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Design and Implementation Protocol for a Neurosurgery-Led Digital Emergency Referral System in Khyber Pakhtunkhwa, Pakistan: A Scalable Model for Low- and Middle-Income Countries

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Muhammad Nawaz Khan¹, Muhammad Sohaib Khan¹, Syed Shayan Shah¹, Bilal Bashir¹, Ali Talha Khalil¹, Almas Fasih Khattak¹, Bipin Churasia²

¹Lady Reading Hospital Peshawar; ²Institute of medical sciences, bharatpuur Nepal

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We use this protocol and it's working

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Abstract

Background

Inefficient emergency referral systems in low- and middle-income countries (LMICs) like Pakistan contribute to delays in patient care, miscommunication, and inadequate preparedness at receiving facilities, ultimately worsening health outcomes specially in time critical specialties like Neurosurgery. Khyber Pakhtunkhwa (KPK), like many regions in Pakistan, lacks a streamlined referral mechanism across its healthcare facilities.

Objectives

This study led by neurosurgical specialists, aims to design, implement, and evaluate a digital emergency referral system—the KPK MTI Referral Application—to enhance patient triage, real-time communication, and system-wide monitoring. The goal is to improve the efficiency, transparency, and responsiveness of the emergency referral process across KPK's healthcare system.

Methods

A user-centered, mobile- and web-based referral platform will be developed, tailored to KPK's health infrastructure and digital landscape. The mixed-methods study will include quantitative analysis of referral patterns and outcomes, as well as qualitative feedback from healthcare providers and patients across major Medical Teaching Institutions (MTIs), district hospitals, and tehsil hospitals. Key features of the application will include a user-friendly interface, real-time bed availability, automated and specialty-specific referral forms, image upload functionality, instant notifications, unique referral IDs, and dashboards for monitoring and analytics. The study will be conducted in phases, including requirement gathering, development, testing, and deployment. Ethical considerations such as data anonymization, patient confidentiality, and secure storage will be addressed.

Expected Outcomes

The evaluation will focus on measurable improvements including a reduction in unnecessary referrals, improved response times, increased bed utilization rates, decreased patient mortality, cost savings, and enhanced satisfaction among patients and healthcare providers. The study's findings will inform policy recommendations for broader adoption of digital referral systems in KPK and other LMICs facing similar challenges.

Image Attribution

Nawaz Khattak

Materials

Study instrument: (study proforma /questionnaire shall be provided)



Safety warnings

! No patient identifiers will be collected, and only operational metrics will be analyzed.

Ethics statement

Ethical considerations such as data anonymization, patient confidentiality, and secure storage will be addressed. Ethical clearance from the NBC-R is mandatory before the project is executed for multicenter/multi-provincial/ and national-level research projects. Single-center research studies do not require NBC-R approval; however, a member of the NBC-R should be co-opted into the TAC to provide ethical insight. Data will be anonymized, and no patient names or identifiers will be stored. Consent will be obtained from the participating clinicians for feedback and interviews. Data security will follow HIPAA-compliant protocols, with access restricted to authorized personnel.

Features and Functional Design of the Digital Referral Platform

- 1 **Real-Time Bed Availability:** Displays current bed occupancy and specialized service availability in all receiving hospitals.
Automated Referral Forms: Specialty-specific forms with fields for patient details, medical history, and reasons for referral.
Image Upload Functionality: Allows attaching of diagnostic images (e.g., X-rays, CT scans).
Instant Notifications: Referral alerts sent to receiving hospitals within a 15-minute timeframe.
Referral ID System: Each referral is assigned a unique ID for traceability, printed on the referral slip.
Reminder and Escalation System: If no response is received within 15 minutes, automated reminders are triggered, and emergency contacts are displayed for follow-up.
Dashboards for Monitoring: Real-time tracking for hospital administrators, emergency managers, and policymakers.
Data Analytics and Reporting: Monthly and quarterly reports highlighting referral patterns, hospital performance, and system bottlenecks.

Web/App Interface Workflow

- 2 **Homepage** – Displays MTI hospital logos; selecting one leads to department listing. (fig:2 and fig:3)
Department Listing Page – Shows all departments in the chosen hospital; selecting one opens the referral form.
Referral Form Page – Includes input fields for patient info, medical history, and upload of diagnostic images.
Dashboards:
Hospital MD Office Dashboard: Tracks incoming/outgoing referrals, response status, and department-wise breakdowns.
Policy Board Dashboard: Aggregated data for strategic oversight, including:
Total referrals (in/out) per MTI
Unplanned referrals
Specialty-wise breakdowns
Most common reasons for referral

Evaluation Parameters

- 3 **Reduction in Unnecessary Referrals:** The number of unnecessary referrals (e.g., cases that could have been managed at district or tehsil hospitals) before and after the portal's implementation was compared.

