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# Crowd-Sourcing For Societal GIS with Open Data Kit an Indian Perspective

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**ABSTRACT:** With 220 million users of smart phones, India is second largest smart phone users in the world. Indian government has launched a Smartphone GIS data collection App setting the trend of crowd-sourcing Geospatial data for societal use. Indian government want to take help of GIS for building SMART and AMRUT cities. Geographic information, of SMART and AMRUT cities, is dynamic and needs regular updation. 'crowd-sourcing of Geospatial data can be provided by using smart phones with well designed, Forms to a large extent 'Open Data kit'(ODK), provides a dependable source for crowd sourcing (point) Geospatial data for societal use. ODK is a suite of tools that allows data collection using smart devices. Planning for a city needs spatial data collection, for data a number of surveys need to be conducted .In this paper ODK is used as a tool to collect spatial point data and populating this data on to WEB-GIS. The results obtained from WEB-GIS are presented for visualization.

**KEYWORDS:** crowd-sourcing, ODK, ODK build, WEB-GIS

### I. INTRODUCTION

A **geographical information system** or **geospatial information system (GIS)** is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. In a general sense, the term explains any information system that collects stores, edits, analyses, shares, and displays geographic information. **GIS** can show many kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships. GIS applications are applications that support users to create interactive and customized queries , analyze spatial data, edit data in maps, and represent the results of all these operations.

GIS can relate unrelated information by using location as the key index variable. Locations or extents in the Earth space-time may be recorded as dates/times of occurrence, and x, y, and z coordinates representing, longitude, latitude, and elevation, respectively. All Earth-based spatial-temporal location and extent references should, ideally, be relatable to one another and ultimately to a "real" physical location or extent. This key characteristic of GIS has begun to open new avenues of scientific inquiry.

There are many applications of GIS ranging from crime mapping, waste water and storm water system, Remote sensing applications, Road networking, public participation GIS and so on. Managing such applications is not a easy task. We need to collect lot of information and we need to arrange it in a systematic way. GIS is a broad term that can refer to several different technologies, processes, and methods. GIS and location intelligence applications can be the foundation for many location-enabled services that rely on analysis and visualization.

Development of the Web and expansion of the Internet provide two key capabilities that can greatly help geoscientists. First, the Web allows visual interaction with data. By setting up a Web Server, clients can produce maps. Since the maps and charts are published on the Internet, other clients can view these updates, helping to speed up the evaluation process. Second, because of the near ubiquitous nature of the Internet, the geospatial data can be widely accessible. Clients can work on it from almost any location. Both of these features alters the way geoscientists do their work in the very near future. The combination of easy access to data and visual presentation of it addresses some of the primary difficulties in performing geosciences evaluations.

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WEB-GIS are a type of distributed information system. Which contains at least one server and a client, where server is a GIS server and client is a web browser? Web-GIS can be a desktop application or mobile application. It refers to any GIS that use client server communication. It has many applications like the maps can be viewed by many people globally. It is easy to use, there will be unified updates and we can create diverse applications.

Government of India is formulating GIS based master plans for SMART AND AMRUT ( Atal Mission for Rejuvenation and Urban transformation) cities. The main objective of it is to develop a common geo-referenced base maps and land use maps using GIS. And it is formulating for 500 cities which are selected under this project. The main task of this project is about surveying of these cities, gathering information from satellite images. Generally , satellite image gives full picture of entire city at a high level.

Getting information from satellite image is not so easy, also we need to concenter many satellite images to obtain accurate information even then the information can not represent real behaviour of the city. We need to plan for geographical point data so that we can take better decisions. For this purpose we need to employ many officials to collect such data which is a big task. Rather we can motivate citizens to supply point data voluntarily. Now a day's smart phone is a common utility. And using smart phones we can collect valuable point data. Open Data Kit (ODK) is a suite of tools and ODK collect is a mobile app that can be installed in mobile phones and using which public can collect point data.

A very little work reported regarding collection of data using ODK and publishing the same into web portal and later analysis for taking business decisions.

