



**HINF 5102**

**Data Management in Healthcare**

**Write Up**

**Resource Allocation Optimization in Healthcare**

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## Project Overview

Our project focused on the optimization of hospital processes by tackling critical patient flow and physician use of resources issues. Based on real-world health care data to reduce operation waste while delivering high-quality care, we aimed. Through exploratory data analysis, statistical modeling, and interactive dashboards, we developed Smartstaff, an intelligent decision-support system that provides actionable insights to optimize resources and staff.

## Report Walkthrough

### 1. Data Cleaning and Standardization

Data was sourced from Kaggle, containing timestamped patient visits and consultation records.

- Formatting dates and times for consistency.
- Calculating consultation durations.
- Normalizing categorical fields like Doctor Type and Financial Class.
- Handling missing values via context-aware imputation or removal.

### 2. Exploratory Data Analysis (EDA)

Conducted using Tableau and Python.

- Consultation workload distribution across doctor types.
- Revenue patterns from medication, labs, and consultations.
- Interactive dashboards for real-time decision-making support.
- Heatmaps and distribution plots to uncover financial and operational outliers.

### 3. Time-Series Forecasting

- We developed an ARIMA-based forecasting model in Python.
- This model predicted consultation demand over the next 30 days.
- Time series decomposition helped isolate trends and seasonality.
- Forecast results were integrated into the dashboard for short-term planning.

## Group Lessons Learned

We learned that effective healthcare solutions should have a balance between data thinking and human thinking. Collaborative group discussions enabled us to view issues from various perspectives and allowed us to develop our strategies further. Handling conflicting views and mediating conflicts taught us patience and negotiation skills, which are vital for interdisciplinary practice in actual healthcare settings. Decision-making collectively promoted mutual respect and accountability. In general, this project not only improved our technical and analytical skills but also equipped us for future careers where flexibility, teamwork, and shared dedication to improving patient care are crucial to success. The experience confirmed the idea that collaboration is what creates meaningful, sustainable solutions.

- Combining Python, Excel, and Tableau maximized our data insight capabilities.
- Cleaning and standardization significantly influenced model reliability and dashboard accuracy.
- Each team member brought unique strengths like python, modeling, visualization and reporting which contributed to the final product.
- Healthcare-specific data required thoughtful interpretation for meaningful insights.

## Final Recommendations (Smartstaff System Outputs)

1. Boost Staffing During Peak Months (Feb–Apr): Anticipate increased patient flow and avoid bottlenecks.
2. Reduce Costs in Low-Demand Months (Jun–Jul, Nov–Dec): Shift non-essential services and cut redundant staffing.
3. Track Short-Term Trends: Maintain baseline staffing post-December with ARIMA model insights suggesting a gradual recovery.
4. Preventive Care Campaigns in Low Months: Drive patient visits by offering wellness screenings and checkups.
5. Promote Underutilized High-Performing Physicians: Adjust scheduling or increase visibility to boost financial performance.
6. Prioritize Inventory for High-Revenue Medications: Ensure continuous supply of top-earning drugs to avoid missed opportunities.

## Conclusion

Smartstaff depicts the power of data analytics to streamline healthcare provision. By the integration of EDA, forecasting, and visualization, we presented an end-to-end solution to improve patient care and operational efficiency. Our strategic recommendations allow hospitals to balance cost, resource usage, and service quality which are the cornerstones of modern healthcare administration.

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