



# PROCESS DOCUMENT

ICT BASED ADAPTATION TO CLIMATE CHANGE IN CITIES

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

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Bonn and Eschborn

**ClimateSmart Cities Project**

B-5/5, Safdarjung Enclave

New Delhi 110 029, India

T + 91 4949 5353

F + 91 4949 5391

**Responsible**

Mrs. Vaishali Nandan

E Vaishali.nandan@giz.de

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# ABBREVIATIONS

- BMC** Bhubaneshwar Municipal Corporation
- BMI** Bundesministerium des Innern, für Bau und Heimat (German Federal Ministry of the Interior, Building and Community)
- BMU** Bundesministerium für Umwelt, Naturschutz und Nukleare Sicherheit  
(German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
- BSCL** Bhubaneswar Smart City Limited
- GIS** Geographic Information System
- GIZ** Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
- ICT** Information And Communication Technology
- ICT-A** ICT-Based Adaptation To Climate Change In Cities
- INDC** Intended Nationally Determined Contributions
- IKI** Internationale Klimaschutz Initiative (International Climate Initiative)
- NGO** Non-Governmental Organization
- SDG** Sustainable Development Goals (17 goals of the 2030 Agenda for Sustainable Development developed by the UN in 2016 for a more sustainable future)



## INNOVATIVE DIGITAL SOLUTIONS: A GAME CHANGER

Global warming is now a reality unfolding right before our eyes and is leading to rise in the average temperature of the Earth's delicate climate system. This has led to changes in rainfall patterns all over the world. More calamities like massive wildfires, heavy rainfalls leading to widespread floods, droughts and glacier melting are expected in the years to come.

The changes in climate patterns are adversely affecting the daily lives of billions of people, especially in the developing world. For example, incessant rainfalls in areas with previously low to moderate rains are now leading to water logging in cities that are already struggling to cope up with the rapid urbanisation and industrialisation. Rapid urbanization leads to more storm water run off due to changed land use. Water logging leads to lack of mobility, illnesses and at times, even death due to slippage or drowning, causing

immense economic and social losses. These current and future challenges need state-of-the-art solutions developed in close cooperation with citizens, governments, scientists and digitalization specialists alike.

Governments across the world are taking various progressive steps to ensure the ever growing problem of climate change impact on cities is addressed and solved. To accomplish these objectives, the new age digital transformation has proved to be a boon for citizens, scientists and govts. alike. With its innovative and cutting edge scientifically based solutions, the impact of any calamity - both natural and man made, has been greatly reduced and hence, been extremely beneficial to societies at large where these technologies have been adopted.

## ABOUT GIZ

As a service provider in the field of international cooperation for sustainable development and international education work, GIZ is dedicated to shaping a future worth living around the world. We have over 50 years of experience in a wide variety of areas, including economic development and employment promotion, energy and the environment, and peace and security. The diverse expertise of our federal enterprise is in demand around the globe – from the German Government, European Union Institutions, the United Nations, the private sector, and governments of other countries. We work with businesses, civil society actors and research institutions, fostering successful interaction between development policy and other policy fields and areas of activity. Our main commissioning party is the

German Federal Ministry for Economic Cooperation and Development (BMZ).

The commissioning parties and cooperation partners, all place their trust in GIZ, and we work with them to generate ideas for political, social and economic change, to develop these into concrete plans and to implement them. Since we are a public-benefit federal enterprise, German and European values are central to our work. Together with our partners in national governments worldwide and cooperation partners from the worlds of business, research and civil society, we work flexibly to deliver effective solutions that offer people better prospects and sustainably improve their living conditions.



## GIZ AND INDIA

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has been working jointly with partners in India for sustainable economic, ecological, and social development.

India is fast emerging as an economic and industrial power. It is a member of the 'Group of Twenty' (G20) as well as one of the five major emerging national economies, namely Brazil, Russia, India, China and South Africa (BRICS). Despite the country's rapidly growing economy, poverty and other socio-economic issues remain a challenge. The burgeoning population and accelerated urbanisation in the country have resulted in an environment at risk and greenhouse gas emissions that continue to spiral upwards.

The thematic areas of GIZ in India are:

- Energy
- Environment, Climate Change and Biodiversity
- Sustainable Urban and Industrial Development
- Sustainable Economic Development

The Federal Ministry for Economic Cooperation and Development (BMZ), the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) as well as the Federal Ministry for Economic Affairs and Energy (BMWi) are the main commissioning parties of GIZ in India. Other clients include Indian public sector clients, the European Union and foundations.

The Government of India has launched numerous important initiatives to address the country's economic, environmental and social challenges, and GIZ is contributing to some of the most significant ones. For example, it supports key initiatives such as Smart Cities, Clean India and Skill India. GIZ, in close cooperation with Indian partners, devises tailor-made, jointly-developed solutions to meet local needs and achieve sustainable and inclusive development.



## GLOBAL PROGRAMME: ICT BASED ADAPTATION TO CLIMATE CHANGE IN CITIES

By 2050, approximately 66 per cent of the world population will live in cities (Source: Department of Social and Economic Affairs, UN). This exponential population growth in cities calls for sustainable climate change adaptations for urban areas. The three main criteria to determine digital cities are:



### Sustainable Urban Development

Rapid urban development in high density cities of the world, in accordance with impending climate changes need modern digital transformations at all levels of planning and execution. For Sustainable development of cities, we must take into account the following factors:

- The spatial growth, infrastructure needs and resource demands of urban areas
- The impact and required adaptation on cities due to rapidly changing climate
- The reach and penetration of ICT infrastructure in the city



### Climate Change Adaptation

The Paris Agreement, signed by major economies of the world in 2015, within the United Nations Framework Convention on Climate Change (UNFCCC), committed to maintaining global warming to below 2.0 degree Celsius. National developmental strategies are already taking climate change into account but lack of data and

expertise is a major impediment in the same. Modern technologies and the necessary involvement of civil society in the existing governance, planning and crisis management structures can make sure all these changes are seamlessly adapted to new and existing layouts.

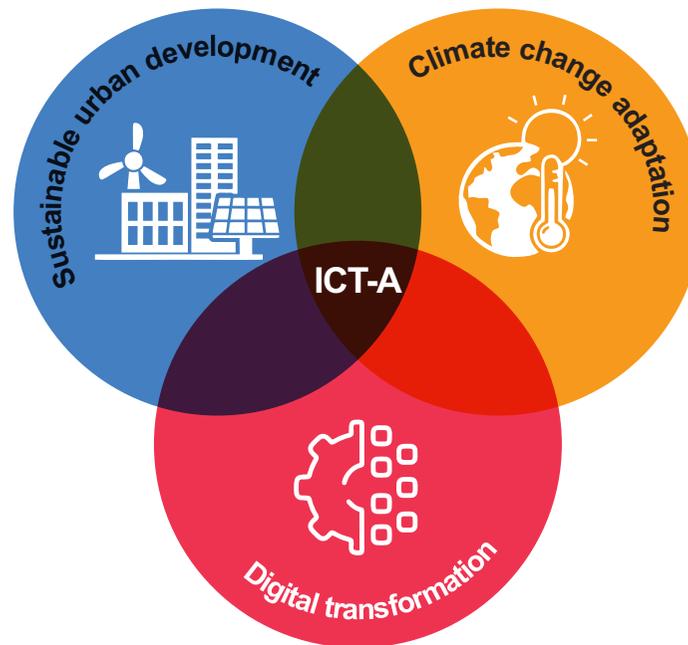


## Digital Transformation

By middle of the century, there will be about 2.5 billion additional people living in cities of the world (Source: UN report of economic and social welfare). With these massive populations claiming more and more space and resources, technology alone can help the cities of the 21st century develop in accordance with rapid climate changes and aspirations.

These Climate Digital Cities equipped with ICT based solutions will not only be able to keep a real-time track of the climate around them, but will also be ready to face any difficulties arising with the help of advanced technological solutions. The solutions pave the way to prioritize resource, reduce damage and save lives at the same time. These solutions are extremely adaptable to local challenges and can be updated regularly for the changing times.

The data collected from all digital applications in the central control rooms can be studied after a certain point in time to derive conclusions that can help in policy making, urban infrastructure planning and disaster management among other very crucial decisions that can be taken by local or central government authorities. This could help governments around the world save lives, property in an efficient manner. These solutions are not only necessary to adopt in the existing cities, but also for the upcoming ones.



**COMPONENTS OF ICT-A CITIES**

This project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has supported the initiative based on a decision of the German Bundestag.

## GLOBAL AND NATIONAL COMMITMENT ON CLIMATE CHANGE



**Clean Water And Sanitation:** By working with relevant stakeholders on ICT-A based solutions, GIZ ensures the reduction or elimination of causes that hinder the distribution of clean, natural and freshwater to the people of a city as well as effective sanitation and solid waste management solutions for a disease-free city and population.



**Industry Innovation And Infrastructure:** The ICT-A based solutions promote rapid industry innovation and modernisation, which in turn lead to infrastructural development that is world-class as well as sustainable in its approach for all future generations.



**Sustainable Cities And Infrastructure:** The ICT-A based solutions also promote existing cities to become sustainable by saving precious resources, better utilisation of existing resources, optimal utilization of existing manpower, minimising wastage and by creating environment and people friendly infrastructure in new and upcoming cities.



**Climate Action:** The rapidly changing climate and growing urban populations are two immediate calls for action that need urgent attention. ICT-A based solutions are a big step towards achieving industrial and human grown at sustainable pace, minimising impact of human activities on nature and climate at large through their scope and action.

# 4

## STRATEGIC PRINCIPLES OF ICT-A



### STRATEGIC PRINCIPLES OF ICT-A FOR CLIMATE CHANGE PROJECT AS UNDERTAKEN BY GIZ

The ICT-A Strategic Principles constitute of 8 ideals around which the entire project revolves.



Foster Citizen Engagement



Plan And Implement For Sustainability



Tackle Local Climate Challenges



Facilitate Transferability And Up-Scaling



Contribute To The City's Planning Process



Create Responsible Data



Foster Local Co-Creation



Prioritize The Open Source

# 5

## METHODOLOGY



Several scientific processes were adopted to reach the goals for ICT based digital solution that was developed for India. Starting with 'Inception or Ice-breaking Workshop' leading to SCRUM, and finally Design Thinking Process which includes 5 stages of Empathising, Defining, Ideating, Prototyping and Testing, each part plays its role in achieving the final result of developing the ICT based tool.

Two separate SPRINTS were also conducted in the entire journey to assess the progress of the project.

INCEPTION WORKSHOP

SCRUM

DESIGN THINKING

### INCEPTION WORKSHOP

The inception workshop as the name suggests, was the first 'ice-breaker' workshop where some very basic requirements of the project were finalised. The stakeholders teams were familiarised with each other and the whole concept and aim of the project was described in detail to them. Several challenges of cities were given to them which were then, narrowed down to

the workable challenge by mutual debates and discussions.

Further, all doubts and questions of participants were cleared by a team of experts and finally detailed plans of working for the whole project was charted. In India the ICT based project to mitigate climate change effects is being implemented in the cities of Bhubaneswar, Odisha and Kochi, Kerala.

## SCRUM

The SCRUM process is an important process to develop trust between the stakeholders and the technical and resource teams of the project. An ideal SCRUM process is based on the values of courage, commitment, focus, openness and respect for stakeholders from the resource team's side. In the inception workshop which served as the first ice breaking workshop between the stake holders and the resource team and helped the resource team understand the needs and expectations of the policy makers of the city, many crucial decisions were taken regarding the entire project in the same workshop.

The technical resource team built the necessary structure of the digital solution in SPRINT 1 and SPRINT 2 and went to the stakeholders again after the completion of the structure to take approval and feedback for the same. This gave the stakeholders reassurance about the entire working of the resource team and they were able to engage with the team regarding any feedback and suggestions for the project directly. It gave them a great sense of ownership towards the project as well. SCRUM ensures a constant feedback loop with the key stakeholders and decision makers and the technical resource teams.

The resource team too was headed by a SCRUM master who was adept in handling the team through the entire process of the SPRINTS and SCRUM. He worked and motivated the entire team on the core values of courage, commitment, focus, openness and respect that form the basis of the SCRUM process.

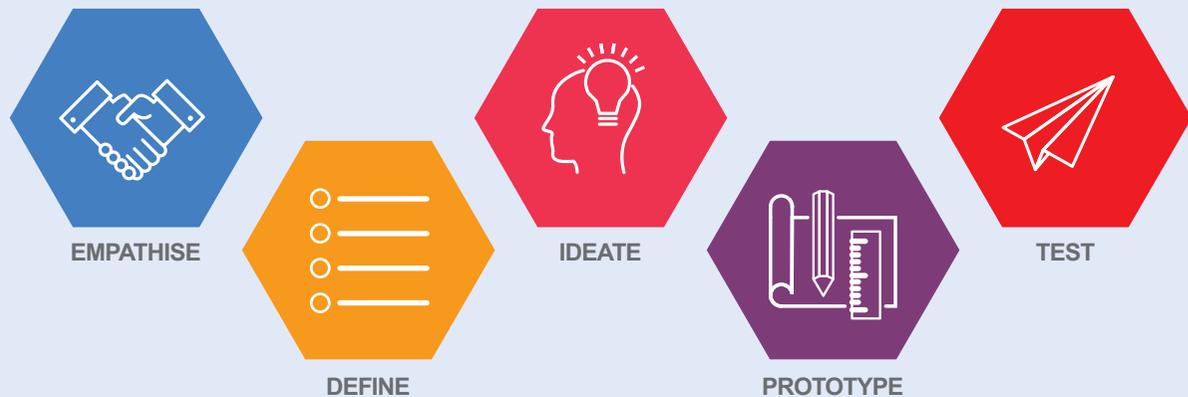


## DESIGN THINKING

Design thinking is a very popular scientifically developed process in the IT and engineering sectors to achieve company/team goals. It consists of 5 stages that enable both the end user and the maker to have the best possible understanding of each other.

Design thinking derives greatly from human behaviour and psychology as well. The stages in the design thinking process are: Empathise, Define, Ideate, Prototype and Test. These are explained as follows:

### DESIGN THINKING



#### STAGE 1: EMPATHISE WITH USERS

The goal here is to empathise with people and appreciate the problems they face by engaging in informal communication, interview and background research. Empathy research helps us in getting a deeper insight into our user's experiences, expectations and motivations. It helps in breaking the ice between the user and designer or team.



#### STAGE 2: DEFINE THE PROBLEM FACED BY USERS

In order to do so, all the relevant information from the discussions and observations from Empathise section of design creation is picked and relevant definitions are derived out of them. A better definition eventually leads to a better solution.



IDEATE

### STAGE 3: IDEATE FOR SOLUTIONS

In the next stage, the whole team of experts and citizens gets to bounce off ideas with each other. The Ideation process leader encourages people not to hold back their thoughts and ideas on the defined problem as above, and answers all their questions. At the end of Ideation process, there usually are several concrete ideas or solutions to the defined problem at hand, to begin working with.



PROTOTYPE

### STAGE 4: PROTOTYPE THE SOLUTIONS CREATED IN THE DESIGN PROCESS

Prototypes are like working models of the ideas as finalised in Stage 3 that enable us to visualise the rough working of the concepts or selected ideas via models, graphs, tools, programs etc. Some of the prototypes that usually are developed are story boards, role plays and paper/cardboard models using different colours, blocks, stationery items and other relevant materials. All these prototypes are non-functional but illustrate the idea that was imagined in the ideation stage.



TEST

### STAGE 5: TEST THE PROTOTYPE WITH THE END USER

In the testing stage, design thinker observes user reactions to prototype and gets feedback on different aspects of its functioning.

# 6

## CITY SELECTION



### CHOICE BASED ON SCIENTIFIC, LOCAL AND TECHNICAL PARAMETERS

For the climate digital city project, 3 cities Coimbatore, Kochi and Bhubaneswar were suggested initially by Ministry of Housing and Urban Affairs (MoHUA) Govt. of India. A two-step selection, firstly, based on available data and the second one by conducting an actual visit by the experts helped the stake holders finalise their decision. The expert teams at GIZ carried out a rapid assessment based on several scientific, local and technical parameters like climate change risk to the city and available data, existing adaptation to rapidly changing climate of the city, presence of digital and ICT based solutions in the city government offices and lastly, presence of robust ICT innovation systems for future innovations in the same area. Based on these parameters, **Bhubaneswar** in Odisha and **Kochi** in Kerala were selected.

### ICT-A: BHUBANESWAR



Bhubaneswar is the capital of the state of Odisha. It is located approximately 50 kilometers inland from the eastern coast of India, on the Bay of Bengal. Bhubaneswar with a population of around 8,50,000 people is a fairly modern city with state's premier scientific, technological establishments spread across the city. The city has an average altitude of 45 m (148 ft) above sea level. It lies southwest of the Mahanadi River that forms the northern boundary of Bhubaneswar metropolitan area, within its delta. The Bureau of Indian Standards places the city inside seismic zone III on a scale ranging from I to V in order of increasing susceptibility to earthquakes. The 2014 UNDP Hazard Risk and Vulnerability Analysis of the City of Bhubaneswar report states that there is "very high damage risk" from winds and cyclones. Floods and waterlogging in the low-lying areas have also become common due to unplanned growth.

The Bhubaneswar Urban Development Area (BUDA) consists of the Bhubaneswar Municipal Corporation (BMC) area, 173 revenue villages and two other municipalities spread over 393.57 square kilometres (151.96 sq mi). The area under the jurisdiction of the Bhubaneswar Municipal Corporation covers 186 square kilometres (72 sq mi). The north–south axis of the city is widest, at roughly

22.5 kilometres (14.0 mi). Growth in the east is restricted due to the presence of Kuakhai River and by the wildlife sanctuary in the northwestern part. The city can be broadly divided into the old town, planned city (or state capital), added areas and outer peripheral areas. It is subdivided into Units and Colonies.

## WHY BHUBANESWAR?

In the rapid assessment, the city of Bhubaneswar scored the highest points on all parameters amongst the three cities of Coimbatore, Kochi and Bhubaneswar. These parameters were Climate change risk, Adaption to rapidly changing climate, Current penetration of digital and ICT based solutions in the government and ICT and the present innovation system in the city.

Based on detailed research and scoping visits on multiple parameters we concluded that Bhubaneswar is the city at most risk of climate change. The city, however, on a positive side also has adept educational and civic society institutions along with adequate digital infrastructure and a high

proportion of the educated population which provide favourable conditions for the IT innovation and growth in the city.

The Odisha government has focused explicitly on Environment and Disasters including mitigating air, water, heat and flood related risks in Bhubaneswar. Bhubaneswar Municipal Corporation also has a dedicated IT cell.

The Odisha State Disaster Management Agency has also been critical in mainstreaming resilience planning in the city. All these factors make Bhubaneswar an ideal city for the project.



## CURRENT CLIMATE SCENARIO IN BHUBANESWAR

Bhubaneswar has faced severe heat waves in recent years which have also led to water shortages. As per a modeling of climate change's impact on Indian cities, Bhubaneswar will see a 37% increase in heat related mortality by 2080. Bhubaneswar is also in the high cyclone risk zone, near the Bay of Bengal coast. It last faced a cyclone in 2013, namely *Phailin*. While cyclones are more destructive in Odisha's coastal and rural regions, Bhubaneswar is also prone to flooding due to cyclones leading to widespread disruption of daily life.

Another cause of flooding is high intensity rainfall in short spans due to climate change. In September 2016, the city

received 155 mm of rainfall in one night, 40 mm of rainfall in 30 minutes in July 2017 and 220 mm of rainfall in less than 18 hours in July 2018. This trend of high intensity rains in short duration of time caused massive water logging in the city. Other factors like lack of adequate drainage, garbage in the drains and encroachments make the water logging challenge even worse. These together pose major problems like affecting mobility of citizens, lost working hours, loss of life due to accidental slippage of both vehicles and people.

