

Analytics Transformation: Strategies And Considerations



SingHealth No Show Analysis

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PATIENTS. AT THE HEART OF ALL WE DO.®



Clinic No Shows

In Singapore, around 25% of patients do not show up for their scheduled appointments



- Clinic no-show **negatively** impacts the **cost** of health care delivery and patient well-being
- **Inefficient** use of precious **hospital** resources
- Patients who fail to show up at appointments in outpatient clinics often **use emergency departments**

Our Approach - Analytics Value Chain

How is Predictive Analytics being applied?

It is used to predict patients with high risk of not showing up for appointments to manage the risk better

Business Goals

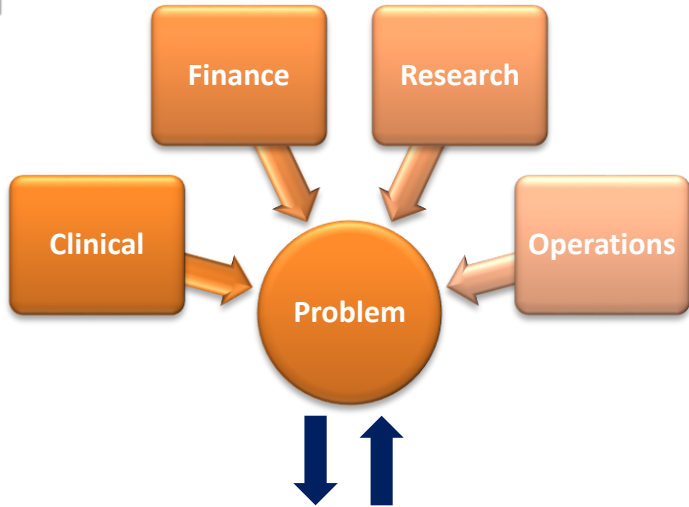
- ✓ Mitigate wasteful appointment no-shows
- ✓ Improve clinic resource planning
- ✓ Enhance accessibility of patient care



