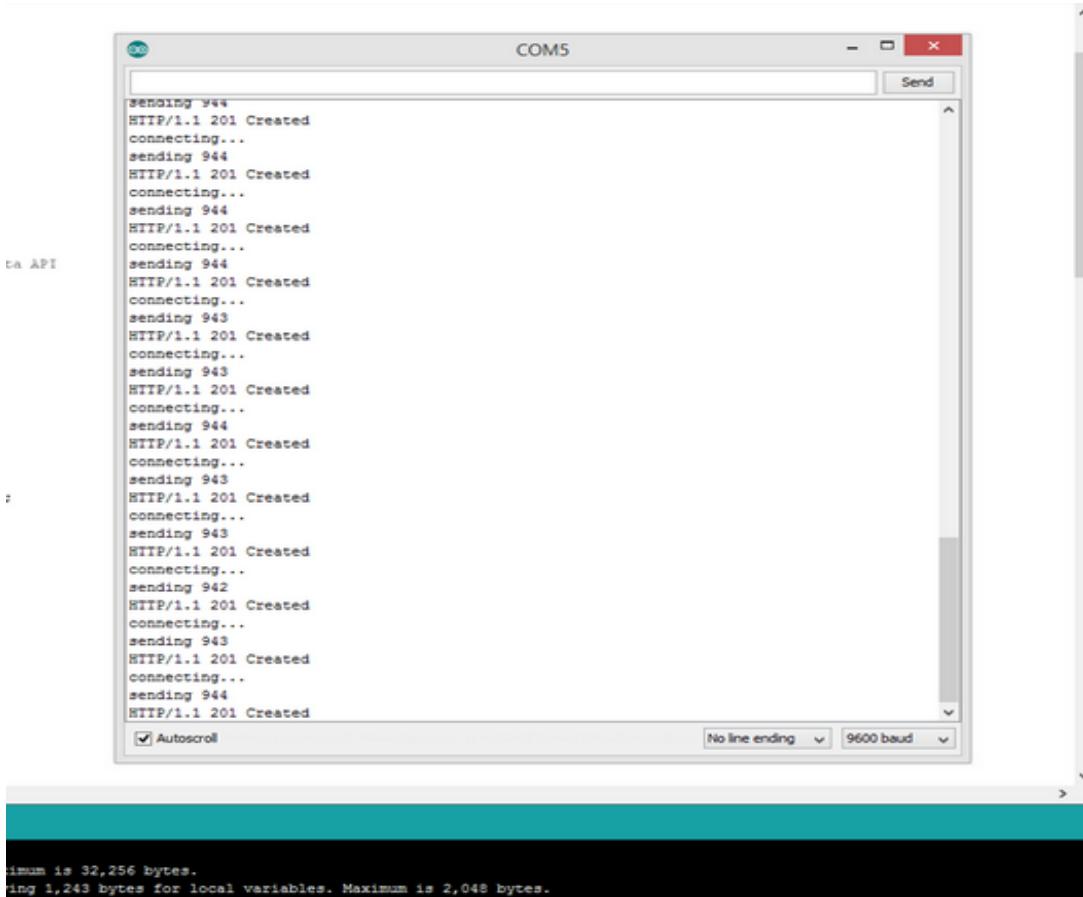
client.println(strlen(buffer));

// End of headers
```

```
client.println();  
  
// Request body  
  
client.println(buffer);  
  
} else {  
  
Serial.println("connection failed");  
  
}  
  
/* Wait for a response */  
  
void wait_response()  
  
{ while (!client.available()) {  
  
if (!client.connected()) {  
  
return; } }  
  
/* Read the response and output to the serial monitor */  
  
void read_response()  
  
{ bool print = true;  
  
while (client.available()) {  
  
char c = client.read();  
  
// Print only until the first carriage return  
  
if (c == '\n')  
  
print = false;  
  
if (print)  
  
Serial.print(c);  
  
}  
  
}  
  
/* Terminate the connection*/  
  
void end_request()
```

```
{  
  
client.stop();  
  
}  
  
/* Arduino Setup */  
  
void setup()  
  
{  
  
Serial.begin(9600);  
  
Serial.println("Starting Bridge");  
  
Bridge.begin();  
  
}  
  
/* Arduino Loop */  
  
void loop()  
  
{  
  
int val = analogRead(A0); //reading value from our sensor  
  
send_request(val); //sending request to server with sensor value as  
parameter  
  
wait_response();  
  
read_response();  
  
send_request();  
  
delay(1000);  
  
}
```

Below a screenshot of the program running in the Arduino IDE, with the Serial Monitor open.



The other way to send data is via GSM AT commands . **AT commands** are instructions used to control a modem. AT is the abbreviation of ATtention. Every command line starts with "AT" or "at". That's why modem commands are called AT commands.

```
void Send2Pachube()
{
    mySerial.println("AT+CGATT?");
    //Attach or Detach from GPRS Service (Result 1 = Attach , 2 = Detached )
}
```

```
delay(300);

ShowSerialData();

mySerial.println("AT+CIPSHUT=0"); //Close TCP Connection

delay(300);

ShowSerialData();

//setting the APN, the second need you fill in your local apn server

mySerial.println("AT+SAPBR=3,1,\"APN\",\"aitelinternet\""); delay(1000);

ShowSerialData();

//mySerial.println("AT+CIFSR");//get local IP adress

//delay(2000);

//ShowSerialData();

mySerial.println("AT+CIPSPRT=0");

delay(3000);

ShowSerialData();

mySerial.println("AT+CIPSTART=\"TCP\", \"sbin.azure-mobile.net\", \"80\"");

//start up the connection

delay(2000);

ShowSerialData();

Serial.println();

mySerial.println("AT+CIPSEND");//begin send data to remote server

delay(4500);

ShowSerialData();

mySerial.print("PUT /telemetry/getdata.php?");

delay(500);
```

```
ShowSerialData();

mySerial.print("TI=");      //DATA feed name

mySerial.print( A0 );      //DATA to send analog input

delay(10);

ShowSerialData();

mySerial.print("&TO=");      //DATA feed name

mySerial.print( A1 );      //DATA to send

delay(10);

ShowSerialData();

mySerial.print("&TR=");      //DATA feed name

mySerial.print(readSensorData( ));      //DATA to send

delay(10);

ShowSerialData();

mySerial.print(" HTTP/1.1\r\n");

delay(500);

ShowSerialData();

mySerial.print("Host: www.sbin.azure-mobile.net\r\n");

delay(500);

ShowSerialData();

mySerial.print("Connection: close");

mySerial.print("\r\n");

mySerial.print("\r\n");

delay(500);

ShowSerialData();
```

```
mySerial.print(0x1A,BYTE);

delay(500);

//waitting for reply, important! the time is base on the condition of

internet

mySerial.println();

ShowSerialData();

mySerial.println("AT+CIPCLOSE");//close the connection

delay(100);

ShowSerialData();

mySerial.println("AT+CIPSHUT=0");

delay(100);

}

readSensorData()

{

digitalWrite(trigPin,LOW);

delayMicroseconds(5);

digitalWrite(trigPin,HIGH);

delayMicroseconds(10);

digitalWrite(trigPin,LOW);

pinMode(echoPin,INPUT);

duration= pulseIn(echoPin,HIGH);

cm=(duration/2)/29.1;

inches= (duration/2)/74;

Serial.print(duration);

Serial.print("in ,");
```

```

Serial.print(cm);

Serial.print("cm  ");

Serial.println();

if(cm<10)

{digitalWrite(13, HIGH); Serial.println("level= full"); }

else

  digitalWrite(13, LOW);

delay(1250);

}

```

**Webpages:****Page: index.html**

Description: This is the homepage of our website.

