HEALTHCARE KPI DASHBOARD FOR HOSPITAL PERFORMANCE TRACKING IN R SHINY

1. Project Background

A large healthcare provider operating five hospitals across three U.S. states sought a robust analytics solution to monitor day-to-day operations. Their existing reporting setup was Excel-based, manually updated, and distributed via email — leading to version control issues, delayed decisions, and siloed data across departments.

The client requested a central dashboard with interactive filtering capabilities to monitor performance metrics across departments, physicians, and time periods. The platform had to meet HIPAA compliance standards and be accessible across internal systems without cloud exposure.

2. Objectives

- Centralize the reporting system for all five hospital locations in a secure on-premise R Shiny dashboard.

- Enable real-time monitoring of KPIs like bed occupancy, average length of stay, patient readmission, and staff allocation.

- Implement department-level filtering (Emergency, Cardiology, Oncology, etc.) with comparative analytics.

- Ensure exportable and printable reports for board meetings and compliance reporting.

- Maintain strict patient data privacy and security, with no PII displayed in the interface.

3. Data & Integration

- **Sources**: SQL Server (EHR), flat files (staff scheduling), JSON API for real-time bed status.

- **Preprocessing**:

    o Aggregated data at the department and physician level, anonymizing patient IDs.

    o Merged time-series logs with static department data to compute ratios and benchmarks.

    o Standardized datetime formats, imputed missing occupancy values.

4. Technology Stack

- **Backend**: R (dplyr, data.table, lubridate), DBI (SQL Server), jsonlite

- **Frontend**: R Shiny + shinydashboard

- **Visualization**: plotly, ggplot2, highcharter, leaflet (for facility locations)

- **Security**: Internal Active Directory + manual role-based user segmentation

- **Deployment**: Shiny Server Pro (on-premise, Linux VM)

5. Key Features Implemented

5.1. Operational KPIs Panel

- Daily/weekly/monthly occupancy rates

- Emergency department average wait times

- Bed turnover rate

5.2. Patient Care KPIs

- Average length of stay (ALOS)

- 30-day readmission rates by department

- Discharge vs. follow-up compliance

5.3. Physician Workload & Performance

- Number of patients per physician per week

- Procedure volume and complication rates

- Dynamic table of top 10 performers and under-performers

5.4. Staff Allocation Matrix

- Heatmap showing staff-to-patient ratio per shift

- Alerts for departments with over- or under-staffing trends

5.5. Department-Wise Filtering and Drill-Down

- Filters: department, physician, time period, hospital location

- Dynamic KPI recalculations with summary comparisons

5.6. Report Export

- Automated RMarkdown summary generator

- One-click export to PDF or Excel for compliance reporting

6. Results & Business Value

- Cut manual report preparation time by over **80%**.

- Enabled department heads to take **proactive actions** using real-time metrics.

- Improved patient care coordination and tracking, leading to a **12% drop** in readmissions within the first quarter of usage.

- Provided the C-suite with up-to-date summaries for executive decision-making.

- Facilitated data-driven staff allocation, reducing burnout in overburdened departments.

7. Challenges and Solutions

- **Challenge**: Live bed-status API had inconsistent formatting. **Solution**: Created a real-time parsing function with fallback to last known status.

- **Challenge**: HIPAA compliance required strict data anonymization. **Solution**: Developed a custom data transformation module that excluded PII before loading into the dashboard environment.

- **Challenge**: Some users had outdated browsers incompatible with newer R Shiny features. **Solution**: Built backward-compatible UI using shinyWidgets and ensured graceful degradation.

8. Future Scope

- Add predictive modules for emergency department congestion based on seasonal trends.

- Incorporate patient satisfaction scores (via survey imports) for department-level analysis.

- Build role-specific mobile dashboards for field nurses and emergency responders.