## II. LITERATURE SURVEY

In Web-GIS Applications Surveys are generally conducted using paper based forms which are slow as we need to upload this data manually and even this is prone to errors, To solve this problem we can take the help of smart phones. Open Data Kit (ODK) an open source project which facilitates data collection using Android based devices. Survey forms are created as Forms either using ODK Build or Xlsforms Form management, survey data submissions and data visualization are handled by a server instance known as ODK Aggregate. ODK Collect is an Android application which displays the survey form and records the responses. The collected data can be sent from ODK Collect to a server, opportunisticly, i.e. the collected forms are saved on the memory card and can be transferred whenever internet connection is available. This allows use of ODK even in areas where network connectivity is an issue.

MainakBandyopadhyay et al [2012] presented how open source software's helps researchers and academicians to create a Web-GIS application for taking business decisions. A Web-GIS application needs a stable storage and a dependable source for data collection. Yaw Anokwa et al. [2009] presented how open Data kit becomes a reliable source for data collection in the developing world. ODK has been used by many people to collect data for various applications. Radhika Tayal et al [2015] presented a survey form for pregnant women to analyze the neonatal mortality rate in India. Here they have created survey forms which will collect data about the socio, economical, health issues of parents and soon. In the process of conducting survey generally the data providers may do many mistakes in filling the form due to misinterpretation, or they are not trained well to fill the form this creates problems in data collection. Abhishek Gupta et al.[2013] presented a paper and it explains how to simplify, improve data collection with features such as pre filling and validation SMS so that the error rate in filling the form can be reduced.

The ODK is supporting in health care sector for implementing clinical decision support system (CDSS) Yaw Anoka et al. [2012] presented a multi-method approach to document four failure models that can effect CDSS implementation using ODK. Data transfer and maintenance is a critical issue, YoonSung Hong et al. [2011] presented ODK Tables which provides a way of organizing data into database tables hosted directly by a smart phone. New applications are also created on top of ODK Collect for general purpose data management like ODK Tables app that helps mobile users to curate their own tables based on their requirements, Waylon Brunette et al. [2013] presented how ODK collect can be integrated to ODK Tables for custom visualization of data.

Some monitoring applications need to sense data and the sensed data is to be sent to the server. Rohit Chaudhry et al. [2012] presented a framework called ODK Sensors using which a mobile phone can collect data using sensors. They presented four application models that tells how easy to connect smart phones with sensors for data

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collection. Used Waylon Brunette et al. [2012] extended this ODK Sensor frame work for interoperability between different mobile devices with different sensors. In certain applications, it needs to be integrated with several sensors with different communicational channels and data formats. SchalkHeuniset al. [2013] implemented ODK tool to collect the site audit survey for domestic electricity load research. Finally, the results are presented on the maps with geo points with data attribution

A very little work reported regarding ODK and its implementation on Web-GIS. A wide variety of data can be analyzed and visualized using ODK. Hence, we designed and developed a Web-GIS system for gathering information about a city for urban planning.

## III. PROPOSED METHODOLOGY

In this paper, we have designed and developed customized ODK form for collecting data. A Web-GIS application was developed using data collected from customized ODK form. A Web -GIS application can be a static, dynamic, or active. Static Web-GIS contents are fixed by the designer for each request for static map we will always get the same response. A Dynamic Web-GIS responds to the users input and generates a new geographical document which gives the attribute values for the geo point dynamically. Active Web-GIS provides facilities like input, output, update, query, and analyze the geo graphical data At the server.

Here we have collected point data for Rajahmundry city which is selected as AMRUT city. We have collected data for Rajahmundry from different perspectives like Education, Entertainment, government offices, Health, Hospitality, Religious structures, Roads, Sewage, Slums, Shops/Bazaars, water supply. And this data can be helpful for the original Master plan preparation. The following Logical Architecture represents the overall system

Fig.1 Describes the proposed methodology for collecting Geospatial point data. Using web browser customized forms are created either using ODK Build tool or An Excel sheet data is converted into XML file and that is uploaded to server. Later using ODK Collect app, mobile phones are connected to the server and Downloads the required survey form. Then the survey form data is stored locally in mobile phone's local storage. Whenever internet is available this data can be uploaded to the server. Server aggregates all the data coming from crowd.