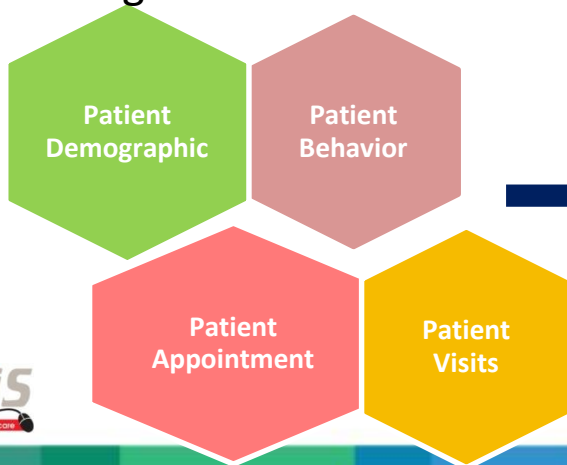
Predictive Analytics

Methodology for Operational Analytics

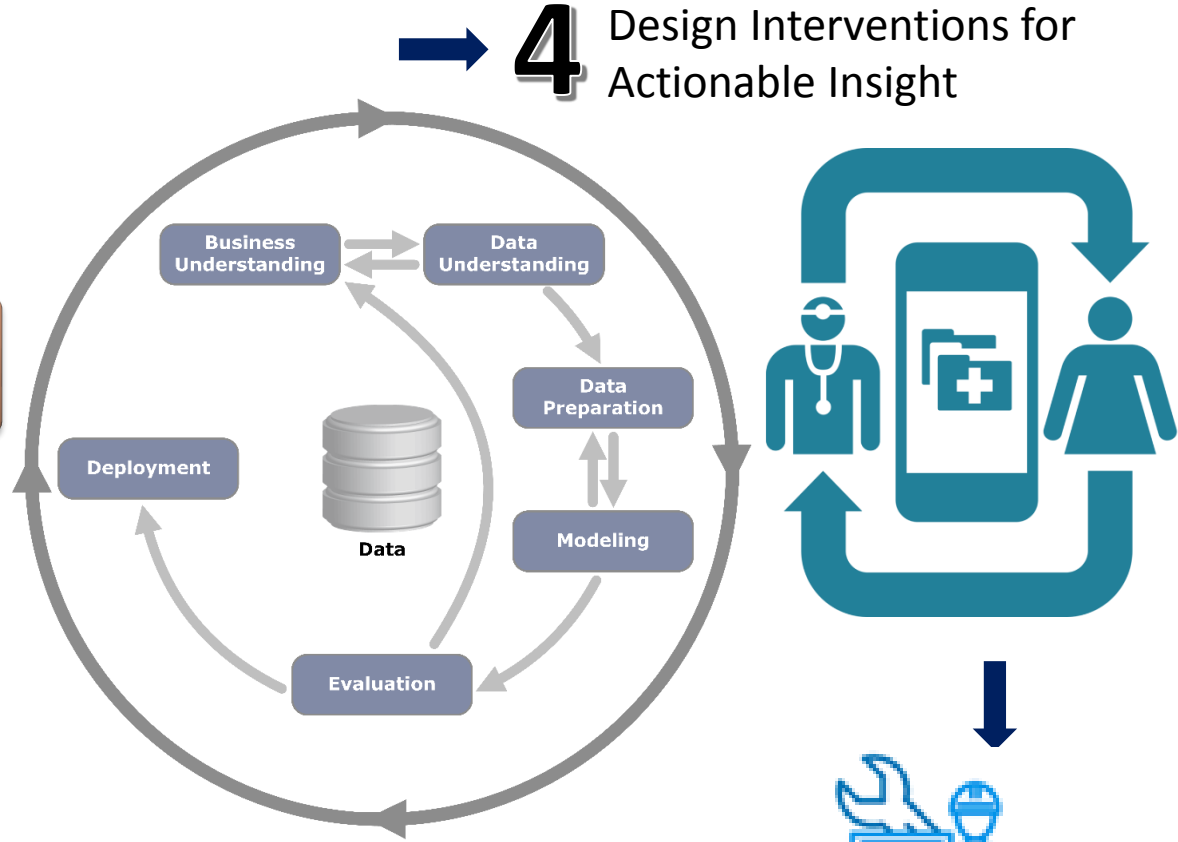
1 Stakeholder & Workflow Analysis



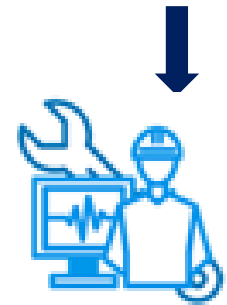
2 Modeling the Business Problem



3 Agile and Iterative Project Cycle



4 Design Interventions for Actionable Insight



Visualizations for Analysis
Enhancements to Existing Transactional Systems



Stakeholder & Workflow Analysis



I wish to receive my consultation within a shorter number of waiting days

Patient



Nurse Manager assigns staff to serve patients

If I can predict my clinic's utilization, I can plan resources better

Nurse Manager



Scheduler assigns earliest available appointment date to Patient

Scheduler



I have to schedule patients within the maximum of 60 waiting days

Doctor provides consultation and treatment to Patient

Nurse Manager assigns case files to Doctor

Doctor



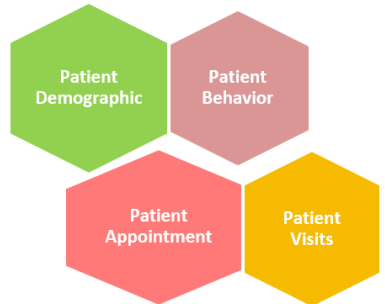
I want good clinical outcomes for my patients