```

!DOCTYPE HTML>

<html>

<head>

<title>SmartBin</title>

<link href="css/bootstrap.css" rel="stylesheet"
type="text/css" media="all">

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

<script type="application/x-javascript"> addEventListener("load",
function() { setTimeout(hideURLbar, 0); }, false);

function hideURLbar(){ window.scrollTo(0,1); }

</script>

```

```
<link rel="stylesheet" href="css/flexslider.css" type="text/css"
media="screen" />

<script src="js/jquery.min.js"></script>

<script type="text/javascript">

function search()

{ var q = document.getElementById("abc").value;

var url=

"https://www.google.co.in/#q="+q+"&site:smartbin.azurewebsites.net";

window.location = url; } </script>

</head>

<body>

<!-- header -->

<div class="container">

<div class="header">

<div class="logo">

<a href="index.html">

</a>

</div>

<div class="header-left">

<div class="head-nav">

<span class="menu"> </span>

<ul class="cl-effect-1">
```

```

<li class="active"> <a href="index.html">Home</a></li>

<li><a href="about.html">About Us</a></li>

<li><a href="services.html">Services</a></li>

<li><a href="products.html">Products</a></li>

<li><a href="usage.html">Stats</a></li>

<li><a href="reg.html">Register</a></li>

<li><a href="contact.html">Contact</a></li>

</ul></div>

<!-- script-for-nav -->

<script>

$( "span.menu" ).click(function() {

$( ".head-nav ul" ).slideToggle(300, function() {

// Animation complete.

}); });

</script>

<div class="search2"><form>

<input type="text" value="Search here.." id="abc" onfocus="this.value = '';" onblur="if (this.value == '') {this.value = 'Search here..';}">

<input type="submit" value="" onclick="javascript:search();">

</form> </div>

</div> </div>

<!--google translator api -->

<div id="google_translate_element"></div>

<script type="text/javascript">

function googleTranslateElementInit() {

```

```
new google.translate.TranslateElement({pageLanguage: 'en'},  
'google_translate_element');
```

```
</script>
```

```
<script type="text/javascript"  
src="//translate.google.com/translate_a/element.js?cb=googleTranslateElement  
Init"></script>
```

```
<!-- banner -->
```

```
<div class="banner">
```

```
    <div class="wmuSlider example1 section" id="section-1">
```

```
        <article style="position: absolute; width: 100%; opacity: 0;">
```

```
            <div class="banner-info">
```

```
                <h1>Welcome to generation of smart waste management system using  
Internet of bins.</h1>
```

```
            </div></article>
```

```
        <article style="position: absolute; width: 100%; opacity: 0;">
```

```
            <div class="banner-info">
```

```
                <h1>Our system can do intelligent waste collection and  
handling.</h1></div></article>
```

```
        <article style="position: absolute; width: 100%; opacity: 0;">
```

```
            <div class="banner-info">
```

```
                <h1>It empowers just-in-time collection, cutting down the unnecessary  
collection redundancy</h1> </div></article>
```

```
            <ul class="wmuSliderPagination">
```

```
                <li><a href="#" class="">0</a></li>
```

```
                <li><a href="#" class="">1</a></li>
```

```
                <li><a href="#" class="">2</a></li></ul> </div>
```

```
<!-- script -->

<script src="js/jquery.wmuSlider.js"></script>

<script>

$('.example1').wmuSlider();  </script> </div>

<!-- feature -->

<div class="feature">

    <div class="col-md-8 feature-left">

        <h3>Featured Products</h3>

        <iframe src="https://vec.com/65?=0&byline=0" width="100%" height="366" ></iframe>

        <h2>SmartBin-An innovation to clean India</h2>

        <p>We're developing a solution to facilitate waste handling and collection process easily.

        We're employing a sensor to measure trash-level of the dustbin, based on that our device will notify the collector through an SMS.

    </p>  </div>

<div class="col-md-4 our-right">

    <h4>Our Services</h4>

    <h5>Contribution for better tomorrow</h5>

    <p>SmartBin can be seen as an asset for coming generation. </p>

    <h5>An initiative to Smart City</h5>

    <div class="learn">

        <a href="single.html" class="link">Learn More</a></div>

    </div>

</div>
```

```
</div> </div>

<!--twitter-- >

<div class="col-md-4 twets">
  <div class="twe-top">
    <div class="twe">
      <h3>Our Tweets</h3></div>
    <h6>Follow
      <a href="http://twitter.com/ProjectSmartBin">SmartBin</a></h6></div>
    <div class="twets-top">
      <a class="twitter-timeline" href="https://twitter.com/ProjectSmartBin"
         data-widget-id="580428500332462080">Tweets by @ProjectSmartBin</a>
      <script>!function(d,s,id){var
js,fjs=d.getElementsByTagName(s)[0],p=/^http:/.test(d.location)?'http':'h
ttps';if(!d.getElementById(id)){js=d.createElement(s);js.id=id;js.src=p+"'
://platform.twitter.com/widgets.js";fjs.parentNode.insertBefore(js,fjs);}
(document,"script","twitter-wjs");</script>
    </div> </div>
  </div>
<!-- downlod -->
<div class="downlod">
  <h3>Download Center</h3>
  <h6>Categories: <a href="#"> All </a>
  <li>
    < href="team.pdf"><div class="team1">
      <div class="tm-left">
        </div>
```

```
<div class="tm-right">

<h5>Finances</h5>

<p>It will show our financing source <a href="team.pdf">More</a></p>

</div> </div> </a> </li>

<li> <a href="mechanism.docx">

<div class="team1"><div class="tm-left">

</div>

</div> </a> </li>

</ul>

<script type="text/javascript">

$(window).load(function() {

$("#flexiselDemo3").flexisel({

visibleItems: 3, animationSpeed: 1000, autoPlay: false,

autoPlaySpeed: 3000, pauseOnHover: true,
enableResponsiveBreakpoints: true,
responsiveBreakpoints: {

portrait: { changePoint:480,visibleItems: 1 },
landscape: { changePoint:640,visibleItems: 2 },
tablet: { changePoint:768,visibleItems: 3 } }});

}); </script>

<script type="text/javascript" src="js/jquery.flexisel.js"></script>

<!-- footer -->

<div class="footer">

<div class="container">

<div class="footer-top">
```

```
<div class="foot-left">  
  
<h5><a href="#">SmartBin</a></h5>  
  
</div>  
  
<div class="foot-right">  
  
<ul>  
  
<li><a href="#"><i class="fb"></i></a></li>  
  
<li><a href="#"><i class="twt"></i></a></li>  
  
<li><a href="#"><i class="in"></i></a></li>  
  
<li><a href="#"><i class="rss"></i></a></li>  
  
</ul> </div> </div>  
  
<i class="line"> </i>  
  
<div class="footer-bottom">  
  
<div class="foot-left">  
  
<div class="foot-nav">  
  
<ul>  
  
<li><a href="index.html">Home</a></li> |  
  
<li><a href="about.html">About Us</a></li> |  
  
<li><a href="services.html">Services</a></li> |  
  
<li><a href="products.html">Products</a></li> |  
  
<li><a href="blog.html">Blog</a></li> |  
  
<li><a href="reg.html">Register</a></li> |  
  
<li class="active"><a href="contact.html">Contact</a></li>  
  
</ul></div></div>  
  
<div class="foot-right">  
  
<p>Copyrights© SmartBin
```

```
<a href="http://smartbin.azurewebsites.net/">SmartBin </a> </p>  
</div></div>  
</div> </div></body></html>
```

**Page: contact.html**

**Description: Contact page of our website to get client/customer feedback about Smartbin**