In order to present the data a Apache web server was created and Geo server was installed to represent Geo points and to Geo-tag the information. Here Open street Maps ,Bing layers are used as background. Postgresql is used as a Database Server, and postGIS for representing Geo special points. Geo-tagging helps the people to see the location of different facilities

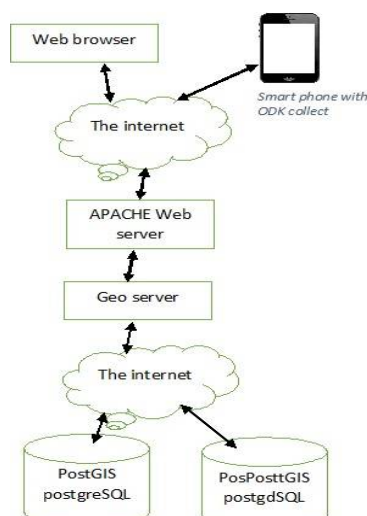


Fig.1 Over all System Structure

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For data collection, we have used Open Data Kit. It is a set of tools containing a tool for form creation (ODK Build), mobile App (ODK collect) to load form, to collect data, and sending the same to the server. At server place the data is aggregated (ODK Aggregate) and can be extracted in useful formats.

ODK implements Open Rosa subset of XForms, with Open Rosa, XForms, and designers can specify a wide variety of control and data types including: text, integer, decimal, select-one, select-multi, image, audio, video, barcode, and location. Designers can also create entry constraints, read-only prompts, ODK has following parts:

## A. ODK Build

Forms can be designed with drag-and-drop facility in ODK Build. Here the form creation is simple with the available controls we can easily create a form. Build is implemented as an HTML5 web-based application using JavaScript and Ruby Rack.

The following fields are defined using XLS2XForms for collecting sewage data

- Recorder information: drainage information, fid, gid, name, type, location, ward information.
- Link in formation; connecting drain information with wards.

Fig.2 shows the ODK Build screen from “<https://build.opendatakit.org/>” site. In this site we have various controls using which we can create our survey forms. The form fields are Text, Numeric, Date/Time, Time, Location, Media, Barcode, and Choose one, Select Multiple, Metadata, and Group. Using these controls we can create our customized forms, we can even include audio video, images and soon. Later this form is downloaded as a xml file and the same is uploaded to server.

