SIH: Borewell Rescue Operation Report for Q/A Round

Problem Statement:

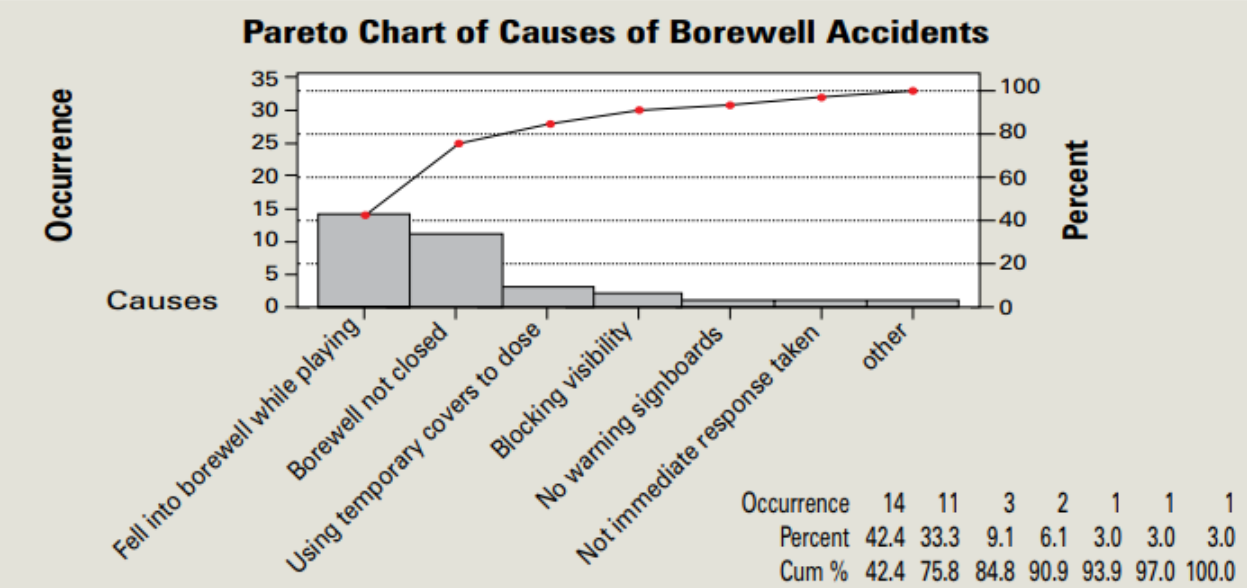
A robotics device for borewell rescue operations for NDRF can be a valuable tool to assist in the rescue of individuals who are trapped in a borewell. These devices can be equipped with cameras, sensors, and other tools that can be used to locate and extract individuals who are stuck in a borewell. In recent years, there have been several incidents in India where children and adults have fallen into open borewells, resulting in tragic outcomes. The rescue of individuals who are trapped in borewells is a complex and challenging operation that requires specialized equipment and expertise. NDRF is often called upon to assist in these rescue operations. A robotics device for borewell rescue operations can significantly enhance NDRF's capabilities in these situations. The device can be equipped with cameras and sensors that can provide real-time data on the location and condition of the individual trapped in the borewell. It can also be equipped with specialized tools that can be used to extract the individual safely The robotics device can be remotely controlled, which means that it can be operated from a safe distance. This feature can be particularly useful in situations where the borewell is unstable, and there is a risk of further collapse. The device can also be designed to be lightweight and compact. making it easy to transport to the rescue site. The deployment of such robotics devices for borewell rescue operations can be a significant step in enhancing NDRF's capabilities in these complex and challenging situations. It can help to save lives and minimize damage during these emergencies.

Introduction:

India is the biggest user of groundwater in the world, drawing around 230 cubic kilometers per year. There are approximately 27 million bore wells in India. Due to water scarcity, low rainfall, drought, and depletion of underground water, a large number of bore wells are dug. When the water gets dried, the motor along with the casing pipe are removed and the outer surface of the bore well is not properly covered or sealed.

Reports say that since 2009, more than 40 children fell into the bore well. On average 70% of the conventional child rescue operation fails.

