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TITLE PAGE

- **Problem Statement ID – 25071**
- **Problem Statement Title - AI-Based Rockfall Prediction and Alert System for Open-Pit Mines**
- **Theme- Disaster Management**
- **PS Category- Software**
- **Team ID- SMD4L**
- **Team Name : SMD4L**

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IDEA TITLE

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❖ Proposed Solution

❖ An **AI-driven Rockfall Prediction System** for open-pit mines that uses **DEM, drone imagery, sensors, and environmental data**. A **hybrid AI model** predicts hazards accurately, sending **real-time SMS/SOS alerts** via a **React-Django dashboard**. Scalable, cost-effective, and **Cloud-Docker** ready, it ensures proactive safety, reduces downtime, and adapts to diverse mining conditions.

- ***Tackling the Challenge***
  - ❖ **Predictive Safety:** Detects rockfall before it happens.
  - ❖ **Real-Time Alerts:** SMS/SOS notifications for quick response.
  - ❖ **Integrated Monitoring:** Combines geospatial, sensor, and environmental data.
  - ❖ **Operational Efficiency:** Reduces downtime and equipment damage.
  - ❖ **Scalable & Flexible:** Cloud-Docker ready for any mining site.

- ***Innovation & Uniqueness***
  - ❖ **Hybrid AI Framework:** Combines geospatial, sensor, and environmental data for accurate prediction.
  - ❖ **Synthetic Data Generation:** Solves scarcity of labeled rockfall data.
  - ❖ **Low-Cost IoT Integration:** Drones and sensors for real-time monitoring.
  - ❖ **Scalable & Open-Source:** Cloud-Docker ready, adaptable to different mining conditions.
  - ❖ **Proactive Safety Focus:** Shifts from reactive monitoring to predictive risk management

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TECHNICAL APPROACH

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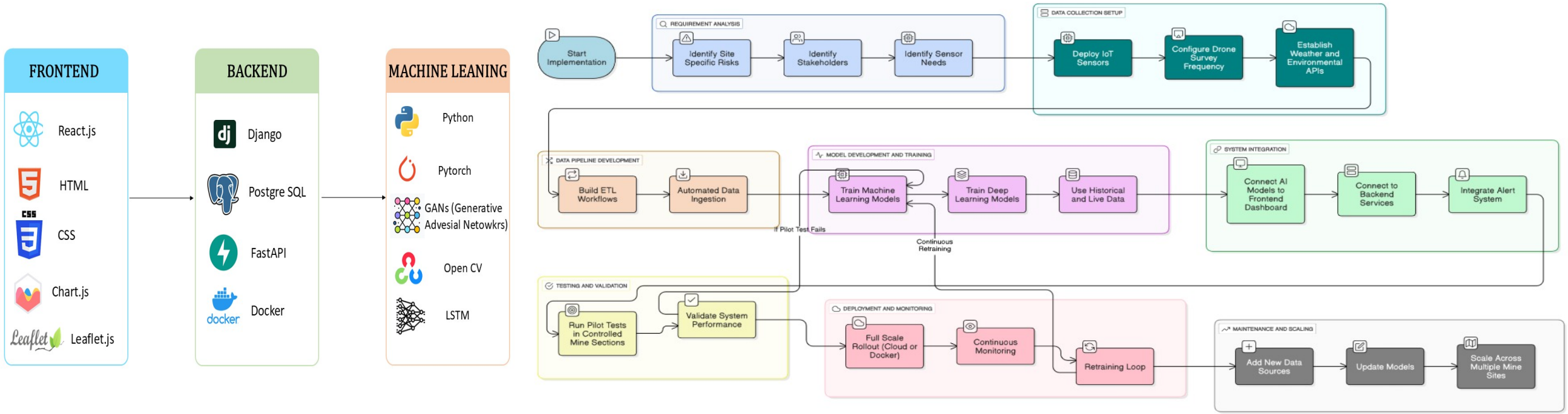
- ***Process for Implementation***
  - ❖ **Requirement Analysis** – Identify site-specific risks, stakeholders, and sensor needs.
  - ❖ **Data Collection Setup** – Deploy IoT sensors, configure drone survey frequency, and establish APIs for weather & environmental data.
  - ❖ **Data Pipeline Development** – Build ETL (Extract, Transform, Load) workflows for automated data ingestion.
  - ❖ **Model Development & Training** – Train ML/DL models with historical + live data.
  - ❖ **System Integration** – Connect AI models with frontend dashboard (React), backend (Django/FastAPI), and alert system (SMS/Email/Alarms).
  - ❖ **Testing & Validation** – Run pilot tests in controlled section of mine.
  - ❖ **Deployment & Monitoring** – Full-scale rollout on cloud or Docker with continuous monitoring and retraining loop.
  - ❖ **Maintenance & Scaling** – Add new data sources, update models, and scale across multiple mine sites.