```
<!DOCTYPE HTML>

<html>

<head>

<title>Contact</title>

<link href="css/bootstrap.css" rel="stylesheet" type="text/css"
media="all">

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

<meta name="viewport" content="width=device-width, initial-scale=1">

<script type="application/x-javascript">

addEventListener("load", function() {

setTimeout(hideURLbar, 0); }, false);

function hideURLbar(){ window.scrollTo(0,1); } </script>

<link
href='http://fonts.googleapis.com/css?family=Lato:100,300,400,700,900'
rel='stylesheet' type='text/css'>

<link rel="stylesheet" href="css/flexslider.css" type="text/css"
media="screen" />

<script src="js/jquery.min.js"></script>

</head>

<body>

<!-- header -->

<!--same as index.html header-->
```

```
<!-- header -->

<div class="content">

<div class="contact about-desc">

<h3>Contact-Information</h3>

<div class="row">

<div class="col-md-8 contact_left">

<h4>We Want to hear from you</h4>

<p class="m_6">We want your response of how you think about  
SmartBin and your suggestions of how it can be made more better. Your  
participation in giving your precious reply will be encouraged. </p>

<p class="m_7">Your feedback will be appreciated.</p>

<div class="contact_grid contact_address">

<p>Mobile : 9631476406</p>

<p>Email :<a href="mailto:prakhar@prakharprasad.com">prakhar@prakharprasad.com</a></p>

<p>Mobile : 8603676516</p>

<p>Email : <a href="mailto:abhishek.official@live.com">abhishek.official@live.com </a></p>

<p>Mobile : 8092409851</p>

<p>Email : <a href="mailto:neerajk551@gmail.com">neerajk551@gmail.com</a></p>

<p>Mobile : 9798765826</p>

<p>Email : <a href="mailto:rishirajbitmca12@gmail.com">rishirajbitmca12@gmail.com </a></p>

<p>Mobile : 8409373716</p>

<p>Email : <a href="mailto:prabhat.samdwar@gmail.com">prabhat.samdwar@gmail.com</a></p>
```

```
</a></p>

</div></div>

<div class="col-md-4 rst">

<div class="contact_right">

<div class="contact-form_grid">

<form method="post" action="https://sbin.azure-mobile.net/tables/contact">

    <input type="text" name="name" class="textbox" value="Your name"
    onfocus="this.value = '';" onblur="if (this.value == '') {this.value =
    'Your name';}">

    <input type="text" name="email" class="textbox" value="Your email"
    onfocus="this.value = '';" onblur="if (this.value == '') {this.value =
    'Your email';}">

    <input type="text" name="subject" class="textbox" value="Subject"
    onfocus="this.value = '';" onblur="if (this.value == '') {this.value =
    'Subject';}">

    <textarea value="Message:" name="msg" onfocus="this.value = '';"
    onblur="if (this.value == '') {this.value =
    'Message';}">Message</textarea>

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

</form>

</div> </div> </div>

<!-- footer -->

    <!--same as index.html footer-->

<!-- footer -->

</body>

</html>
```

**Page: reg.html**

**Description: Registration page for new users using SmartBin**

```
<!DOCTYPE HTML>

<html>

<head>

<title>Registration</title>

<link href="css/bootstrap.css" rel="stylesheet" type="text/css" media="all">

<link href="css/style1.css" rel='stylesheet' type='text/css' />

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

<meta name="viewport" content="width=device-width, initial-scale=1">

<meta name="google-translate-customization" content="b5e3432b5ac4b05-
90278cb4cb425569-ga00fcbc56c827de1-1b">

</meta>

<link href='http://fonts.googleapis.com/css?family=Lato:100,300,400,700,900'
rel='stylesheet' type='text/css'>

<link rel="stylesheet" href="css/flexslider.css" type="text/css"
media="screen" />

<script
src="https://ajax.googleapis.com/ajax/libs/jquery/2.1.3/jquery.min.js"></scr
ipt>

<script src="js/jquery.min.js">

<script >

addEventListener("load", function() { setTimeout(hideURLbar, 0); }, false);
function hideURLbar(){ window.scrollTo(0,1); }

function done()

{ var u = document.getElementById("Username").value;
```

```
var p = document.getElementById("pass").value;
var e = document.getElementById("email").value;
var s = "Username="+u+"&email="+e+"&pass="+p;
$.post("http://sbin.azure-mobile.net/tables/user",s,
function(data, status){
    if(status == "success")
        { alert("Registered! :) "); }
    else{
        alert("Uh-Oh! Something went wrong");
    }}); }

</script>

</head>

<body>

<!-- header -->

<!--same as index.html header - - >

<!-- header -->

<div class="content text-center">

<div class="header" >

<h1>Login or Create a Free Account!</h1>

</div>

<p>You can login or create a free account here . </p>

<form onSubmit="done();">

<ul class="left-form">

<h2>New Account:</h2>

<li>

<input type="text" name="Username" placeholder="Username" required/>
```

```
<div class="clear"> </div>

</li>

<li>

<input type="email" name="email" placeholder="Email" required/>

<div class="clear"> </div>

</li>

<li>

<input type="password" name="pass" placeholder="password" required/>

<div class="clear"> </div>

</li>

<label class="checkbox"><input type="checkbox" name="checkbox"
checked=""><i> </i>Please inform me of upcoming Promotions and news</label>

<button onclick="javascript:done();">Register</button>

</form>

<div class="clear"> </div>

</ul>

<form>

<ul class="right-form">

<h3>Login:</h3>

<div>

<li><input type="text" placeholder="Username" required/></li>

<li> <input type="password" placeholder="Password" required/></li>

<h4>I forgot my Password!</h4>

<input type="submit" onclick="login()" value="Login" >

</div>

</ul>
```

```
</form>

</div>

<!-- footer -->

<!-same as index.html footer-->

<!-- footer -->

</body>

</html>
```

**Page: services.html**

**Description: Service page, listing the services we provide and data visualisation**

```
<!DOCTYPE HTML>

<html>

<head>

<title>SmartBin</title>

<link href="css/bootstrap.css" rel="stylesheet" type="text/css" media="all">

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

<meta name="viewport" content="width=device-width, initial-scale=1">

<meta name="google-translate-customization" content="b5e3432b5ac4b05-
90278cb4cb425569-ga00fcfc56c827de1-1b"></meta>

<script > addEventListener("load", function() { setTimeout(hideURLbar, 0);
}, false);

function hideURLbar(){ window.scrollTo(0,1); } </script>

<link rel="stylesheet" href="css/flexslider.css" type="text/css"
media="screen" />

<script src="js/jquery.min.js"></script>

</head>
```

```
<body>

<!-- header -->

<!-same as index.html-->

<!-- header -->

<div id="google_translate_element">

</div><script type="text/javascript">

function googleTranslateElementInit() {

  new google.translate.TranslateElement({pageLanguage: 'en'},
  'google_translate_element');