Doctor submits clinic schedule to Scheduler

Understand the needs from the ground



Modeling the Business Problem



Patient Data Source

Patient data such as

- age
- gender
- address
- medical history

Nurse Manager's Expertise

Nurse manager's expertise such as

- clinic's workflows
- operation concerns
- feasible points of intervention



Appointment Data Source

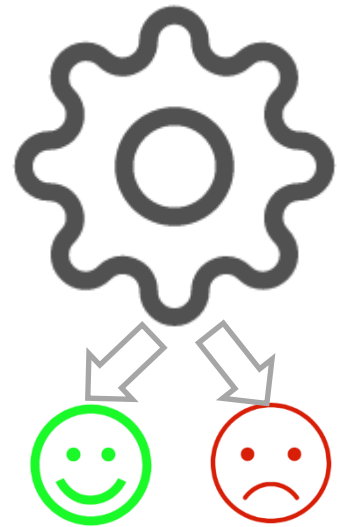
Appointment data such as

- time and date
- month of year
- appointment waiting days
- referral source

Doctor Data Source

Doctor's data such as

- doctor rank
- specialty
- resource type
- change of doctor

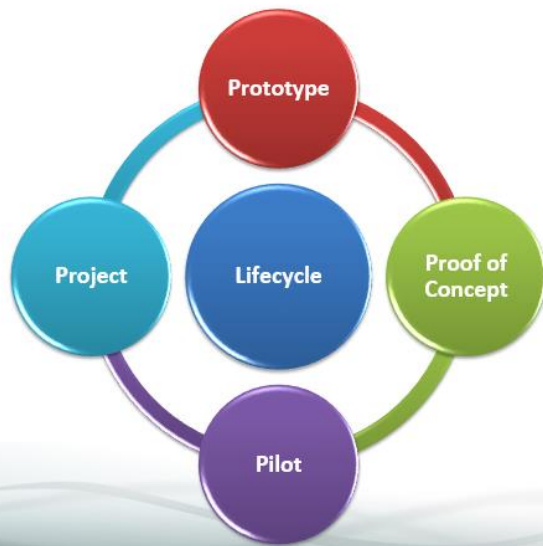


Is this patient going to come for the scheduled appointment?

Descriptive Analysis

- Average No Show Rate
- Average Actualized Rate
- Appointment Waiting Days
- Any significant patterns etc.

Agile and Iterative Project Cycle

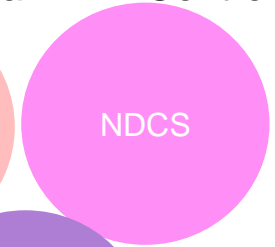
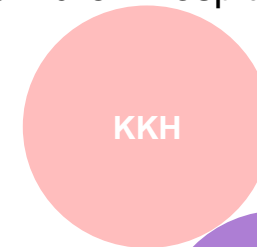