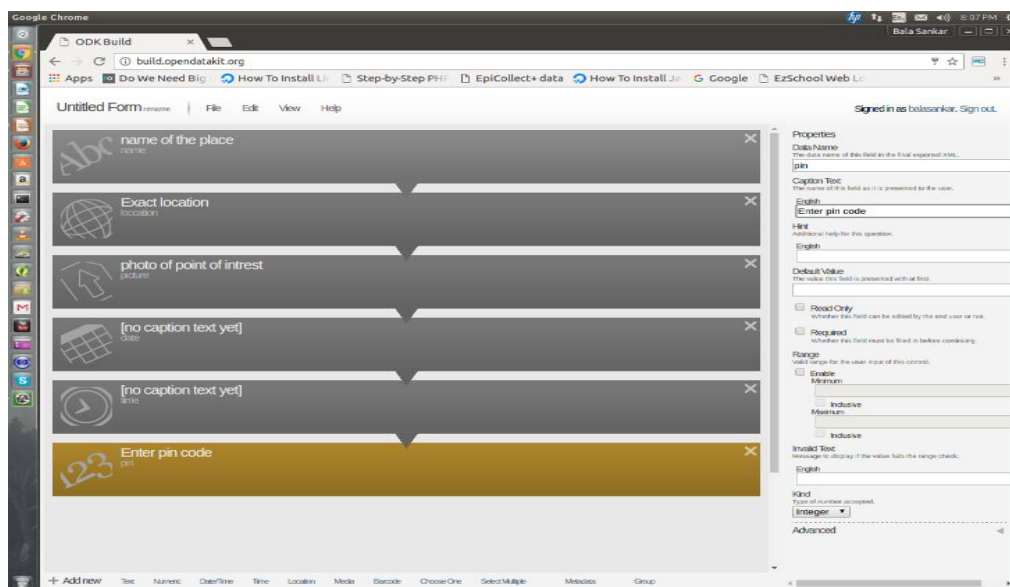


Fig.2 ODK Build screen

## B. ODK COLLECT

ODK Collect is a customized android based mobileApp, which can be used in the smart device to load forms from the ODK Aggregate server and used to collect data, stores the data on smart device SD card until the data is submitted to the server. By this way, it helps us in collecting data even at remote places where internet connection are not available. Here we have used it to collect data for drainages and their location and soon.

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The following step represents the ODK collect usage.

1. Configuration of ODK collect: With in the App first we have given the url path of Aggregate server. Next, we should provide the user name and password then the configuration process will be completed. With this process, smart devices can communicate and send data to the server.
2. In the home screen we can see many options like Fill blank form, Edit saved form, send finalized form, get blank form, delete saved form, from this select get blank form button. Then it shows all the available forms where we will select required forms.
3. Filling forms: To fill forms we need to click Fill form button now form appears and we can fill it and at the end we need to click save and exit.
4. Publishing the data to the server: Until now the form data is not sent to the server it is placed in the local SD card. To send this data to Aggregate server click on Send Finalized Form button available in the main menu now need to select the form data and click on send selected.

Fig.3.shows the ODK collect home screen.ODK collect has various options are there, like Get blank form for downloading the form from the Aggregate server, Fill blank form for filling the survey form through the mobile phone, Edit saved form for editing collected data, Delete saved form, Send finalized form to transfer form data from mobile phone local memory to server.

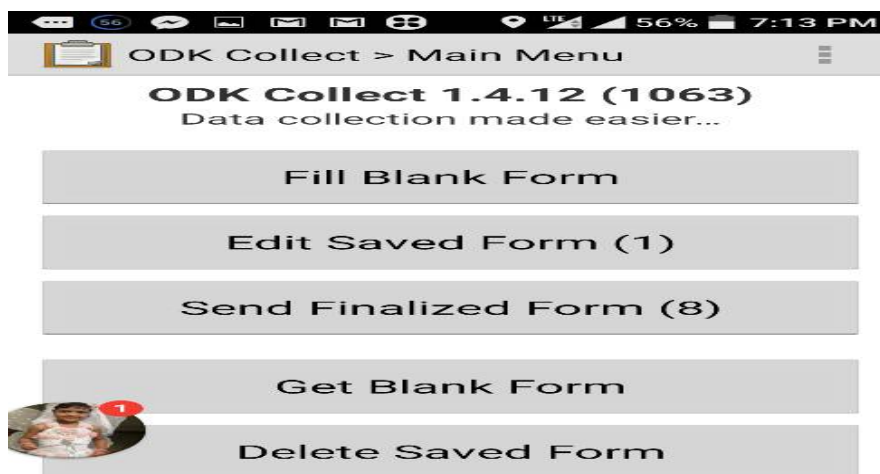


Fig.3 ODK Collect Home Screen

## C. ODK Aggregate

Aggregate is a ODK server which manages all the activity at server. It has various functionalities like Form management, Site administration, Submission. All Forms related tasks like adding, deleting, maintaining form list and soon. Site administration provides permissions for all activities of ODK server. Submissions shows all the data submissions from smart devices through forms. We have deployed ODK aggregate on Linux server whose url address is: <http://mana-rajahmundry.org:8181/ODKAggregate/>.

Aggregate is a repository that can receive data from any smart device which are Open Rosa compliant. The fig.4 shows the aggregate server with various server management activities..it has administrative controls using which we can manage forms, create user permission for data collection, adding forms, Published data, Forms list, form submissions and soon.

