Smart India Hackathon

Problem Statement - 1314

Problem: Real-time visibility of Dumper load status to Shovel operator

Institute Code (AISHE): U0100

Institute Name: Indian Institute of Technology, Delhi

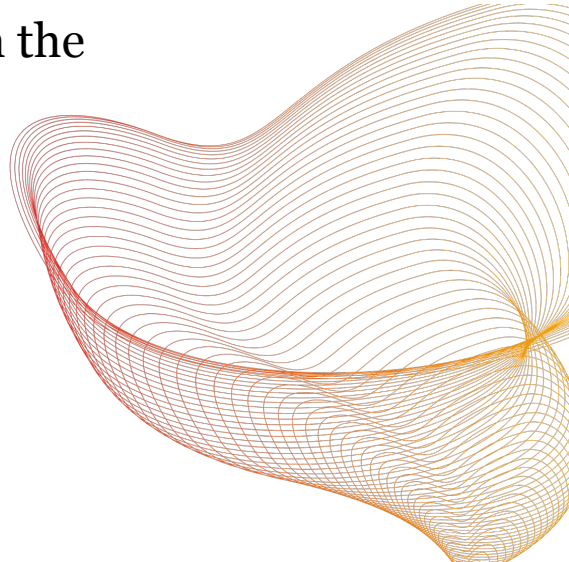
Theme Name: Smart Automation

The Problem

In large-scale mining, shovel operators face challenges when loading materials onto dumpers.

The lack of real-time visibility regarding the load status of dumpers often **leads to inefficiencies and delays** in the workflow.

In worst cases, it leads to accidents!