Longer duration water logging in the housing areas causes several health issues as well (GIZ, 2018).



### SELECTION OF BHUBANESWAR AS A CITY

Selection of Bhubaneswar was made after a careful evaluation of facts and on-ground research on various parameters between three cities known as rapid assessment. It was noted that Bhubaneswar not only tops the climate risk index but is also technically

most prepared in terms of climate adaptation practices, substantial presence of digital solutions in the governance and carries a robust ICT innovation ecosystem.

### PROJECT INCEPTION

The initial meeting that took place with all the stakeholders brainstormed on several challenges that the city faced and possible solutions for them.

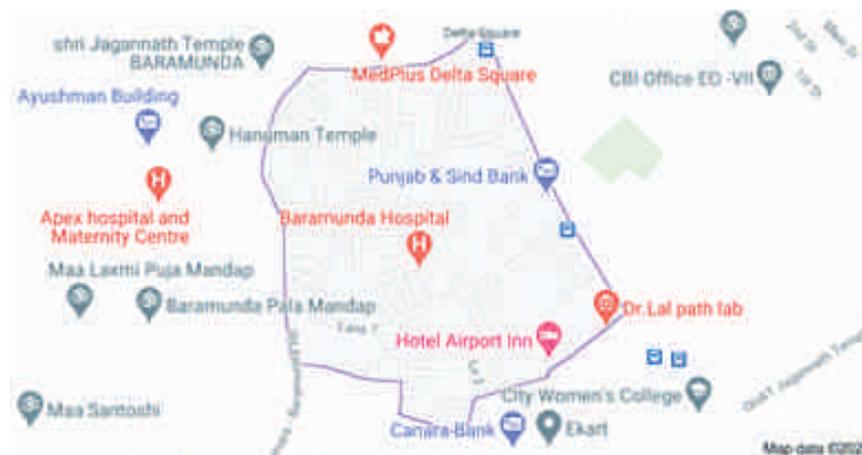
After much deliberation, it was decided to work on urban flooding and develop an ICT based solution to better deal with the problem.

### REACHING A COMMON AIM: BHUBANESWAR, CLIMATE CHANGE AND ICT-A (GIZ)

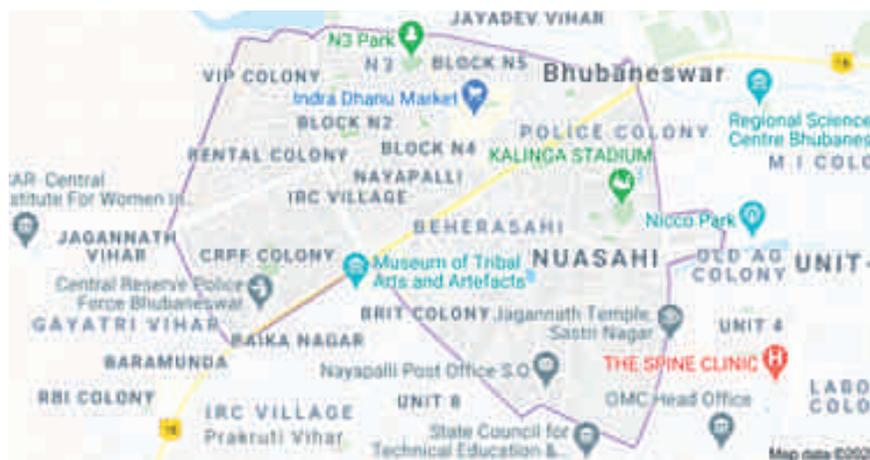
After several rounds of discussions with various stakeholders like Bhubaneswar Developmental Authority (BDA), Bhubaneswar Municipal Corporation (BMC), Bhubaneswar Smart City Limited (BSCL) and various NGOs, it was concluded that urban flooding has become a major challenge for cities and governments to deal with, and a solution was much needed that can help tackle the same problem.

The aim of the project was to encourage citizens of Bhubaneswar city to jointly come up with a digital solution along with stakeholders to better deal with urban flooding in rainy seasons, enabling state governments and local authorities to integrate evidence-based climate change adaptation into urban development methodologies by drawing upon innovative solutions in order to collect and analyse data, ideas, proposals, opinions, decisions, etc.

## PILOT AREA IDENTIFICATION



*Satabdi nagar*



*Nayapalli area*

BMC had previously identified 56 low lying areas that were prone to flooding due to various natural or manmade reasons. For the pilot project, stakeholders chose the areas of Satabadi Nagar and Nayapalli in Bhubaneswar based out of inception research conducted at the beginning of the project. Both these areas have an extensive network of drains and often get choked or flooded due to various reasons.



The project was completed in two phases. In Phase 1, the focus was on two aspects of the design process: Empathy Research and design thinking. Phase 2 consisted of Ideation and Prototyping & Testing.

## PHASE 1

### STEP 1: EMPATHY RESEARCH

Empathy research is the first part of Design thinking process and derives greatly from human behaviour and psychology. The goal is to understand the feelings of people and appreciate the problems they face by engaging in informal communication, interview and background research on the given issue at hand. Empathy research helps us in getting a deeper insight into our user's experiences, expectations and motivations. It helps in breaking the ice between the user and designer or team.

### STAKEHOLDERS

For empathy research for Bhubaneswar following stake holders were identified:

- BMC Officials
- Indian Meteorological Department Officials
- Bhubaneswar Smart City Officials
- Eminent Citizens including Volunteers, Complainants Among Others
- Drain Cleaning Agencies
- Odisha State Fire Service Department



BMC OFFICIALS



INDIAN METEOROLOGICAL  
DEPARTMENT OFFICIALS



BHUBANESWAR  
SMART CITY OFFICIALS



CITIZENS



DRAIN CLEANING AGENCY



ODISHA STATE FIRE  
SERVICES DEPARTMENT

These people were interviewed at length and their issues with city's flood situation were acknowledged in great detail by the design team experts. Based on these discussions, the following feedback came back from the stakeholders:

The BMC officials faced a major problem of not knowing where and how much a certain drain was blocked. Their other comments were about lack of infrastructure and equipment like pumps available with BMC for flood management. The BMC officials hoped for a computerised solution that could help them navigate faster to the pressure points with minimum resources available.

Similarly, Indian Meteorological Department officials also shared their insights about the lack of infrastructure to give now-casts at local area levels. The BMC officials spoke about toll free numbers on which the people could register their grievances about floods and other related matters.

They also shared plans to develop a central grievance system where all modes of complaints could be viewed centrally.

The citizens on the other hand had many complaints with the BMC officials and government staff about lack of cleaning of drains and planning.

The drain cleaning agency spoke about how from hotel waste to construction debris and tyres, tree branches etc. are found in the drains. They also spoke about the need to frequent de-silting during rainy season. The Odisha State Fire Service Department also commented on the issue of small lanes where large pumps cannot be taken for pumping the flood waters, as well as, heavy flooding where situation goes out of control from BMC's hands and thus, the fire department usually has to step in and install large pumps.

## STEP 2: PROBLEM DEFINITION

Empathy research was then presented to stakeholders and was further deliberated by them. Together, they came down with three problem areas under urban flooding which need further evaluation on the possibility of making of an ICT solution.

*As the aim was to find the area with the highest priority for ICT solution, all the stakeholders went on to critically evaluate the three problem definitions finalised above so as to build consensus on one.*





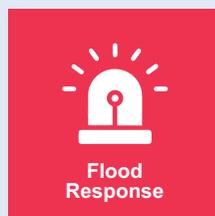
## 1. Flood Prevention

The empathic research with the BMC officials revealed that almost all choked drains had two common agents' viz. garbage and silt. Therefore, a mechanism that could be adopted to identify these drains on priority, could help get them cleaned sooner and thus, avoid the risk of floods to bare minimum, was needed. This would help BMC in keeping track of the complaints for future references, as well as keep track of cleaning agencies. It was observed that at present BMC starts to clean all the city drains simultaneously, without a priority plan and therefore, often tends to miss the necessary areas.



## 2. Flood Damage Minimisation

It was explored, whether a system can be put in place or not which can tell the citizens of the city of expected heavy rains and therefore possible flood like situation at short duration of two hours. On further exploration it was realized that the technology for this task exists for larger cities but has not been implemented for small areas of one municipality and therefore, would not be feasible.



## 3. Flood Response

### It has two components:

- Citizen reporting to the authorities about flood like situations where in they call on a centralised number to a representative who then further coordinates the resolution to be taken.
- A temporary task force that is raised only during the flooding times of the year that deals with all the calls for help from citizens.

Both the above points have their limitations of communication gap, feasibility, coordination issues and therefore, this was dropped from our line of thought of ICT-A application. Keeping in view all three problem definition areas as arrived after due deliberations and considerations, it was decided to work upon the first problem area of Flood Prevention with the help of ICT based application, as flood prevention seemed like an area that not only would nip the problem in the bud, but also set an example to replicate it in almost all other Indian cities.

The same discussion further concluded the most common reasons for flooding of the drains in selected areas as:

- Accumulation of garbage near/inside the drain
- Blockages due to man-made or natural reasons in the drain
- Water levels and flow of water inside the drains
- Amount of rainfall actually received on a certain day

## PHASE 2

### STEP 3: IDEATION

Two separate SPRINTS helped us finalise the ideation process, as well the creation of the ICT based solutions. SPRINT 1 was devised to finalise the approach to the App. To build on to the progress achieved in SPRINT 1, the SPRINT 2 was initiated with only the core teams of GIZ, design and technical teams. This discussion happened after the completion of Stage 4 and user feedback integration.

### SPRINT 1

In the SPRINT 1 of the ICT-A solution development, selected stakeholders participants from BMC, BDA, BSCL, technology experts and citizens from the city of Bhubaneswar were invited for a period of 6 days for brainstorming sessions, based upon the final problem identified as per the first phase of the design thinking process. The aim of the SPRINT was to further narrow down the work areas and develop the concrete models of prototypes of the ICT solution. All kinds of discussions, brainstorming, and questions were encouraged in the workshop.



A common problem statement was therefore identified and finalised as under:

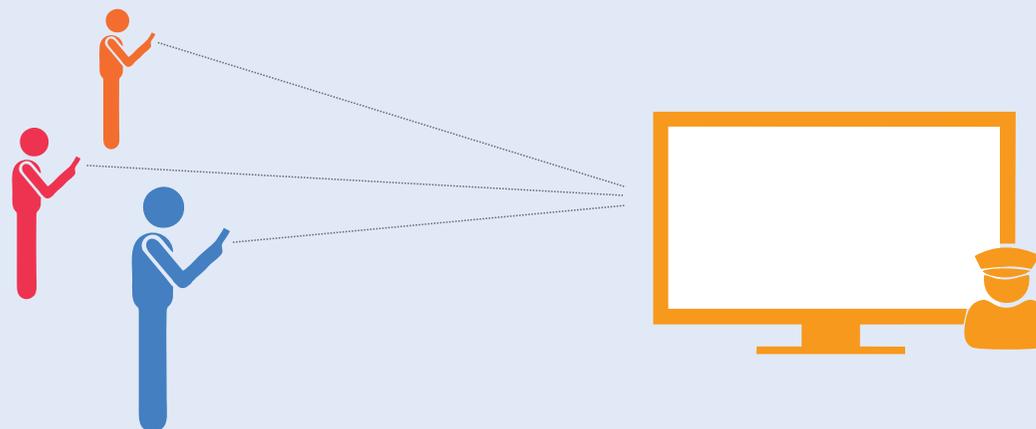
*“How best to help the BMC officials in finding out the drain flow situation in Nayapalli and Satabadi Nagar in as real time and live settings so as to enable them to optimise their resource personal for easy, timely and priority based resolution of the same, helping the city and citizens avoid a flood like situation in the process.”*

Keeping the above problem statement in mind, by the end of the day, many ideas towards the drain situation problem in the city were presented. From reporting with the help of cameras, to floating paper boats denoting water levels, happy and sad clown face drawings, to sound turbines and promotion schemes and asking people to make calls to authorities, were some of the suggestions by the participants.

# PROJECT IMPLEMENTATION



Based on the interesting ideas that were further refined after consulting the technical teams and stakeholders, the teams came up with an idea of developing an ICT based application that would help the citizens of the city to give an input to the BMC officials. The information from the app would be displayed on an electronic dashboard at the centralised control room for BMC officials, where they could see the real-time, live and dynamic status of the critical spots identified and pre-marked through GPS on the app by end user or citizens.



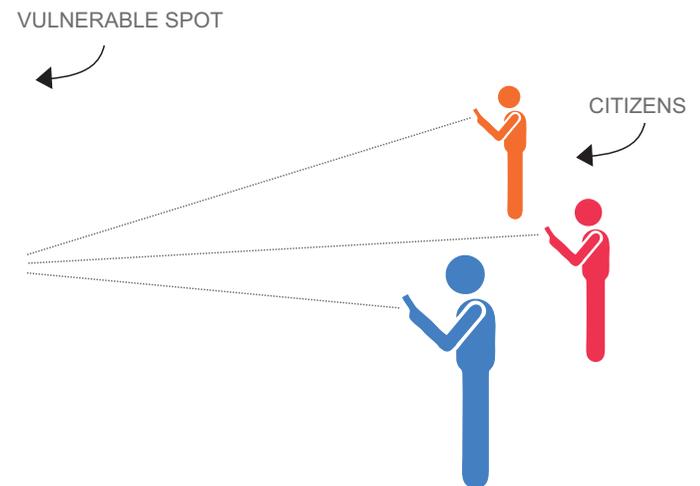
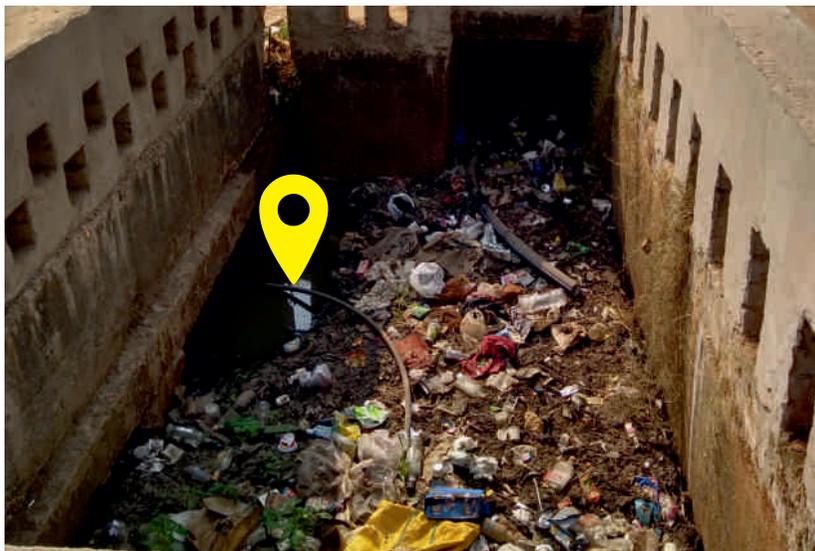
CITIZEN INPUTS  
THROUGH APP

BMC DASHBOARD

## STEP 4: PROTOTYPING AND TESTING

Dummy prototype of the selected idea was made in this stage. This helped in giving a concrete shape to the idea. The team designed the Prototype Version 1.0 (V1.0) which was the mock-up or a representative image of the screen of the app. It showed how the app screen would look in case it is designed by the programmer to be tested by users.

### CITIZENS SPOT THE PHYSICAL MARKERS PLACED ON THE PRE IDENTIFIED VULNERABLE SPOT

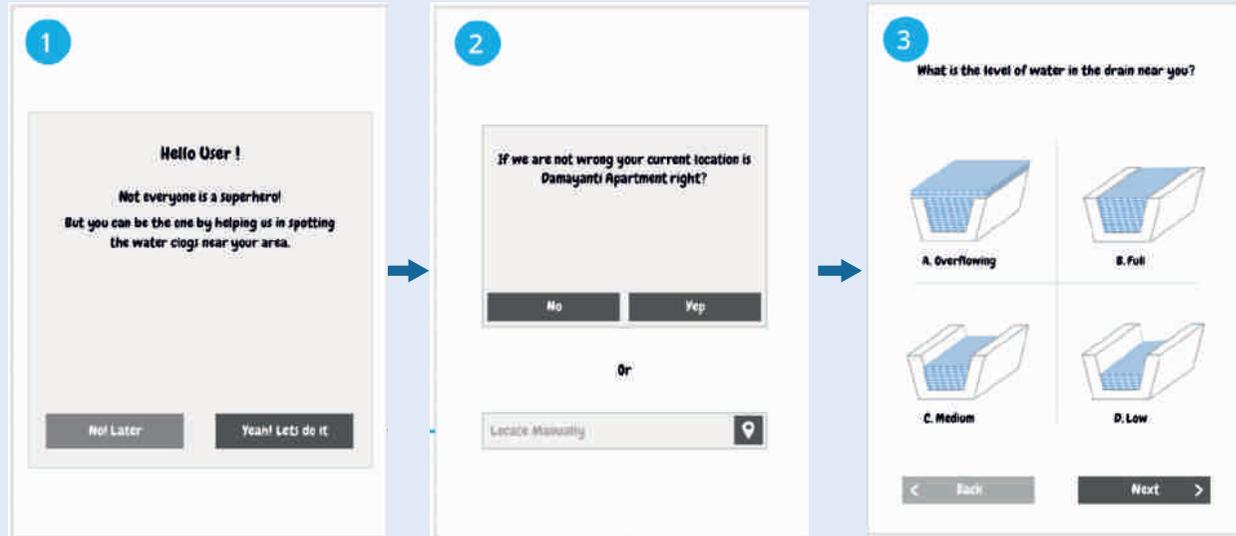


*Citizens spot the physical markers placed on the pre identified vulnerable spot*

A digital meter to notify the level and drain status indicator will be used instead of a physical gauge. The digital markers will be shown on screen at the place of the marked vulnerable spots. These spots will be geo-located on the map of the city. Further, paper prototypes for the Mu City Savior citizen's app and BMC dashboard were designed and tested with the actual users. The testing helped us to get the feedback for further improvements in the design and the process of the digital solution.