- 4 Improvement in Response Times: The average time taken for receiving hospitals to respond to referral requests (acceptance or rejection) was measured.
- 5 Increase in Bed Utilization Rates: Monitor bed occupancy rates at district and tehsil hospitals before and after the implementation of the portal.
- 6 Reduction in Patient Mortality Rates: Track mortality rates for trauma and emergency cases before and after the implementation of the portal.
- 7 Cost Savings: Analyze the reduction in out-of-pocket expenses for patients (e.g., travel and accommodation) and the overall healthcare system costs related to patient transfers.
- 8 Patient and Provider Satisfaction: Measure patient and healthcare provider satisfaction with the referral process through surveys and interviews.
- 9 Reporting and Policy Recommendations: The findings from the evaluation will be compiled into a comprehensive report that will be shared with healthcare administrators, policymakers, and other stakeholders. The report will include the following:
- 10 Policy Recommendations: Recommendations for scaling up the referral portal to include all district and tehsil hospitals in KPK, as well as suggestions for further improvements to the system are provided.

Ethical Considerations

- 11 Ethical clearance from the NBC-R is mandatory before the project is executed for multicenter/multi-provincial/ and national-level research projects. Single-center research studies do not require NBC-R approval; however, a member of the NBC-R should be co-opted into the TAC to provide ethical insight.
Data will be anonymized, and no patient names or identifiers will be stored. Consent will be obtained from the participating clinicians for feedback and interviews. Data security will follow HIPAA-compliant protocols, with access restricted to authorized personnel.

Timeline and Implementation Plan

- 12 The project will be executed in four key phases over a 10-month period, combining application development, system integration, training, deployment, monitoring, and evaluation. Each phase has clearly defined deliverables to ensure smooth implementation and scalability. (Fig:4)
Phase 1: Application Development and Data Preparation (Months 1–5)
Phase 2: Implementation and Integration (Months 3–7)
Phase 3: Monitoring and Data Collection (Months 5–10)



Phase 4: Evaluation and Reporting (Months 8–10)

Data Analysis

Final Report Preparation

Policy Recommendations

Potential Limitations and Mitigation Strategies

- 13 The study may face several challenges, including:
- Limited smartphone and internet access in rural areas, which could hinder adoption and consistent use of the referral system.
 - Variability in digital literacy among healthcare providers, potentially affecting the efficient use of the application.
 - Resistance to change from clinicians accustomed to existing manual workflows, which may delay implementation.
- Mitigation strategies include targeted training sessions, simplified user interfaces, phased implementation with continuous support, and engagement with local stakeholders to build ownership and trust in the new system.

Funding

- 14 This study will be internally funded by the participating Medical Teaching Institutions (MTIs), with financial support and oversight provided through their respective hospital administrations.