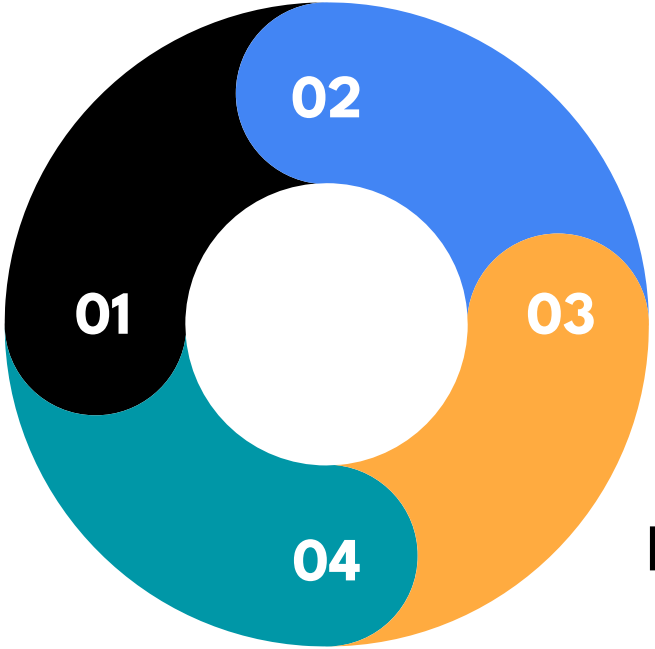


Our Solution - Elevate app and website

Our Solution - Elevate app

Chatbot support

Language support



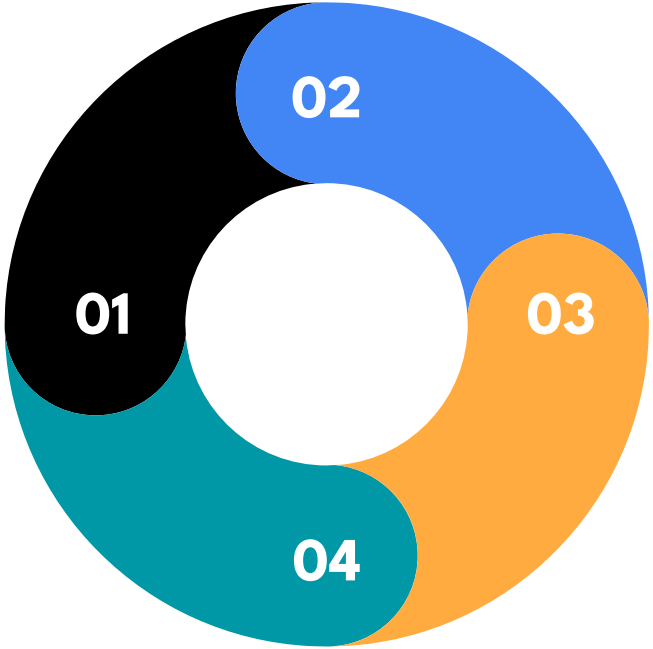
Data security

Emergency alerts

Our Solution - Elevate app

Real time cloud-update

Live Map



Worker analytics

Voice and camera integration

Elevate App Frontend

Language : Dart

Framework : Flutter

App Settings

Language
English

Machine Details

Vehile Number
MH-712-jkj

Unique ID
MH-712-jkj

Capacity
75

Model Number
712-jkj

Working Condition
A+

Distance travelled
545121 km

Load carried
4565 ton

LOG OUT

Which machine likely to break down

Chatbot access

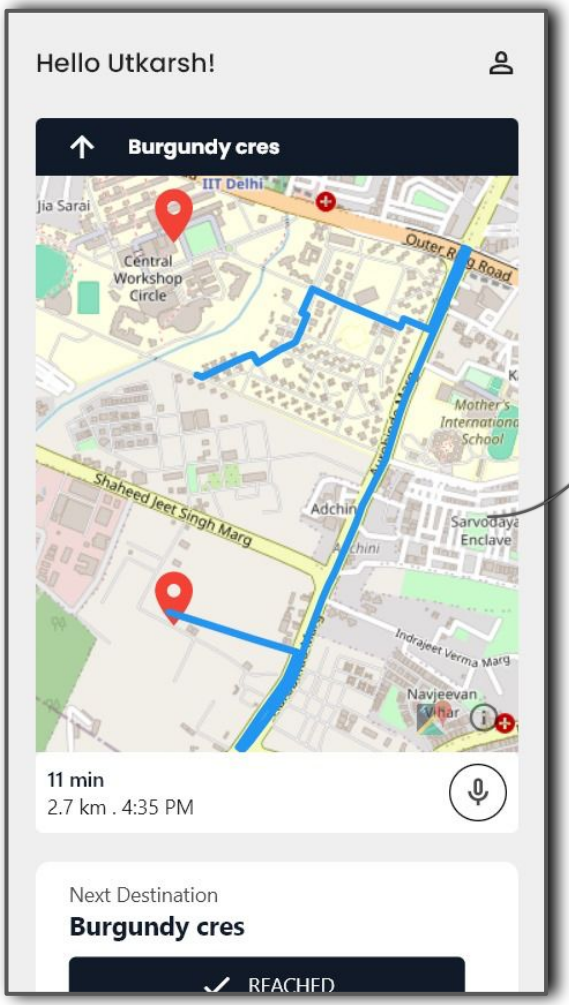
Hello Utkarsh!

Name
Utkarsh

Filled
12/14 tons

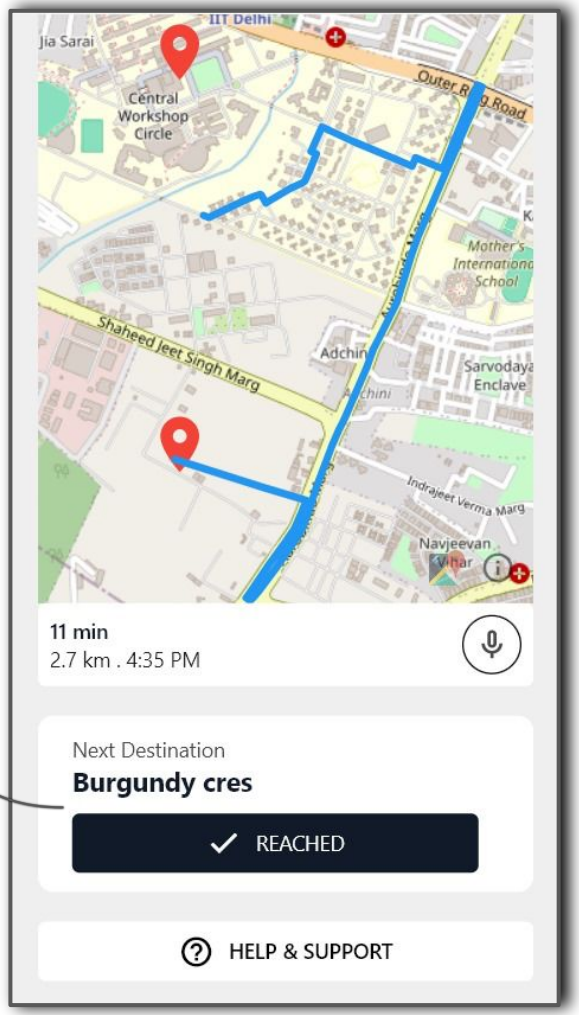
FILLED

HELP & SUPPORT



Live map of mining site

Next location to go to



Elevate Website

Elevate

- Dashboard
- Monitoring
- Announcement
- Message

Showel

Active: 4

Inactive: 3

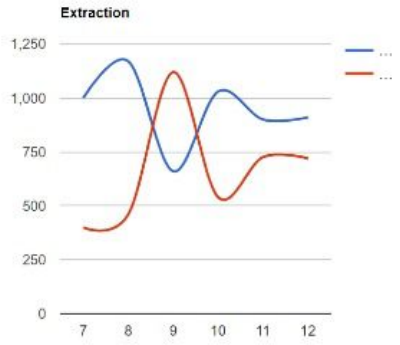
Dumper

Active: 2

Inactive: 4

Alerts

- 20/12/2023, 11:21:52: We are getting evaluated at 1121
- 20/12/2023, 11:00:35: testing 1 2 3
- 20/12/2023, 10:15:18: Meet is cancelled
- 20/12/2023, 09:58:38: Meet at 3:50 today
- 20/12/2023, 02:07:55: arnav
- 19/12/2023, 23:01:17: tester
- 19/12/2023, 23:01:17: tester
- 19/12/2023, 23:01:17: tester