## CITIZEN'S APP V1.0

Once the citizen spots the blockage in the drain and wants to report it to the BMC, he will be shown the following on the screen:



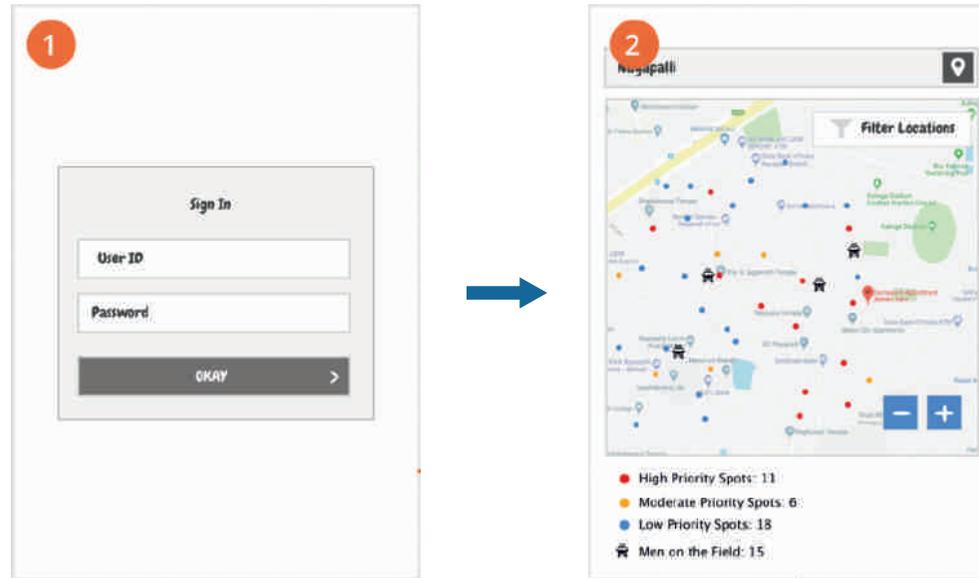
Screen 1 and 2: The app shows notification prompting contribution and confirms location of the user  
Screen 3 and 4: Questions about the drain level and speed pop up



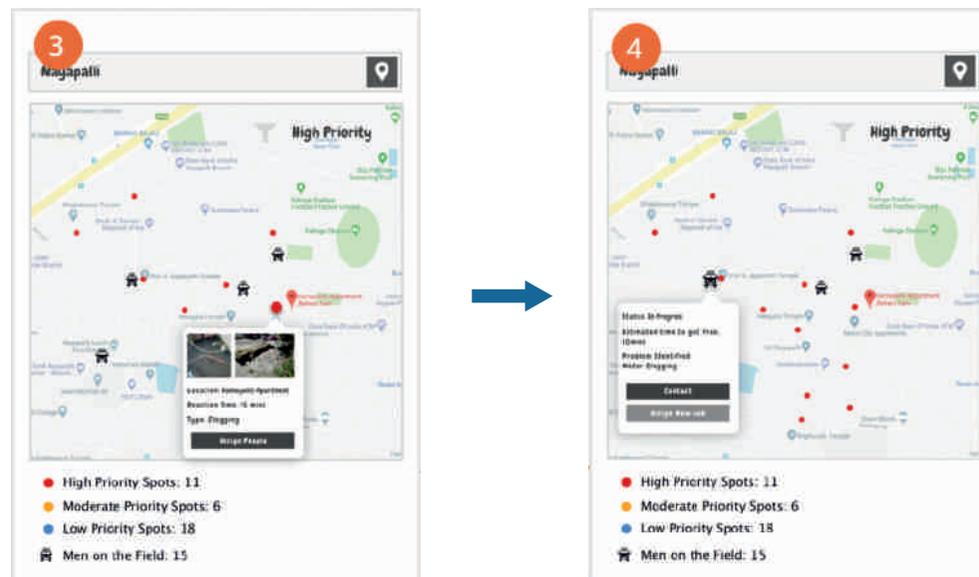
Screen 5 and 6: Further questions on garbage and rainfall received are asked

## BMC DASHBOARD V1.0

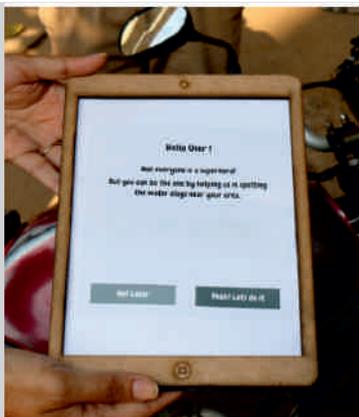
After the citizen has entered the relevant information on the first 6 pages of the screen as shown above, this is what the BMC officials will be able to see on their digital Dashboards. The first screen is the login screen. In subsequent screens live status of vulnerable spots and BMC resources can be seen.



Screen 1 and 2: Overview of the vulnerable spots



Screen 3 and 4: Details about the live status of the vulnerable spots and BMC resources become available in subsequent screens



## TESTING THE APP AND TAKING THE FEEDBACK

The teams that participated in the SPRINT were sent to the designated locations in the Nayapalli and Satabadi Nagar areas to explain to the citizens and BMC officials how the app prototype worked, so as to take actual on-site working feedback from them. This turned out to be a very good exercise.

## USER FEEDBACK AND APP ITERATION

Based on the feedback received with the citizens on the prototype, the app iterations were designed. This process was repeated three times till a final consensus was reached.

## FIRST ROUND OF ITERATION ON CITIZEN FEEDBACK

- The first response was that there were many steps involved in filling the feedback form on App.
- There was also feedback on the images shown on the app and their co-relation with the actual water level in the drain. This is what the user told us, - *"I got slightly confused at the exact water level inside the drain, as I cannot see the bottom of it. The image of the drain on the app shows a cross section of the drain with clearly marked out bottom."*
- Another user said, - *"It was difficult to judge water level and flow as drain width, depth and size are not constant."*
- There was some very relevant feedback on the garbage screen of the app as well, the user wanted to add an option of the type of garbage seen in the drain. This included bottle and cans, polythene bags, construction debris, dead animals, trees and leaves.
- Some users also commented about the ability of the app to take the pictures of inside the drains. Based on the above feedback, new additions were made and the app was improved for one more round of feedback by users.



Actual location visible to the user

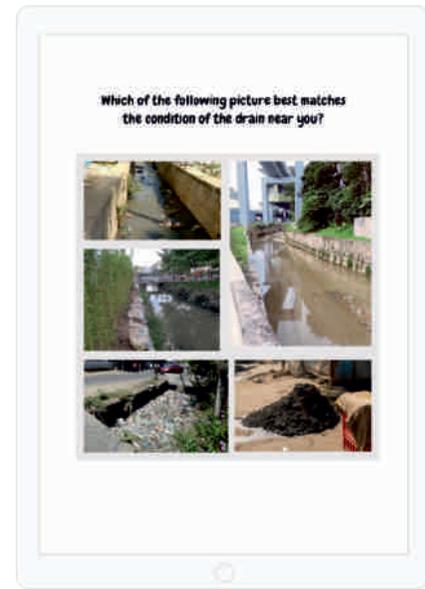
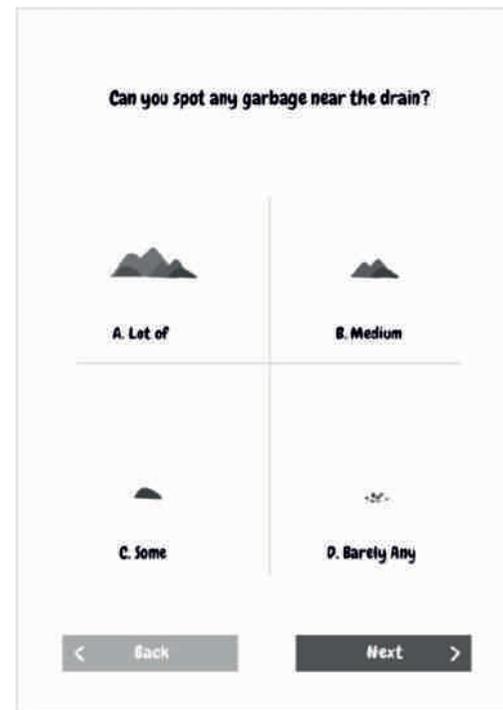


Image displayed on the app to match with the actual situation

Fig: Another design option for the citizen app which uses real images instead of vector graphics



Use of more familiar visual metaphor for garbage

Fig: Garbage status screen old (left), new (right)

## SECOND ROUND OF ITERATION ON CITIZEN FEEDBACK

- “There should be provision to add text commentary along with pictorial survey.”
- “Exact spot on the vulnerable drain should be visible.”
- “People and BMC should be able to communicate via the app and take status of the complaint.”

Second Representation as might be seen on Citizen’s App:

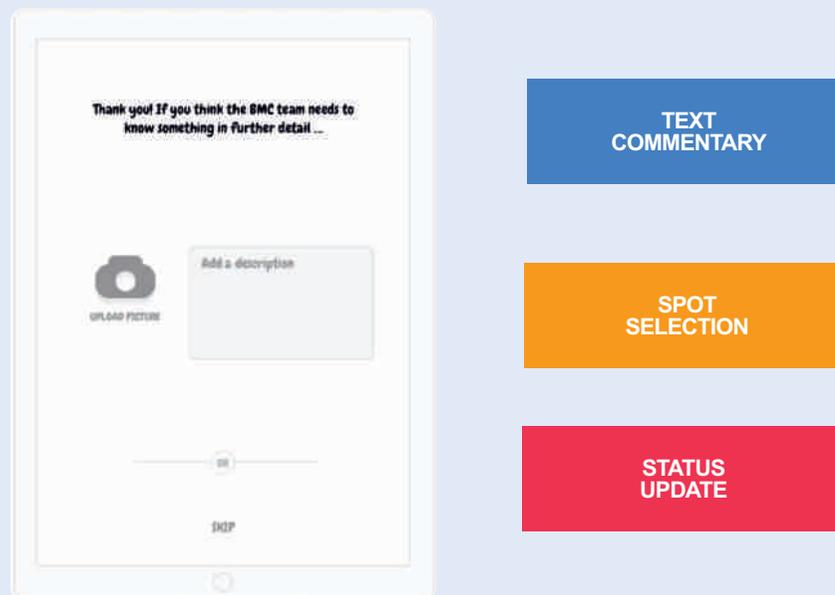


Fig: New Screen to upload the picture and short description about the drain in case the user is not sure about it

## THIRD ROUND OF ITERATION ON CITIZEN FEEDBACK

- “Garbage screen: Easy to select what is not there inside the drain (like dead animals, construction debris) but difficult to judge what other options to choose?”
- “Please make provisions to suggest new vulnerable spots to the BMC via the App.”
- “The condition of the drainage in some areas especially slums is quite different, so the images used in the questionnaire should reflect that.”
- “If I know that my complaint has been attended in affirmative then I will be encouraged to use this app regularly.”
- “I can report vulnerable spots on routes I visit but I won’t be going outside my route to report the spots.”
- “I can stop and report only if I’m walking. If I am in a vehicle, I won’t take efforts to stop and report.”
- “I found the GPS navigation confusing especially for short distances, it was not showing clearly.”



Physical marker kept at the vulnerable spots so that people can easily identify them and mark their observation

## THIRD REPRESENTATION

Based on the above 3 rounds of feedback with citizens, it was decided by the stakeholders to involve willing volunteers for App testing in SPRINT 2.0

- Volunteers are better motivated to sign up for the app as the cause appeals to them
- Trustworthiness is improved
- Likelihood of accurate response increases as self-interest does not govern the response



## FIRST ROUND OF FEEDBACK ON THE BMC DASHBOARD

As part of the feedback exercise, due feedback was also taken on BMC dashboard with BMC officials. Some of the comments were:

- “Problematic areas are being understood in the order of priority.”
- “Citizens’ complaints are always exaggerated regarding the flood, the information on the dashboard can be useful to verify those.”
- “The higher officials will catch hold of us, if they see a lot of problems show up on screen.”
- “In the BMC dashboard, adding more attributes to the spot like drain type, width, depth, water carrying capacity, frequent reasons for the blockages etc., can be helpful.”



## THE SOLUTION CONCEPT: GAMIFICATION INTEGRATED

Final deliberations between the GIZ and technical development partners led to the following conclusions:

Based on the comprehensive feedback, following considerations were made in the citizen's app after going through the App V1.0, feedback in the first SPRINT.

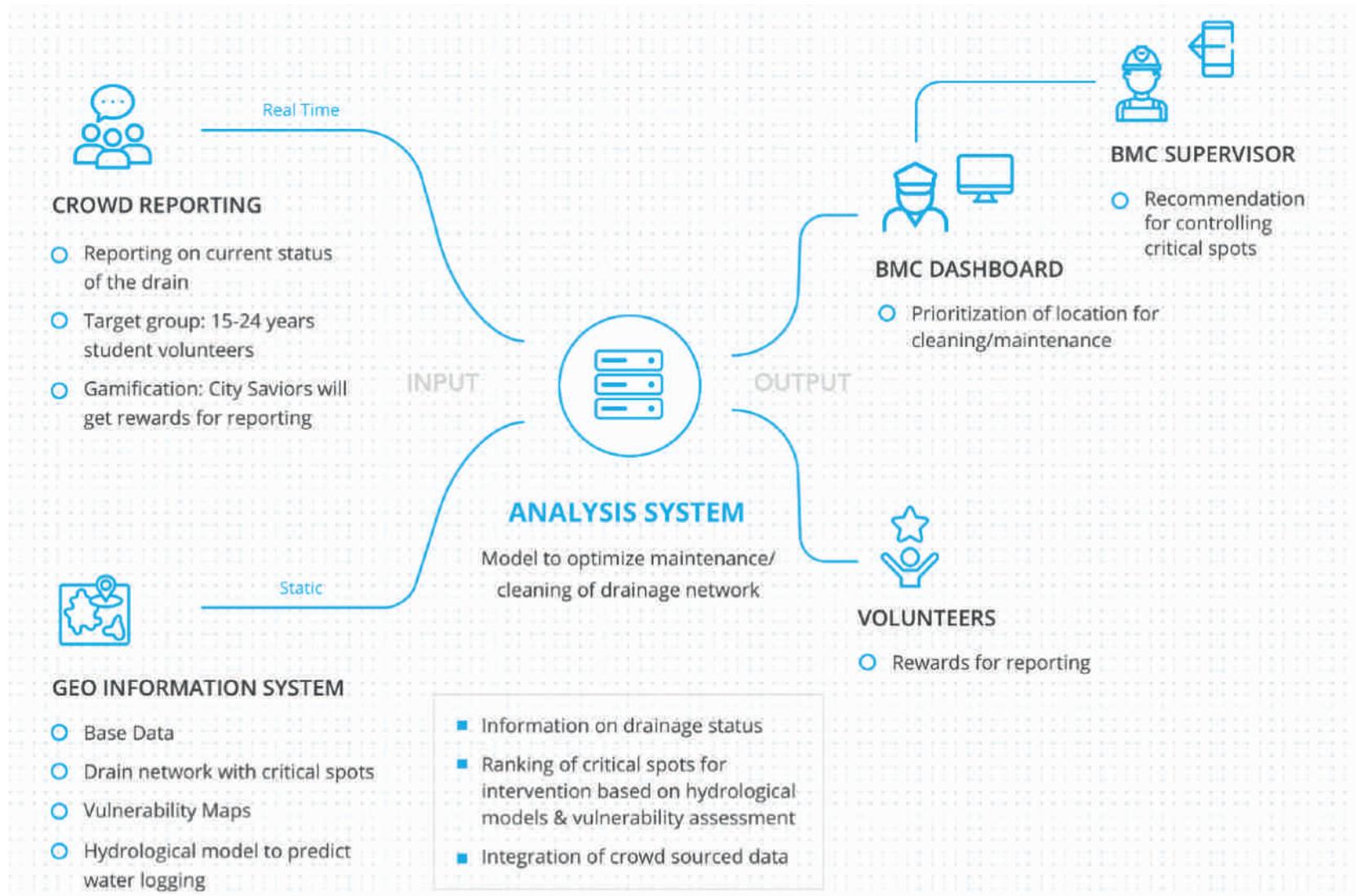
It was decided to keep the volunteers aged 15-24 to test the prototype that will be developed as per feedback in the SPIRINT 1.0 as they are young and tech savvy. It was also decided to gamify the application which meant to create an interface that has a story with characters that are easily relatable with the target audience. This makes it interesting to the user to get involved with the steps of the application and keep operating it.

For gamification in this app, it was decided that the tasks related to reporting the condition of the drains will be abstracted to a mission in the game, where volunteers would need to walk to the location of the drain and then identify the critical spots to mark the condition of the drain by either of the two methods of picture survey or clip art survey.

Secondly, deliberations between the GIZ and technical development partners led to the development of final solution concept of the application as described below.

The solution comprises of a centralised system that gathers information related to the drain status from the various sources like citizens (through crowdsourcing app), IOT sensors, rain gauge etc. and predicts the criticality level of the spots. This information can be accessed by BMC on the dashboard designed for it. The BMC can use this information to guide their field officials and take necessary actions to prevent or control the flood. A detailed digram is shown on the next page.

## SOLUTION CONCEPT (END TO END SYSTEM NETWORK)



## SPRINT 2

### RECAP

Following suggestions were made in the citizen's app after going through the testing feedback in the first sprint:

It was decided to shift the focus entirely from the citizens of all age groups as users to a specific age group that was tech savvy as well and was willing to bring positive change to the city. We decided to shift focus and keep it specifically for young adults between the age of 15-24 years for the same reasons.

In order to make it appealing to this young age group, it was decided to give an interactive gaming interface to the app consisting of a storyline that users can identify and engage with.

Once a person downloaded the app, he or she became the volunteer for the city. The story line consisted of an army of volunteers who are out to save the city from flooding. Each army volunteer started off as a cadet and got points for every spot reported by them via the app. The candidate with more points in the kitty would rise higher in the ranks.

The volunteer therefore has to walk to the location of the drain, identify the critical spot on the map on the app and mark in the app via actual pictures or graphic art.

### CO-WORKING TO CREATE THE SOLUTION: CITIZEN'S APP V2.0

The SPRINT 1.0 was a great success under which much progress was made and approach to the app was finalised. To further build on progress, a second workshop known as SPRINT 2.0 was initiated with only the core teams of GIZ and design and technical teams. Here, the features of the entire solution were finalised so testing could happen in the next stage of solution development. The technical expert agency was then chosen to develop the ICT based solution.

In the first meeting of SPRINT 2.0 all the 3 technical teams got together and gave presentations of the work done so far. This helped the other teams to understand, as well as ask relevant questions on the same. It was based on this meeting and deliberations, following decisions were taken:

- Divide the SPRINT 2.0 to into two parts SPRINT 2.0A and SPRINT 2.0 B
- Refine and further test the mockup as developed in SPRINT 1.0 based on the feedback from technical team and GIZ
- Test the pilot with young volunteer group of similar age as in SPRINT 1.0
- Remove the confusing interactions that the citizens faced while using the app
- Get the user reaction on the gamification aspect of the App
- Finalise between real pictures or clip arts to showcase the drain situation

## REFINEMENT AND FURTHER TESTING OF THE MOCK-UPS

It was identified that the critical spot markers in SPRINT 1.0 were not clear. They were non descriptive and were difficult to spot as per users. It was therefore decided to make them slightly more detailed with bright colours and with more written description so as to make the reader understand the situation easily.

## REDESIGNING THE CRITICAL SPOT MARKERS



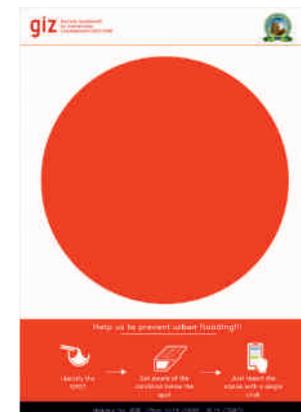
Fig: Spot Marker designed in SPRINT 1 (left) and designed in SPRINT 2 (right)



Fig: Spot Marker as seen deployed in the field

Prominent red color draws the attention and step by step instructions mentioned on the marker guides the user on how to report the drain status.

The new Spot Marker had a bright red circle on a white background with no text inside. Below the circle, a three step guided process was mentioned for the user about how to proceed further with the marker.