}</script>

<script type="text/javascript"
src="//translate.google.com/translate_a/element.js?cb=googleTranslateElement
Init"></script>




<!-- banner -->

<div class="content text-center">

<div class="services_overview">

<h3>Current level readings</h3>

<style>

#loadImg{position:absolute;z-index:999; }

#loadImg div{display:table-cell; width:950px; height:633px; background:#fff; text-align:center; vertical-align:middle; }

</style>

<div id="loadImg" width="100%" height="70%">

<div></div></div>
```

```

<iframe border=1 name=iframe src="map2.html" width="80%" height="503"
scrolling="no" noresize frameborder="0"
onload="document.getElementById('loadImg').style.display='none';" ></iframe>

</div>

<!--footer same as index.html -->

</body> </html>

```

**Page: map2.html**

**Description: Map visualisation through Bing Maps API**

```

<!DOCTYPE html>

<html>

<head>

<title>SmartBin Uses in India </title>

<meta name="viewport" content="initial-scale=5.0, user-scalable=no">

<script type="text/javascript"
src="http://ecn.dev.virtualearth.net/mapcontrol/mapcontrol.ashx?v=7.0"></scr
ipt>

<meta name="google-translate-customization" content="b5e3432b5ac4b05-
90278cb4cb425569-ga00fcbc56c827de1-1b"></meta>

<meta charset="utf-8">

<style>

html, body, #map-canvas {

    height: 100%;

    margin: 0px;

    padding: 0px

}

```

```
</style>

<script>

    function setView()

    {

map.setView({zoom: 6, center: new Microsoft.Maps.Location(23.3477700,
85.3385600)});    }

var map = null;

function getMap()

{

Microsoft.Maps.loadModule('Microsoft.Maps.Themes.BingTheme', { callback:
function()

{

map = new Microsoft.Maps.Map(document.getElementById('myMap') ,

{ credentials:

'Ai82lc-fgGXjJzyy3sRAzVUZs8rbZyZBZaJ_I7Igbg01Y2GZ_3R1Lt1pAaxi36TP' ,
theme: new Microsoft.Maps.Themes.BingTheme()

}) ;

var pin1 = new Microsoft.Maps.Pushpin(new
Microsoft.Maps.Location(23.3477700, 85.3385600), null);

map.entities.push(pin1);

map.entities.push(new Microsoft.Maps.Infobox(new
Microsoft.Maps.Location(23.3477700, 85.3385600), {title: 'Ranchi',
description: 'usage 60%', pushpin: pin1}));}

var pin2 = new Microsoft.Maps.Pushpin(new Microsoft.Maps.Location(23.352234,
84.243684), null);
```

```
map.entities.push(pin2);

map.entities.push(new Microsoft.Maps.Infobox(new
Microsoft.Maps.Location(23.352234, 84.243684), {title: 'Ramgarh',
description: 'usage 50%', pushpin: pin2}));

var pin3 = new Microsoft.Maps.Pushpin(new Microsoft.Maps.Location(23.077700,
85.85600), null);

map.entities.push(pin3);

map.entities.push(new Microsoft.Maps.Infobox(new
Microsoft.Maps.Location(23.077700, 85.85600), {title: 'Ranchi', description:
'usage 60%', pushpin: pin3}));

var pin4 = new Microsoft.Maps.Pushpin(new Microsoft.Maps.Location(23.72234,
84.43684), null);

map.entities.push(pin4);

map.entities.push(new Microsoft.Maps.Infobox(new
Microsoft.Maps.Location(23.72234, 84.43684), {title: 'near ranchi',
description: 'usage 50%', pushpin: pin4}));

map.setView({zoom: 6, center: new Microsoft.Maps.Location(23.3477700,
85.3385600)});

});

}

</script>

</head>

<body onload= "getMap();">

<div id='myMap' ></div>

</body>

</html>
```

**Page: usage.html**

**Description: Level of junk that is filled in through Area-chart via SyncFusion javascript API**

```
<!DOCTYPE HTML>

<html>

<head>

<title>Stats</title>

<link href="css/bootstrap.css" rel="stylesheet" type="text/css" media="all">

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

<meta name="viewport" content="width=device-width, initial-scale=1">

<meta name="google-translate-customization" content="b5e3432b5ac4b05-
90278cb4cb425569-ga00fcbc56c827de1-1b"></meta>

<script type="application/x-javascript"> addEventListener("load", function()
{ setTimeout(hideURLbar, 0); }, false);

function hideURLbar(){ window.scrollTo(0,1); }

</script>

<link href='http://fonts.googleapis.com/css?family=Lato:100,300,400,700,900'
rel='stylesheet' type='text/css'>

<link rel="stylesheet" href="css/flexslider.css" type="text/css"
media="screen" />

<script src="js/jquery.min.js"></script>

</head>

<body>

<!-- header -->

<!--same as index.html-->
```

```
<!-- header -->

<div id="google_translate_element"></div><script type="text/javascript">

function googleTranslateElementInit() {

    new google.translate.TranslateElement({pageLanguage: 'en'},
    'google_translate_element');

}

</script><script type="text/javascript"
src="//translate.google.com/translate_a/element.js?cb=googleTranslateElement
Init">

</script>

<!-- banner -->

<iframe border=1 name=iframe src="area.html" width="99%" height="503"
scrolling="no" noresize frameborder="0" ></iframe>

<!-- footer -->

<div class="footer">

    <div class="container">

        <div class="footer-top">

            <div class="foot-left">

                <h5><a href="#">SmartBin</a></h5>

            </div>

            <div class="foot-right">

                <ul>

                    <li><a href="#"><i class="fb"></i></a></li>

                    <li><a href="#"><i class="twt"></i></a></li>

                    <li><a href="#"><i class="in"></i></a></li>

                    <li><a href="#"><i class="rss"></i></a></li>

                <div class="clearfix"> </div>
```

```
</ul>

</div>

<div class="clearfix"> </div>

</div>

<i class="line"> </i>

<div class="footer-bottom">

    <div class="foot-left">

        <div class="foot-nav">

            <ul>

                <li><a href="index.html">Home</a></li>

                <li><a href="about.html">About Us</a></li>

                <li><a href="services.html">Services</a></li>

                <li><a href="products.html">Products</a></li>

                <li><a href="usage.html">Stats</a></li>

                <li><a href="reg.html">Register</a></li>

                <li class="active"><a href="contact.html">Contact</a></li>

            <div class="clearfix"></div>

        </ul>

    </div> </div>

<div class="foot-right">

    <p>Copyrights © SmartBin

        <a href="http://smartbin.azurewebsites.net/">&nbsp; SmartBin </a>

    </p>

</div>

<div class="clearfix"> </div>
```

```

</div>

</div>

</div>

<!-- footer -->

</body>

</html>

```

**Page: area.html****Description: Area-chart via SyncFusion javascript API**

```

<!DOCTYPE html>

<html xmlns="http://www.w3.org/1999/xhtml">

<head>

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

    <link href="../themes/bootstrap.min.css" rel="stylesheet">

    <link href="../themes/default-theme/ej.widgets.all.min.css"
    rel="stylesheet" />

    <link href="../themes/default.css" rel="stylesheet" />

    <link href="../themes/default-responsive.css"      rel="stylesheet"/>

    <script src="../scripts/jquery-1.10.2.min.js"
    type="text/javascript"></script>

    <script src="../scripts/jquery.globalize.min.js"></script>

    <script src="../scripts/ej.web.all.min.js"
    type="text/javascript"></script>

```