Pratyaksh
2022CS51654

Logout

Elevate

- Dashboard
- Monitoring
- Announcement
- Message

Pratyaksh
2022CS51654

Logout

Vehicle Status | Live data | history

Filter

Vechile Id	Type	Model	Capactity	Status
STH60	Shovel	shovel-600	100	Working
STH62	Shovel	shovel-604	100	Not Working
STH64	Shovel	shovel-605	100	Working
STH66	Shovel	shovel-606	1000	Working
STH68	Shovel	shovel-607	100	Not Working
STH70	Shovel	shovel-608	1000	Working
STH72	Shovel	shovel-609	1000	Not Working
STH256	Dumper	dumpster-300	1000	Not Working
STH246	Dumper	dumpster-380	100	Working
STH236	Dumper	dumpster-360	1000	Not Working
STH226	Dumper	dumpster-300	100	Not Working
STH166	Dumper	dumpster-420	100	Working
STH276	Dumper	dumpster-430	100	Not Working

Innovations and USPs

1) Secure Wi-Fi network to pair the Shovel and the nearest Dumper

- Range of **~60 metres,** which is better than the existing Thread/Zigbee implementation
- **Secure** from Local Network Disruption

2) Secure and Reliable data storage in cloud

- Using Secure-Boot and Flash **encryption** to prevent data theft
- **Distribution of data** according to administrative access

Innovations and USPs

3) Interactive and User-friendly Admin portal

- **Live status** of working Dumpers and Shovel Trucks
- Interface to make any **announcements**
- Monthly report in excel sheet with **interactive graphs**
- Interface to deal with all Alerts raised

4) Final Dumper Load status trained on Neural Networks:

- Considered factors like input from various sensors along with **inclination** of Dumper, **Age** of Load sensors
- Prevents underloading

Innovations and USPs

5) Cloud Based Secure Smart AI chat-bot

- Available in all Indian regional language
- Emergency Alert system
- Vehicle breakdown alert

6) Real-time GPS tracking between Dumper and Shovel operator

- **Automatic pairing** with nearest dumper
- Approximate arrival time of dumper visible to shovel operator

Innovations and USPs

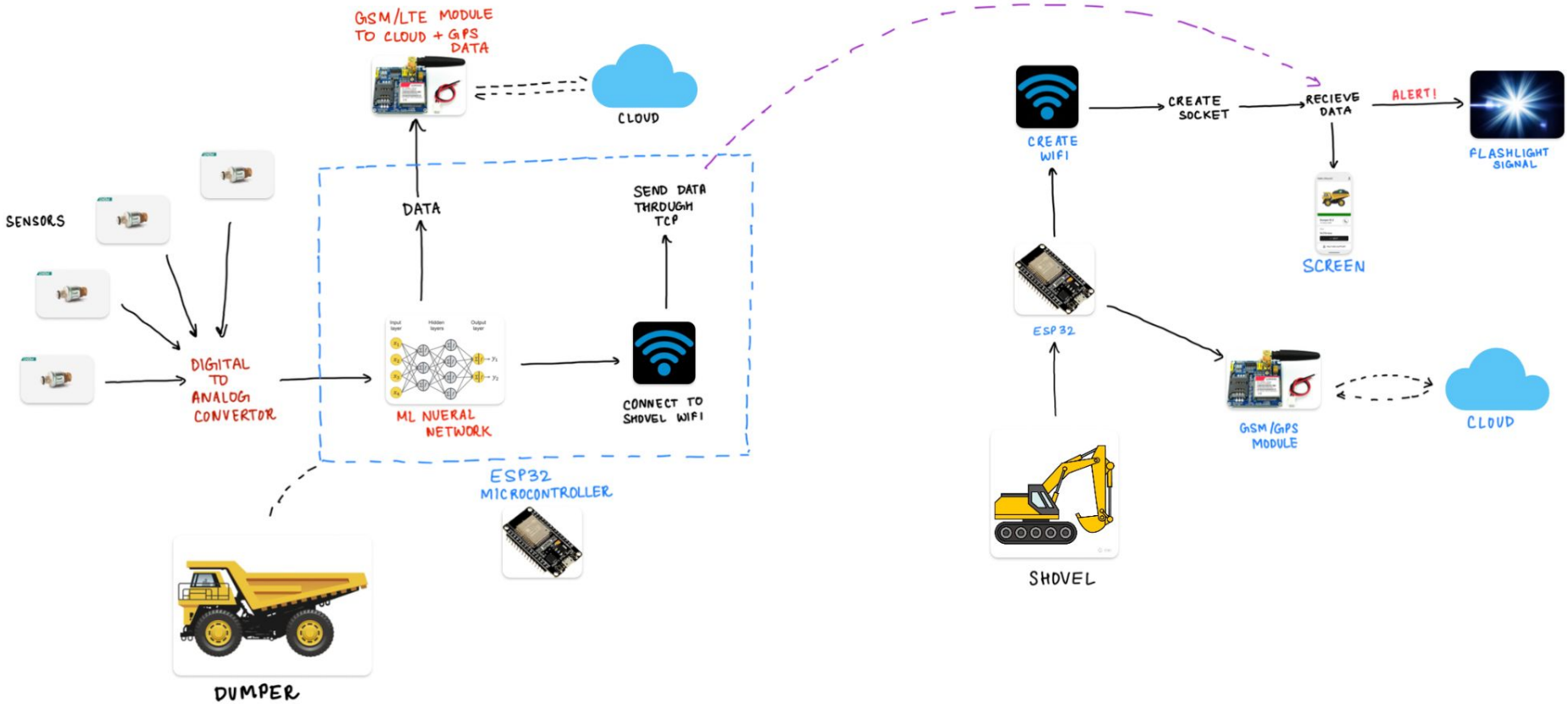
7) Secure and Reliable data storage in cloud