From Data to Value

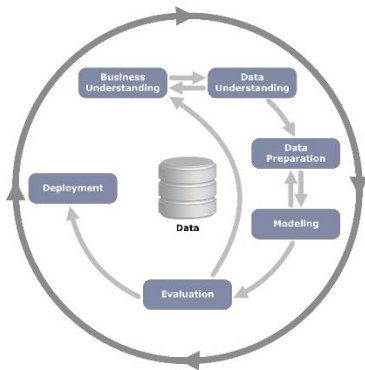


KK Women & Children Hospital

National Dental Centre



Singapore General Hospital



Data Driven Methodology



1. Merged Data Sources

Normalize all data into a flat file



2. Prediction Model

Extreme Gradient Boosting Tree



3. Model Evaluation

Test AUC averages at 0.81



4. Dashboard Development

Build decision support tools from prediction scores



5. Deployment Evaluation

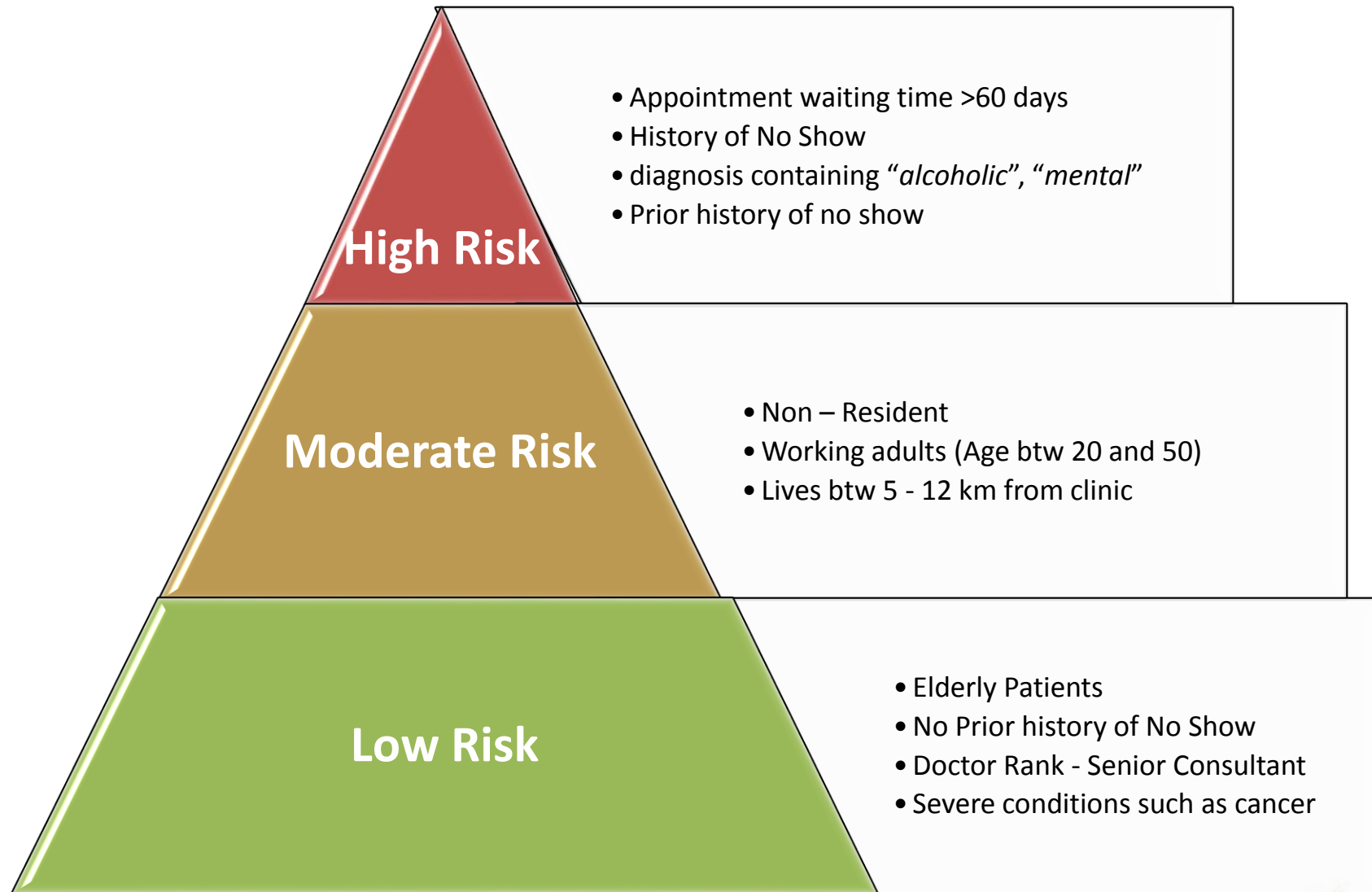
Deployment AUC averages at 0.77



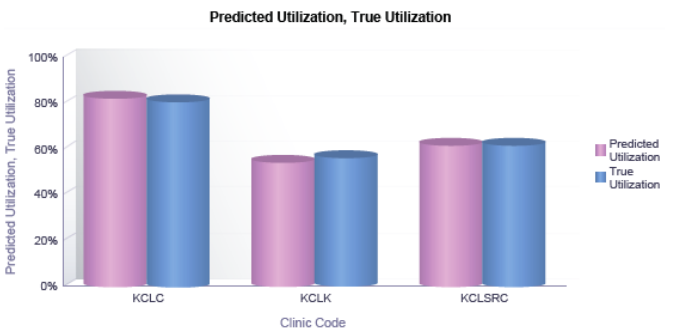
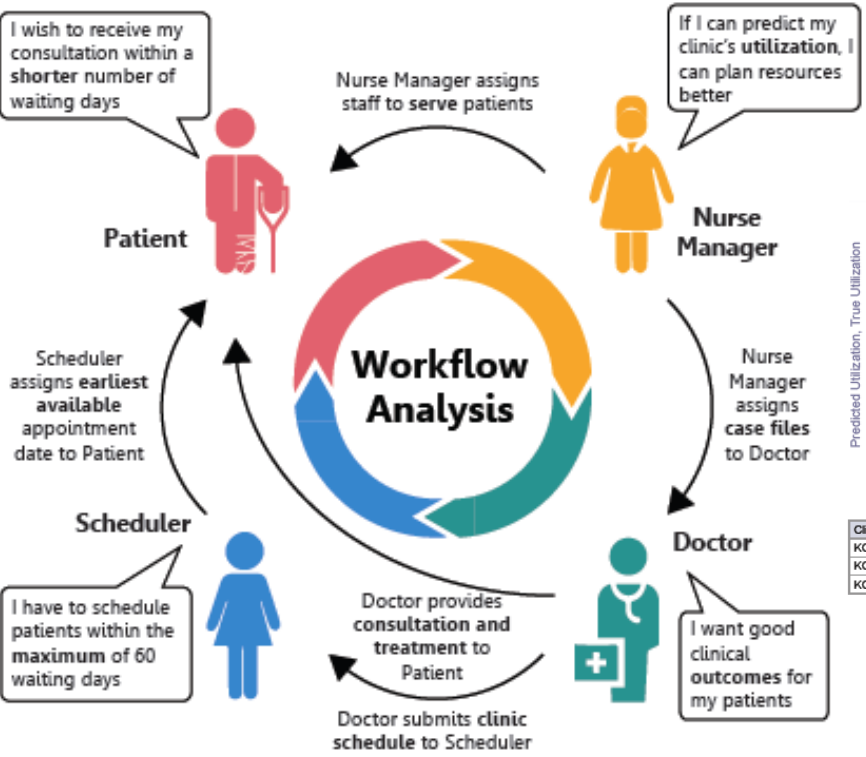
6. Success Measurement