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TECHNICAL APPROACH

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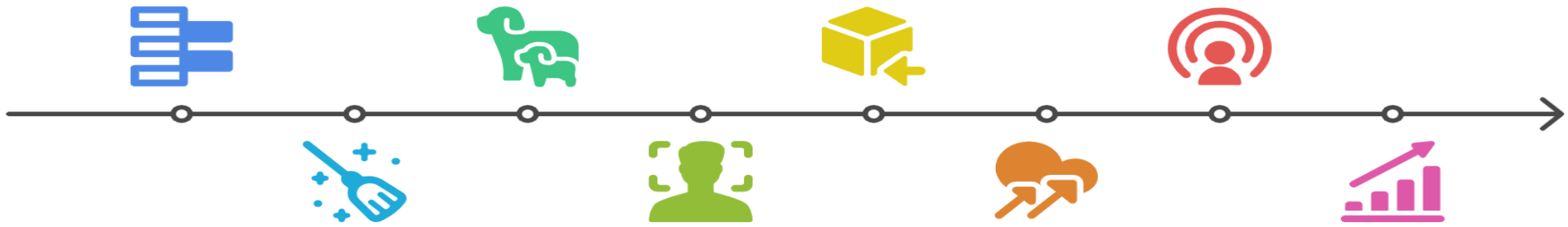
Data Processing and System Integration Workflow