- Unique USP as we are providing latest map route data to Dumper Truck operators
- Using A*-Algorithm to find the approximate travel time and distance

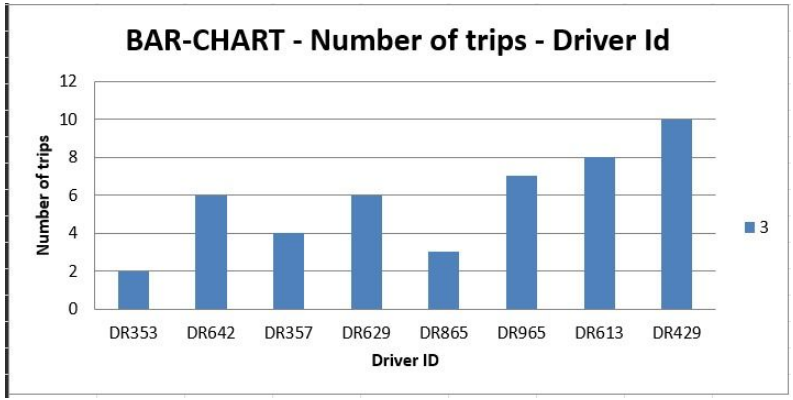
8) Red, Yellow, Green Flashlight alert to indicate the level of filled status of the Dumper Truck

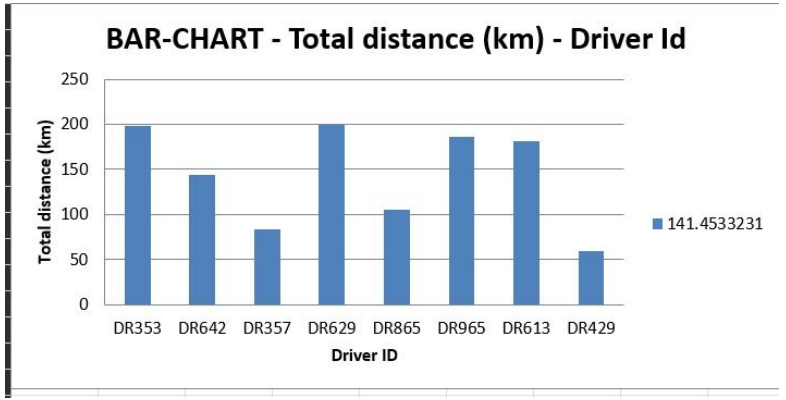
9) Secure and Reliable data storage in cloud

