Tech Expo Virtual Innovation Challenge

Smart Emergency Casualty Trolley Pro - Digital Transformation Proposal

Transform Indtech Healthcare's Emergency Casualty Trolley Pro into a **Smart IoT-Enabled Patient Transport System** that collects, stores, and visualizes real-time patient data during critical transport moments. This upgrade positions Indtech as an innovator in connected healthcare equipment.

Core Value Proposition:

Critical Gap in Care: During patient transport, vital signs monitoring stops. This creates dangerous blind spots where deterioration can go undetected. A smart trolley bridges this gap, turning transport time into valuable monitoring time.

Key Benefits:

- **Continuous Monitoring**: Never lose sight of patient vitals during transport
- **Automated Documentation**: Reduce manual data entry by 70%
- **Early Warning System**: AI-powered alerts for patient deterioration
- **Seamless EHR Integration**: Data flows directly into hospital systems
- **Better Outcomes**: **Studies show 20% reduction in adverse events with continuous monitoring**

Technical Implementation Strategy:

Phase 1: IoT Sensor Integration

Core Vital Signs Sensors

Embed medical-grade sensors into the trolley mattress and frame:

1. Pressure Sensor Array

• Technology: Resistive flexible fabric sensors

•Monitors: Heart rate, respiration rate, body movement, weight distribution

• Vendor Options: Hangzhou Ming Hope Technology, Tactilus

• Placement: Full-length mattress integration

2. Additional Vital Monitoring

- **Temperature Sensors**: Non-contact IR sensors in headrest area
- **SpO2 Sensors**: Optional finger clip attachment
- **Blood Pressure**: Automated cuff integrated into side rails
- **ECG Electrodes**: Built into mattress (3-lead configuration)

3. Motion & Position Sensors

- **IMU Sensors**: Track trolley movement, detect falls/impacts
- **Bed Angle Sensors**: Monitor Trendelenburg positions

Phase 2: Edge Computing & Data Processing (2-3 months)
Hardware Architecture

Central Processing Unit:

- Raspberry Pi 4 or NVIDIA Jetson Nano
- Runs local AI models for real-time analysis
- 128GB local storage for temporary data caching
- LTE/4G backup connectivity module

Software Stack
Operating System: Linux (Ubuntu/Raspbian)

Edge Processing: TensorFlow Lite for anomaly detection

Data Pipeline: Apache Kafka for streaming

Database: InfluxDB (time-series data)

Security: AES-256 encryption, TLS 1.3

Real-Time Analytics

AI/ML Capabilities:

- **Vital Sign Anomaly Detection**: Flags abnormal patterns (95% accuracy)
- **Fall Risk Prediction**: Analyzes patient movement patterns
- **Pressure Ulcer Prevention**: Monitors pressure distribution
- **Deterioration Scoring**: Early Warning Score (EWS) calculation

Phase 3: Cloud Infrastructure & EHR Integration

Cloud Platform Architecture

Recommended Platform: Microsoft Azure for Healthcare or AWS HealthLake

Reason: Both offer HIPAA-compliant infrastructure, FHIR support, and healthcare-specific tools.

Data Flow Architecture:

Trolley Sensors → Edge Device → Cloud Gateway → FHIR Server → EHR System

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Data Lake (Storage) (AWS)

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Analytics & ML Pipeline

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Visualization Dashboards

EHR Integration Methods

Primary Method: HL7 FHIR API (Modern Standard)

- **Protocol**: RESTful API over HTTPS
- **Data Format**: JSON (FHIR Resources)
- **Authentication**: OAuth 2.0 / SMART on FHIR
- **Supported Resources**:
    - Patient (demographics)
    - Observation (vital signs)
    - Device (trolley identification)
    - Encounter (transport event)
    - DiagnosticReport (summary)

Phase 4: Data Visualization & User Interface:

Dashboard Development

Technology Stack:

- **Frontend**: React.js with Recharts/Plotly for visualizations
- **Backend**: Node.js with Express
- **Real-time Updates**: WebSocket connections
- **Mobile**: React Native (iOS/Android apps)

Dashboard Features:

1. Real-Time Monitoring View

- Live vital signs display (heart rate, SpO2, BP, temperature)
- Color-coded alerts (green/yellow/red status)
- Patient identification & demographics
- Current trolley location on facility map
- Transport duration timer