Mobile App Interface

- 15 Following is the Mobile App interface
Flowchart of the referral process

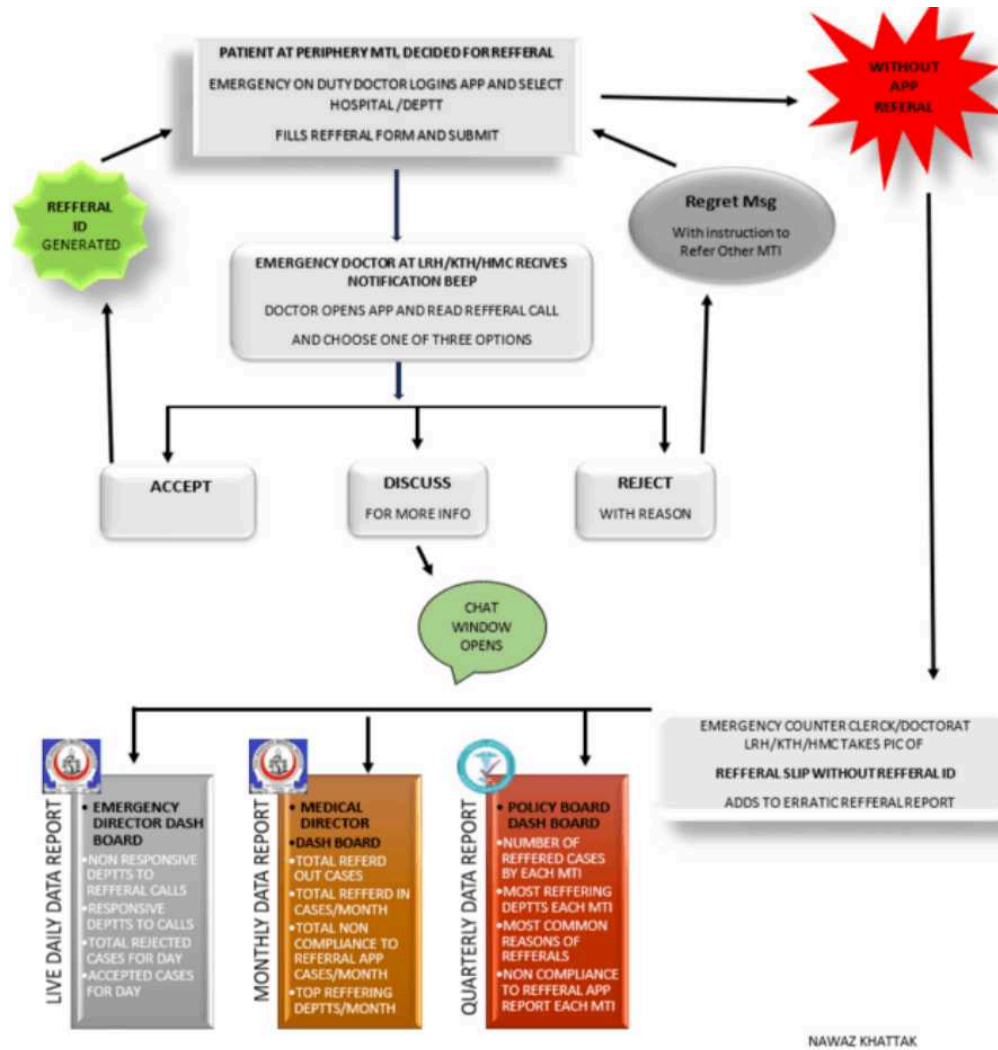