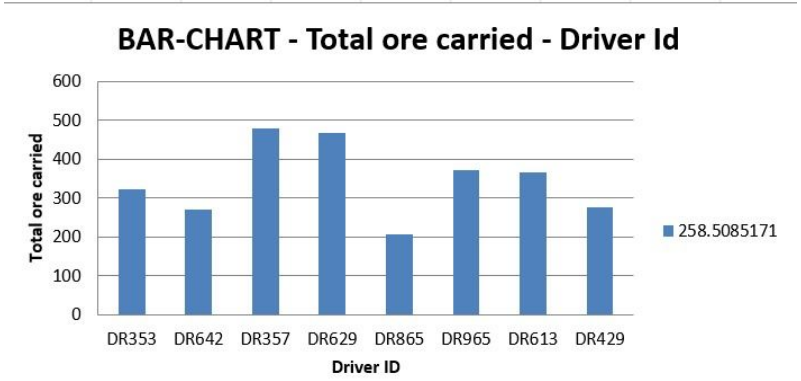
Hardware and solution approach

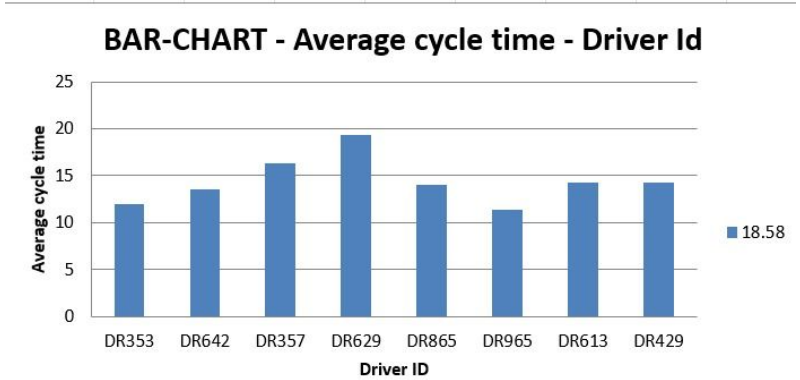

GSM/LTE MODULE
TO CLOUD + GPS
DATA
CLOUD
SENSORS
DATA
SEND DATA
THRDUGH
TCP
DIGITAL
TO
ANALOG
CONVERTOR
ML NUERAL
NETWORK
CONNECT TO
SHOVEL WIFI
ESP32
MICROCONTROLLER
DUMPER
CREATE
WIFI
CREATE
SOCKET
RECIEVE
DATA
ALERT!
FLASHLIGHT
SIGNAL
SCREEN
ESP32
GSM/GPS
MODULE
CLOUD
SHOVEL