Data Collection & Integration

Gathering and combining data from various sources

Data Preprocessing & Feature Engineering

Cleaning and preparing data for analysis

Model Training & Validation

Training and testing models to ensure accuracy

Feature Extraction

Identifying and extracting relevant features from data

Model Integration

Integrating models with backend and frontend systems

Deployment

Deploying the system to cloud or containerized environments

System Integration

Ensuring seamless interaction between system components

Monitoring & Continuous Improvement

Continuously monitoring and improving system performance

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FEASIBILITY AND VIABILITY

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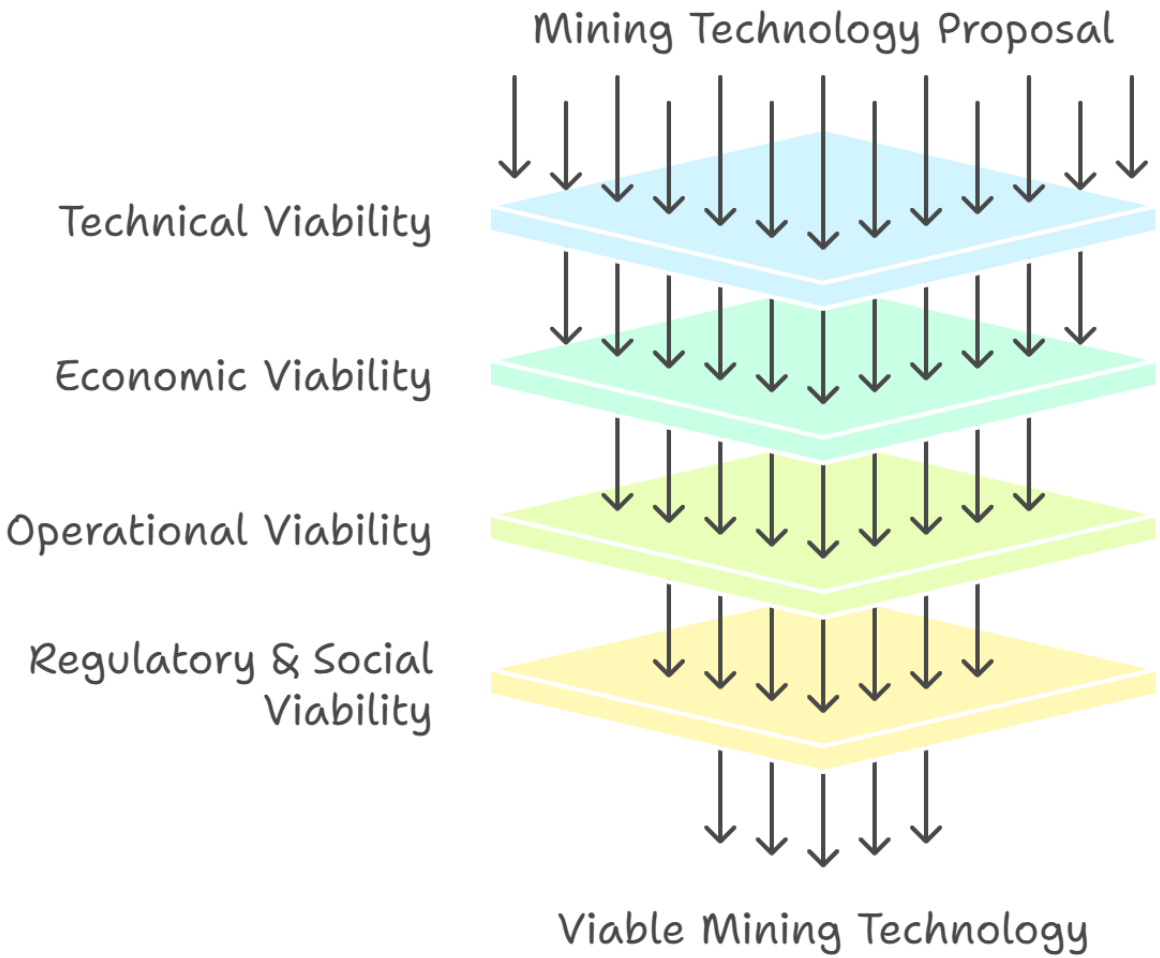
- ***Technical Viability***
  - ❖ IoT sensors & drones already in Indian mines.
  - ❖ AI/ML for slope stability proven globally; adaptable to India.
  - ❖ Wireless infra (LTE/private Wi-Fi) supports real-time alerts.
  - ❖ Builds on DGMS-mandated monitoring (no replacement).
- ***Economic Viability***
  - ❖ Cost: Basic ₹20–30L | Advanced ₹1–2Cr.
  - ❖ Savings: One avoided accident = ₹50–100Cr.
  - ❖ ROI < 1 year in high-production mines.
- ***Operational Viability***
  - ❖ Fits existing workflows (blasting, inspections, drainage).
  - ❖ Alerts in local languages → higher worker adoption.
  - ❖ Easy maintenance; scalable from one mine to clusters.
- ***Regulatory & Social Viability***
  - ❖ Strengthens DGMS compliance on slope safety.
  - ❖ Builds worker & union trust via proactive safety.
  - ❖ Supports ESG & sustainable mining practices.



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IMPACT AND BENEFITS

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- ***Impact***

  - **Enhanced Worker Safety:** The system minimizes the risk of rockfall-related accidents by providing predictive alerts, ensuring timely evacuation or preventive actions. This directly protects the lives of workers in hazardous open-pit mining zones.
  - **Reduced Financial Losses:** By predicting potential slope failures, the solution helps avoid equipment damage and unplanned downtime, reducing both immediate repair costs and long-term operational disruptions.
  - **Operational Efficiency:** Mine planners receive real-time insights into slope stability, enabling them to schedule activities more effectively and reduce delays caused by unforeseen hazards.
  - **Open-Source Collaboration**: By using open-source tools and working with universities, research institutes, and global mining communities, the system stays affordable, scalable, and innovative. This collective effort ensures faster improvements, shared knowledge, and practical solutions tailored for India's mining challenges.

- ***Benefits***

  - **Cost-Effective and Scalable:** Built on open-source frameworks and low-cost IoT integration, the system is affordable for both small and large mines, with easy scalability across different geological settings.
  - **Adaptable for Diverse Mining Operations:** The flexible architecture supports deployment in public and private mines, adjusting to varying terrains, climates, and operational requirements.
  - **Sustainable Mining Practices:** By reducing accidents and failures, the system promotes environmental stability, social responsibility, and safer long-term mining operations.

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RESEARCH AND REFERENCES

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