Estimates suggest 14% increase in clinic capacity

Sample insights



Transformation – Design Interventions

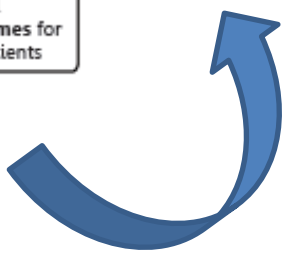


Clinic Code	Predicted Number of Actualized Appointments	Number of Appointments	Predicted Utilization	True Utilization
KCLC	267	324	82%	81%
KCLK	134	240	54%	57%
KCLSRC	13	21	62%	62%

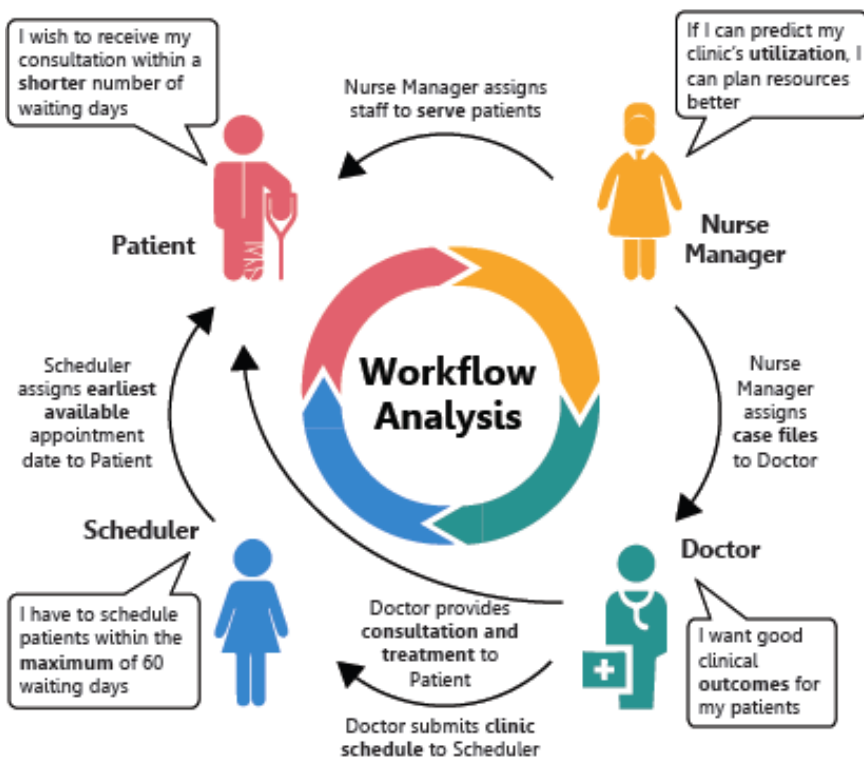
Resource Optimization

For whom:

Purpose: Gives an overview of the clinic's utilization so as to plan resources better and reduce inefficiencies.