Reports - Reports ready for download at admin dashboard



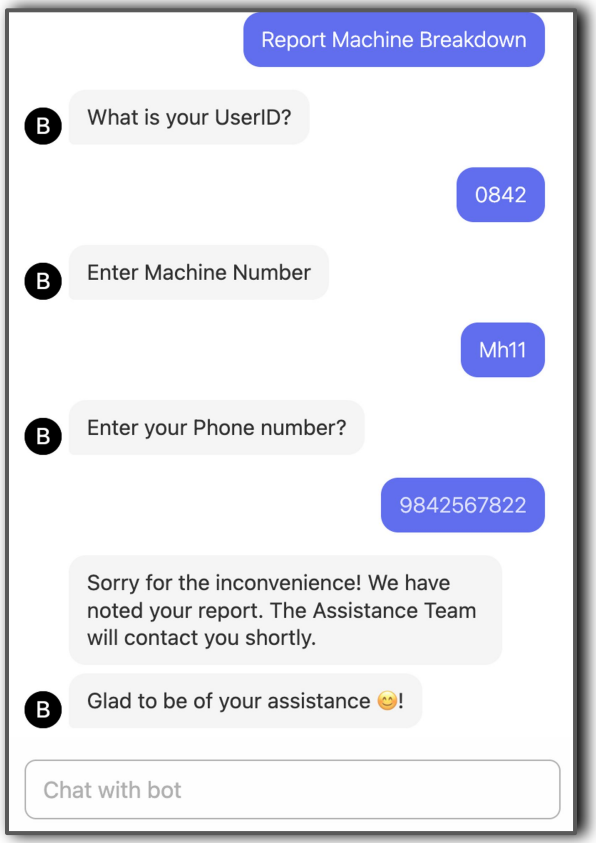


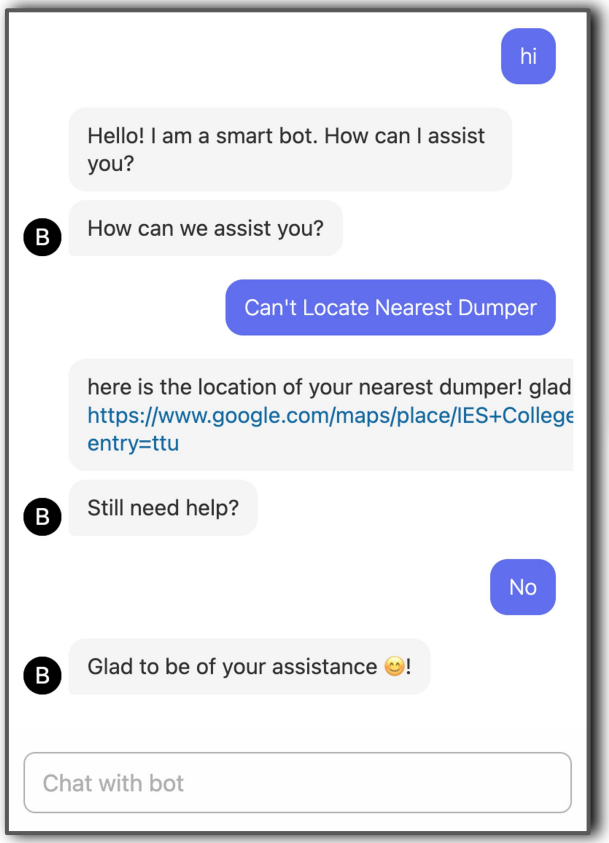


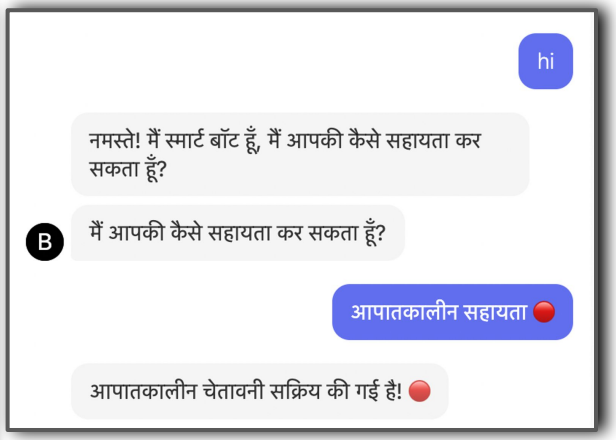


Chatbot

- Multilingual, for help and support, emergency help







B मैं आपकी कैसे सहायता कर सकता हूँ?

ऑपरेट करने के लिए सहायता चाहिए

B अपना प्रश्न दर्ज करें!

शव्ल् कैसे चलाना है

एडमिन से संपर्क करना है

B अपनी समस्या का वर्णन करें।

मैं शिकायत करना चाहता हूं

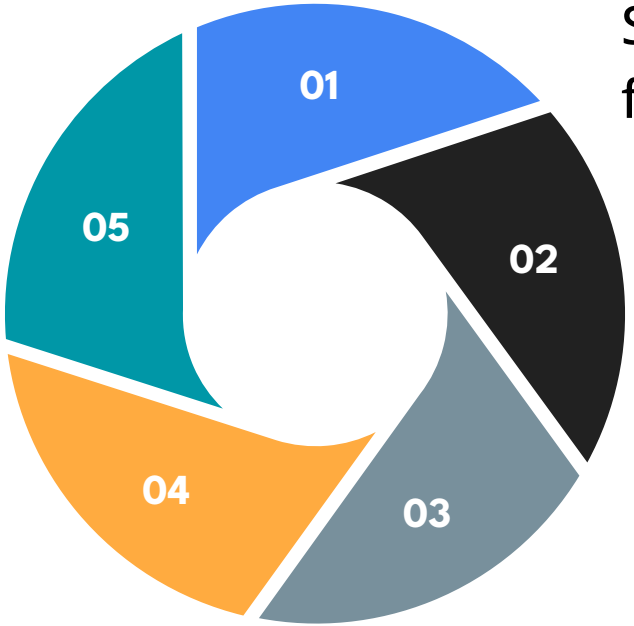
आपकी शिकायत के बारे में अधिक जानकारी के लिए धन्यवाद। कृपया अपनी शिकायत के विषय को विस्तार से बताएं ताकि मैं आपकी मदद कर सकूं। कोयला खनन और परिवहन क्षेत्र से संबंधित किसी भी मुद्दे पर मैं आपकी सहायता करने के लिए यहां हूं। कृपया अपनी समस्या को विस्तार से समझाएं ताकि मैं आपको ठीक से जवाब दे सकूं।

मशीन को चलाने के लिए, इन चरणों का पालन करें:

1. रखरखाव के बाद काम के लिए मशीन को भेजने से पहले, इंजीनियर, मैकेनिकल फोरमैन या अन्य प्रबुद्ध व्यक्ति द्वारा प्रबंधक द्वारा अधिकृत लिखित रूप में जांच की जानी चाहिए।
2. हर जांच को एक बाउंड पेज में दर्ज किया जाना चाहिए और जांच करने वाले व्यक्ति द्वारा हस्ताक्षर और तारीख के साथ साइन किया जाना चाहिए।
3. सुनिश्चित करें कि मशीन यानी यान मैकेनिकल रूप से सुरक्षित है और कार्यक्षमता में है।
4. मशीन के रखरखाव के लिए निर्माताओं द्वारा प्रदान की गई निर्देशिका का पालन करें।
5. मशीन के रखरखाव के लिए हर हफ्ते कम से कम एक दिन आवंटित करें।
6. सुनिश्चित करें कि मशीन बिना सुरक्षा सुविधाओं जैसे पीछे की दिशा कैमरा, स्वचालित डिपर, प्रोक्सिमिटी चेतावनी, टेलगेट सुरक्षा या थकाने की संवेदनशील उपकरण के चलने के रूप में तोड़फोड़ के रूप में नहीं चल रही है।