Fig:1 Flowchart of the referral process

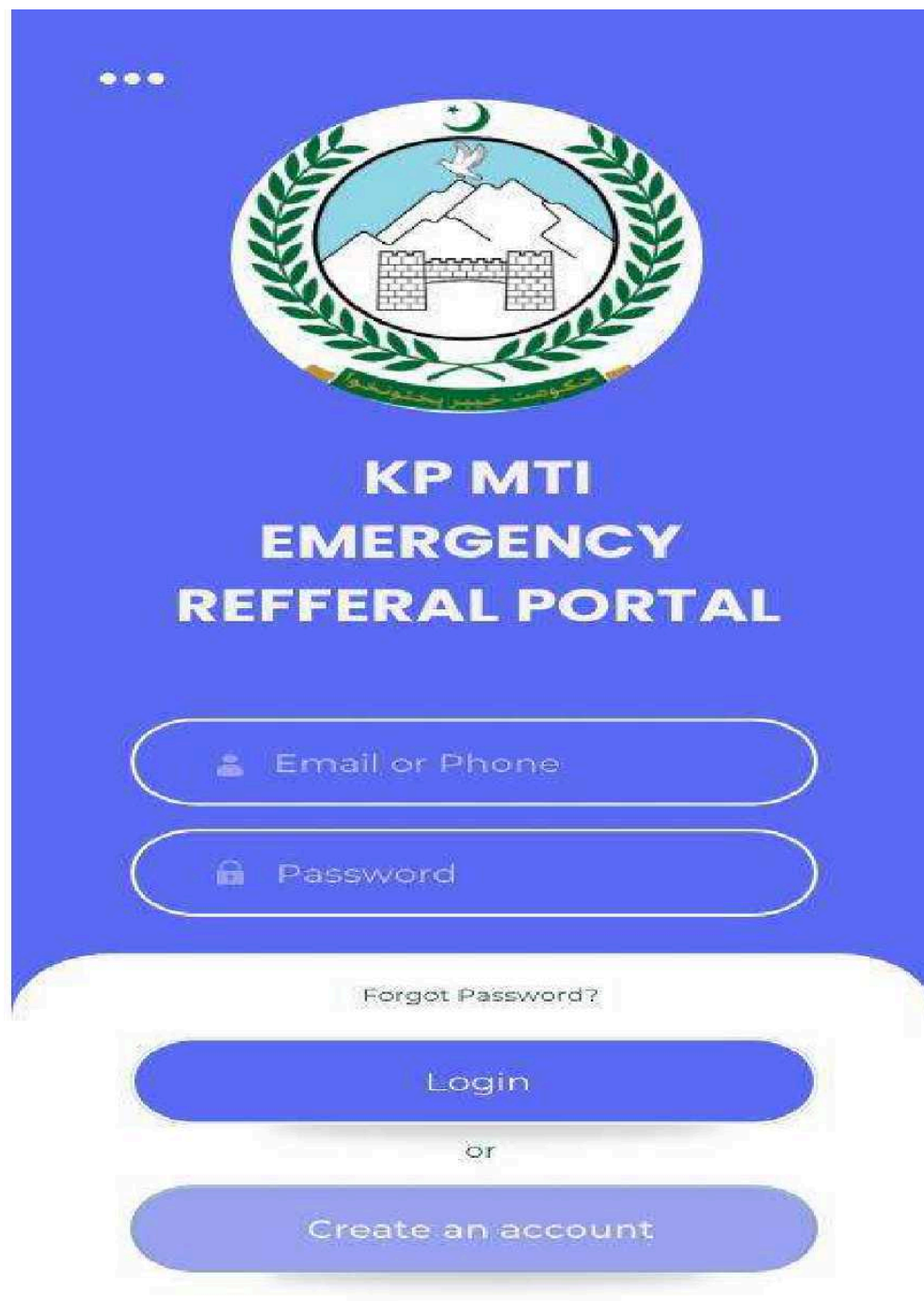


Fig:2 Mobile App Interface

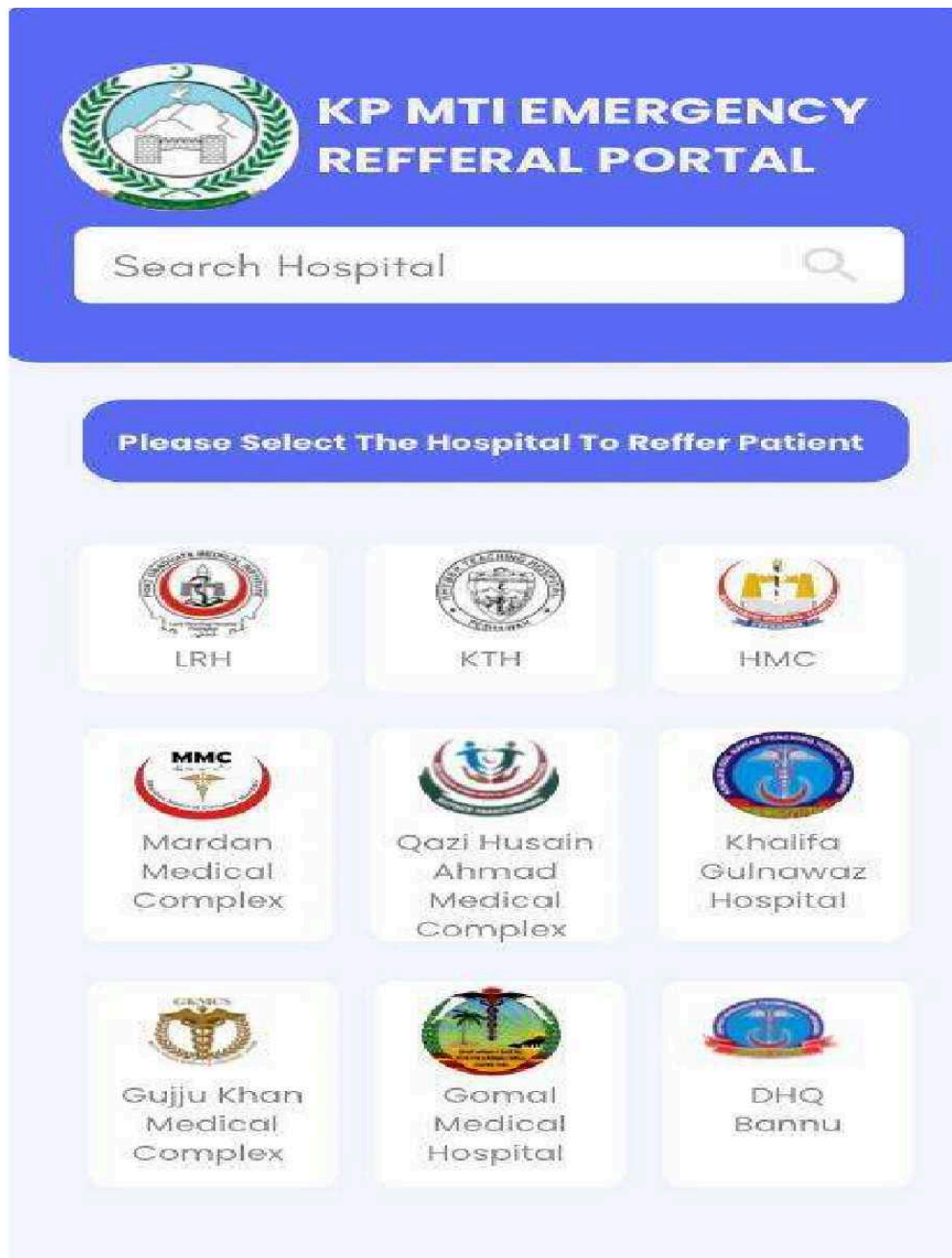