Main Causes of Bore Well Accidents:



Classification of Bore-well based on diameter:

1. High Capacity Bore well: 10-12 inches.
2. Medium Capacity Bore well: 8 inches.
3. Low Capacity Bore well: 6 inches.

Challenges in bore well rescue:

1. Tender and small age of victims.
2. The remoteness of bore well locations.
3. Confined space.
4. Low visibility.
5. Weather condition.

6. Lack of immediate oxygen supply.
7. Lack of supportive infrastructure.

Most commonly used types of drilling methods:

1. **Water Jetting**: Water jetting is typically used for shallow bores in alluvial formations. It may not be the best choice for deep-bore well rescue operations but can be used for shallow and small-diameter wells.
2. **Augur Drilling**: Augur drilling is also suitable for shallow bores in alluvial formations and may be used for smaller-diameter bore wells.
3. **Calyx Drilling**: Calyx drilling is a versatile method that can be used for shallow bore wells in both hard rock and alluvial formations. It may be considered if the geological conditions are mixed or not well-defined.
4. **Down the Hole Hammering (DTH) Drilling**: DTH drilling is ideal for drilling large and deep bore wells in hard rock formations. If the bore well is in a hard rock formation, DTH drilling is often the most effective method.

In borewell rescue operations, Ground Penetrating Radar (GPR) data is collected to gain insights into the surrounding soil and geological conditions. This data is then processed and analyzed using predictive models, typically decision trees or random forests, to determine the most suitable drilling approach. By assessing soil composition, moisture content, and potential obstacles, these models can provide recommendations for drilling equipment, depth, and challenges, optimizing the chances of a successful rescue operation. Continuous learning and data updates ensure the model's accuracy and adaptability to changing soil conditions, making it a vital tool in borewell rescue planning.

The difference between the existing structure and the model we are proposing:

1. **LiDAR Mapping for Precision Insights**

In our borewell rescue operations, we employ LiDAR (Light Detection and Ranging) technology to meticulously map the borewell's interior. This advanced system utilizes a network of laser beams, maneuvered by two servo motors, which pivot the laser beam

both horizontally and vertically. This movement creates a detailed 3D map of the borewell's inner surface. This invaluable data helps us assess the condition of the borewell and pinpoint the exact location of the individual in need of rescue.

2. **GPR: Uncovering Alternate Pathways**

In scenarios where the 3D mapping reveals that the rescue bot may encounter obstacles or challenges while descending the borewell, or if the individual's position makes a direct rescue difficult, Ground Penetrating Radar (GPR) comes to our aid. GPR allows us to scan the surroundings of the borewell, helping us identify alternative excavation paths leading to the rescue site.

3. **Machine Learning: Predicting the Optimal Excavation Route**

To make well-informed decisions based on GPR data, we harness the power of machine learning. Our predictive model analyzes the GPR data and calculates the best alternative excavation path. This data-driven approach enhances our ability to plan and execute rescue operations efficiently and effectively.

4. **Robotic Precision with IoT and Embedded Systems**

Our rescue bot, equipped with state-of-the-art technology, is the heart of our operations. It features an air balloon for buoyancy control, a camera for real-time victim assessment, and a remotely controlled gripper powered by LoRaWAN (Long Range Wide Area Network). These integrated robotics, IoT, and embedded systems ensure that we can execute precise and safe rescue missions, even in challenging borewell environments.

Our Solution:

Advanced Robotic Borewell Rescue Device for NDRF Utilizing LiDAR

The Evolution:

1. From IR to LiDAR:

- In the past, borewell rescue bots predominantly relied on Infrared technology for sensing and navigation within confined spaces.

- The transition to LiDAR marks a substantial improvement. LiDAR provides superior accuracy in mapping and spatial perception, enabling precise navigation and obstacle detection. It empowers our rescue bots to operate with enhanced efficiency and safety in complex borewell environments.