Integration and improvements

Fully Functional Website



Simulation ready for load sensors

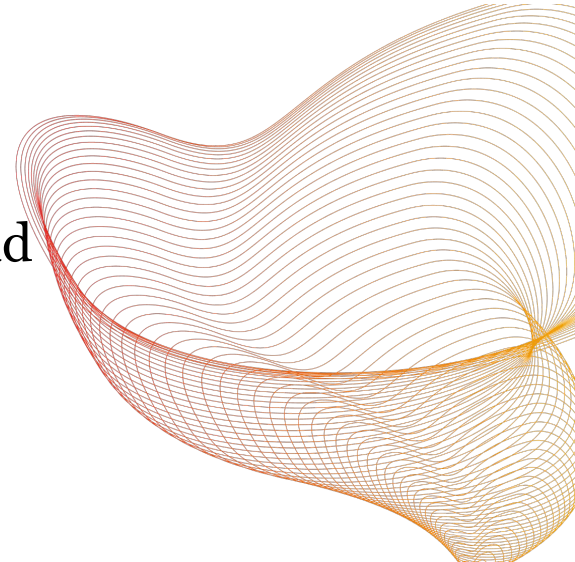
Neural -network ready to train from load sensors.

Working Chatbot

Reports analysis with interactive graphs

How Scalable is our Solution?

- Our map system can accommodate 10^4 individual machines.
- Our network is based on point to point connection with negligible reliance on cellular connectivity.
- MongoDB ensures quick parsing and dynamic data-types ensuring future scale-ups.
- Quick and automatic reports ready for download at admin dashboard.
- Exhaustive solution to all problems faced from shovel operator to admin.



Technological Feasibility

Why GPS? Why not RFID or GNSS (Global Navigation Satellite System) or others?

- GPS provides **real time location tracking**, whereas RFID provides point-in-time data when a tagged item passes within the read range of an RFID reader.
- GPS systems operate over **large geographical areas** whereas RFID systems operate within a limited range, typically a few meters to a few dozen meters.
- GNSS is an expensive system, and for the task, it is not required as GPS works fine in almost all mines today.

Why Simulate sensors as compared to using Arduino load sensors ?

- Simulating the sensors gives more accurate sensor values compared to the **original value.**

- If we use Arduino load sensors they are just miniaturised versions of the actual values we will be getting, hence not a reliable source of data.

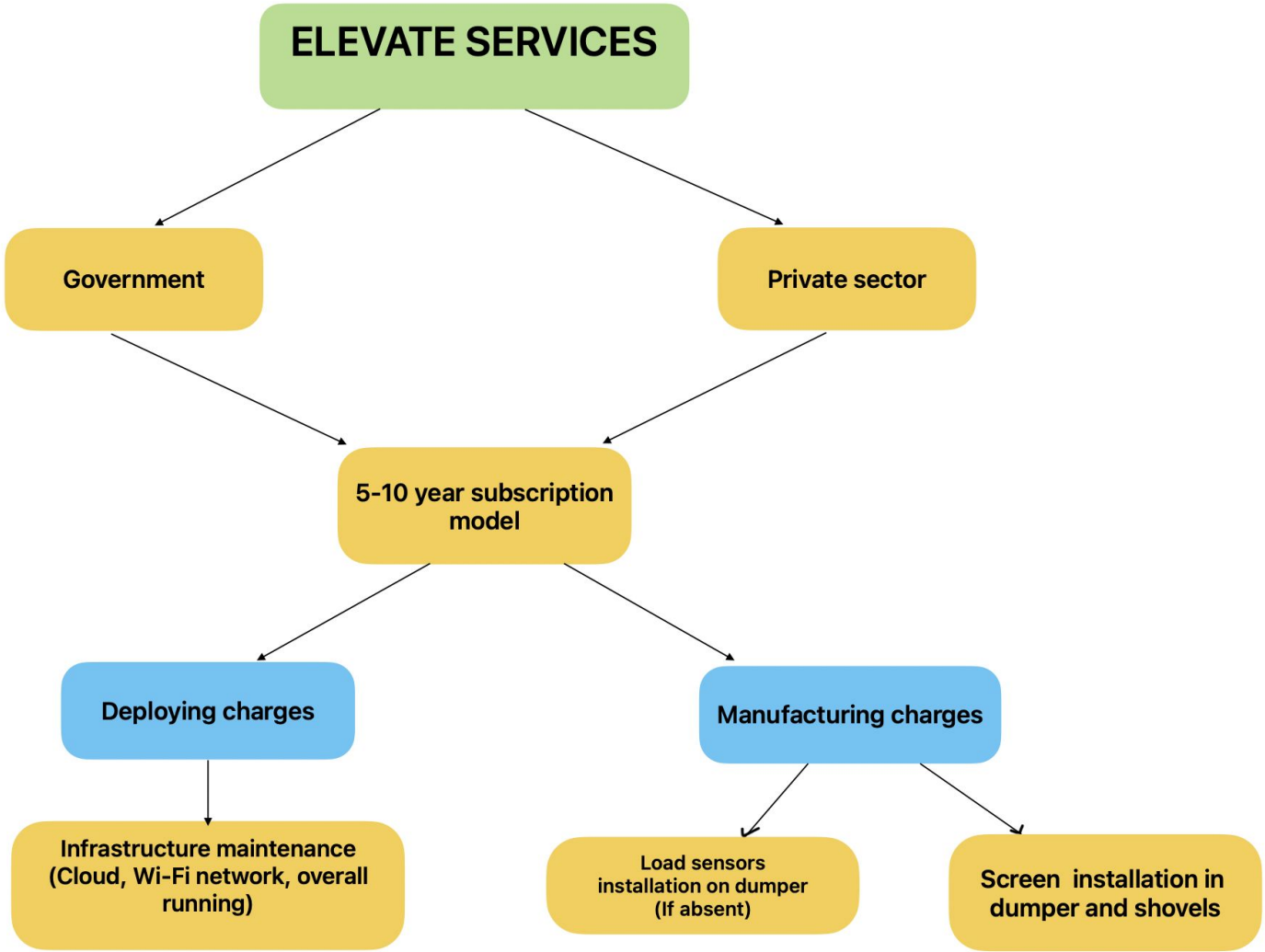
Why use neural networks to train your overloading status? Why not just take the average output of load sensors?