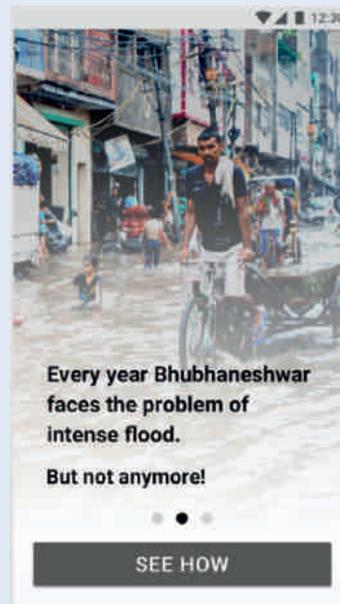


## THE ENTIRE USER-FLOW OF THE CITIZEN'S APP V2.0 WITH GAMIFICATION

With this feedback the first impressions of the app user-flow could be designed, which is shown:



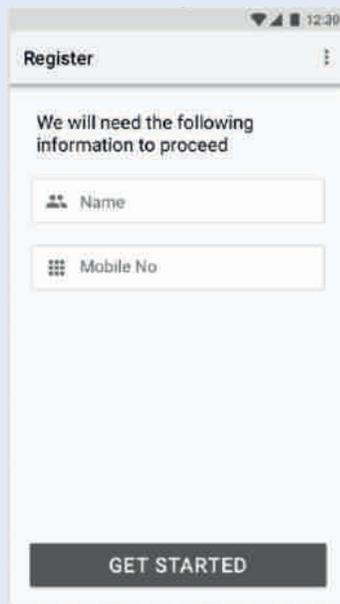
Welcome



App Background  
(About the app)



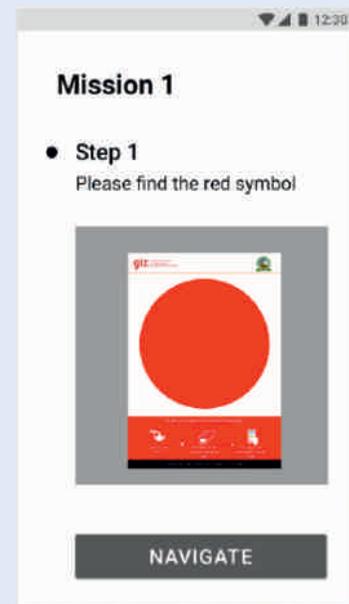
How it works



Registration



Play Game

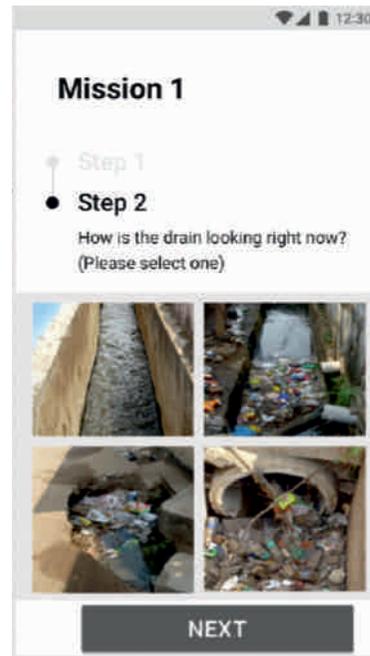


Step 1 of mission 1

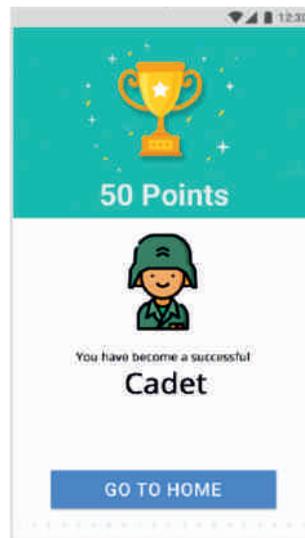


Navigate with GPS

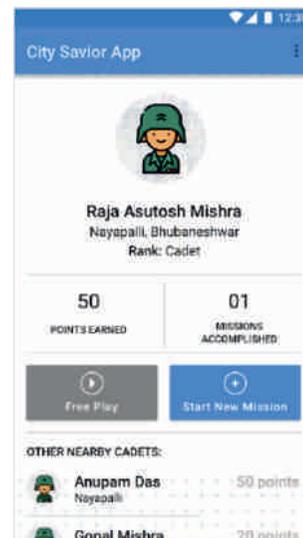
Two options  

Report the drain conditions: Step 2 of 2 (options)



Mission Accomplished



Home Page



*Testing the App Version 2.0 with the chosen volunteers in the age group of 15-24*

## FIRST ROUND OF FEEDBACK ON VOLUNTEER'S REPORTING APP V2.0

Seven randomly selected users of the defined age group were asked to test the paper prototype. The questions to be answered in this round of testing were:

- What is the better representation of the drain situation on the app: picture method or the clip art method?
- Were the users able to follow the instructions in the app and act accordingly?
- What were the hiccups in using the app?
- What is the feedback of the users on the gamification of the entire application?

## RESULTS FROM THE FIRST ROUND OF FEEDBACK

- Some users found it difficult to understand the app working and had to be prompted repeatedly.
- However, the app users could easily identify the critical spot posters and most of them preferred the picture method over clip art method on posters.
- Also, there was major confusion at the time of identifying the status of the drain. The users got confused with the images given.

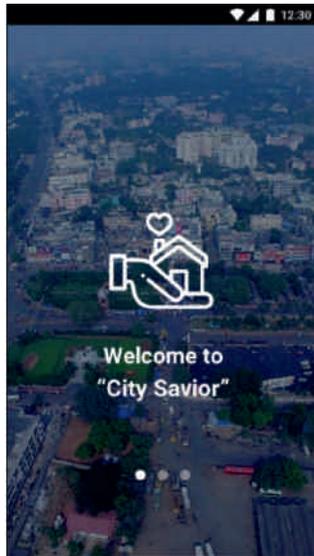
## TASKS FOR THE SECOND ROUND OF APP REFINEMENT AND FEEDBACK

- Simplifying the copies of the screen, reframing the question pertaining to the current status of the drain
- Refining the storyline of the game
- Adding more than 4 images in the picture survey for easy identification
- Using male and female characters in the game to make it identifiable with everyone

## RESULTS FROM SECOND ROUND OF FEEDBACK

Positive feedback was received on all the above mentioned changes in the second round of community feedback.

## FINAL MOCK-UP OF APP AFTER SPRINT 2.0



*Welcome*



*App Background  
(About the app)*



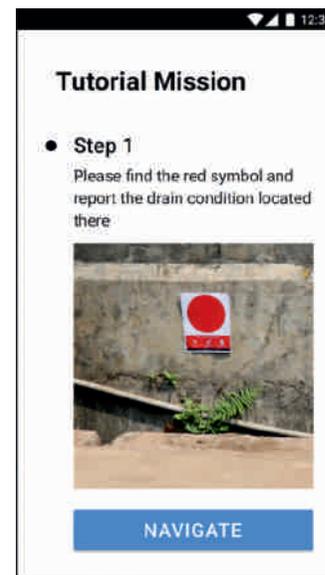
*How it Works*

The screen is titled "Register". It contains the text "We will need the following information to proceed". Below this, there are two input fields: "Name" with a person icon and "Mobile No" with a mobile phone icon. At the bottom, there is a blue button with the text "GET STARTED".

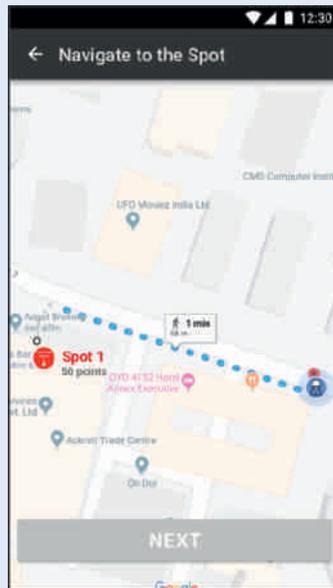
*Registration*



*Play Game*



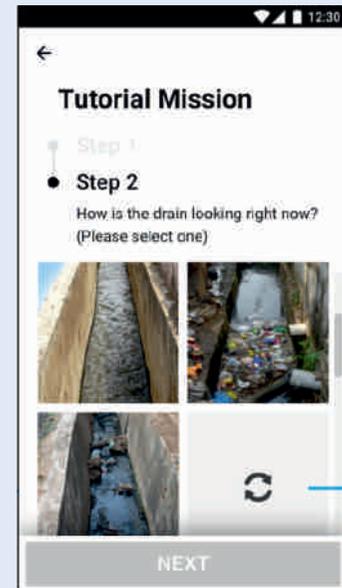
*Step 1 of mission*



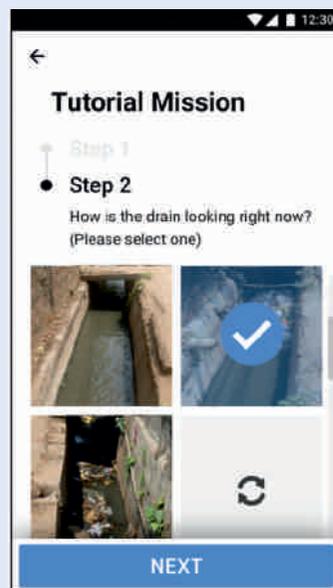
Navigate to the Spot



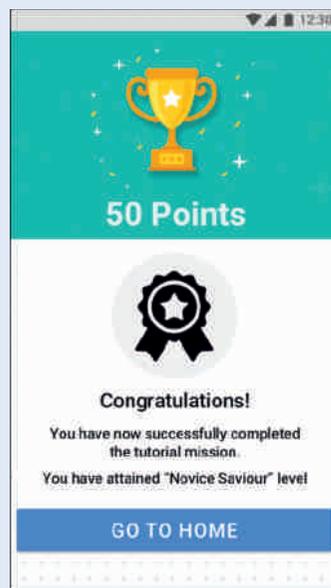
User almost reaches the spot and the next button at the bottom turns blue



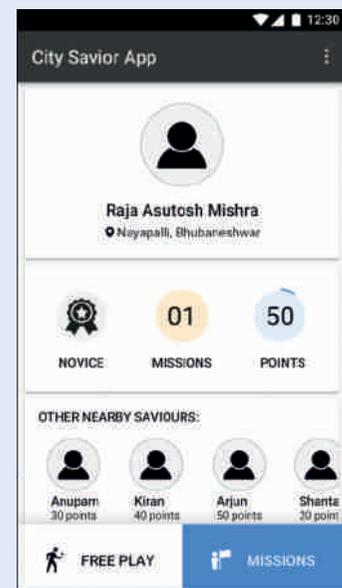
Step 2 of the Mission and Reloads a new set of images



User selects the matching picture and next button turns blue



Mission Accomplished



Home Screen



## CONCURRING ON THE FEASIBILITY AND VIABILITY ASPECT OF THE ENTIRE SOLUTION CONCEPT

- Base data needed as input for the computerised analysis and recommendation
- The technical development experts based on the expectations, drafted a plan of action to gather that data needed and a working draft for the pilot

## SCOPE AND DEPTH OF GIS SURVEY

- For the final pilot app to be developed, a better mapping of the length and breadth of the area defined that needed to be included in the app, including all the major and minor drains to be covered in the same. This was then shortlisted by technical team
- Some of the indicators like population, number of houses, industries, slums to be measured, surveyed and modeled, were agreed upon with technical team
- Finally, to get the required data of the drainage network, permissions and collaborations with the BMC were also sought by GIZ and technical team
- Time and resource needed were also estimated

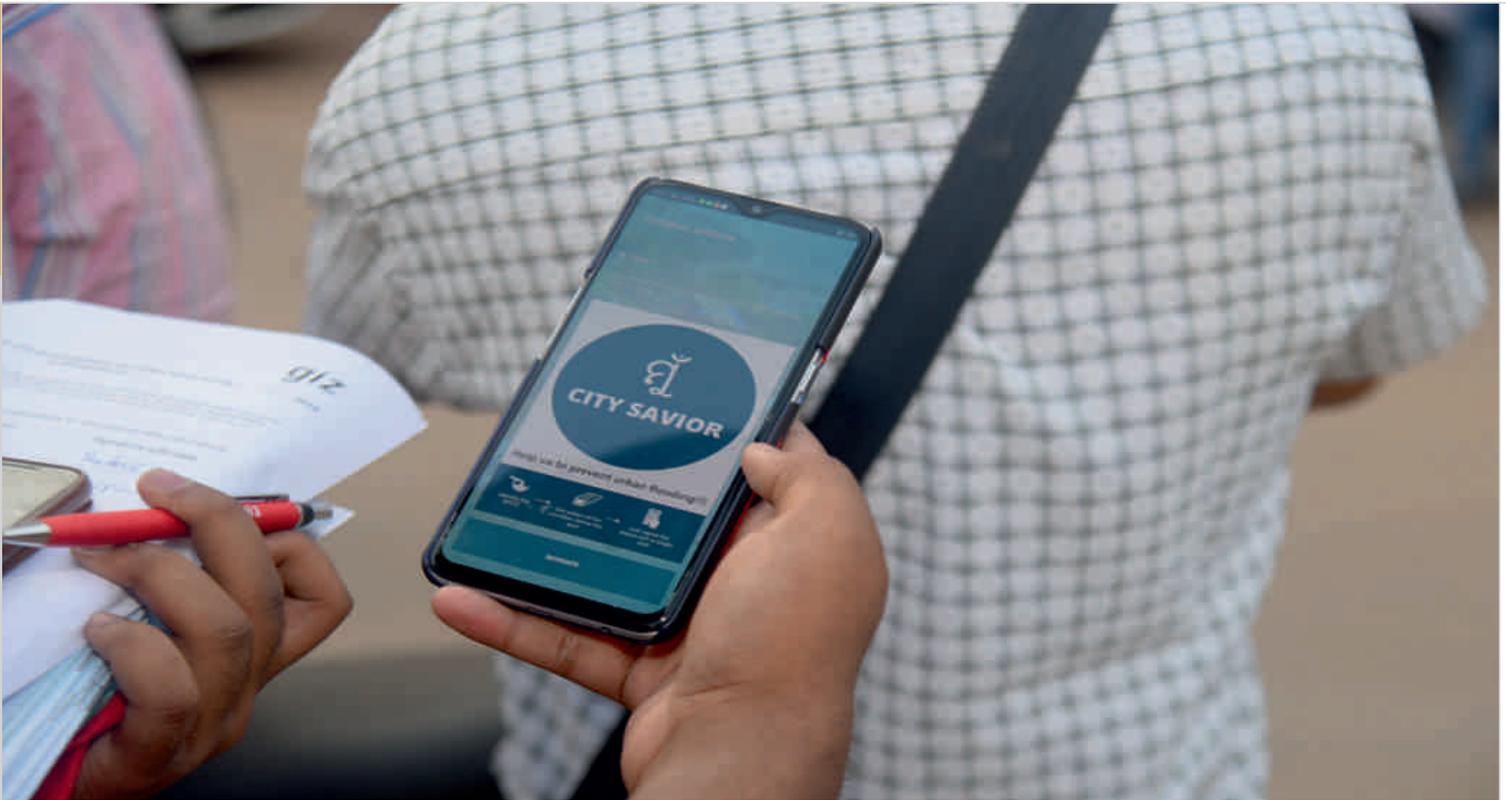
## LOGIC DEVELOPMENT FOR RANKING OF THE CRITICAL SPOTS

The technical team explained the software logic to be developed for the ranking of the critical spots to be seen by the BMC officials on their dashboard to decide the order of criticality of drains and hence, order of rescue/drain cleaning operations.

## MOBILE APP AND WEB PLATFORM DEVELOPMENT

The software developers and UI/UX designers from technical team got a brief on the expectations of the desirability aspect of the volunteer app and the dashboard for BMC officials before the beginning of the process.

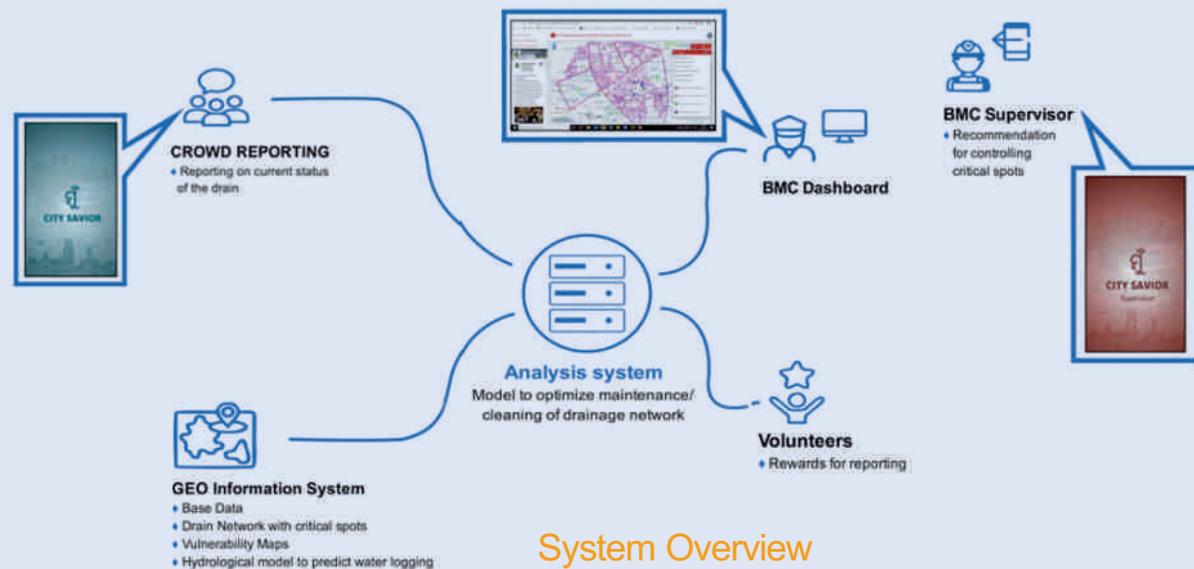
Based on the deliverables, the tech team got their questions cleared and made a roadmap for the software development, assessing which software codes were already available in their development libraries and which ones would need to be freshly written.