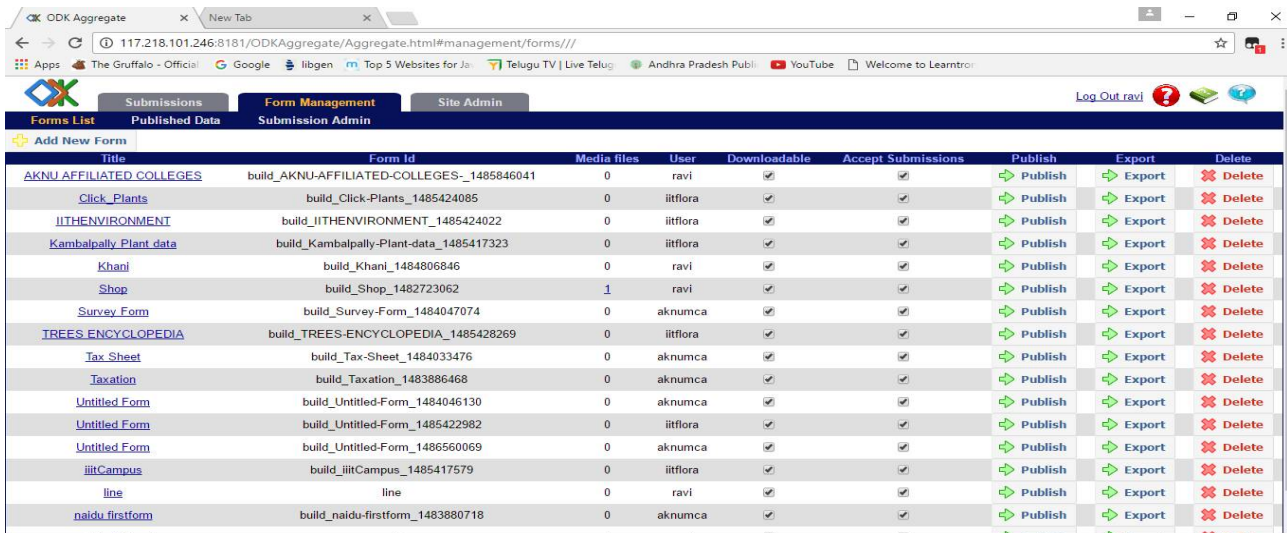


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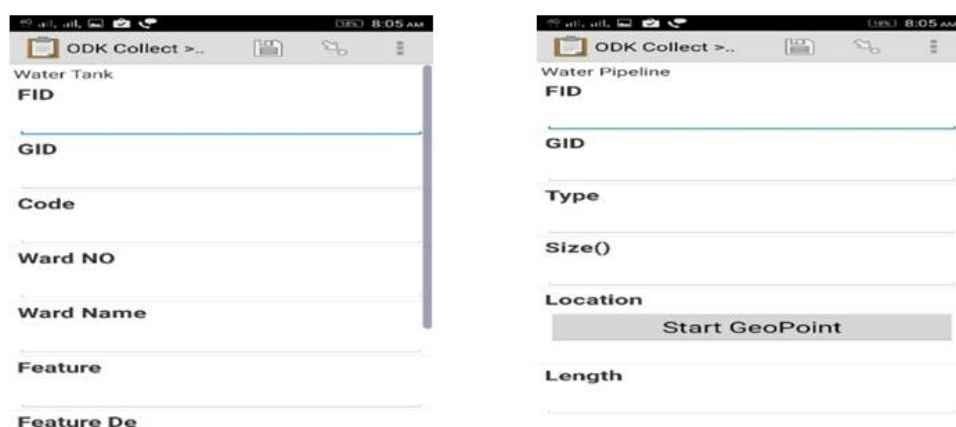
| Title                    | Form Id                                    | Media files | User     | Downloadable                        | Accept Submissions                  | Publish                             | Export                              | Delete                              |
|--------------------------|--|-------------|----------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| AKNU AFFILIATED COLLEGES | build_AKNU-AFFILIATED-COLLEGES_-1485846041 | 0           | ravi     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Click_Plants             | build_Click-Plants_1485424085              | 0           | itfflora | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| IITHENVIRONMENT          | build_IITHENVIRONMENT_1485424022           | 0           | itfflora | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Kambalpally Plant data   | build_Kambalpally-Plant-data_1485417323    | 0           | itfflora | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Khani                    | build_Khani_1484806846                     | 0           | ravi     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Shop                     | build_Shop_1482723062                      | 1           | ravi     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Survey Form              | build_Survey-Form_1484047074               | 0           | aknumca  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| TREES-ENCYCLOPEDIA       | build_TREES-ENCYCLOPEDIA_1485428269        | 0           | itfflora | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Tax Sheet                | build_Tax-Sheet_1484033476                 | 0           | aknumca  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Taxation                 | build_Taxation_1483886468                  | 0           | aknumca  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Untitled Form            | build_Untitled-Form_1484046130             | 0           | aknumca  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Untitled Form            | build_Untitled-Form_1485422982             | 0           | itfflora | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Untitled Form            | build_Untitled-Form_1486560069             | 0           | aknumca  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| iiitCampus               | build_iiitCampus_1485417579                | 0           | itfflora | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| line                     | line                                       | 0           | ravi     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| naidu firstform          | build_naidu-firstform_1483880718           | 0           | aknumca  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Fig.4 ODK aggregate server showing form submissions