Transformation – Design Interventions



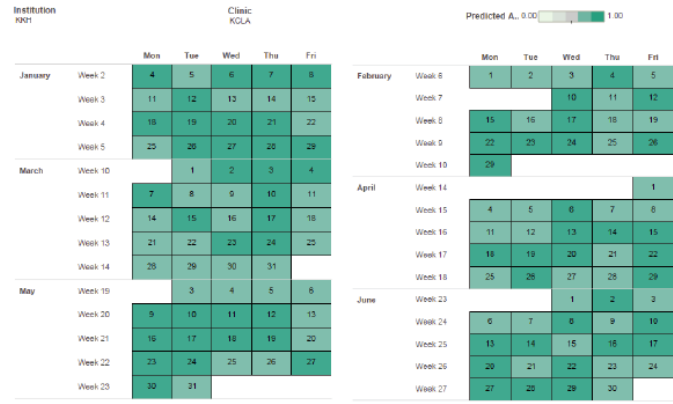
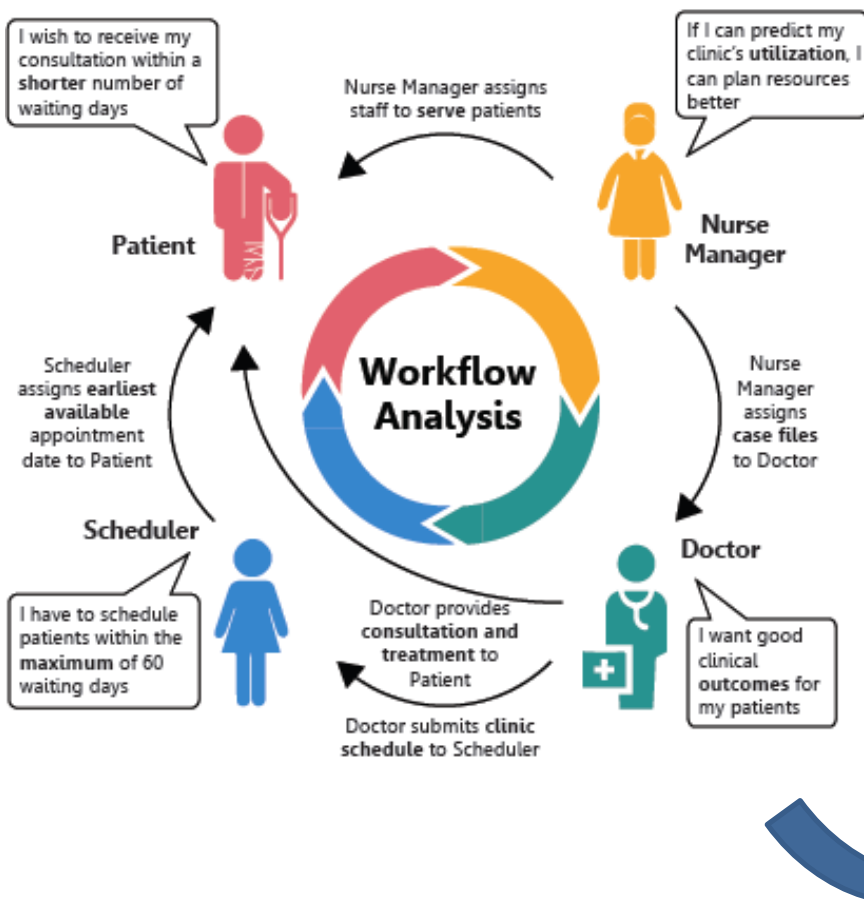
Appointment Time	Appointment Date	Clinic Code	Patient ID	Patient Name	Specialty	Sub Specialty	Patient Tel Mobile	Patient Tel Home	Appointment Status	No-Show Probability	
08:10	13/05/2016	KCLC	551234560	APPLE	OBSTETRICS	OBSTETRICS	94567890	62345624	ACTUAL	0.76	
08:10	13/05/2016	KCLC	523456810	BERNICE	GYNAECOLOGY	GYNAECOLOGY	93454398	68324524	ACTUAL	0.52	
08:10	13/05/2016	KCLC	525789911	CARRIE	OBSTETRICS	POST-NATAL		83454670	ACTUAL	0.29	
08:10	13/05/2016	KCLC	90358953J	DENISE	GYNAECOLOGY	Expected Unknown		92345484	CANCELLED	0.19	
08:10	13/05/2016	KCLC	854897438	EUNICE	OBSTETRICS	Expected Unknown		91254355	65632577	ACTUAL	0.13
08:10	13/05/2016	KCLC	834257842	FELICIA	GYNAECOLOGY	Expected Unknown		96334833	69678221	CANCELLED	0.07
08:10	13/05/2016	KCLC	83457828H	GERMAINE	GYNAECOLOGY	GYNAECOLOGY	98412346	67543788	CANCELLED	0.03	
08:15	13/05/2016	KCLC	58878636H	HELEN	OBSTETRICS	OBSTETRICS	93251445	67574296	ACTUAL	0.48	
08:15	13/05/2016	KCLC	81345679G	JASMINE	OBSTETRICS	POST-NATAL		94578255	CANCELLED	0.21	
08:15	13/05/2016	KCLC	58878543J	KATHERINE	GYNAECOLOGY	Expected Unknown		87538845	67500007	ACTUAL	0.13
08:15	13/05/2016	KCLC	58778548Z	LAUREN	GYNAECOLOGY	GYNAECOLOGY	91234874	63323883	ACTUAL	0.09	
08:20	13/05/2016	KCLC	83456787Z	MAURICE	GYNAECOLOGY	Expected Unknown		97548722	62345878	CANCELLED	0.70
08:20	13/05/2016	KCLC	81239853Z	NATASHA	GYNAECOLOGY	Expected Unknown		92485487	62345889	ACTUAL	0.42
08:20	13/05/2016	KCLC	81234854G	OLIVA	GYNAECOLOGY	GYNAECOLOGY			ACTUAL	0.28	
08:20	13/05/2016	KCLC	98543088H	PATRICIA	OBSTETRICS	Expected Unknown		83456790		ACTUAL	0.18
08:20	13/05/2016	KCLC	58878234Z	REBECCA	OBSTETRICS	OBSTETRICS	96579000		ACTUAL	0.14	
08:20	13/05/2016	KCLC	82345789E	SAMANTHA	GYNAECOLOGY	Expected Unknown		96574884	65456789	NO-SHOW	0.08
08:30	13/05/2016	KCLC	58786345D	TRIA	GYNAECOLOGY	Expected Unknown			ACTUAL	0.73	
08:30	13/05/2016	KCLC	73448789E	VERONICA	PAEDIATRIC GENERAL MEDICINE	P. GENERAL PAEDS		82345788	NO-SHOW	0.82	
08:30	13/05/2016	KCLC	74587854H	YANIS	PAEDIATRIC GENERAL MEDICINE	P. GENERAL PAEDS	92456589	62345623	NO-SHOW	0.58	
08:30	13/05/2016	KCLC	73457895A	JAMES	PAEDIATRIC GENERAL MEDICINE	P. GENERAL PAEDS	92345689	93456789	ACTUAL	0.56	
08:30	13/05/2016	KCLC	77654369E	ERIC	PAEDIATRIC GENERAL MEDICINE	P. GENERAL PAEDS	82343455	81348008	ACTUAL	0.41	
08:30	13/05/2016	KCLC	84567435J	JESSICA	GYNAECOLOGY	GYNAECOLOGY	92348772	83854845	ACTUAL	0.41	

