Final Project Report

KAUST Academy Summer Program – Data Science Institute Summer Undergraduate Data Science (SUDS) – 2025

Abstract

In 2023, 669 women died of maternal causes in the United States (US), with a disproportionate impact on racial/ethnic minorities. The maternal mortality rate among Black women was about 3.5 times compared to non-Hispanic White women, and they faced more than twice the risk of severe maternal morbidity. Equity dashboards are key to identifying and monitoring variations in maternal care within hospitals. However, developing equity dashboards in hospitals may be hindered by data scarcity and limited expertise. This study aims to refine a maternal care equity dashboard by integrating user feedback and providing a publicly available maternal equity dashboard template to facilitate adoption and guide development in hospitals.

The datasets were obtained from incident reports and delivery datasets of a US-based academic health system from 2019 and 2020. The original dashboard contained 20 Tableau charts across 5 sections. Usability testing conducted with 12 healthcare professionals and stakeholders described difficulty comparing metrics, visual clutter, unclear acronyms, and limited flexibility for customization.

To incorporate testing feedback and simplify dashboard creation, the team built a macro-enabled Excel template, which contains two input sheets and an interactive control page with command buttons that are activated by Visual Basics for Applications (VBA) and Macros. The "Link & Clean" feature joins two input sheets, standardizes data format, regroups categorical values, and splits composite variables. The "Build Dashboard" feature generates a full set of charts and filters natively within Excel. The "Forecast Metrics" feature applies trend lines, moving averages and ARIMA models to feasible outcome measures. Lastly, the "Clear" command resets the workbook for a new upload, while the "Add" command appends additional data to the existing sheets.

The team will develop the template on Power BI and create a documentation handbook that will provide guidelines on running the Excel macro template, publishing visualizations on Excel, Tableau Public or Power BI, and forecasting feasible outcome measurement. Together, these resources will help streamline data processing and offer multiple pathways for developing maternal care equity dashboards. The adoption of these dashboards will support hospitals in identifying racial/ethnic disparities in maternal care and make informed decisions to address them.

Project Title

Integrating Predictive Analytics into a Maternal Health Equity Dashboard

Group Members and Contributions

- **Abdulrahman Malibari** – Developed Power BI dashboards and implemented machine learning models.
- **Max Bao** – Built and optimized Excel macros, and designed the Excel-based dashboard.
- **Audrey Tian** – Designed and refined the Tableau dashboard.
- **Eleanora Burner** – Led documentation efforts and developed the step-by-step user handbook.

Project Supervisor

Prof. Myrtede Alfred – Safety, Equity, and Design (SED) Lab, University of Toronto

Project Mentor

Tosin Akintunde – Safety, Equity, and Design (SED) Lab, University of Toronto

Project Objectives and Goals

- Develop a cross-platform maternal health equity dashboard (Excel, Power BI, Tableau).
- Integrate predictive analytics (ARIMA forecasts, patient-level risk models) into dashboard outputs.
- Provide hospitals with actionable insights into maternal health disparities.
- Create a user-friendly workflow for healthcare professionals to replicate dashboards in their own systems.

Current Progress and Milestones Achieved

- Developed automated Excel macros for data cleaning, aggregation, and visualization export.
- Completed three dashboards across Excel, Power BI, and Tableau.
- Incorporated usability feedback from last year into visualization design (color-blind palettes, foldable icons, statistical overlays).
- Implemented ARIMA forecasting models for Estimated Blood Loss (EBL) and Length of Stay (LOS).

- Tested patient-level machine learning approaches (Random Forest, Gradient Boosting) to predict adverse outcomes.
- Drafted and revised a user handbook with step-by-step instructions.

Methodology and Approach

- **Research Training:** During the first weeks, we focused on learning how to read and write academic research, and reviewed research papers related to maternal health equity to better understand the problem and guide our project.
- **Data Preparation:** Built an Excel macro to clean and link patient-level maternal health data across demographic, clinical, and outcome variables.
- **Visualization:** Developed dashboards across three platforms (Excel, Power BI, Tableau) to ensure accessibility and flexibility for hospitals.
- **Forecasting:** Applied ARIMA models to predict monthly trends in LOS and EBL.
- **Patient-Level Models:** Tested classification models to predict risk of high blood loss ($\geq$1000 mL) and prolonged stay ($\geq$5 days).
- **User-Centered Design:** Integrated usability testing feedback to guide visualization and feature design.

Preliminary Results and Findings

The forecasting models showed promise in anticipating future trends in Length of Stay (LOS) and Estimated Blood Loss (EBL), although their accuracy was limited by the size of the dataset. At the patient level, the models identified meaningful predictors such as delivery method, complications, and maternal age. The dashboards also highlighted disparities across race, ethnicity, and delivery practices, providing evidence of inequities in maternal care. In addition, users reported that the inclusion of color-safe visuals, average lines, and tooltips made the dashboards easier to interpret and more useful for decision-making.

Challenges and Obstacles

- Limited dataset: only two years of records from one hospital.
- Missing data in key clinical variables.
- Patient-level models lacked robustness for real-world deployment.
- Balancing cross-platform functionality while ensuring consistency.
- Implementing features suggested by usability testing (such as foldable terminology icons and custom statistical overlays) was technically challenging and time-intensive, often requiring creative workarounds and non-standard solutions.

Next Steps and Future Work

- Expand dataset with additional hospitals and longer time spans.
- Refine patient-level prediction models with larger, more balanced data.
- Deploy dashboards in pilot hospital sites to assess impact on equity monitoring.
- Integrate real-time updating and streaming data for proactive interventions.
- Develop automated data ingestion pipelines so hospitals can upload and integrate their data without requiring the same exact file format, reducing manual preprocessing and improving scalability.

Resources and Tools Used

We used **Python**, **Power BI**, **Tableau**, and **Excel with VBA macros**. The dataset came from a hospital in the USA. We also reviewed and referenced several research papers to guide our methodology and strengthen the project design.

Conclusion

This project advanced the design of maternal health equity dashboards by integrating predictive modeling and usability-driven design. While limited by dataset size, the work demonstrates feasibility for forecasting outcomes and identifying disparities, laying the groundwork for scalable, hospital-ready dashboards.