

# Comprehensive System Development Plan for Coal Mining Operations

## 1. Overview

This system is designed to streamline and digitize coal mining operations, improving productivity, safety, and communication across different roles. The system consists of both a web-based application and a mobile app. The mobile app is provided specifically for stakeholders who need real-time, on-the-go access.

## 2. Role-Based System Breakdown

### 2.1. Supervisor Role

**Responsibilities:**

- Make shift plans.
- Manage and monitor alerts.
- Assign work and oversee mine operations.

**Web App Features:**

- **Dashboard:**
  - **Overview:** Comprehensive view of the current shift status, worker assignments, and active alerts.
  - **Shift Summary:** Quick glance at the previous shift's summary, highlighting key tasks completed, incidents reported, and alerts managed.
- **Shift Planning Module:**
  - **Create Shift Schedules:** Intuitive interface to plan shifts, assign tasks, and modify existing schedules.
  - **Resource Allocation:** Manage resource distribution, including workforce and machinery assignments.
- **Alert Management System:**
  - **Receive Alerts:** Real-time alerts for incidents, equipment failures, and safety concerns.
  - **Prioritize & Assign:** Categorize and prioritize alerts, assigning them to the appropriate workers or teams.
- **Task Assignment Interface:**
  - **View Worker Status:** Real-time view of worker availability and task completion status.
  - **Assign/Reassign Tasks:** Ability to assign new tasks or reassign existing ones based on priority and worker availability.
- **Mine Operations Overview:**
  - **Real-Time Monitoring:** Dynamic map or interface showing the status of different mine sections, machinery, and worker locations.

**Mobile App Features:**

- **Quick Task Assignment:** Allows for quick task assignments directly from the app.
- **Real-Time Alerts:** Instant notifications of critical alerts and incidents that need immediate attention.
- **Shift Summary Card:** Provides a snapshot of the previous shift's tasks and incidents.

**Case Scenario Example:**

**Morning Shift Planning**

- **6:00 AM:** The supervisor logs in to the web app and reviews the previous shift's summary, including tasks completed and pending incidents. Using the Shift Planning Module, they create a new shift schedule and assign tasks to workers based on priority.
- **6:15 AM:** As alerts are received throughout the shift, the supervisor uses the Alert Management System to categorize and assign them to available operators. If a critical incident occurs, they quickly assign the task via the mobile app.
- **End of Shift:** The supervisor reviews the shift's performance and logs any unresolved tasks for the next shift.

### 2.2. Operator Role

**Responsibilities:**

- Perform assigned tasks.
- Report incidents and hazards.
- Respond to emergency alerts.
- Track productivity and work timing.

**Web App Features:**

- **Personal Dashboard:**
  - **Assigned Tasks:** View tasks assigned by the supervisor, with deadlines and priority levels.
  - **Shift Log:** Access to the current shift log, including ongoing tasks and recent alerts.
- **Incident Reporting Tool:**

- **Structured Forms:** Report incidents with options to upload photos, documents, and select incident type.
- **Real-Time Submission:** Immediate submission of incident reports, with notifications sent to supervisors.
- **Emergency Alert System:**
  - **Instant Alerts:** Receive and acknowledge emergency alerts.
  - **Response Interface:** Access tools to take immediate action on alerts.
- **Work Timing Tracker:**
  - **Automatic Logging:** Automatically logs start and end times of shifts, including break periods.
  - **Manual Adjustments:** Operators can manually adjust timings if needed, with supervisor approval.

#### Mobile App Features:

- **Shift Overview:** Displays tasks for the day and any pending tasks from previous shifts.
- **Incident Reporting:** Quick access to report incidents or hazards, with photo upload functionality.
- **Emergency Alerts:** Real-time notifications and a response interface for emergency situations.
- **Work Timing:** A simple clock-in/clock-out feature to track work hours.

#### Case Scenario Example:

##### Handling a Safety Hazard

- **During Shift:** An operator notices a loose cable near a machine. Using the mobile app, they report the hazard by filling out the Incident Reporting form and uploading a photo of the cable.
- **Immediate Action:** The supervisor receives the alert and assigns the task of fixing the cable to a nearby operator. The operator acknowledges the task through the mobile app and proceeds to fix the issue.

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## 2.3. Admin Staff Role

#### Responsibilities:

- Maintain operational data.
- Manage worker and supervisor information.
- Generate reports.
- Handle payroll and compliance management.