Fig:3 Mobile App Interface

18

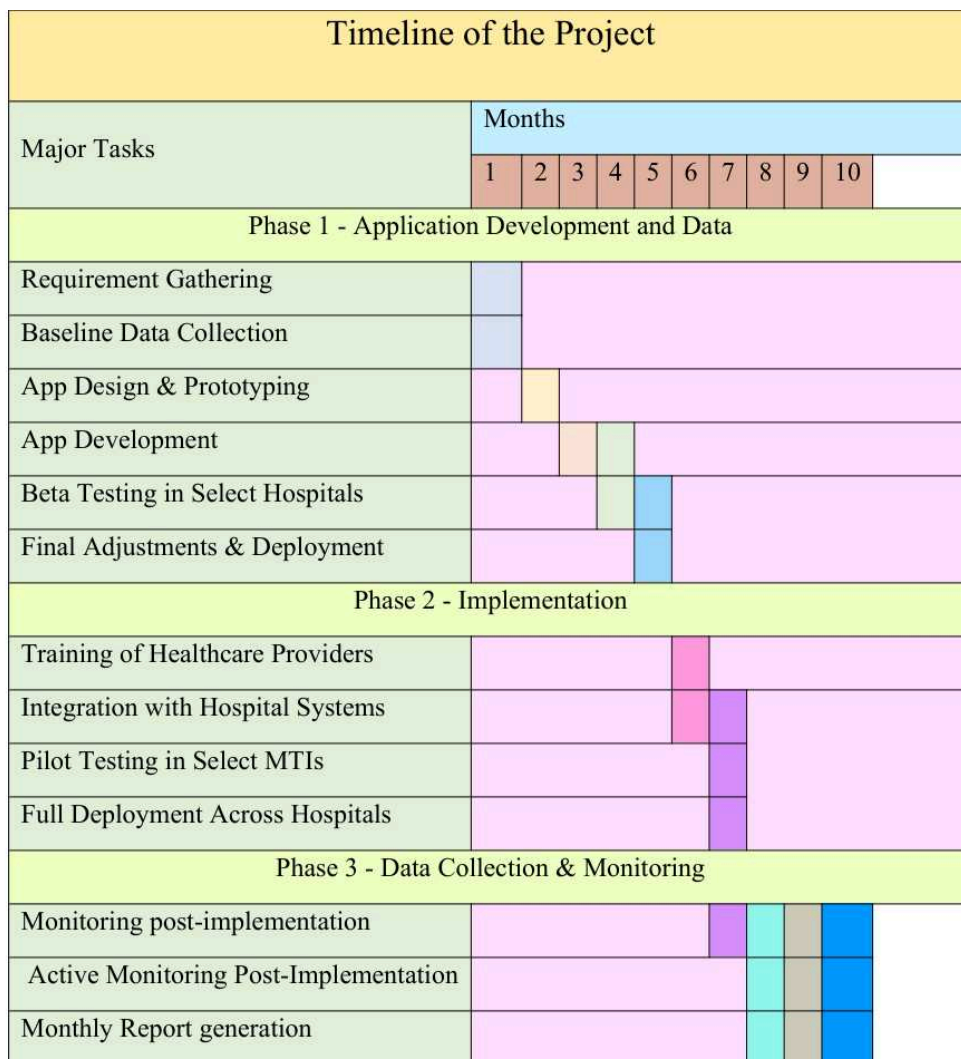


Fig:4 Timeline of the Project

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