## ICT BASED DIGITAL SOLUTION FOR FLOOD MANAGEMENT

The technical team developed the end to end solution based on the feedback from the team, resulting in a comprehensive solution that consisted of 4 parts:

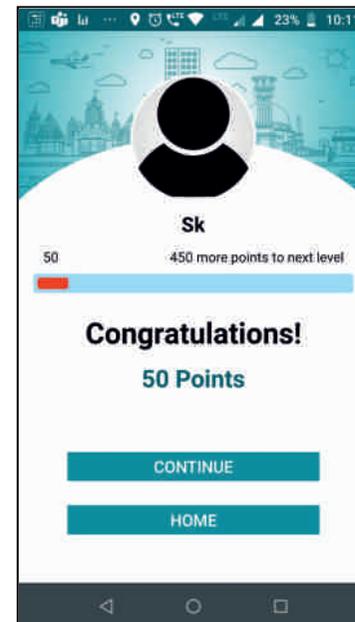
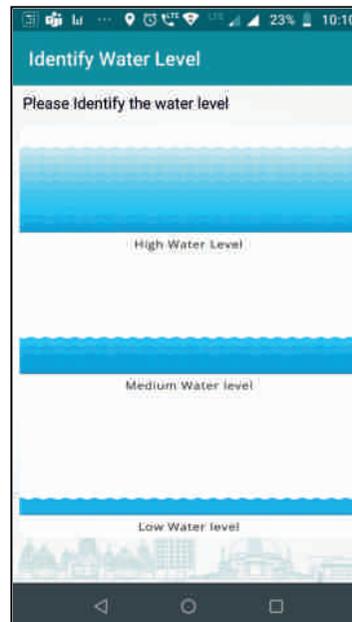
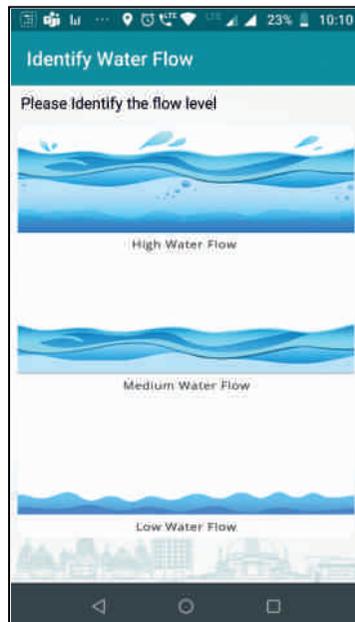
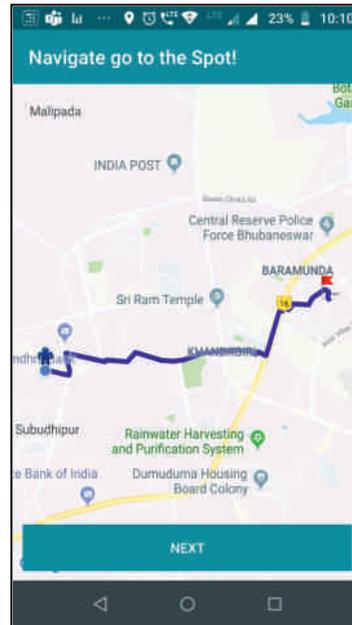
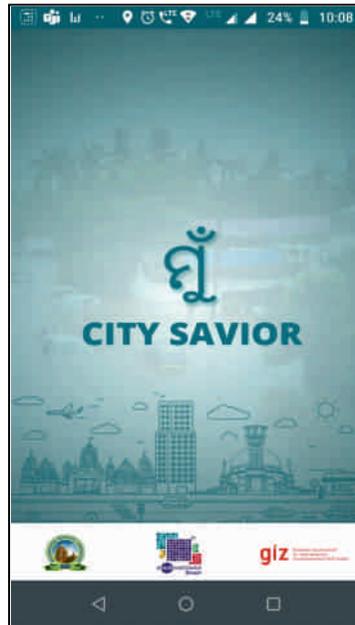
- Volunteer reporting Application
- Dashboard incl. Mobile App Version
  - GIS
  - Analysis system
- Supervisor Application



System Overview

# THE INDIVIDUAL COMPONENTS OF THE SYSTEM ARE EXPLAINED AS FOLLOWS:

## Volunteer Reporting Application



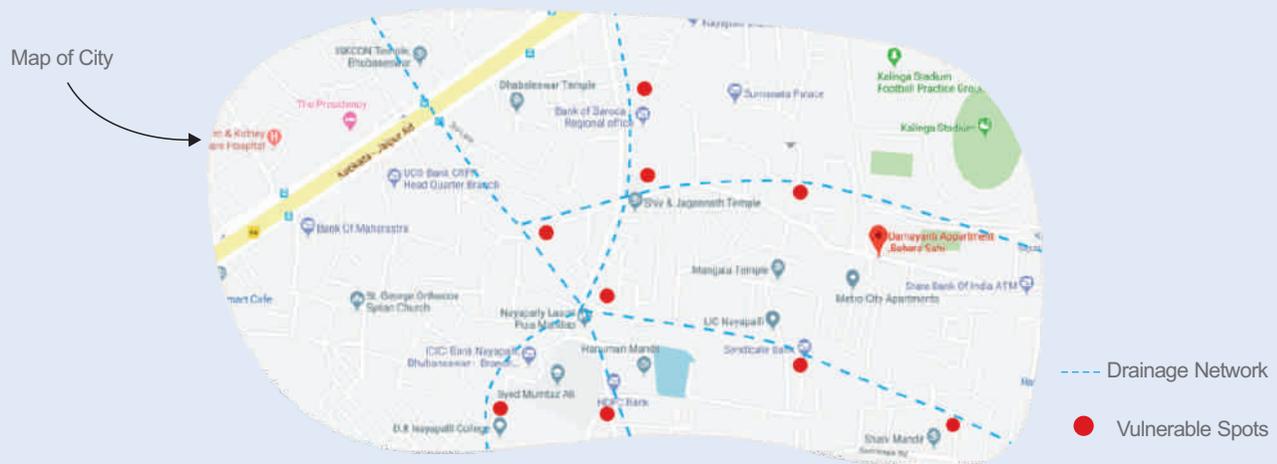
## Volunteer Reporting Application

The Mu City Savior application is developed, keeping in mind the flooding situation in Bhubaneswar city. The app is oriented towards 15-24 year young adolescents who are tech friendly and are keen to change the city for the better. They are outgoing and it is easy for them to operate the app. The app has gamified the reporting tasks, where the volunteers get points and ranking for reporting on the conditions of the pre-selected spot of the drain system. The app guides the volunteers to those locations (the locations are pre-marked with a visual marker).

Next, with the help of a reference picture, the volunteer identifies the current status of water flow in the drain, the garbage levels in the drain and then taps the “report” button. This information is then sent to BMC dashboard for further analysis. For each report, the volunteers gain virtual points, which increase their ranking in the game.

## Geo-information System (GIS)

As the name suggests, the geo information system provides information on the geography of a particular territory. Besides basic information about the topography, land use, population and roads etc, GIS developed specifically for the app will also have information about the drainage system network (including critical spots), vulnerability map which displays the static relative risk ranking of the critical spots due to their geo-locations and the hydrological model of the city.

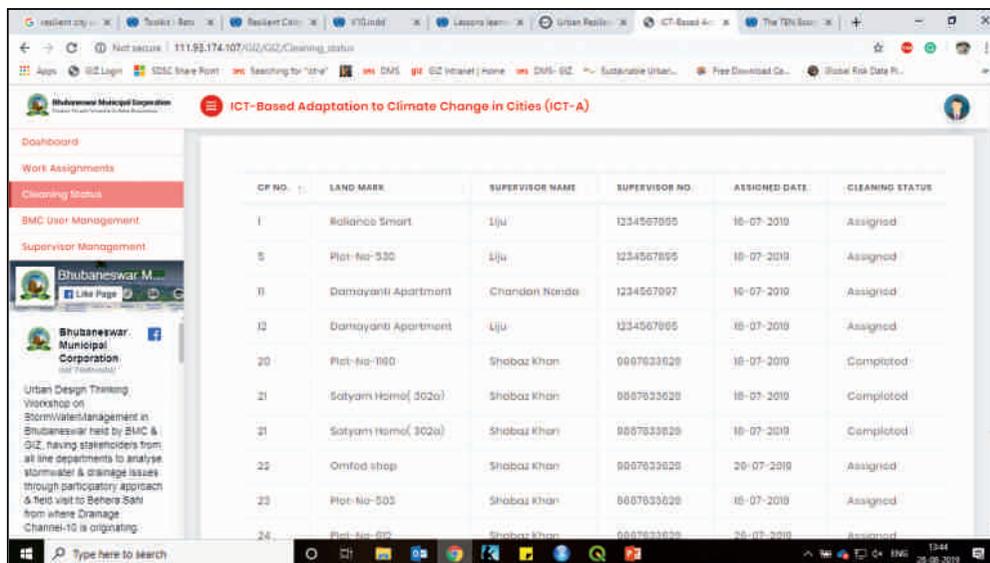
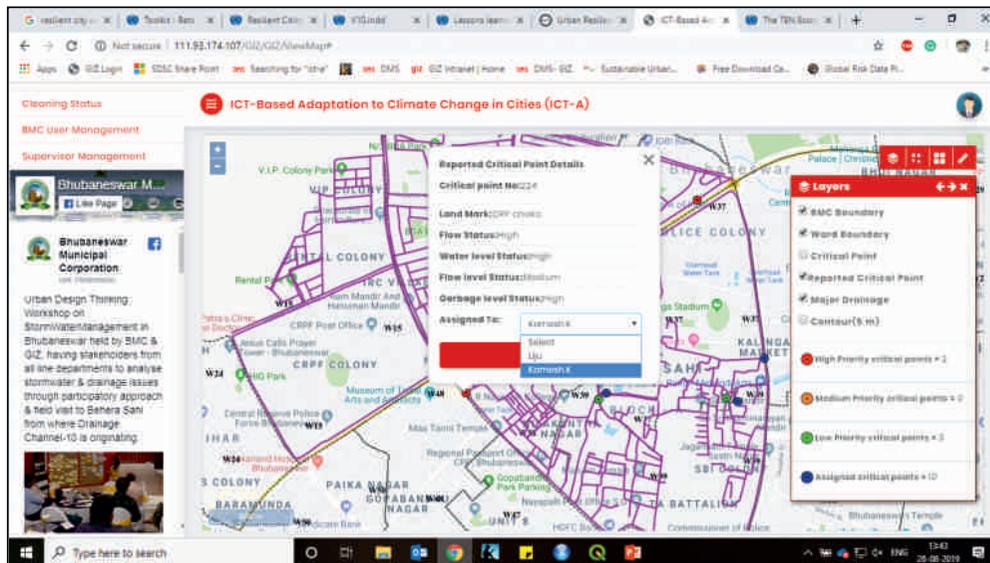


## ANALYSIS SYSTEM (RANKING MODEL)

The algorithm of analysis system analyses the input data from the Mu City Savior App and the GIS to sort and prioritize (rank) the critical spots. This will help in recommendations about the order in which these spots are to be cleaned and those can be displayed to the BMC. The drains will be ranked in order of their urgency in cleaning. The ranking model will consider the vulnerability of the area, the hydrological criticality and real time information about the flow status of the drain.

The output of the model is a clear ranking of the critical spots, which will be displayed on the Bhubaneswar Municipal Corporation (BMC) dashboard. This will help BMC to prioritize resources for drain cleaning. In the near future, the analysis system will be able to predict the flooding and help the planning authorities to sustainably plan the city infrastructure as well.

# Display Dashboard & Mobile Application

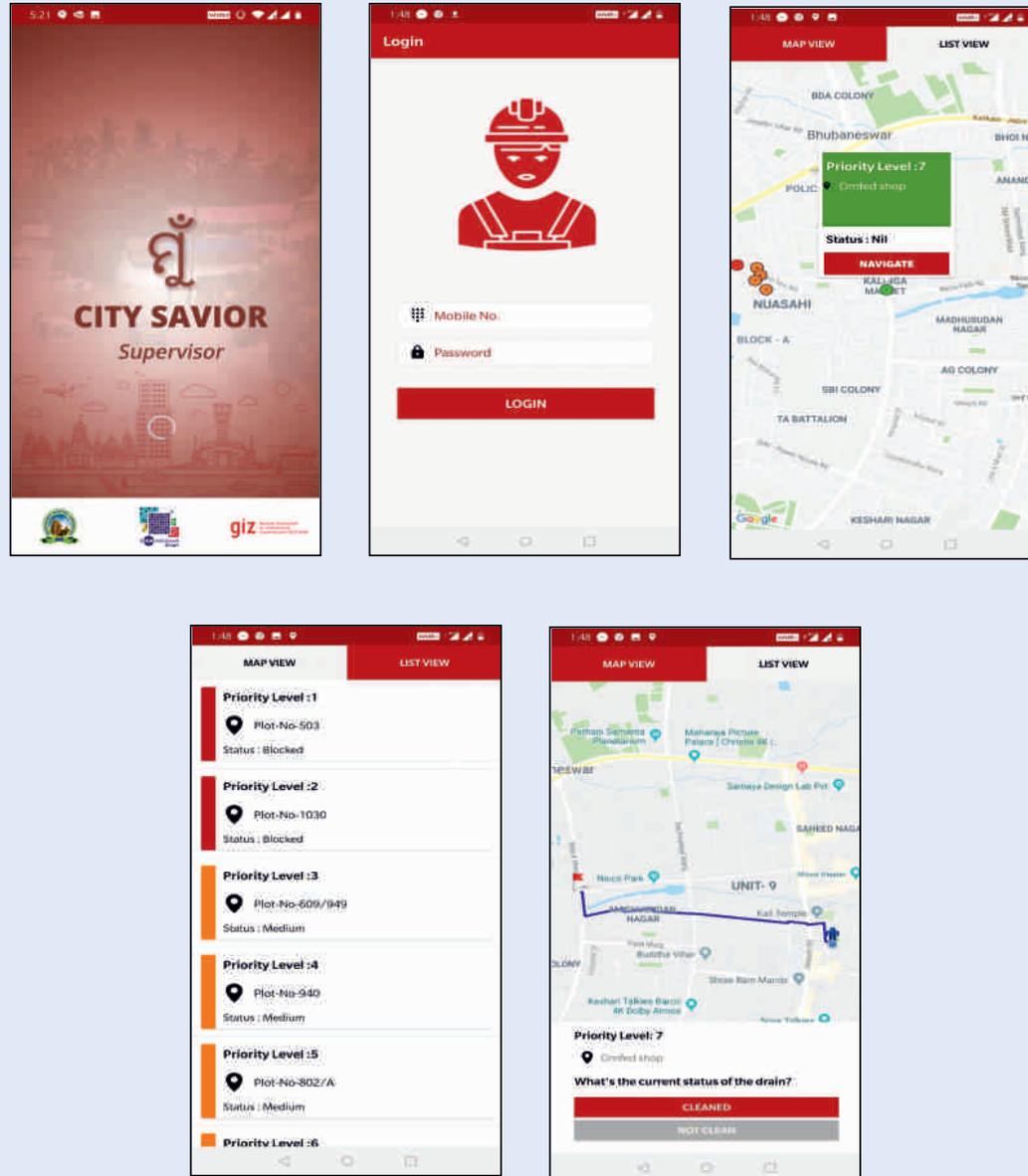


The dashboard displays the recommendations of the analysis system to the Bhubaneswar Municipal Corporation officials. Each critical spot is visualised with its cleaning priority ranking and a colour code for a specific action is assigned as follows:

- Red - Urgent cleaning required
- Yellow - Regular cleaning required
- Green - No cleaning action required

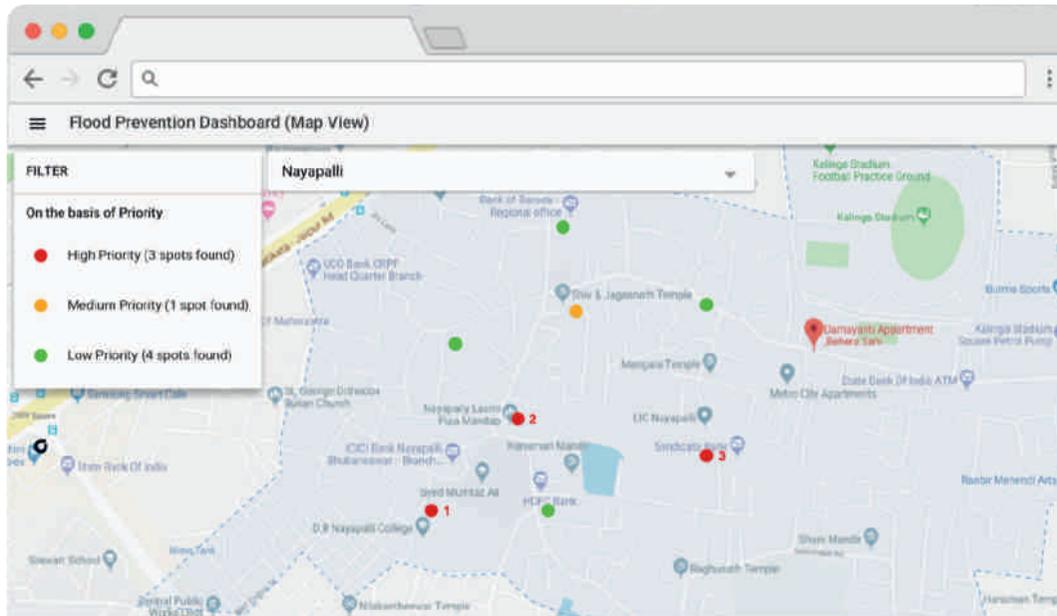
The city officials can utilise this information to improve the management of the cleaning and maintenance of the drains in order to prevent the flood situation.

## Supervisor Application

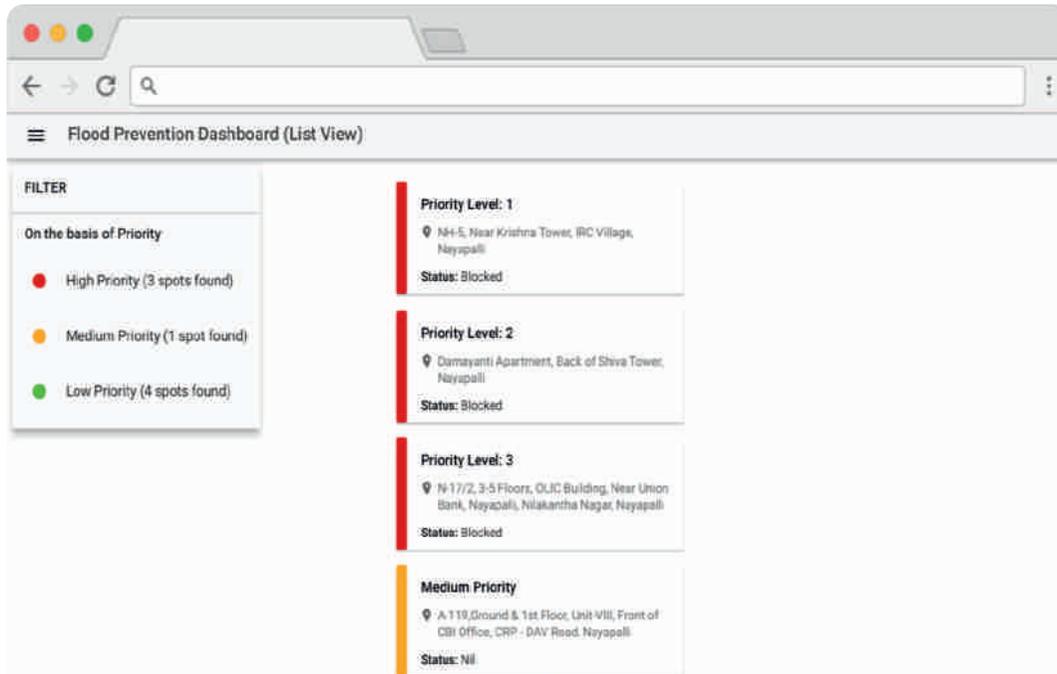


Beside the dashboard, a mobile app will support supervisors to control the critical spots and mark the cleaning status of the drain. The information will be fed back into the analysis system and will update the overall system.

# Mock-Ups Of BMC Dashboard

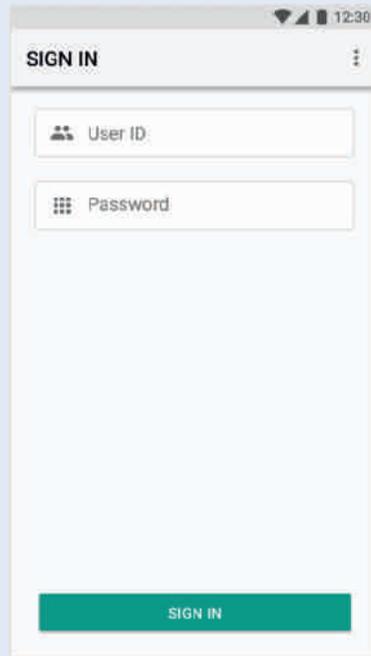


Map view

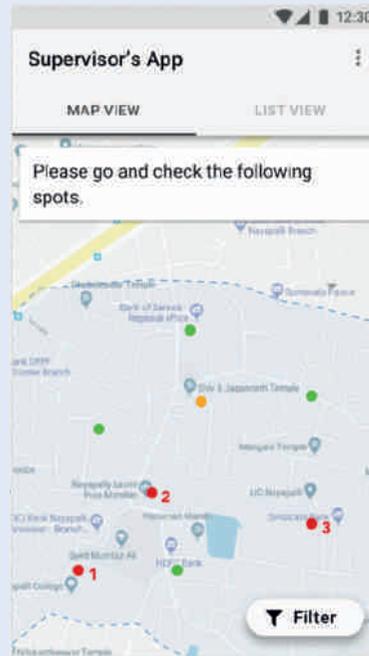


List view

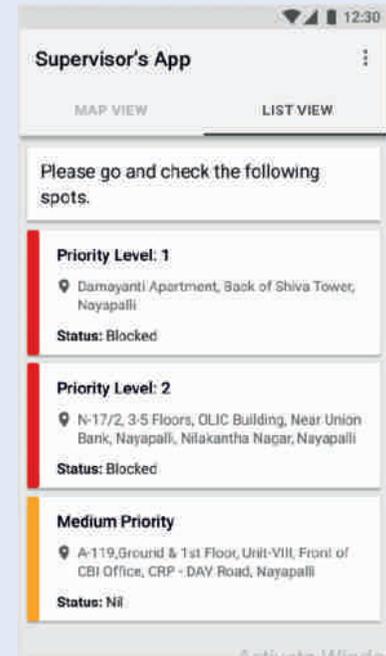
## Mock-Ups Of BMC Supervisor App



Screen 1



Screen 2



Screen 3

### Screen 1: Log-in

Shows the Sign-In window where the supervisor can feed his log-in Username and Password to begin accessing the application. This is needed to create secure log-in for all supervisors of the city so as to enable them access their respective area profiles.