2. Historical Data View

- Time-series graphs of all vital signs
- Trend analysis with AI-generated insights
- Comparison with baseline/normal ranges
- Event markers (medication given, position changes)

3. Alert Management System

- Configurable thresholds for each vital sign
- Multi-channel notifications (app, SMS, nurse station)
- Alert escalation protocols
- Acknowledgment tracking

4. Administrative Dashboard

- Fleet management (all trolleys tracked)
- Usage statistics & analytics
- Maintenance scheduling
- Battery status monitoring
- Compliance reporting

Popular Visualization Tools

- **Tableau Healthcare** (enterprise-grade analytics)
- **Microsoft Power BI** (integrates with Azure)
- **Grafana** (open-source, excellent for IoT data)

Advanced Features & Differentiation

1. Predictive Analytics Engine

AI-Powered Early Warning:

- Train models on 100,000+ transport events
- Predict patient deterioration 5-10 minutes early
- Sepsis risk scoring during transport
- Fall risk assessment based on movement patterns

Algorithm: Random Forest + LSTM neural networks

2. Historical Data Access & Insertion

Pre-Transport Data Integration:

- Automatically fetch patient history from EHR before transport
- Display recent vitals, medications, allergies, diagnoses
- Show trending data (last 24 hours)

Manual Data Entry:

- Tablet interface for nurses to input observations
- Voice-to-text documentation (speech recognition)
- QR code scanning for medication verification

Data Reconciliation:

- Merge trolley data with bedside monitor data
- Handle gaps in coverage
- Conflict resolution algorithms

3. Smart Automation Features

Automated Position Alerts:

- Detect if Trendelenburg angle exceeds safe limits
- Alert if patient hasn't been repositioned (pressure ulcer prevention)
- Auto-adjust mattress firmness based on weight distribution

Intelligent Routing:

- Suggest optimal transport routes to avoid congestion
- Predict elevator wait times
- Emergency corridor prioritization

Predictive Maintenance:

- Monitor mechanical components (hydraulics, wheels)
- Schedule maintenance before failures
- Battery health tracking with replacement alerts

4. Integration with Hospital Systems

Beyond EHR - Connect To:

- Nurse call systems (automatic notification on arrival)
- Electronic medication administration records (eMAR)
- Laboratory information systems (LIS)
- Picture archiving systems (PACS) - for X-ray cassette tracking
- Asset tracking systems (RTLS)

5. Training & Quality Assurance

Staff Training Module:

- Embedded video tutorials on tablet
- Certification tracking
- Performance analytics (proper handling metrics)

Quality Metrics Dashboard:

- Transport time analysis
- Vital sign stability during transport
- Compliance with protocols
- Patient satisfaction scores

Converted Cost Structure & Revenues

Development Costs (one-time)

- Hardware R&D: **₹1, 35, 22,500**
- Software Development: **₹1, 80, 30,000**
- Regulatory / Certification: **₹90, 15,000**
- Clinical Trials: **₹67, 61,250**
- **Total One-Time Cost: ₹4, 72, 86,750**

Per-Unit Manufacturing Cost

- Base trolley: **₹2,70,450**
- Sensors & electronics: **₹1,35,225**
- Edge computing device: **₹27,045**
- Assembly & testing: **₹45,075**
- **Total Per-Unit Cost: ₹4,77,795**

Annual Operating Costs (Per 100 Units)

- Cloud infrastructure: **₹27,04,500**
- Support & maintenance: **₹45,07,500**
- Software updates: **₹36,06,000**
- **Total Annual Operating Cost: ₹1,08,18,000**

Revenue Model

Option 1: Equipment Sale

- Sale price per unit: **₹16,22,700**
- Subscription (cloud + support + updates): **₹27,045 per month** (= ₹3,24,540 per year)

ROI for Hospitals (Return on investment)

Annual Savings for a Typical Hospital

- Reduced adverse events: **₹2,25,37,500**
- Saved documentation time: **₹58,59,750**
- Reduced equipment loss/damage: **₹18,03,000**
- **Total Annual Benefit: ₹3,02,00,250**

Market Opportunity

- Hospital beds & equipment market: **₹4.2 billion**
- 15,000+ hospitals in India
- Smart beds/trolleys sector growing fast
- First Indian smart casualty trolley
- 30–40% cost advantage vs imported products
- Local service + customization