## IV. EXPERIMENTAL RESULTS

We have designed multiple forms to collect transport, sewage, Educational institutions, and entertainment data. The aggregate server contains Postgresql database where this data will be stored. Finally the data is published on the webpage using web server and geo server.

The fig.5a,5b shows the screen shots of ODK collect, configured with water Tank form, water pipe line information questionnaire With various fields for collecting different features of water tank and water pipeline.



ODK Collect >..

Water Tank

FID

GID

Code

Ward NO

Ward Name

Feature

Feature De

ODK Collect >..

Water Pipeline

FID

GID

Type

Size()

Location

Start GeoPoint

Length

Fig 5(a). Customized Form for Water tank 5(b) Customized form for Water pipeline

After collecting all this information we have retrieved this data from Postgre SQL database and published the data on to a website called "http://mana-rajahmundry.org/" site the final output is presented in the following fig.6. The water tank information is posted as geo points on open street map layer. Upon clicking on the geo points the attribute data is presented as small window.

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Fig.6 shows water tank information. If we click on the geo point it pops up with a window which contains information about water tank the background for this map is loaded from openstreet map layer. We can pan or zoom the map for selecting a specific geo point.

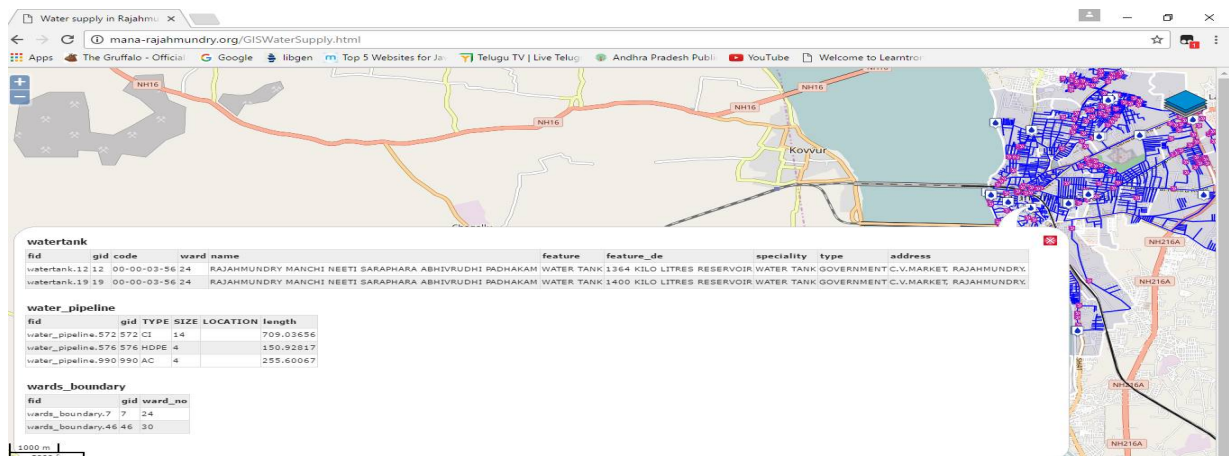


Fig.6 Screen shot of Open street map showing water tank information

Fig.7 shows drainage information. Drainage facilities are mapped as lines on clicking on the lines we can get attribute information about the drainage line, here Rajahmundry shape file is represented as a layer on top of openlayers map. The data collected from mobile phone is presented as a pop up window.