### Screen 2: Home Screen (Map View)

Shows the areas in order of priority for inspection as decided by the Bhubaneswar Command Centre for the supervisor to begin inspection. The area marked as 1 in Red spot deserves the highest priority in terms of inspection and resolution. The areas in Yellow are medium priority and Green are low priority areas.

### Screen 3: Home Screen (Live View)

Shows a description of the areas in accordance with their priority is given along with their location and address. This enables the supervisor to easily access the areas and manage his time and resources accordingly.



### THERE ARE SEVERAL BENEFITS OF MU CITY SAVIOR APPLICATION FOR ALL STAKEHOLDERS:

- 1** The Mu City Savior is an ICT-A based application that is going to add to the growing efforts of the govt. for the sustainable development of the city.
- 2** Mu City Savior addresses the current need for problem solving with respect to prevention of urban flooding and creates a platform for planning of the future of smart and digital cities.
- 3** The ICT based solution provides real-time information about identified blockages in the drainage system in Bhubaneswar so that BMC can prioritise its workforce to clean the blockage.
- 4** The application also deals with the specification of the issues like blockage type, level of water and flow status that eventually will support the city officials to make informed planning decisions for all future purposes.
- 5** The application will help city officials to allocate manpower and technical resources efficiently.
- 6** The application will increase the efficiency of the responsible department, but also reduce cost of operation during emergencies in the times of floods and heavy rains.
- 7** The data gathered about the blockages and rectifications from the central dashboard can be collated and studied for all future city drainage planning purposes, as well as lessons learned can be used to replicate and upgrade the same models for existing and new cities elsewhere in the state or the country.
- 8** The Mu City Savior application will help the citizens avoid major inconveniences due to waterlogging, urban flooding, including loss of life due to slippage in flooded open manholes and drains; loss of working hours, health issues, diseases, electrocutions among, vehicle and property damage.



## WAY FORWARD

The successful development of ICT-A based digital solution for the city of Bhubaneswar after a pilot project has given an opportunity to carry forward the development of similar solutions for all other cities at the national and international level.

In order to assist the interested stakeholders, governments and city councils a detailed transfer package has been prepared with relevant source codes, process documents, ready reckoner and guidelines, that serve as an instant reference material for the success of the project in the cities that they are planned for. These documents combine the lessons, the processes and the researches conducted over three years and distill the information for anyone who is interested in the development of a similar solution for their respective area or cities.

## TRANSFER OF DIGITAL SOLUTION TO NATIONAL AND INTERNATIONAL CITIES

**Flood Free Kochi (FFK)**, the ICT-A solution for flood control in Kochi is a hybrid combination of two solutions: The AylluDamos from Peru and Mu City Savior, Bhubaneswar, India. The Flood Free Kochi App is an actual example of how flexible, open ended and adaptable the whole ICT-A solution to flood control is, that can be customized, upgraded and changed according to local needs and challenges.

Flood Free Kochi not only deals with tackling of the flooding situation in the city, but also engages users to report road blocks due to collection of garbage and similar issues to the authorities.

This makes the ICT-A solutions truly remarkable in capacity to adapt to each city they are being developed for across the world.



## OVERVIEW

The other city for which the urban flooding solution was developed in India was, Kochi, in the state of Kerala. Flood Free Kochi is an upscaled adaptation to the ICT based solution developed by GIZ for different developing cities of the world starting with Trujillo in Peru.

In Peru the program's political partner was the Secretary of Digital Government of the Presidency of the Council of Ministers (SEGDI/PCM), in cooperation with the Ministry of Environment (MINAM).

In March 2017, 67 people lost their lives due to heavy rainfall and 11,000 houses were damaged in Peru. 25 million Peruvians live under the threat of flooding due to rising global temperature, making it about 79% of the total population. GIZ with the help of stakeholders developed 'AylluDamos' an ICT based application with which data can be collected in real time during flooding and action can thus be taken. AylluDamos also helps people locate missing persons.

AylluDamos was then upscaled and brought to India and was adapted to Indian political, social, climatic, geographical and technological realities. It was rechristened as Flood Free Kochi with significant changes and improvements and continues to evolve.

The transformation of AylluDamos to Flood Free Kochi is a great example of how the successful international transfers can work as great technical assets for rapidly developing urban cities dealing with climate change issues.



## KOCHI, KERALA AND ICT- A

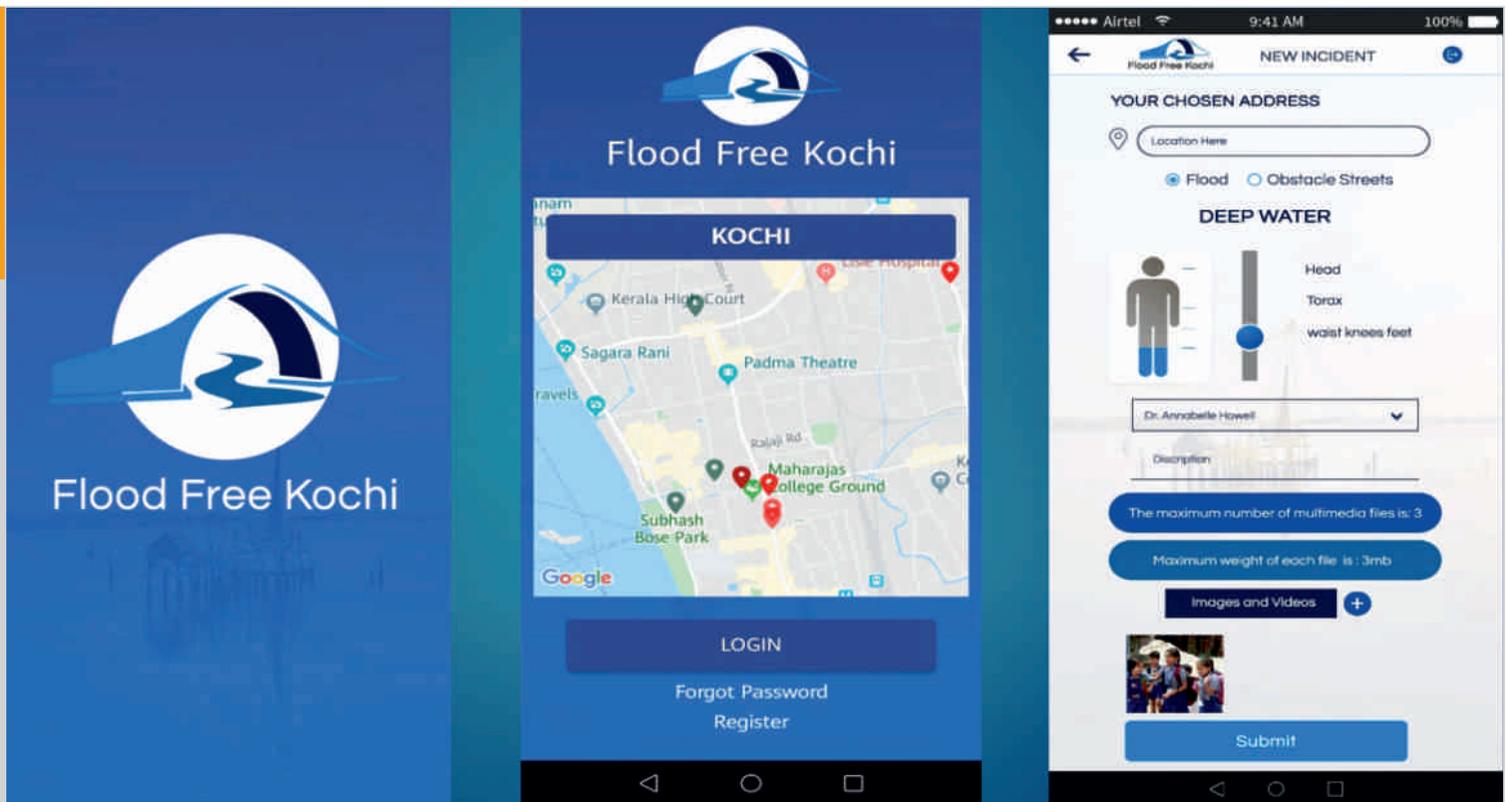
Kochi or Cochin is a rapidly growing city situated in the coastal area of Kerala stretching to around 94.88 square km and is also the largest urban agglomeration in the state. Kochi is a major port city on the south-west coast of India bordering Lakshadweep. It is part of the district of Ernakulam in the state of Kerala and is often referred to as Ernakulam. Kochi is the most densely populated city in Kerala. As of 2011, it has a corporation limit population of 6,77,380 within an area of 94.88 km<sup>2</sup> and a total urban population of more than 2.1 million within an area of 440 km<sup>2</sup>, making it the largest and the most populous metropolitan area in Kerala.

Kochi city is also part of the Greater Cochin Region and is classified as a Tier-II city by the Government of India. The civic body that governs the city is the Kochi Municipal Corporation, which was constituted in the year 1967, and the statutory bodies that oversee its development are the Greater Cochin Development Authority (GCDA) and the Goshree Islands Development Authority (GIDA).

Kochi Corporation has 22 health circles. Each circle has one Health Inspector and a Health Officer to take care of all public health related issues. Around 45 Junior Health Officers (JHO) to support their work at an average one JHO to one ward. In total, 67 people will work as Supervisors on the digital solution.

Due to the adjacent sea and very heavy monsoon, the commercial capital of the state is prone to floods. Kochi was heavily flooded in 2019, due to incessant heavy rains at the beginning of the monsoon season. Heavy water logging was recorded at very busy areas including bus stations, railway stations namely Panampilly Nagar, Kaloor and Edappally leaving the city in chaos. The public transport system and residential, commercial apartments too were flooded. Sewage drain canals were also overflowing.

Waterlogging in the city was primarily attributed to unprecedented rainfall, natural or man-made obstructions at the drainage channels and the proximity to coastal waters. Since, flash-flood phenomena has become frequent in Cochin, a long-term initiative for a permanent mechanism to control water-logging or flood in the city was thought to be of utmost priority.



## THE SOLUTION

As with Mu City Savior, Flood Free Kochi too is an ICT-A based solution developed by the International development provider GIZ in close cooperation with the Cochin Corporation and other stakeholders including citizens. The android and hybrid based App is designed to collect data from any location in the Corporation where water-logging is rampant during the rainy season. The Application has also an added feature of reporting obstacles on the street like fallen trees, garbage dumps, potholes among others, serving as an overall cleaning and maintenance application tool for the Kochi Municipal Corporation as well as the citizens.

The data reported by the crowd about the level of water at critical locations, overflowing drainages, man-made or natural obstacles that play a critical role during urban flooding, is being shared with the officials through an uninterrupted network system. This enables the officials to ensure timely maintenance of the critical points ahead of rainfall and prevent urban flooding like situations. The app is only successful because of the active participation of the volunteers.

## FUNCTIONING OF THE APPLICATION

The crowd reporting application engages citizens and city officials as volunteers. A citizen, on seeing the drain that needs cleaning or de-clogging, marks the location on the app with necessary pictures. The issue can be reported to the command centre/authority with photos or videos with a brief description of the issue to confirm the issue. The command centre system can identify the location and notify the supervisors in that area for immediate action on it. The supervisor has to solve or direct the issue to higher officials/ other agencies if the issue is above his capacity to resolve. The entire report is collected in the command centre and the reporting volunteer gets information about the action taken for his/ her reported incidents.

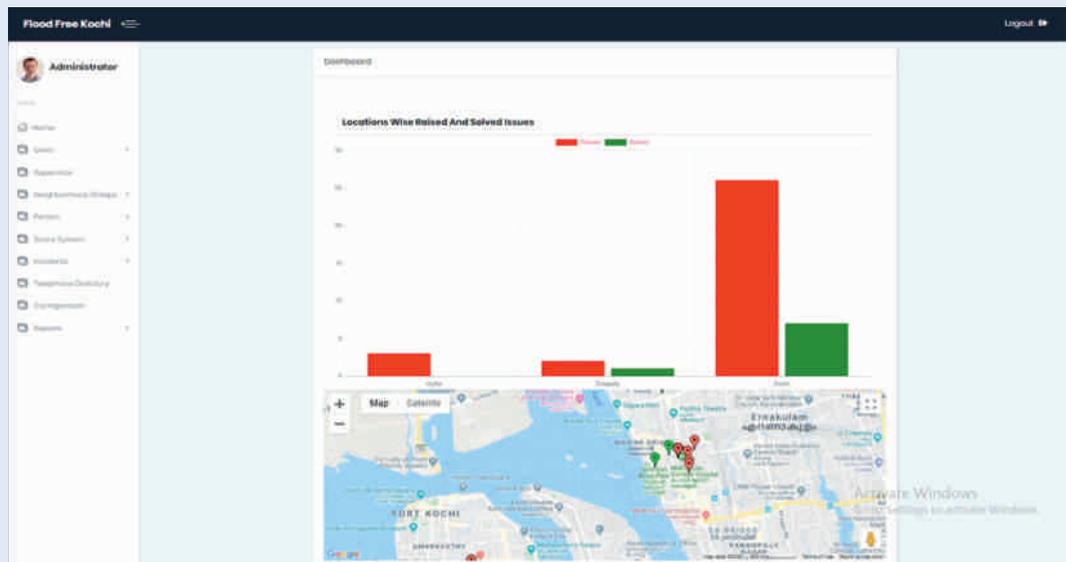
## GEOGRAPHIC INFORMATION SYSTEM (GIS) FOR KOCHI

The Geographic Information System provides information on the territorial aspects of defined areas. Beside basic information about the topography, land use and population, it provides data on the status of the hydrological network and the vulnerability of the specific areas.

## ANALYSIS SYSTEM RANKING MODEL

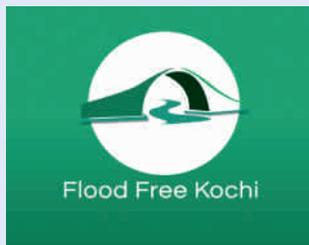
The Analysis System embodies the core of the overall solution. This output is displayed on the Smart City Command Centre with the help of a refresher. Analysis System supports evidence based decision making within the local government and promotes the efficient use of government resources. In the future, Analysis System will be able to contribute to a more sustainable urban development.

## DISPLAY DASHBOARD



The dashboard displays the recommendations of the analysis system to the officials. Each critical spot is visualised with a cleaning priority ranking and a color code for a specific action. The city officials can utilise this information to improve the management of the cleaning and maintenance of the drains in order to prevent the flood situation.

## SUPERVISOR APPLICATION

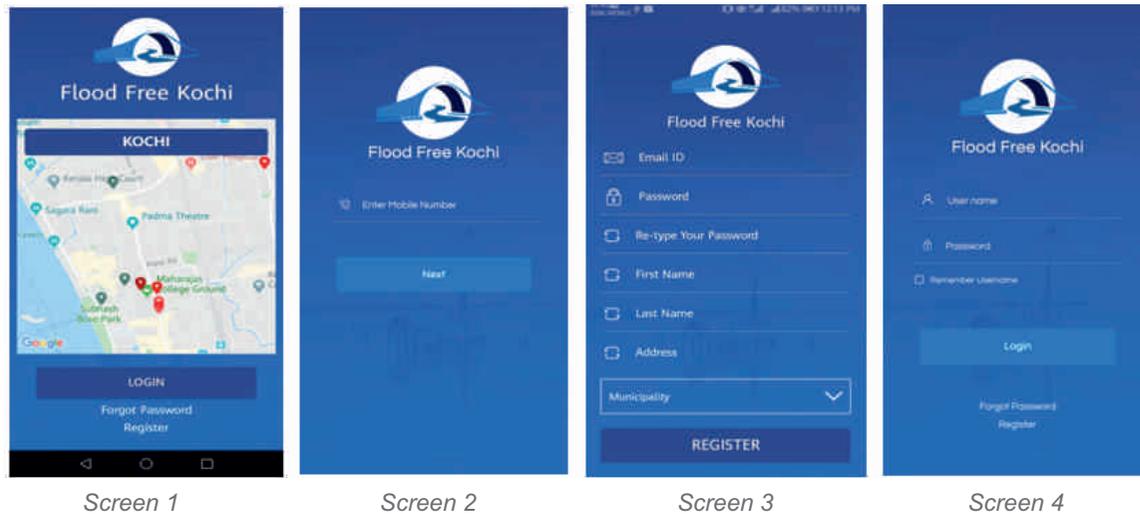


The Supervisor App is Green in colour which clearly distinguishes it from the Flood Free Kochi User App which is Blue in colour. In terms of interface also the Supervisor App is simpler and tells the Supervisor about all lodged complaints in order of priority. He can see both the location map, as well as detailed addresses of complaints. The Supervisor can also add any images for better understanding of the cleaning agency if he feels the need to do so.

## THE ENTIRE SOLUTION FOR FLOOD FREE KOCHI IS DIVIDED INTO 3 PARTS:

- User App:** The User App is the main application that the volunteers can download in their phones. This is the app that will help them report any cases of water logging, road blocks to the Kochi Command Centre for further resolution.
- Admin Module:** The Admin Panel Control is situated at a central location where all complaints from across the Kochi Municipal area come and are prioritized, monitored and acted upon by a team of specialists. The tasks areas are assigned to Supervisors for cleaning purposes.
- Supervisor App:** The Supervisor App will help the designated Supervisor of the area to check the number and location of complaints in his area by the users. The App will then help him to coordinate with the prioritized resources to resolve the complaints.

### A. USER APP



Screen 1

Screen 2

Screen 3

Screen 4

#### Screen 1: The Launcher

This is the main screen of the application. When a citizen or user downloads the application, he/she will see the launcher screen with the logo of the application and a login tab at the lower bottom of the screen. To give an example of the inside working of the application, the launcher screen will show 2-3 critical spots marked in a designated area in Kochi as shown in the screen.

#### Screen 2: User Registration

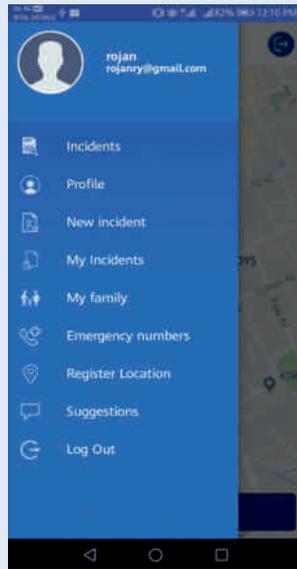
On Screen 2, the user is asked to enter their his/her mobile number and press next in order to create a user account to enable him/her to use the application.

#### Screen 3: User Registration (contd.)

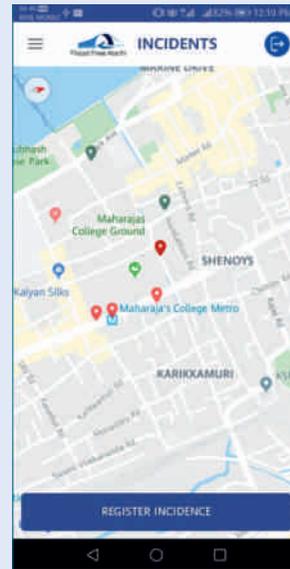
Screen 3 deals with more information needed like email ID, desired password, first and last name of the user and their residential address along with the municipality zone they belong to, to finish creating their account. Email is for password recovery or other related notifications. This is shown in the graphic above.