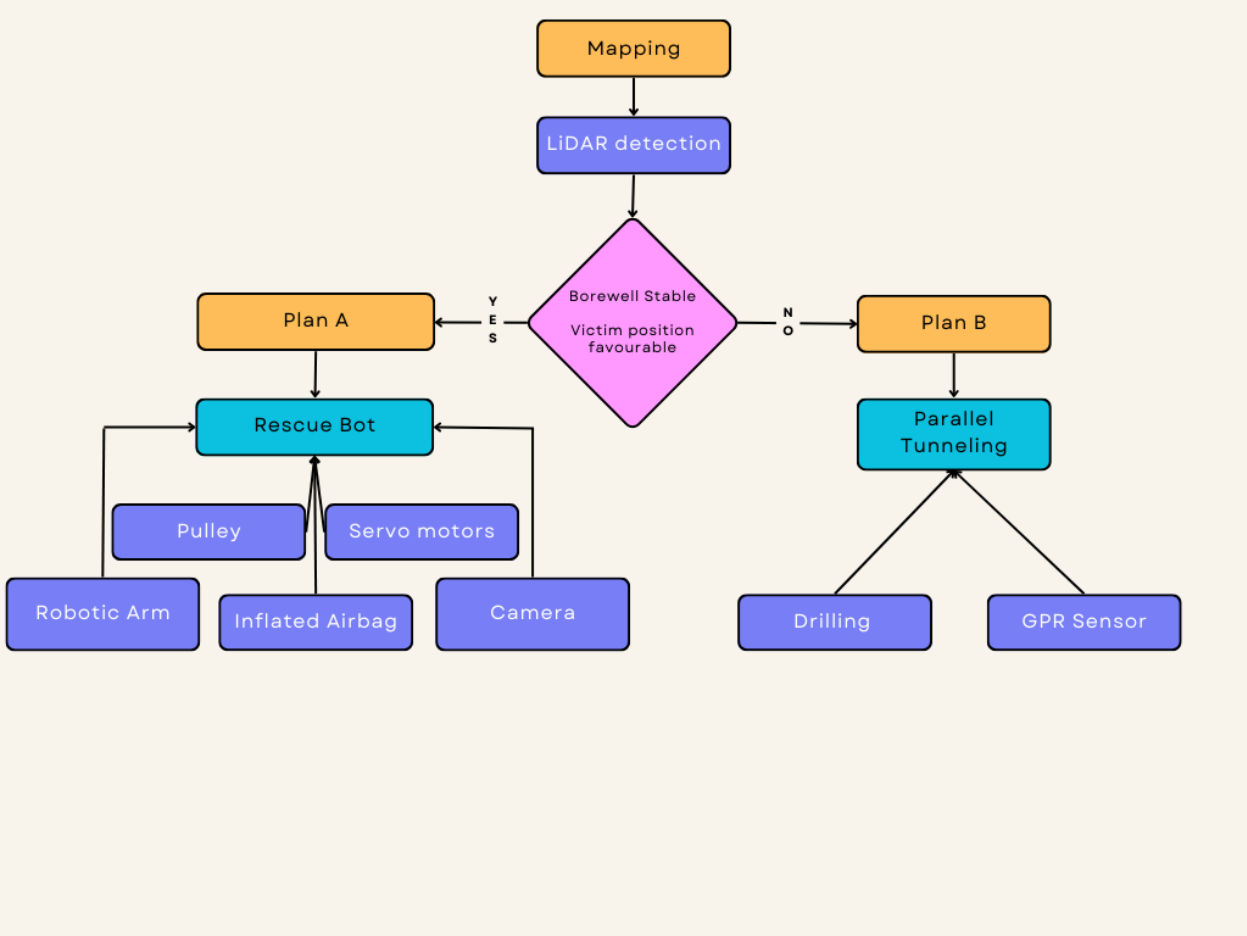
2. Introducing GPR:

- GPR is a new addition to our rescue toolkit, further augmenting our capabilities. It offers the ability to scan the borewell's surroundings, identifying alternate pathways for excavation and optimizing rescue strategies.
- The integration of GPR allows us to proactively plan and adapt to rescue scenarios where the direct path may be obstructed or challenging.