```
<script src="../scripts/properties.js"
type="text/javascript"></script>

</head>

<body>

<div class="content-container-fluid">

<div class="row">

<div class="cols-sample-area">

<div id="container"></div>

</div>

</div>

</div>

<script type="text/javascript" language="javascript">

$(function ()


{

    $("#container").ejChart(


    {


        //Initializing Primary X Axis

        primaryXAxis:


        {


            axisLine:{visible:false},

            majorGridLines:{visible:false},

            majorTickLines: { visible: false },

            range: { min: 1900, max: 2000, interval: 10 },

            title: { text: 'Year' }

        },


        },


        {


            axisLine:{visible:false},

            majorGridLines:{visible:false},

            majorTickLines: { visible: false },



            range: { min: 1900, max: 2000, interval: 10 },



            title: { text: 'Year' }

        },


        {


            axisLine:{visible:false},

            majorGridLines:{visible:false},

            majorTickLines: { visible: false },



            range: { min: 1900, max: 2000, interval: 10 },



            title: { text: 'Year' }

        }

    }

}

});
```

```
//Initializing Primary Y Axis

primaryYAxis:

{

    axisLine: { visible: false },
    majorTickLines: { visible: false },
    range: { min: 2, max: 5, interval: 0.5 },

    title: { text: 'Amount of waste handled in tons' }

},

//Initializing Series

series:

[

{ points: [{ x: 1900, y: 4 }, { x: 1920, y: 3.0 },
    { x: 1940, y: 3.8 }, { x: 1960, y: 3.4 },
    { x: 1980, y: 3.2 }, { x: 2000, y: 3.9 }],
    name: 'Product A',
    type: 'Area',
    enableAnimation: true,
    border:{color: 'transparent'},
    opacity: 0.5,
    fill:'#69D2E7'

},

{

    points: [{ x: 1900, y: 2.6 }, { x: 1920, y: 2.8 },



```

```
{ x: 1940, y: 2.6 }, { x: 1960, y: 3 },
{ x: 1980, y: 3.6 }, { x: 2000, y: 3 }],
name: 'Product B',
type: 'Area',
enableAnimation: true,
opacity: 0.5,
border: { color: 'transparent' },
fill: '#C4C24A'

},

{
points: [{ x: 1900, y: 2.8 }, { x: 1920, y: 2.5 },
{ x: 1940, y: 2.8 }, { x: 1960, y: 3.2 },
{ x: 1980, y: 2.9 }, { x: 2000, y: 2 }],
name: 'Product C',
type: 'Area',
enableAnimation: true,
opacity: 0.5,
border:{color: 'transparent'},
fill: '#6A4B82'

},
load:"loadTheme",
canResize: true,
title:{text: 'SmartBin Average usage' },
size: { height: "600" },
```

```
        legend: { visible: true }
```

```
    } );
```

```
});
```

```
</script>
```

```
</body>
```

```
</html>
```

**Page: about.html**

**Description: About the SmartBin project and team.**

```
<!DOCTYPE HTML>

<html>

<head>

<title>About us</title>

<link href="css/bootstrap.css" rel="stylesheet" type="text/css" media="all">

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

<meta name="viewport" content="width=device-width, initial-scale=1"> <meta
name="google-translate-customization" content="b5e3432b5ac4b05-
90278cb4cb425569-ga00fcbc56c827de1-1b"></meta>

<script type="application/x-javascript"> addEventListener("load", function()
{ setTimeout(hideURLbar, 0); }, false); function hideURLbar(){
window.scrollTo(0,1); } </script>

<link href='http://fonts.googleapis.com/css?family=Lato:100,300,400,700,900'
rel='stylesheet' type='text/css'>

<link rel="stylesheet" href="css/flexslider.css" type="text/css"
media="screen" />

<script src="js/jquery.min.js"></script>

</head>

<body>

<!--header same as index.html -->

<div id="google_translate_element"></div>

<script type="text/javascript">

function googleTranslateElementInit() {

  new google.translate.TranslateElement({pageLanguage: 'en'},
'google_translate_element');
```

```
}

</script>

<script type="text/javascript"
src="//translate.google.com/translate_a/element.js?cb=googleTranslateElement
Init"></script>

<div class="content text-center">

<div class="who_we_are">

<div class="grid_12">

<header>

<h3>Who We Are</h3>

</header>

<h5>Title of The project: SmartBin- An innovative
waste handling system</h5>

<p> Our team is working on SmartBin</p>

<p>We'll offer a cloud-based interface to the
collectors to monitor trash-level and location of
dustbins falling under their service zone, so that
they can plan-ahead of time. This will ensure that the
collector knows when a dustbin needs to be emptied, if
neglected and the level is full then an SMS will be
sent to the collector, notifying an urgent/priority
handling of that particular dustbin. </p>

</div>

<div class="grid_5">

</div>

<div class="grid_6">

</div>

<div class="clearfix"></div>

</div>
```

```
</div>

</div>

<!-- footer -->

<!-- same as index.html footer-->

<!-- footer -->

</html>

</body>
```

## Windows Phone App:

```
<!--This is the MainPage.xaml of SmartBin mobile app -->

<phone:PhoneApplicationPage

    x:Class="sdkHybridWebAppWP8CS.MainPage"
    xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
    xmlns:phone="clr-
    namespace:Microsoft.Phone.Controls;assembly=Microsoft.Phone"
    xmlns:shell="clr-
    namespace:Microsoft.Phone.Shell;assembly=Microsoft.Phone"
    xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
    xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
    mc:Ignorable="d"

    FontFamily="{StaticResource PhoneFontFamilyNormal}"
    FontSize="{StaticResource PhoneFontSizeNormal}"
    Foreground="{StaticResource PhoneForegroundBrush}"
    SupportedOrientations="Portrait" Orientation="Portrait"
    shell:SystemTray.IsVisible="True">

    <!-- The UI consists of a web view control and ApplicationBar -->
    <!--LayoutRoot is the root grid where all page content is placed-->
    <Grid x:Name="LayoutRoot" Background="Transparent">
        <phone:WebBrowser x:Name="Browser"
            HorizontalAlignment="Stretch"
            VerticalAlignment="Stretch"
        </phone:WebBrowser>
    </Grid>
</phone:PhoneApplicationPage>
```

```
        IsGeolocationEnabled="True"  
  
        IsScriptEnabled="True"  
  
        Background="#FF15A692"  
  
        Foreground="#FF33C8EA" />  
  
</Grid>  
  
<!-- ApplicationBar -->  
  
<phone:PhoneApplicationPage.ApplicationBar>  
  
<shell:ApplicationBar IsVisible="True" IsMenuEnabled="True" Mode="Default">  
  
<shell:ApplicationBarIconButton IconUri="/Assets/AppBar/home.png"  
  
    IsEnabled="True" Text="home" Click="HomeApplicationBar_Click"/>  
  
<shell:ApplicationBarIconButton IconUri="/Assets/AppBar/refresh.png"  
  
    IsEnabled="True" Text="refresh" Click="RefreshApplicationBar_Click"/>  
  
<shell:ApplicationBarIconButton IconUri="/Assets/AppBar/pin.png"  
  
    IsEnabled="True" Text="pin to start" Click="PinApplicationBar_Click"/>  
  
<shell:ApplicationBarIconButton IconUri="/Assets/AppBar/share.png"  
  
    IsEnabled="True" Text="share" Click="ShareApplicationBar_Click"/>  
  
<shell:ApplicationBar.MenuItems>  
  
<shell:ApplicationBarMenuItem Text="share with world!"  
  