- Using Neural networks with continuous data training we will eventually **minimize the error** and hence optimize the overall system.
- Neural networks consider the **different variables** affecting the overloading alarm like, aged load sensors, tilt of vehicle with respect to its central axis, etc. Hence making it a permanent solution as well as a reliable solution to date!

Why an Internal Wi-Fi system? Why not Thread/ZigBee/Lora-wan?

- Although Wi-fi uses more battery power, it's crucial to understand that this is still the best way to go, as we need **real-time updates** of load status.
- We need a range of **30-60 meters.**
- Using Thread/Zigbee/Lora-Wan, we will not get the optimum range for connection nor real-time data transfer.
- Lora-wan has a long-range (in km). Can cause interference.

Business Model


ELEVATE SERVICES
Government
Private sector
5-10 year subscription model
Deploying charges
Manufacturing charges
Infrastructure maintenance (Cloud, Wi-Fi network, overall running)
Load sensors installation on dumper (If absent)
Screen installation in dumper and shovels

Cost Model on a Mine Site

Manufacturing Charges

Dumper

Item	Price	Quantity
Sensors - GNOM S7 + Protective gear	Rs. 18,500 + Rs. 5000	2-4 (optional)
ESP32 C3	Rs. 500	1
GSM + GPS Module /LTE	Rs. 550	1
R12T600 Mount Display	Rs. 2100	1

Manufacturing Charges

Shovel

Item	Price	Quantity
ESP32 C3	Rs. 500	1
GSM + GPS Module /LTE	Rs. 550	1
R12T600 Mount Display	Rs. 2100	1

Deployment Charges (per Year)

Item	Price	Quantity
Cloud Hosting	Rs. 56,000	1
Web Hosting	Rs. 15,000	1
App Hosting	Rs. 4000 X 2	2
Cellular connectivity	Rs. 600/operator	-

+

Service Charges

= Rs. 40,000

Example Per Year Cost

1 Shovel, 5 Dumpers

Item	Price
Shovel costs	Rs. 3150
Dumper cost * 5	Rs. 133,250
Other costs	Rs. 122,600

Total Cost = Rs. 260,000 / Year

Our Challenges

1. Challenge : Our App has integrated maps from google maps, but we want to handle the ever changing routes and landscape of mining sites by using modified customized maps to calculate estimated arrival time and distance.

   Solution : We plan on using Bresenham algorithm to identify routes.

2. Challenge : We are using load sensors only to calculate the weight of load, but there can be one issue when the load is wet and it has gained additional weight due to water. This can lead to inaccuracy in weight.

   Solution : We can resolve this using ultrasound sensors.

1. Challenge : Defining hierarchy for customized administrative data access.

   Solution : We plan to deal with this as we will get to know more about the hierarchy levels.

2. Challenge : We have not dealt with IP protections or loss of calibration due to shock.

   Solution : We will deal with this by first installing shock absorbers and smart software that detects loss of calibration and automatically calibrates it.

ThankYou