#### Web App Features:

- **Data Management Interface:**
  - **Centralized Database:** Access to all operational data, including shift logs, incident reports, and worker details.
  - **Data Entry & Modification:** Admins can input, modify, and retrieve data across the system.
- **User Management System:**
  - **Manage Profiles:** Admins can create, update, or delete profiles for workers and supervisors.
  - **Role-Based Access:** Assign roles and permissions, ensuring that each user has appropriate access to system features.
- **Report Generation Module:**
  - **Custom Reports:** Generate reports on productivity, safety incidents, payroll, and compliance metrics.
  - **Automated Scheduling:** Set up automated report generation at specific intervals.
- **Payroll System:**
  - **Integrated with Shift Logs:** Automatically calculate salaries based on logged work hours, including overtime and bonuses.
  - **Compliance Management:** Ensure that all payroll processes adhere to local labor laws and company policies.

#### Case Scenario Example:

##### End of Month Processing

- **Data Review:** Admin staff use the web app to review all shift logs, ensuring that data is accurate and up-to-date.
- **Report Generation:** A report on worker productivity and safety incidents is generated and shared with management.
- **Payroll Processing:** The payroll system calculates salaries, considering any overtime, and generates pay slips for all workers.

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## 2.4. Management Role

#### Responsibilities:

- Monitor overall shift performance.
- Align operations with organizational goals.
- Review productivity and safety metrics.
- Ensure compliance with industry regulations.

#### Web App Features:

- **Executive Dashboard:**
  - **High-Level Overview:** A snapshot of key performance indicators (KPIs) such as productivity, safety incidents, and operational efficiency.
  - **Drill-Down Reports:** Ability to click into specific KPIs to see more detailed reports and trends.
- **Performance Analytics:**
  - **Trend Analysis:** Graphs and charts displaying trends in productivity, incident frequency, and compliance.
  - **Comparative Metrics:** Compare current performance against historical data or industry benchmarks.
- **Compliance Monitoring:**
  - **Safety Protocol Compliance:** Monitor adherence to safety protocols and industry regulations.
  - **Audit Trails:** Access logs of all actions taken within the system for auditing purposes.
- **Strategic Planning Tools:**
  - **Goal Setting:** Tools to set organizational goals and track their achievement over time.
  - **Task Delegation:** Assign tasks to different departments or roles to meet strategic objectives.

#### Mobile App Features:

- **Performance Alerts:** Management can receive alerts on their mobile devices if any KPI deviates significantly from expected norms.
- **Quick View Reports:** Access high-level reports and KPIs directly from the mobile app.
- **Compliance Notifications:** Notifications if any compliance issues arise.

#### Case Scenario Example:

##### Quarterly Review

- **Dashboard Review:** Management logs into the web app and reviews the quarterly performance of the mine. They note that safety incidents have decreased by 10% but productivity has also dropped slightly.
- **Strategic Adjustment:** Management uses the Strategic Planning Tools to set new goals for the upcoming quarter, focusing on improving productivity without compromising safety.

## 2.5. Safety Supervisor Role

#### Responsibilities:

- Monitor safety protocols.
- Handle safety alerts and incidents.
- Ensure compliance with safety regulations.
- Oversee machinery and mine conditions.

#### Web App Features:

- **Safety Dashboard:**
  - **Central Hub:** A centralized location for all safety-related data, including alerts, incidents, and compliance checks.
  - **Incident Tracking:** Monitor the status of all reported safety incidents, from reporting to resolution.
- **Real-Time Alert Monitoring:**
  - **Prioritize Alerts:** Safety alerts are categorized and prioritized based on severity.
  - **Escalation Management:** Escalate unresolved alerts to higher management or external agencies.
- **Incident Log Access:**
  - **Detailed Logs:** Access to a searchable and filterable log of all safety incidents.
  - **Compliance Reporting:** Generate reports for regulatory bodies, ensuring that all incidents are documented according to standards.
- **Safety Compliance Checker:**
  - **Protocol Monitoring:** Automated checks to ensure that all safety protocols are being followed.
  - **Deviation Alerts:** Instant alerts if any protocol deviations are detected.
- **Machinery Status Monitoring:**
  - **Real-Time Data:** Monitor the operational status of critical machinery, with alerts for any issues that may arise.
  - **Maintenance Logs:** Access logs of all maintenance performed on machinery, ensuring that it meets safety standards.

#### Mobile App Features:

- **Incident Reporting & Monitoring:** Safety supervisors can use the mobile app to report incidents or monitor ongoing safety issues.
- **Compliance Checker Alerts:** Receive alerts directly on the app if any safety protocol deviations occur.
- **Quick Access to Safety Logs:** Access detailed logs and reports on safety incidents.