    Click="ShoppingCartMenuItem_Click" />  
  
</shell:ApplicationBar.MenuItems>  
  
</shell:ApplicationBar>  
  
</phone:PhoneApplicationPage.ApplicationBar>  
  
</phone:PhoneApplicationPage>
```

**MainPage.cs**

```
using System;
using System.Collections.Generic;
using System.Diagnostics;
using System.IO.IsolatedStorage;
using System.Linq;
using System.Windows;
using System.Windows.Navigation;
using Microsoft.Phone.Controls;
using Microsoft.Phone.Shell;
using Microsoft.Phone.Tasks;
namespace sdkHybridWebAppWP8CS
{
    public partial class MainPage : PhoneApplicationPage
    {
        private string _homeURL = "http://smartbin.azurewebsites.net/";
        // Serialize URL into IsoStorage on deactivation for Fast App Resume
        private Uri _deactivatedURL;
        private IsolatedStorageSettings _userSettings =
            IsolatedStorageSettings.ApplicationSettings;
        // To indicate when we're navigating to a new page.
        private ProgressIndicator _progressIndicator;
        // Constructor
        public MainPage()
        {
            InitializeComponent();
            // Setup the progress indicator
            _progressIndicator = new ProgressIndicator();
            _progressIndicator.Indeterminate = true;
            _progressIndicator.Visible = false;
        }
    }
}
```

```
SystemTray.SetProgressIndicator(this, _progressIndicator);

// Event handler for the hardware back key

BackPressed += MainPage_BackKeyPress;

// Fast app resume events

PhoneApplicationService.Current.Deactivated +=

    Current_Deactivated;

PhoneApplicationService.Current.Closing += Current_Closing;

}

#region App Navigation Events

protected override void OnNavigatedTo(NavigationEventArgs e)

{ base.OnNavigatedTo(e);

// Browser event handlers

Browser.Navigating += Browser_Navigating;

Browser.Navigated += Browser_Navigated;

Browser.NavigationFailed += Browser_NavigationFailed;

Browser.IsEnabled = true;

// Try to get the URL stored for fast app resume.

try

{

    _deactivatedURL = (Uri) (_userSettings["deactivatedURL"]);    }

catch (System.Collections.Generic.KeyNotFoundException keyNotFound) {

    Debug.WriteLine(keyNotFound.Message);    }

    Browser.Navigate(new Uri(_homeURL, UriKind.RelativeOrAbsolute));    }

}
```

```
protected override void OnNavigatedFrom(NavigationEventArgs e)
{
    base.OnNavigatedFrom(e);

    Browser.Navigating -= Browser_Navigating;
    Browser.Navigated -= Browser_Navigated;
    Browser.NavigationFailed -= Browser_NavigationFailed;
}

}

#endregion

#region Browser Events

void Browser_Navigating(object sender, NavigatingEventArgs e)
{
    // If the URL is a telephone number, turn off the progress indicator
    if (!e.Uri.Scheme.Contains("tel"))
        {_progressIndicator.Visible = true;}
}

Void Browser_Navigated(object sender,
    System.Windows.Navigation.NavigationEventArgs e)
{
    // Save for fast resume
    _deactivatedURL = e.Uri;

    // We have arrived at a new page,
    _progressIndicator.Visible = false;
}

}

#endregion
```

```

#region AppBar/Menu Events

// Navigates to the web site home page

private void HomeApplicationBar_Click(object sender, EventArgs e)
{
    if (Browser.Source.ToString() != _homeURL)
        {Browser.Navigate(new Uri(_homeURL,
UriKind.RelativeOrAbsolute));}

}

// Reloads the current page in the web browser control

private void RefreshApplicationBar_Click(object sender, EventArgs e)
{
    // Reload the current page.

    if (Browser.Source != null)
        { Browser.Navigate(Browser.Source); }

}

#endregion

}
}

```

### Page: WMAppManifest.xml

```

<?xml version="1.0" encoding="utf-8"?>

<Deployment
xmlns="http://schemas.microsoft.com/windowsphone/2012/deployment"
AppPlatformVersion="8.0">

<DefaultLanguage xmlns="" code="en-US" />

<App      xmlns=""          ProductID="{7169bc56-350d-46cc-b3fe-f1986cec4834}"
Title="SmartBin"          RuntimeType="Silverlight"          Version="1.0.0.0"
Genre="apps.normal"      Author="Abhishek Chourasiya"    Description="SmartBin
Mobile App" Publisher="Abhishek Chourasiya" PublisherID="{00a35363-f772-
44f9-9356-b33fb26f52cd}">

```

```

<IconPath IsRelative="true" IsResource="false">logo.png</IconPath>
<Capabilities>
    <Capability Name="ID_CAP_NETWORKING" />
    <Capability Name="ID_CAP_MEDIALIB_AUDIO" />
    <Capability Name="ID_CAP_MEDIALIB_PLAYBACK" />
    <Capability Name="ID_CAP_SENSORS" />
    <Capability Name="ID_CAP_WEBBROWSERCOMPONENT" />
    <Capability Name="ID_CAP_LOCATION" />
</Capabilities>
<Tasks>
    <DefaultTask      Name="_default"          NavigationPage=" MainPage.xaml"
ActivationPolicy="Resume" />
</Tasks>
<Tokens>
    <PrimaryToken TokenID="sdkHybridWebAppWP8CSToken" TaskName="_default">
        <TemplateCycle>
            <SmallImageURI
                IsResource="false">logo.png</SmallImageURI>
                IsRelative="true"
            <Title>SmartBin</Title>
            <Photo01ImageURI
                IsResource="false">banner.png</Photo01ImageURI>
                IsRelative="true"
            <Photo02ImageURI
                IsResource="false">p.png</Photo02ImageURI>
                IsRelative="true"
            <Photo03ImageURI
                IsResource="false">logo.png</Photo03ImageURI>
                IsRelative="true"
            <Photo04ImageURI
                IsResource="false">truck.png</Photo04ImageURI>
                IsRelative="true"
            <Photo05ImageURI
                IsResource="false">bin.png</Photo05ImageURI>
                IsRelative="true"
            <Photo06ImageURI IsRelative="true" IsResource="false">
            </Photo06ImageURI>
            <Photo07ImageURI IsRelative="true" IsResource="false">
            </Photo07ImageURI>
            <Photo08ImageURI IsRelative="true" IsResource="false">
            </Photo08ImageURI>
        </TemplateCycle>
    </PrimaryToken>
</Tokens>

```

```

<Photo09ImageURI IsRelative="true" IsResource="false">
</Photo09ImageURI>
<Count>0</Count>
<HasLarge>True</HasLarge>
<DeviceLockImageURI IsRelative="true" IsResource="false">
</DeviceLockImageURI>
</TemplateCycle>
</PrimaryToken>
</Tokens>
<ScreenResolutions>
<ScreenResolution Name="ID_RESOLUTION_HD720P" />
<ScreenResolution Name="ID_RESOLUTION_WXGA" />
<ScreenResolution Name="ID_RESOLUTION_WVGA" />
</ScreenResolutions>
</App>
</Deployment>

```

## SmartBin Android App

Page: AndroidManifest.xml