Patient Risk

For whom:

Purpose: Allow nurse managers to **contact** high no-show risk patients to reconfirm attendance or reschedule slot.

Transformation – Design Interventions



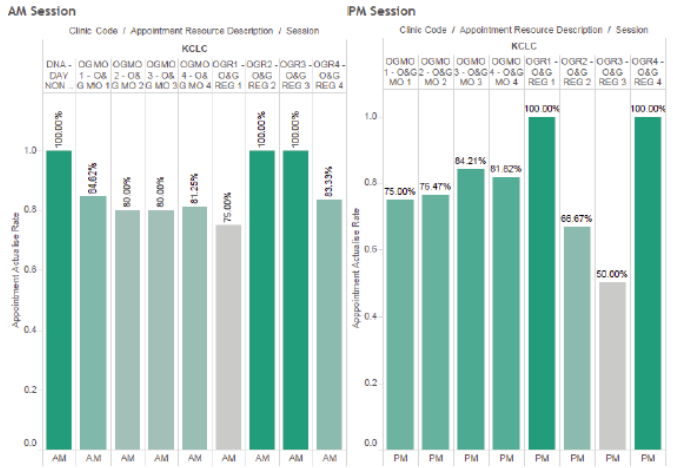
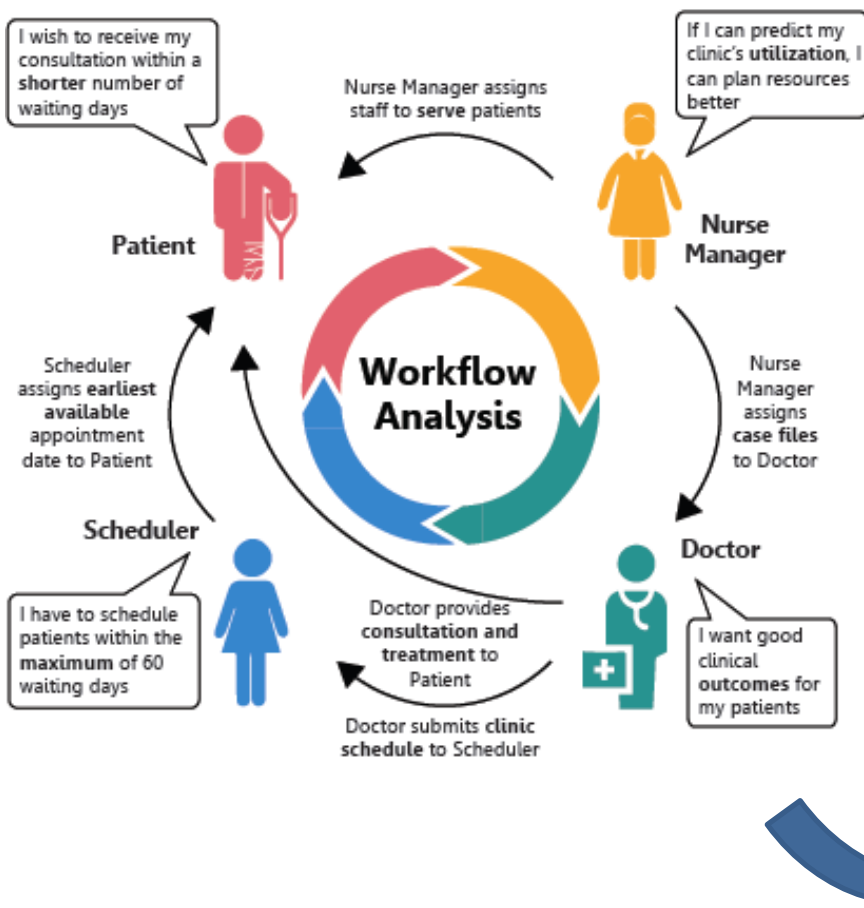
Scheduling

For whom:



Purpose: Allow schedulers to assign patients the **earliest available** appointment slot on days with **lower** clinic utilization.

Transformation – Design Interventions



Clinic Utilization

For whom:

Purpose: Allow nurse managers to distribute case files to doctors **evenly** based on the daily predicted risk.

eHIntS - Platform for Operationalization



Reporting and Analytics Solution

ORACLE BUSINESS INTELLIGENCE

Dashboard / Scorecards

Adhoc Reports

Location Analytics

Predictive Analytics

Future Phase

Text Mining

enterprise technology infrastructure information scorecards analytics objectives text mining applications connections solution stakeholder

Data Management Services

ORACLE DATABASE Microsoft SQL Server

eHIntS (Data Repository)

Analytics Engine

Integration Services

INFORMATICA ORACLE SERVICE BUS

BATCH

EXTRACT TRANSFORM LOAD

Real-Time*

ENTERPRISE SERVICE BUS

Data Sources

Microsoft SQL Server ORACLE DATABASE IBM DB2

Operational, Finance and Clinical Data Sources

SAP-ISH C&S LIS Maxcare SCM OAS Emerge RIS RMS Others

Information Security

Data Quality

Metadata Management

Data Governance

eHIntS – electronic Health Intelligence System



Analytics in Practice

- **How to evaluate our models ?**
- **Which model do I use ?**
- **How many models do I need to build ?**
- **Model completed, so what?**

Thank you