#### Case Scenario Example:

##### Handling a Critical Incident

- **During Shift:** A critical machinery failure is detected. The Safety Supervisor receives an alert on their mobile app and

immediately accesses the real-time data on the machinery's status.

- **Escalation:** The incident is categorized as high-priority, and the Safety Supervisor escalates the issue to higher management and assigns a team to handle the repair.
  - **Post-Incident Review:** After the incident is resolved, the Safety Supervisor logs the details in the Incident Log and generates a report for compliance review.
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## 3. Technical Architecture

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### 3.1. System Architecture

- **Frontend:**
  - **Web App:** Built using **React.js** for a responsive, interactive user interface.
  - **Mobile App:** Developed using **React Native** for cross-platform compatibility on both iOS and Android devices.
- **Backend:**
  - **Node.js with Express.js:** For managing API endpoints, business logic, and real-time data handling.
  - **Database:**
    - **PostgreSQL** for relational data management (e.g., user profiles, shift schedules).
    - **MongoDB** for document-based data storage (e.g., incident logs, alert history).
- **Real-Time Data:**
  - **WebSockets:** For real-time data synchronization, particularly for alerts and notifications.
  - **Service Workers & IndexedDB:** For offline support and local data storage, ensuring the app remains functional without an internet connection.
- **Authentication & Security:**
  - **JWT-Based Authentication:** Secure, role-based access control with JSON Web Tokens.
  - **Encryption:** SSL/TLS for data in transit, AES-256 for sensitive data at rest.
  - **Security Audits:** Regular penetration testing and security audits to ensure system integrity.

### 3.2. Deployment & Infrastructure

- **Containerization:**
  - **Docker:** For containerizing microservices, ensuring consistency across development and production environments.
  - **Kubernetes:** For managing container orchestration, scaling, and high availability.
- **CI/CD Pipelines:**
  - **GitHub Actions/Bitbucket Pipelines:** Automated testing, integration, and deployment pipelines.
  - **Monitoring & Logging:** Integrated with tools like **Prometheus** and **Grafana** for real-time monitoring and alerting.

### 3.3. Data Synchronization

- **WebSockets & REST API:**
  - **WebSockets:** Used for instant data updates (e.g., alerts, real-time monitoring).
  - **REST API:** For standard CRUD operations, including data fetching, updating, and deletion.
- **Offline Support:**
  - **Service Workers:** For background sync and offline capabilities.
  - **IndexedDB:** To store data locally on the device, synchronizing with the server once a connection is re-established.

### 3.4. Security Considerations

- **Data Encryption:**
  - **In Transit:** All communications between client and server are encrypted using SSL/TLS.
  - **At Rest:** Sensitive data stored in the database is encrypted using AES-256 encryption.
- **Role-Based Access Control (RBAC):**
  - **Granular Permissions:** Ensuring that each role has access only to the data and features necessary for their responsibilities.
  - **Audit Logs:** All actions within the system are logged and auditable to ensure compliance and traceability.

### 3.5. User Experience (UX) Design

- **Mobile-First Design:** Both the web and mobile applications are designed with a mobile-first approach to ensure usability on smaller screens.
- **Intuitive Navigation:** Role-based dashboards and easy-to-navigate menus tailored to each user role.
- **Accessibility:** Compliance with WCAG (Web Content Accessibility Guidelines) to ensure the system is usable by all workers, including those with disabilities.

### 3.6. Integration with Existing Systems

- **Mine Monitoring Systems:**
  - **Real-Time Data Integration:** The system integrates with existing mine monitoring systems, providing real-time data on machinery, worker locations, and environmental conditions.

- **Third-Party Software Integration:**

- **Payroll Systems:** Integration with external payroll systems for seamless salary processing.
  - **Compliance & Reporting Tools:** Integration with third-party compliance software for generating required regulatory reports.
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## 4. Conclusion

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This comprehensive system for coal mining operations is designed to enhance productivity, ensure safety, and streamline communication across different roles. The combination of a web app and mobile app provides flexibility, allowing each role to perform their tasks efficiently, whether in the office or in the field. With robust security, real-time data synchronization, and a mobile-first design, this system will significantly improve the overall efficiency of coal mining operations.

By adopting this system, coal mining companies can expect improved operational efficiency, better safety compliance, and enhanced data-driven decision-making.

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