Why LiDAR and GPR Make the Borewell Rescue Robot Superior:

1. **Enhanced Precision and Accuracy**
2. **Minimized Risks**: LiDAR and GPR contribute to minimizing risks associated with borewell rescue missions. By accurately assessing the borewell's interior and surroundings, the rescue robot can avoid potential hazards and plan for safe excavation routes. This directly translates to increased safety for both rescue personnel and individuals in distress.
3. **Increased Success Rates**
4. **Timely Rescues**
5. **Minimized Costs:** While the initial investment in advanced technology may seem significant, the long-term benefits far outweigh the costs.

Flow Chart:



Rescue Operation:

1. **Inflated airbags** play a critical role in borewell rescue operations, serving as a protective barrier and cushion for individuals who have fallen into borewells. During the initial assessment, the rescue team evaluates the borewell's depth, casing size, and the condition of the trapped person. When lowered into the borewell, these durable airbags can be rapidly inflated, effectively creating a vital barrier that minimizes direct contact between the person and the borewell walls. Beyond providing protection, inflated airbags also facilitate communication with the trapped individual and help establish a connection for coordination and reassurance during the rescue process. As part of a comprehensive rescue plan, the careful use of inflated airbags ensures a controlled and safe ascent, significantly reducing the risk of further harm to both the trapped person and the rescue team.

Attachment of Communication Devices: Rescuers can attach communication devices, such as two-way radios or mobile phones, to the inflated airbag or the equipment used for lowering and raising the airbag. These devices allow direct verbal communication between the rescue team and the trapped individual.

Providing Reassurance: The mere presence of the inflated airbag can offer psychological reassurance to the trapped individual. Knowing that rescue efforts are underway and that communication is established can help alleviate anxiety and fear during the rescue operation.

2. **Parallel Tunneling**: Machine Learning (ML) plays a pivotal role in borewell rescue operations, synergizing with Ground Penetrating Radar (GPR) data to optimize drilling and parallel tunneling decisions. ML algorithms analyze GPR data to assess subsurface conditions, identify the geological composition, and recommend the ideal drilling method, considering factors like soil type, depth, and potential obstacles. Simultaneously, ML facilitates precise decision-making for parallel tunneling, suggesting the exact drilling locations based on the GPR data. This data-driven approach ensures drilling methods are tailored to geological contexts, while parallel tunneling is strategically executed alongside borewell drilling. This multifaceted solution not only enhances accuracy but also conserves valuable time and resources, offering an efficient and effective approach to borewell rescue operations, significantly increasing the likelihood of a successful outcome."

Direct Access: Parallel tunneling provides direct physical access to the trapped individual, allowing for more immediate and controlled contact. In contrast, inflatable airbags create a barrier but do not provide direct access.

It's important to note that while parallel tunneling offers these advantages, it is a more complex and resource-intensive approach that requires specialized equipment and expertise.

Social Impact:

India has over 27 million borewells, of which several have dried up and are abandoned. Small in diameter (about 4.5 - 12 inches), borewells are used to tap into underwater aquifers. According to the NDRF, after 2009 over 40 children died after falling into borewells and over 70% of rescue operations have failed. Over 92% of these accidents

involve children below 10 years of age. We conducted research to find out the main cause of such accidents, which mostly originate from the lack of proper precautionary measures and soil conditions.

1. **Safety and Lives Saved**: The project addresses a critical safety issue involving borewells, which have been the cause of accidents resulting in fatalities, particularly among children. By developing a model that helps predict the probability of borewell caving and identifies the best location for parallel tunneling, the project aims to save lives and prevent accidents, especially among vulnerable populations.
2. **Efficiency in Rescue Operations**: The project's focus on decreasing the time required for decision-making in rescue operations can significantly improve the efficiency of emergency response efforts. This efficiency can directly impact the success rate of rescue operations and reduce trauma for both victims and their families.

In summary, the project's focus on borewell safety, accident prevention, and more efficient rescue operations directly contributes to social impact by saving lives, raising awareness, and leveraging technology to address a significant safety concern in India.