```

<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.example.smartbin" android:versionCode="1"
    android:versionName="1.0" >
    <uses-sdk
        android:minSdkVersion="8"
        android:targetSdkVersion="19" />
    <uses-permission android:name="android.permission.INTERNET"/>
    <application
        android:allowBackup="true"
        android:icon="@drawable/ic_launcher"

```

```

        android:label="@string/app_name"
        android:theme="@style/AppTheme" >
    <activity
        android:name="com.example.smartbin.MainActivity"
        android:label="@string/app_name" >
        <intent-filter>
            <action android:name="android.intent.action.MAIN" />
            <category android:name="android.intent.category.LAUNCHER" />
        </intent-filter>
    </activity>
</application>
</manifest>

```

#### Page: Strings.xml

```

<?xml version="1.0" encoding="utf-8"?>
<resources>

    <string name="app_name">SmartBin</string>
    <string name="hello_world">Welcome to SmartBin mobile app!</string>
    <string name="action_settings">Settings</string>

</resources>

```

#### Page: activity\_main.xml

```

<FrameLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"

```

```
    android:id="@+id/container"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context="com.example.smartbin.MainActivity"
    tools:ignore="MergeRootFrame" >

<WebView
    android:id="@+id/w1"
    android:layout_width="match_parent"
    android:layout_height="match_parent" />

<ProgressBar
    android:id="@+id/pb1"
    style="?android:attr/progressBarStyleLarge"
    android:layout_width="match_parent"
    android:layout_height="match_parent" />

<TextView
    android:id="@+id/textView1"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_marginLeft="70dp"
    android:text="@string/hello_world" />

</FrameLayout>
```

Page: MainActivity.java

```
package com.example.smartbin;
```

```
import android.webkit.WebView;
import android.support.v7.app.ActionBarActivity;
import android.support.v7.app.ActionBar;
import android.support.v4.app.Fragment;
import android.os.Bundle;
import android.view.LayoutInflater;
import android.view.Menu;
import android.view.MenuItem;
import android.view.View;
import android.view.ViewGroup;
import android.os.Build;
import android.widget.ProgressBar;
import android.webkit.WebChromeClient;

public class MainActivity extends ActionBarActivity {

    WebView browser;
    private ProgressBar progress;
    int n=0;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        // find the WebView by name in the main.xml of step 2
        browser=(WebView)findViewById(R.id.w1);

        // Enable javascript
        browser.getSettings().setJavaScriptEnabled(true);

        // load home
        browser.loadUrl("http://smartbin.azurewebsites.net/");
    }
}
```

```
if (savedInstanceState == null) {  
    getSupportFragmentManager().beginTransaction()  
        .add(R.id.container, new PlaceholderFragment())  
        .commit();  
}  
}  
  
@Override  
public boolean onCreateOptionsMenu(Menu menu) {  
  
    // Inflate the menu; this adds items to the action bar if it is  
    // present.  
    getMenuInflater().inflate(R.menu.main, menu);  
    return true;  
}  
  
@Override  
public boolean onOptionsItemSelected(MenuItem item) {  
    // Handle action bar item clicks here. The action bar will  
    // automatically handle clicks on the Home/Up button, so long  
    // as you specify a parent activity in AndroidManifest.xml.  
    int id = item.getItemId();  
    if (id == R.id.action_settings) {  
        return true;  
    }  
    return super.onOptionsItemSelected(item);  
}  
  
/**  
 * A placeholder fragment containing a simple view.  
 */
```

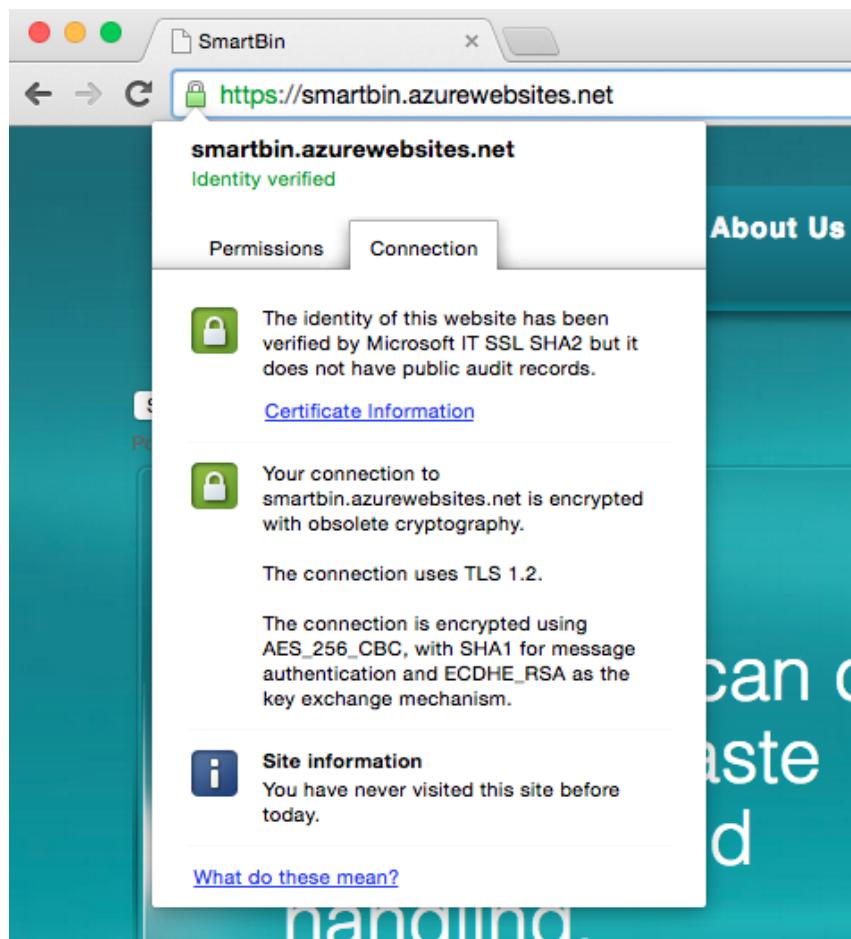
```
public static class PlaceholderFragment extends Fragment {  
  
    public PlaceholderFragment() {  
        }  
  
    @Override  
    public View onCreateView(LayoutInflater inflater, ViewGroup container,  
                            Bundle savedInstanceState) {  
        View rootView = inflater.inflate(R.layout.fragment_main, container,  
false);  
        return rootView;  
    }  
  
}
```

## 10. SYSTEM SECURITY AND TESTING

### 10.1 HTTPS

HTTP Secure is a communications protocol for secure communication over a computer network, with especially wide deployment on the Internet. Technically, it is not a protocol in and of itself; rather, it is the result of simply layering the Hypertext Transfer Protocol (HTTP) on top of the SSL or TLS protocol, thus adding the security capabilities of SSL/TLS to standard HTTP communications. The main motivation for HTTPS is to provide authentication of the visited website and to protect the privacy and integrity of exchanged data.

We've deployed HTTPS in our web application to prevent man-in-the-middle (MiTM) attacks.



## 10.2 HTTP Strict Transport Security

HTTP Strict Transport Security (HSTS) is an opt-in security enhancement that is specified by a web application through the use of a special response header. Once a supported browser receives this header that browser will prevent any communications from being sent over HTTP to the specified domain and will instead send all communications over HTTPS. It also prevents HTTPS click through prompts on browsers.

Simple example, using a year max-age with all present and future subdomains will be HTTPS:

```
Strict-Transport-Security: max-age=31536000; includeSubDomains
```

Below is the screenshot of our HTTP request/response pair showing HSTS being enforced.

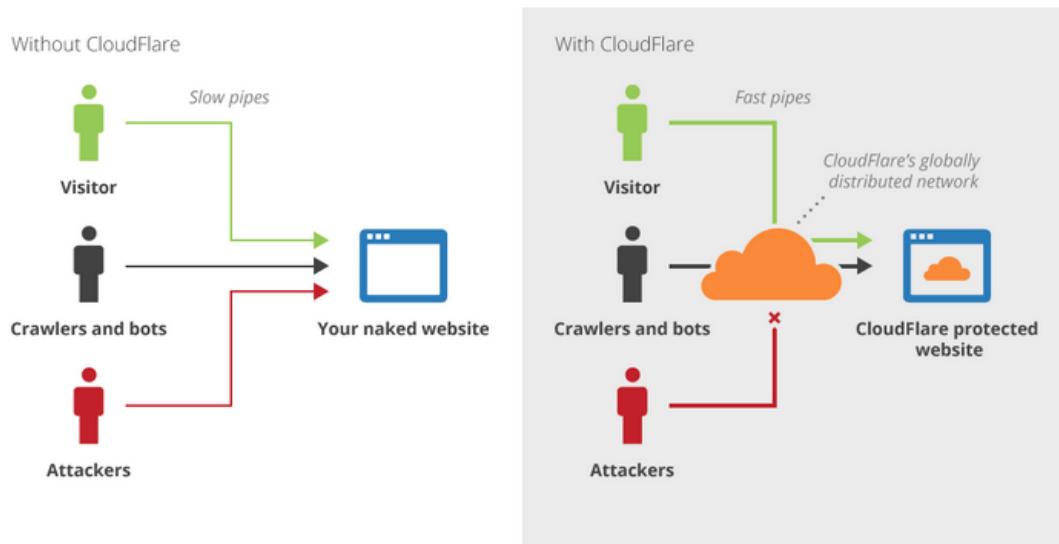
```
GET / HTTP/1.1
Host: smartbin.prakharprasad.com
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10.10; rv:32.0) Gecko/20100101 Firefox/32.0
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-GB,en;q=0.5
Accept-Encoding: gzip, deflate
Cookie: __cfduid=d46cb0a6f864a5c8ff992bc32c296b0451391708214679; _ga=GA1.2.627385116.1401874449;
X-Forwarded-For: 1.1.1.255
Connection: keep-alive

HTTP/1.1 200 OK
Server: cloudflare-nginx
Date: Fri, 01 May 2015 10:06:32 GMT
Content-Type: text/html; charset=utf-8
Strict-Transport-Security: max-age=63072000; includeSubDomains
Upgrade: HTTP/2.0
X-Frame-Options: SAMEORIGIN
x-content-type-options: nosniff
Last-Modified: Sat, 25 Apr 2015 05:15:01 GMT
Etag: W/"ee65b9c7167fd01:0"
Vary: Accept-Encoding
X-Powered-By: ASP.NET
Set-Cookie: ARRAffinity=f88122ab7c701f87739d63e74efb9a84a18d5c19801e902c66520b60832c9e13;Path=/;
CF-RAY: 1dfaac96166e0bc3-HKG
Content-Encoding: gzip
X-Firefox-Spdy: 3.1
```

### 10.3 CloudFlare

CloudFlare leverages the knowledge of a diverse community of websites to power a new type of security service. Online threats range from nuisances like comment spam and excessive bot crawling to malicious attacks like SQL injection and denial of service (DOS) attacks. CloudFlare provides security protection against all of these types of threats and more to keep your website safe.

CloudFlare's technology automatically detects new attacks that arise against any website on its network. Once CloudFlare identifies that there is a new attack, CloudFlare starts to block the attack for both the particular website and the entire community. This also means the longer you are on CloudFlare, the better the protection becomes.



CloudFlare's WAF stops attacks at the network edge, protecting our website from common web threats and specialized attacks before they reach our servers. It covers both desktop and mobile websites as well as applications.

#### Features

- Automatic protection from diverse threats, with strong default rule sets and extensive customization providing Layer 7 protection that is fully integrated with DDoS mitigation
- Lightning-fast 0.3 ms processing times with instant global updates
- Cost-effectively fulfil PCI compliance by utilizing CloudFlare's WAF to meet requirement 6.6
- Real-time reporting and robust logging lets you see what's happening instantaneously
- Easy set up with no hardware, software, or tuning required

## 10.4 PROGUARD

ProGuard tool shrinks, optimizes, and obfuscates our code by removing unused code and renaming classes, fields, and methods with semantically obscure names. The result is a smaller sized .apk file that is more difficult to reverse engineer. Because ProGuard makes our application harder to reverse engineer

ProGuard is integrated into the Android build system, so we do not have to invoke it manually. ProGuard runs only when our application is in release mode, so we do not have to deal with obfuscated code when our application in debug mode.

## 10.5 SOFTWARE TESTING

Software testing is an investigation conducted to provide stakeholders with information about the quality of the product or service under test. Software testing can also provide an objective, independent view of the software to allow the business to appreciate and understand the risks of software implementation. Test techniques include the process of executing a program or application with the intent of finding software bugs (errors or other defects).

### 10.5.1 FUZZING

Fuzz testing or Fuzzing is a Black Box software testing technique, which basically consists in finding implementation bugs using malformed/semi-malformed data injection in an automated fashion.

The great advantage of fuzz testing is that the test design is extremely simple, and free of preconceptions about system behaviour. The random approach allows this method to find bugs that would have often been missed by human eyes. Plus, when the tested system is totally closed, fuzzing is one of the only means of reviewing its quality. Fuzzers usually tend to find simple bugs; plus, the more a fuzzer is protocol-aware, the less weird errors it will find. This is why the exhaustive / random approach is still popular among the fuzzing community.

Another problem is that when you do some black-box-testing, you usually attack a closed system, which increases difficulty to evaluate the impact of the found vulnerability (no debugging possibilities).

## 11. CONCLUSION – FUTURE ASPECTS

In the near future the Internet and wireless technologies will connect different sources of information such as sensors in an ever tighter manner. The number of devices which connect to the Internet is – seemingly exponentially – increasing. These billions of components produce consume and process information in different environments such as logistic applications, factories and airports as well as in the work and everyday lives of people. The society need new, scalable, compatible and secure solutions for both the management of the ever more broad, complexly-networked smart bins, and also for the support of various business models.

Smart dustbins will utilise the benefits of the technological advancements and internet and will certainly help people in the task of waste management and handling.

In near future we'll have a better social media integration to help us post complains to the respective waste handlers.

Incase of urgent treatments there would be a button (either physical or virtual in the form of smartphone applications or a website)

Cloud services play a vital role in smart bins as all data and telemetric data will be hosted on cloud services. Data representation will be done in simpler formats such JSON and etc.

Manufacturers and agencies have already begun implementing a small-scale version of it, in Abu Dhabi. The main reasons why it has not truly been implemented is the impact it will have on the legal, ethical, security and social fields.

Workers could potentially abuse it, hackers could potentially access it, corporations may not want to share their data, and individual people may not like its privacy. For these reasons, the smart bins may very well be pushed back longer than it truly needs to be.

Smart bins can be scary or threatening to some people— too close to an automated, robotic world. But the reality is that we've already begun to automate as many aspects of the workplace as possible, and the home is just the next step.

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