#### Screen 4: Login and Forgot Password

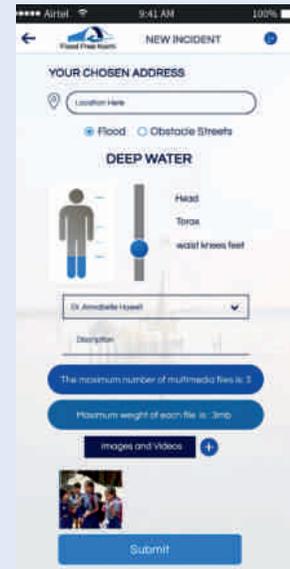
Once the user account is made by the citizen, he/she has to re-login to get access to his/her account and use the features of the application. If the user has forgotten his or her password, they can retrieve or change it at this stage.



Screen 5(a)



Screen 5(b)



Screen 5(c)

## Screen 5: Home Screen

Screen 5, the Home Screen is the main screen of the application where a lot of information is given and which leads the user to the process of registering his or her own complaint with the agencies.

The screen has the following components in the drop down menu that can be accessed from the top left corner of the App:

- a) Profile - The Profile of the user, which can be customized with his photographs, details etc.
- b) Incidents - The already reported Incidents by the other users can be seen on the screen. If the marker on the incident is red that means the work on that location/incident still needs to be done, if it is Green that means that the complaint has been successfully solved.
- c) New Incident - The New Incident reported by the user can be seen here. New Incident is described in detail in the following pages.
- d) My Family - The Family menu shows the other members of the same family using this app with whom the user can remain in touch.
- e) Emergency Numbers - The Emergency Numbers section lists the numbers of the services provided by the city government to the people of the city like fire services, ambulance, municipality etc.
- f) Register Location - To Register new locations in the application.
- g) Suggestions - The Suggestions given by the users can directly be submitted to the concerned officials that can help them in improving the application as well municipality services over time.
- h) Log Out - Once the task is finished the user can Log Out of the application.

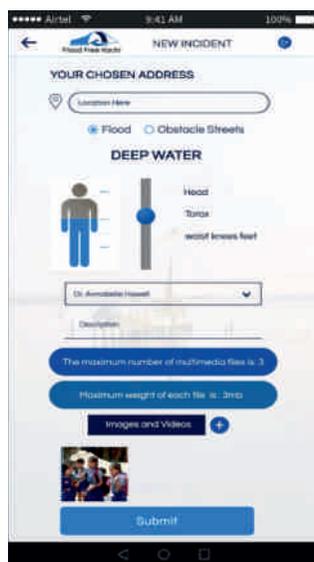
**Screen 6: New Incident: Flood Option**

By clicking on the ‘New Incident’ icon in the drop down menu, the user goes to the page of registering the incident, where he or she can add detailed information on the page for the marked location. The user can choose either of the two options of 1. Floods or 2. Obstacle Streets. If the user chooses the Flood option, then he has to follow a certain protocol. The user also has to give the location and then upload a picture or a small video by accessing the phone camera via the application itself. It has to be noted that the photo or the video should not be more than 3 MB in file size. A total of 3 files can be uploaded.

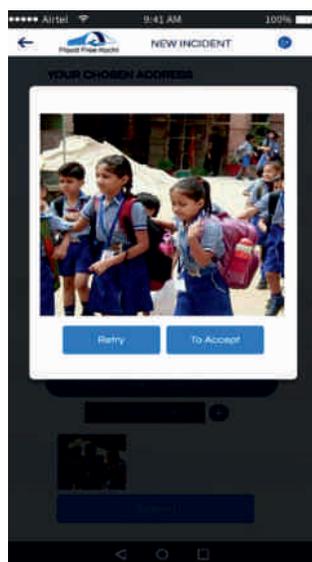
**Screen 7. New Incident: Obstacle Street Option**

If the user chooses ‘Obstacle Street’ option then he has to fill the site address of the incident. Then he has to choose from the already given options of fallen trees or waste on the streets or other. If the user chooses the other as an option, he/she can describe it by typing from the keypad in the specific space provided on the page.

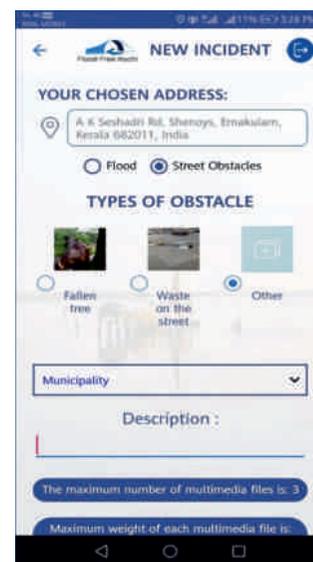
**Screen 8:** The user can upload 3 pictures of up to 3 MB each or 3 videos of 3 MB each.



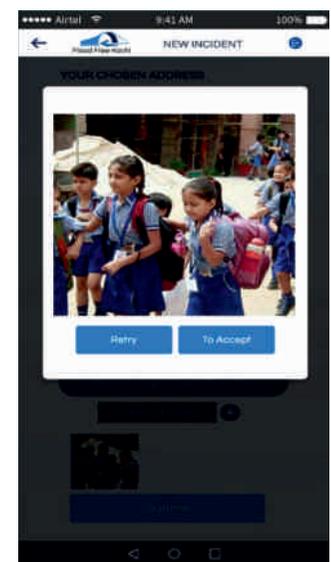
Screen 6(i)



Screen 6(ii)

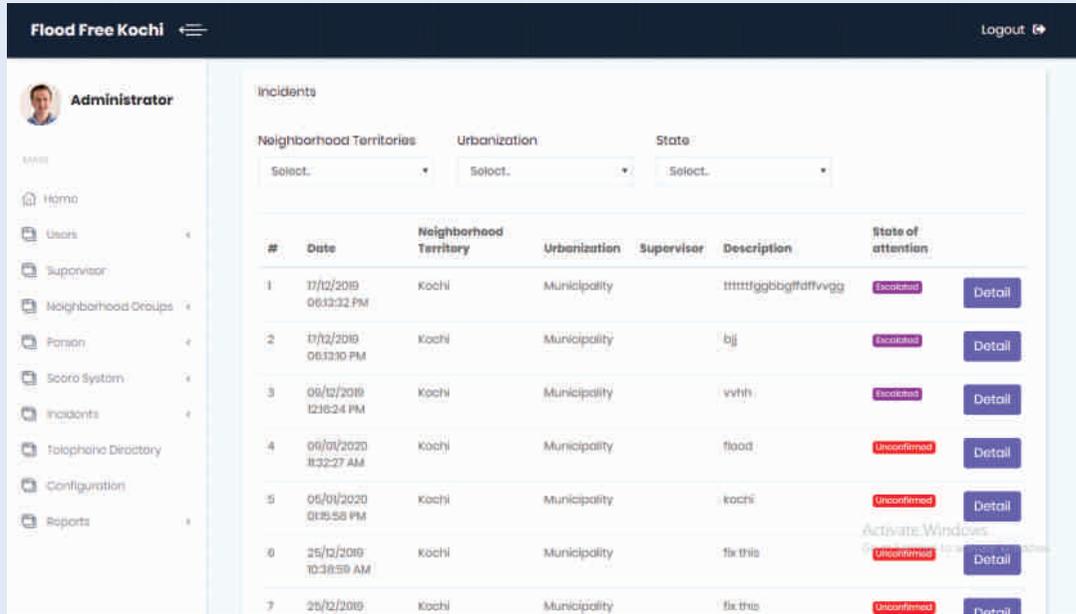


Screen 7



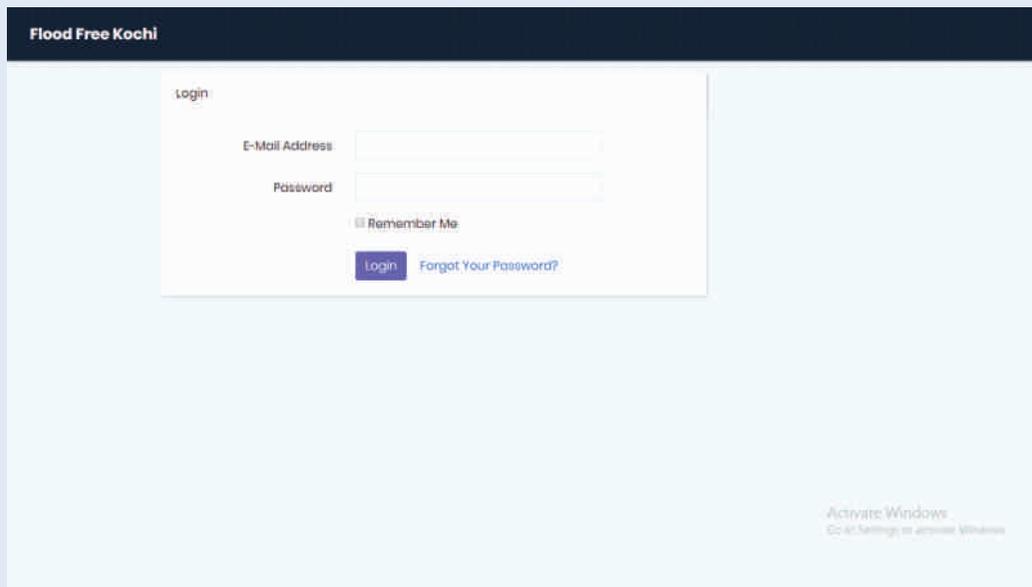
Screen 8

## B. ADMIN MODULE



Screen 1:

The Admin Panel Control is situated at a central location where all complaints from across the Kochi Municipal Area come and are prioritized, monitored and acted upon by a team of specialists. The task areas are assigned to Supervisors for cleaning purposes.

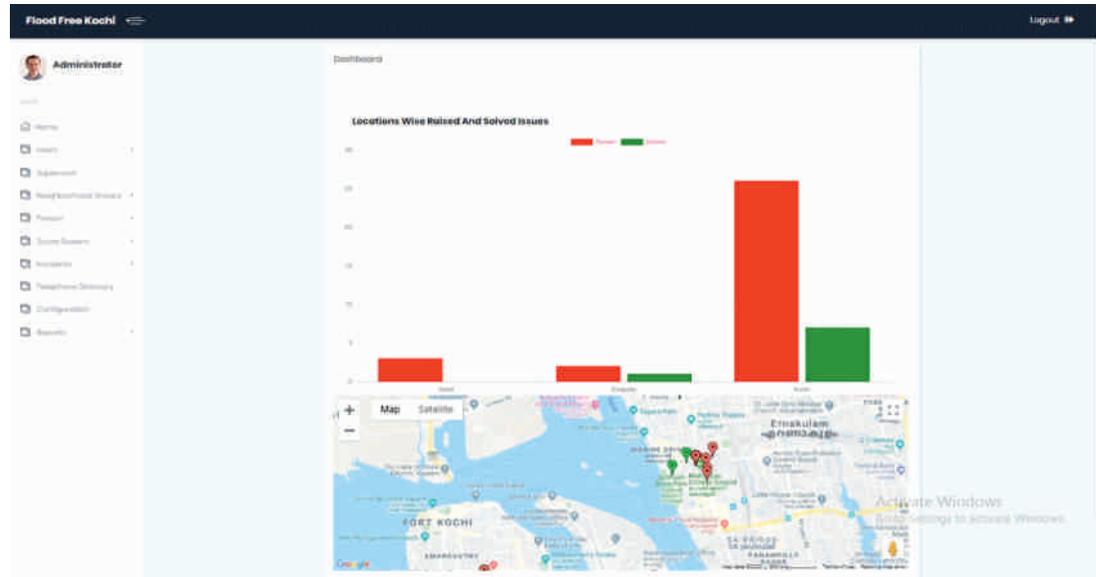


The Lead Administrator needs to login by opening the site of Flood Free Kochi which is [www.floodfreekochi.com/public/login](http://www.floodfreekochi.com/public/login) He/She has to enter their email address and password and then click login as shown in the graphic.

### Screen 2: The Dashboard

The Administrator can see a menu bar on the left side of the screen with many tabs like Users, Supervisors, Neighbourhood Groups, Person, Spare System, Incidents, Telephone Directory, Configuration and Reports. Each tab is for a separate function.

The Dashboard shows the graphical representation of incidents status in total. The area map below shows the details of the incidents posted and solved.



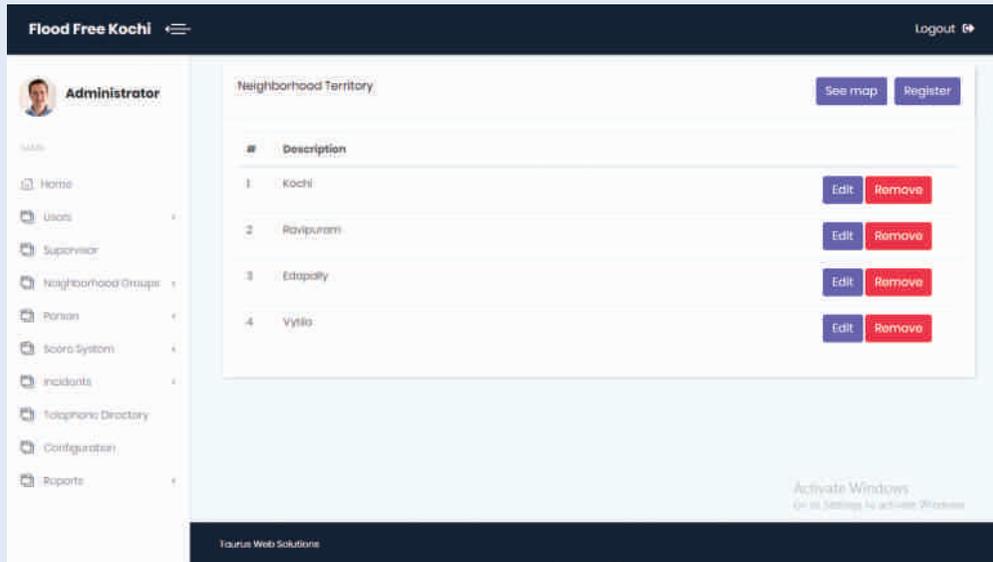
### Screen 3: User List

The User List shows the details of every user of the App in the city and their Registration date.

#	First name	State	Role	Registration date	
1	Administrator	Active	Administrator	01/1/2019	<a href="#">Edit</a> <a href="#">Remove</a>
2	rajan	inactive	Citizen	09/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>
3	Sachin	inactive	Citizen	09/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>
4	arreja	inactive	Citizen	10/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>
5	aritis	inactive	Citizen	11/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>
6	teit	inactive	Citizen	10/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>
7	nhf	inactive		11/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>
8	hghh	inactive		11/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>
9	som	inactive	Citizen	11/12/2019	<a href="#">Edit</a> <a href="#">Remove</a>

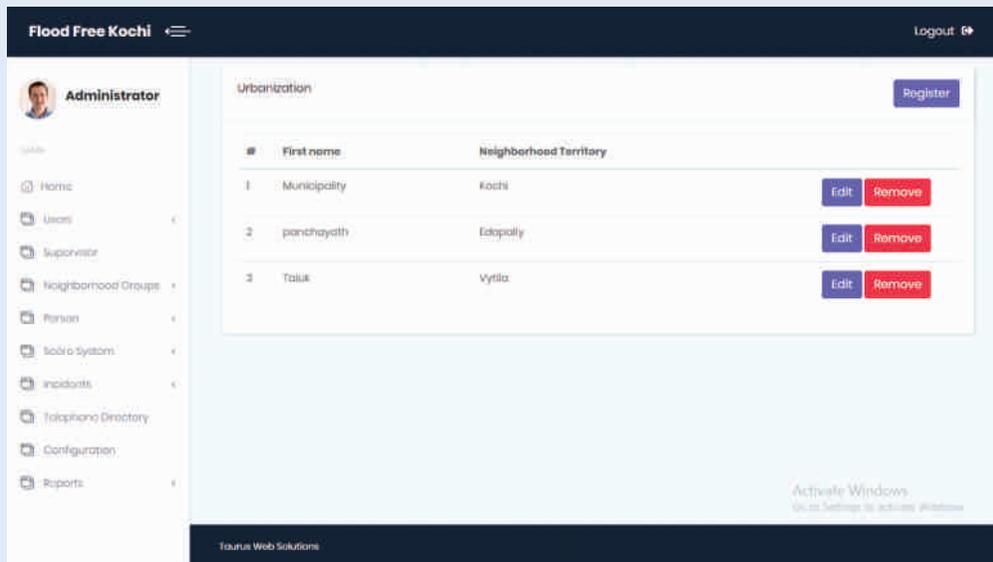
### Screen 4: Neighbourhood Territory

The Neighbourhood Territory page on the Admin Panel shows all the Municipal areas where the Flood Free Kochi application is operating. The administrator can just click the area name and take all the work progress details from that area.



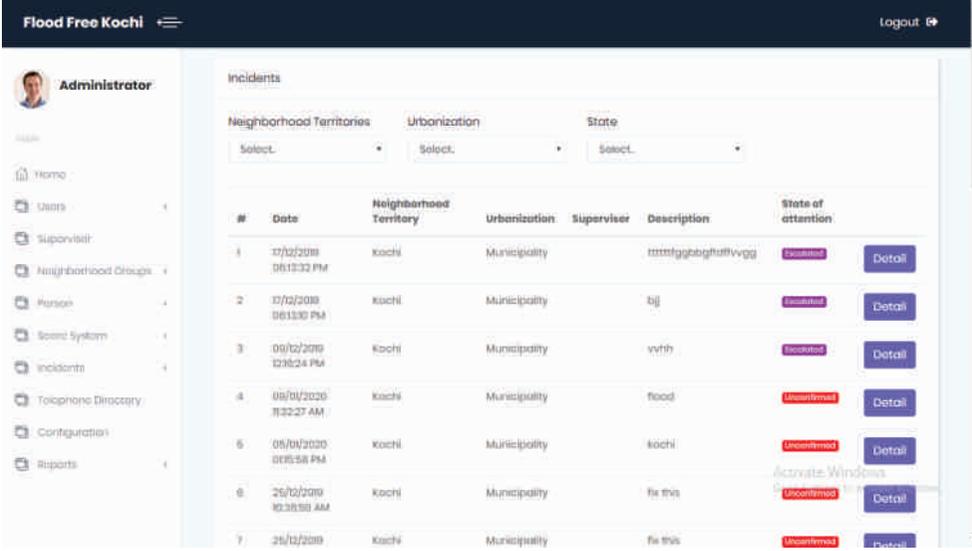
### Screen 5: Locality List

List of different localities as per the App availability.



## Screen 6: Incident List

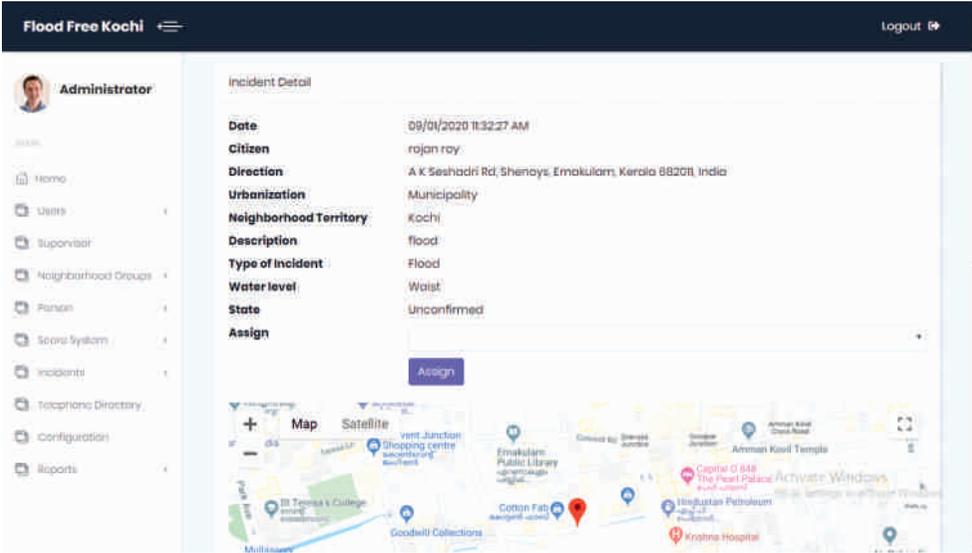
The Incident List page shows a list of current incidents in the city with respect to water logging and road blockages. It gives their date of reporting, time of reporting, the neighbourhood territory, the municipality they fall under, supervisor responsible and finally the state of attention to the problem as shown in the graphic below.