Business Model:

1. Sustainable Material Sourcing:

- **Recycled Aluminum**: Emphasize the use of recycled aluminum from obsolete vehicles for building the main frame and robot components. This not only reduces costs but also aligns with sustainability and environmental objectives. You can source this recycled aluminum from car recycling centers and salvage yards.

2. Environmental Responsibility:

- **Environmental Benefits**: This includes reducing the carbon footprint associated with aluminum production and contributing to the responsible recycling of obsolete vehicles.

3. Improved Technology:

- **LiDAR Integration**: LiDAR's accuracy and efficiency in mapping borewell conditions contribute to faster decision-making, improving the effectiveness of your

rescue operations.

Customer Segments:

- Government agencies responsible for emergency response.
- Non-governmental organizations (NGOs) involved in disaster management.
- Local authorities in regions with borewell incidents.
- Research institutions and universities for collaborative projects.
- Potential global markets facing similar challenges.

Revenue Systems:

1. **Consultation and Advisory Fees for Borewell Rescue Expertise:**
    - This revenue stream involves offering expert consulting and advisory services to government agencies, NGOs, and organizations involved in borewell rescue operations. Clients pay fees to access your team's knowledge and expertise in borewell rescue strategies, technology implementation, and best practices.
2. **Licensing of Proprietary Technologies and Software:**
    - If your project develops proprietary technologies, algorithms, or software for borewell rescue optimization, you can license these to interested parties. Licensees pay fees or royalties for the right to use your intellectual property, which can include advanced ML algorithms, LiDAR software, or other unique solutions.
3. **Data Analysis and Reporting Services for Borewell Safety Assessments:**
    - This revenue stream involves offering data analysis and reporting services based on Ground Penetrating Radar (GPR) and LiDAR data. Clients, such as government agencies and rescue teams, can hire your project to analyze borewell conditions, assess safety risks, and provide detailed reports with actionable recommendations.
4. **Sale or Lease of Specialized Borewell Rescue Equipment:**

- If your project designs and manufactures specialized equipment for borewell rescue, such as robots or GPR devices, you can generate revenue by selling or leasing this equipment to rescue teams, government agencies, and organizations involved in emergency response.

5. **Subscription-Based Access to Predictive Models and Real-Time Data Analytics:**
    - Offer subscription-based access to predictive models and real-time data analytics platforms developed by your project. Subscribers, such as rescue teams and agencies, pay recurring fees for access to these tools, which can assist in rapid decision-making during rescue operations.
6. **Training Programs and Certification Courses:**
    - Generate revenue by offering training programs and certification courses in borewell rescue, GPR usage, LiDAR technology, and machine learning applications. Participants pay tuition fees for enrollment in these programs, which can be conducted in-person or online.
7. **Government Contracts for Borewell Safety Assessments and Technology Deployment:**
    - Pursue contracts with government agencies responsible for disaster management and emergency response. Governments may contract your services for borewell safety assessments, deployment of rescue technology, and training. Revenue is generated through government contracts.
8. **Sponsorships and Grants for Public Awareness Campaigns:**
    - Collaborate with corporate sponsors, foundations, and governmental organizations to fund public awareness campaigns on borewell safety and responsible borewell construction practices. These campaigns can generate revenue through sponsorships and grants to support the project's advocacy efforts.

Scalability:

Cutting-Edge Tech: We use advanced technology like LiDAR and machine learning, which can be easily expanded to handle more rescue operations at once.

Resource Management: We can scale up our resources as needed. As demand increases, we'll add more skilled personnel, get more equipment, and set up regional centers to help with more rescues.

Global Reach: Borewell issues aren't just in one place; they happen all over. Our project can adapt to different locations, so we're not limited to India.

Market Demand: Borewell accidents happen everywhere, so there's always a need for what we do.

Funding Potential: As we prove our effectiveness, we can attract more funding from investors and grants to grow even faster.

Partnerships: We work with other organizations to extend our reach. These partnerships help us tap into their networks and resources.

Eco-Friendly: Our use of recycled materials appeals to organizations that care about the environment, which can bring in more support.

In a nutshell, our project is designed to get bigger and help more people effectively and sustainably."