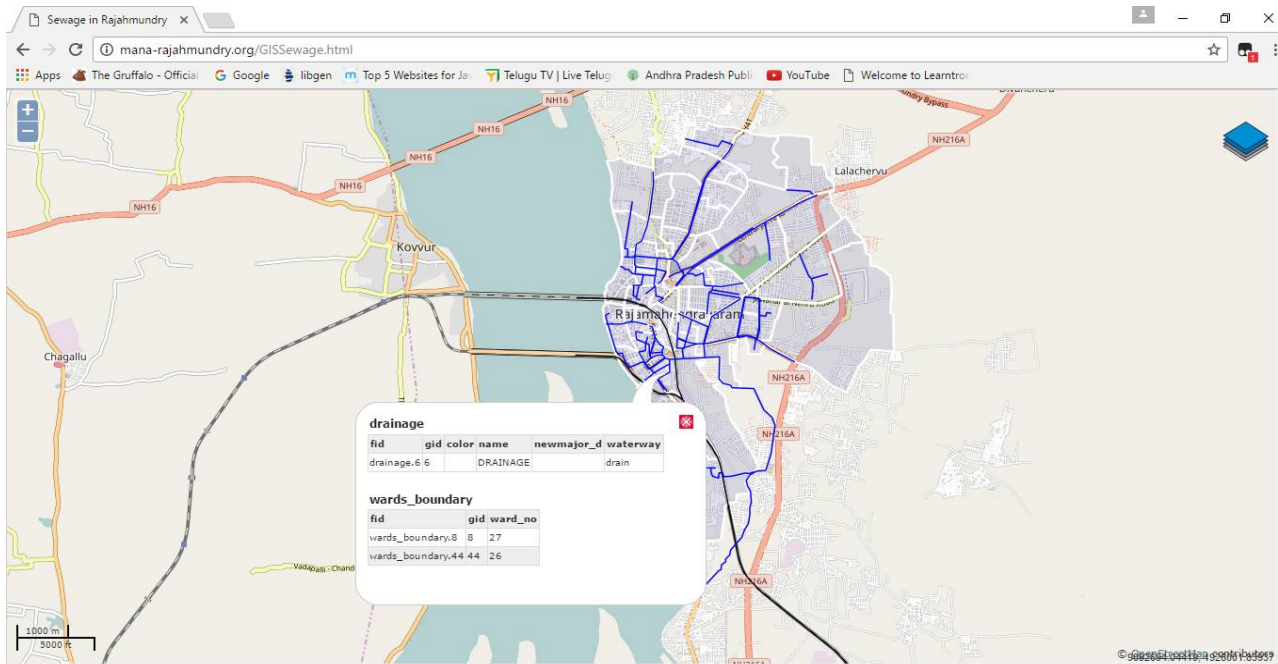


Fig. 7 Open street map layer showing drainage pipe line information

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## V.CONCLUSION

An ODK based data collection for Rajahmundry city information was successfully completed for different aspects like Education, Entertainment, Facilities, Government offices, Health, Hospitality, sewage, slums, and water supply. The collected data were used to verify data from the municipal authorities to identify the issues master plan preparation process. The geo-tagged photos and data are valuable sources for local authorities and researchers to visualize the physical locations of the facilities

Using ODK, the cost of collecting data is reduced as the data is sourced by the citizens, after proper validations these data were presented. This way many national and international government projects can be benefited by using ODK tool for data collection. This tool provides greater support for developing countries. Geo server provides all the necessary support for geo referencing and list attribute data on web site.

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