#	Date	Neighborhood Territory	Urbanization	Supervisor	Description	State of attention
1	17/12/2019 08:13:32 PM	Kochi	Municipality	ttttttfgbgbgtttfvvgg		Assigned
2	17/12/2019 06:13:30 PM	Kochi	Municipality	bij		Assigned
3	09/12/2019 12:38:24 PM	Kochi	Municipality	vvfh		Assigned
4	09/01/2020 11:32:27 AM	Kochi	Municipality	flood		Unconfirmed
5	09/01/2020 09:55:58 PM	Kochi	Municipality	kochi		Unconfirmed
6	26/12/2019 10:38:50 AM	Kochi	Municipality	file this		Unconfirmed
7	26/12/2019	Kochi	Municipality	file this		Unconfirmed

## Screen 7: Incident Details

The supervisor can select a particular incident of flooding and see all details about it including its location and address, reporting citizen, date and time of reporting, description of the incident, water level if the report is about the flood, status of the report and then assign the person from the municipality. The assigned person is responsible for the resolution of the problem.



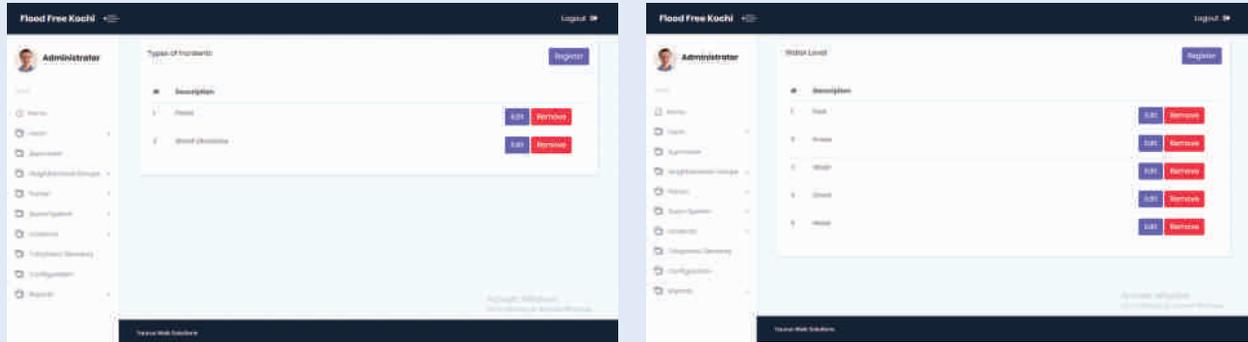
<b>Date</b>	09/01/2020 11:32:27 AM
<b>Citizen</b>	rajan ray
<b>Direction</b>	A K Seshadri Rd, Shenoy's, Emakulam, Kerala 682011, India
<b>Urbanization</b>	Municipality
<b>Neighborhood Territory</b>	Kochi
<b>Description</b>	flood
<b>Type of Incident</b>	Flood
<b>Water level</b>	Waist
<b>State</b>	Unconfirmed
<b>Assign</b>	

**Screen 8: Types of Incidents**

Types of Incidents screen shows all the incidents under two headings Flood and Street Obstacles

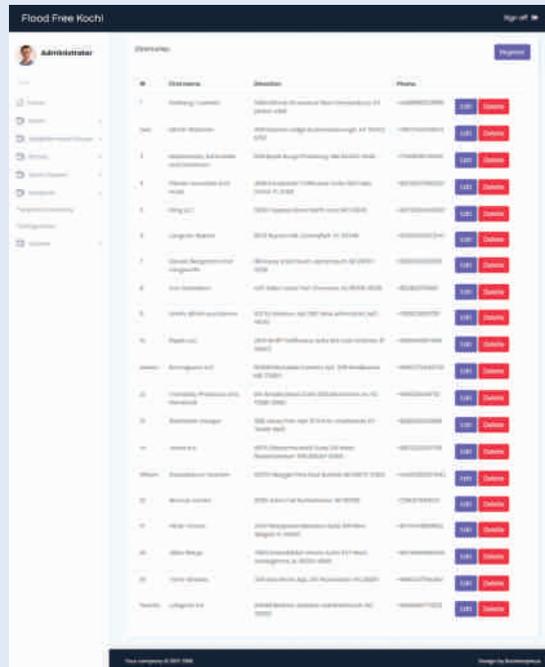
**Screen 9: Water Levels**

Shows the screen with Water Levels of different incidents.



**Screen 10: Directory**

Screen 10 shows the Directory of important numbers needed in the emergency situations for every user.



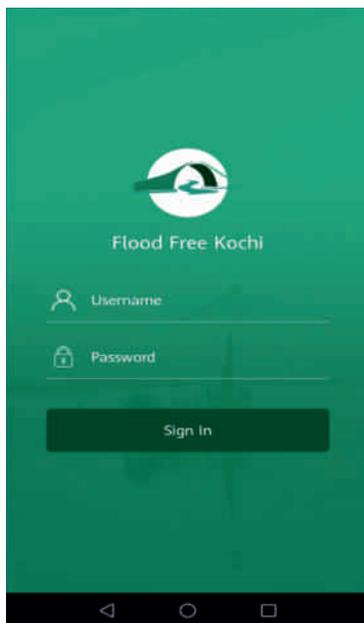
## C. THE CITY OFFICIAL/SUPERVISOR APP



The supervisor App is green in colour which clearly distinguishes it from the Flood Free Kochi User app which is blue in colour. In terms of interface also the Supervisor App is simpler and tells the supervisor about all lodged complaints in order of priority. He can see both the location map as well as detailed addresses of complaints. The supervisor can also add any images for better understanding of the cleaning agency if he feels the need to do so.

### Screen 1: Login

On this screen the supervisor needs to login by filling in username and password details to him as provided by the senior officials.

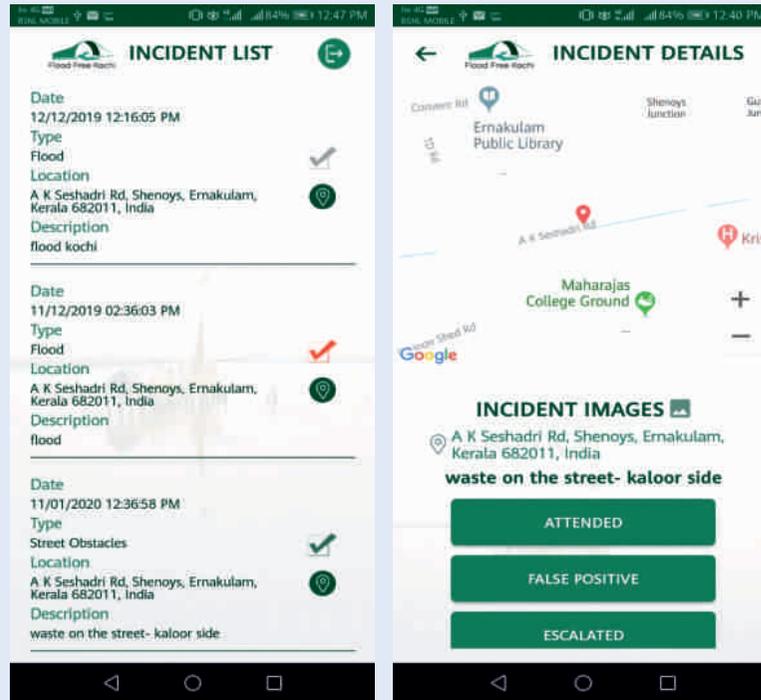


### Screen 2. Assigned Locations

Once a supervisor logs in, he can see all the complaints registered by the citizens as a type of complaint between flood or street obstacle, location, date and time of complaint. There is also a small description which helps the supervisor with any additional details about the blockage. On selecting the problem and clicking the location icon as shown in the graphic, the supervisor can see the location and also click on the images if any, sent by the user. The supervisor then needs to update the completion of the status of the problem after visiting the area.

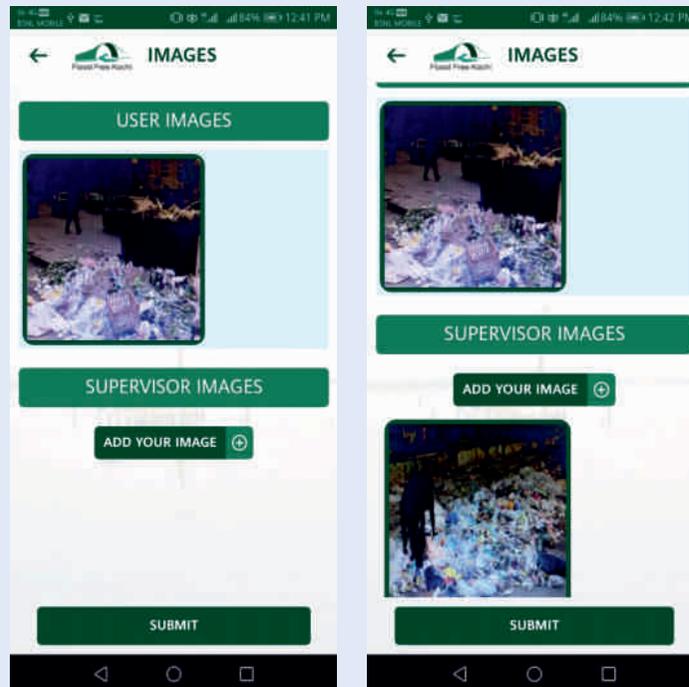
#### He would have 3 options:

- a) **Attended** - For the problems that have been taken care of by KMC.
- b) **False Positive** - When someone has given false information or the garbage/block has been cleared by a third party.
- c) **Escalated** - For problems that need larger resources/manpower to deal with or have not been resolved even after the stipulated time, the supervisor can escalate the problem to his higher authorities.



Screen 3: Incident Images

Here Supervisor can see images of the assigned locations. Also, he can add images of the same location if needed.





### BENEFITS OF ICT BASED DIGITAL SOLUTIONS FOR KOCHI

- 1 Flood Free Kochi tool is designed to help achieve the sustainable goal for the city in the times to come, keeping in mind the impending challenges it is bound to face with rising global temperatures. It is certainly a step up in the fight to reduce disaster related problems.
- 2 Flood Free Kochi is a digital solution that will provide valuable real-time information about existing drainage systems in the city and any problem areas can be duly rectified that may lead to flooding in the rainy season. The Flood Free Kochi App also has an add-on feature of reporting about road blockages due to various reasons. This will also help in cleaner cities and blockade-free vehicular and citizen movement.
- 3 Flood Free Kochi helps the authorities by telling the actual type of problem that certain drainage is facing like type of blockage, water level etc. In the long run when this data is collated and studied, it can definitely help the city officials to come up with innovative solutions and strategies to deal with the same.
- 4 Flood Free Kochi helps the authorities in dealing with the issues on priority basis. This helps in saving resources, time, effort and effective utilisation of manpower while saving the city from flooding and blockages thus, ensuring smooth flow of water and citizens across the city.
- 5 The data collected and the lessons learnt by the Flood Free Kochi Application in the Central Command Centre can thus be collated and studied for all future resolution of the same problems in the city in a much more effective manner.
6. The data from the app can also be used to create policies for future upgradation of the city, as well as planning of better drainage system and remedial measures for all other municipalities of the other cities.



## ICT-A AND GLOBAL OUTREACH

The world has gone digital and is rapidly moving towards artificial intelligence. Mu City Savior and Flood Free Kochi, both applications with certain city specific modifications can be replicated world over, and citizens, respective municipalities and governments can reap their benefits.

**Mu City Savior** and **Flood Free Kochi** both are open source technology and therefore, fully replicable. An exhaustive interactive documentation package has been prepared to transfer and upscale the platform to other international cities. The idea is to make the platform available using web-based hosting services.

The digital solution can be made available to other cities using web-based hosting services so that they can easily transfer and customise it to their specific needs. Interested cities can easily transfer and customise the platform to their specific technicalities, capacities and IT requirements. This is an option that can be easily transferred and tailored to fit specific needs.



Flood Free Kochi

Easy Adaptation through  
Web-based Hosting Services

CUSTOMISED FOR  
OTHER CITIES

Technicalities

Capacities

IT Requirements



## USHERING THE ERA OF CLIMATE RESISTANT DIGITAL CITIES

The Kochi ICT-A digital solution for flood control is a hybrid solution that derives from the two different solutions namely the 'Aylludamos' developed for the cities of Trujillo and Chiclayo in Peru and 'Mu City Savior' developed for the city of Bhubaneswar in Odisha, India. It was realized a direct transfer of the solution is not possible due to local challenges of each city.

This new solution comes with a complete and detailed transfer package and associated guidelines that makes it replicable in any new city it is being considered for. The solution is highly adaptable to the individual needs of the city and the challenges it faces.

The ICT-A solutions are future centric and are a great asset for any council or government as they can be used extensively for the development and the planning of the cities of the future. The extensive data collected via the application and the command centre can be studied to see the patterns in flooding and used for planning of railway lines, smart cities, drainage systems, just to name a few.





## ICT-A SOLUTION IN INDIA WAS AWARDED FOR ITS INNOVATIVE APPLICATION 'MU CITY SAVIOR'

The Bhubaneswar 'Mu City Savior' ICT-A solution for transformative climate change received the Smart City India Awards, 2020. This prize was conferred by the Indian Minister for Housing and Urban Affairs, Shri Hardeep Singh Puri, to Bhubaneswar Smart City Limited (BSCT) on 28 February, 2020 for this innovative solution to manage urban flooding across the city. In particular, the application offers citizens an effective tool to report data when there is any blockage in the city drains due to any reason, manmade or natural. In essence, this ICT-A solution was built in a partnership between BSCT, Bhubaneswar Municipal Corporation and the German Development Cooperation (GIZ).

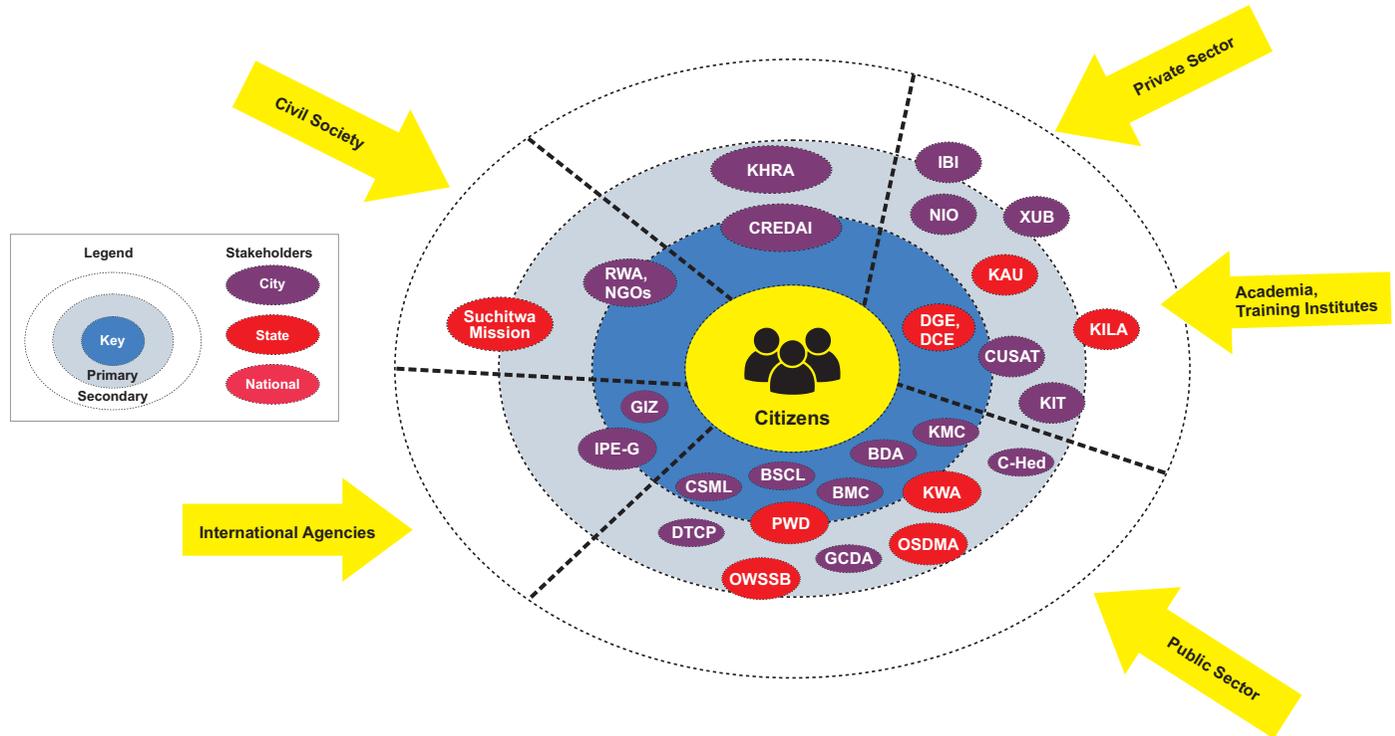
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## STAKEHOLDER MAP - BHUBANESWAR AND KOCHI CLIMATE ADAPTATION, DIGITAL AND ICT ECOSYSTEM



### ABBREVIATIONS

**KHRA** - Kerala Hotel & Restaurant Association  
**CREDAI** - Confederation of Real Estate Developer's Associations of Kerala, India  
**IBI** - IBI Group Inc.  
**NIO** - National Institute of Oceanography  
**XUB** - Xavier University Bhubaneswar  
**KAU** - Kerala Agricultural University  
**KILA** - Kerala Institute of Local Administration  
**KIIT** - Kalinga Institute of Industrial Technology  
**CUSAT** - Cochin University of Science and Technology  
**DGE/DCE** - General Education Department  
**CSML** - Cochin Smart Mission Limited  
**BSCL** - Bhubaneswar Smart City Ltd.  
**BMC** - Bhubaneswar Municipal Corporation  
**DTCP** - Directorate of Town and Country Planning

**BDA** - Bhubaneswar Development Authority  
**KMC** - Kochi Municipal Corporation  
**C-HED** - Centre for Heritage, Environment and Development  
**KWA** - Kerala Water Authority  
**OSDMA** - The Odisha State Disaster Management Authority  
**GCDA** - Greater Cochin Development Authority  
**OWSSB** - Odisha Water Supply and Sewerage Board  
**PWD** - Public Works Department  
**GIZ** - Deutsche Gesellschaft für Internationale Zusammenarbeit  
**IPE-G** - Public Works Department  
**Suchitwa mission**  
**RWA/NGO's** - Resident welfare association / Non-Governmental Organisation



**DR. TERESA KERBER**  
HEAD OF PROGRAM  
BONN, GERMANY.



**VAISHALI NANDAN**  
HEAD OF PROGRAM  
(CLIMATE SMART CITIES)



**SHABAZ KHAN**  
INDIA ADVISOR  
BUBHANESWAR, ODISHA.



**DR. RAMESH P.K.**  
INDIA ADVISOR  
KOCHI, KERALA.





Deutsche Gesellschaft für  
Internationale Zusammenarbeit (GIZ) GmbH

ClimateSmart Cities Project  
Second Floor, B-5/5  
Safdarjung Enclave  
New Delhi 110029, India

T + 91 4949 5353  
F + 91 4949 5391  
E [giz-indien@giz.de](mailto:giz-indien@giz.de)  
I [www.giz.de](http://www.giz.de)