

Optimizing IVF Operations for Efficiency and Care

Subtitle: Improving Clinical Efficiency Through Workforce Insights

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Business UnderStanding & Business Objective

Business Understanding

The IVF clinic is experiencing operational inefficiencies that affect both patient experience and staff productivity. Key challenges include:

- Inefficient appointment scheduling
- Long patient wait times
- Imbalanced staff workload (overload or idle time)
- Underutilized equipment and procedure rooms
- Increased operational costs
- Reduced overall clinic throughput and performance

Business Objective

Maximize patient satisfaction and clinic throughput by improving appointment scheduling, staff allocation, and equipment utilization.

Business Constraints & Success Criteria

Business Constraint:

- Minimize wait times
- staff overload/idle time
- operational costs

Success criteria:

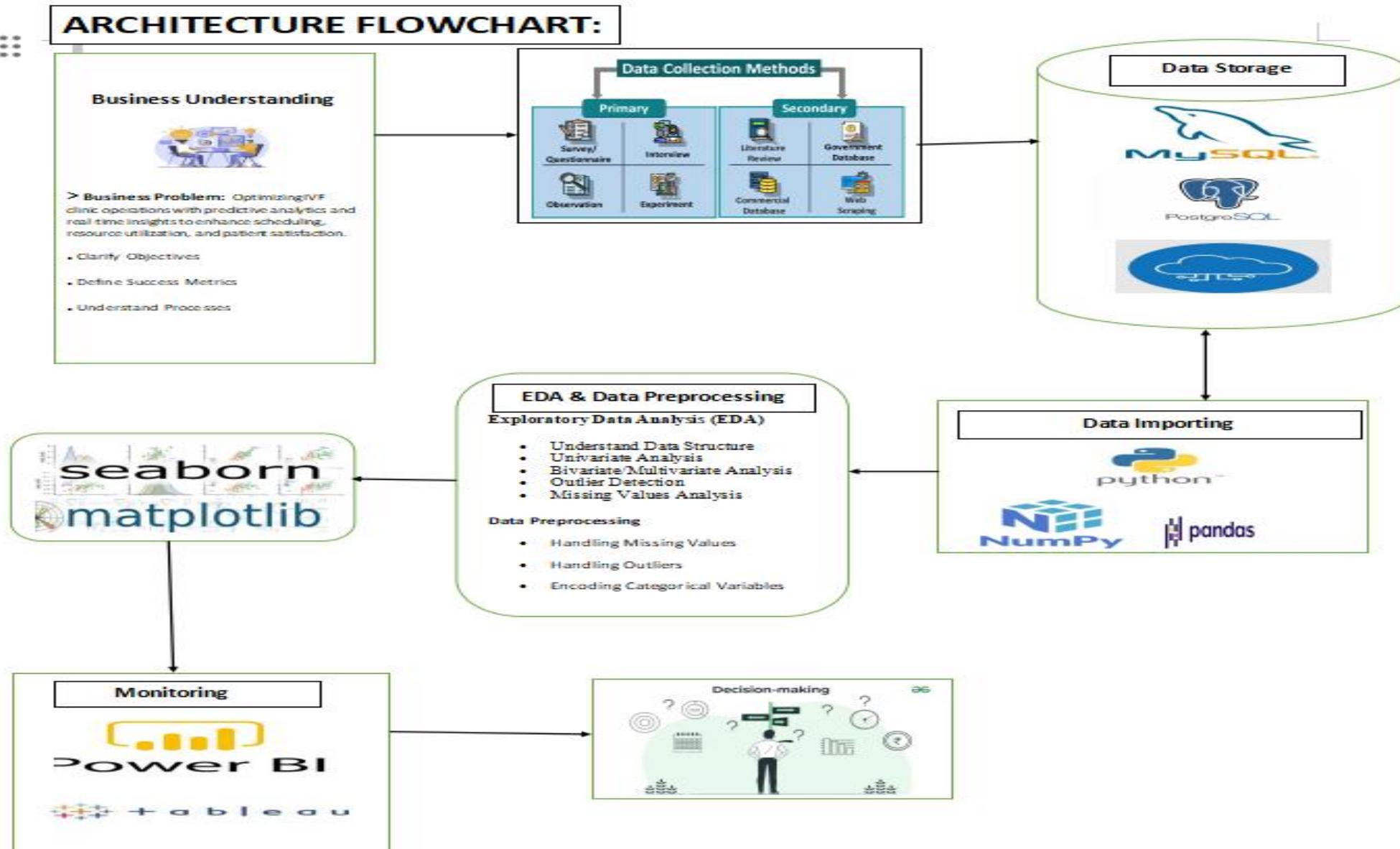
Business Success Criteria:

Improve patient satisfaction and clinic throughput by optimizing staff and equipment utilization.

Economic Success Criteria:

Reduce operational costs and increase revenue through efficient resource allocation.

Project Architecture - Data Flow Diagram



Data Collection:

Source: IVF Clinic (Client) internal System.

Purpose: To analyze patient wait times and reduce unnecessary delays.

Datasets Collected:

- ivf_appointments
- ivf_equipment
- ivf_operational_costs
- ivf_patient_wait_times
- ivf_performance_kpis
- ivf_room_utilization
- ivf_staff

Project Overview & Scope:

Project Overview:

This project focuses on analyzing operational data from an IVF clinic to identify inefficiencies and improve workflow performance. Using Power BI, predictive analytics, and optimization techniques, the project aims to enhance scheduling, staff allocation, room utilization, and patient experience.

Project Scope:

1. Data Collection & Integration
2. Descriptive & Diagnostic Analysis
3. Predictive & Optimization Modeling
4. Dashboard Development
5. Recommendations
 - Provide actionable strategies for improving scheduling, utilization, and cost efficiency
 - Support operational decision-making

Exploratory Data Analysis [EDA]

Statistical Insights

1. Appointment Scheduling Insights:

- Peak patient arrival observed during morning hours (9 AM–12 PM)
- Appointment load is unevenly distributed across weekdays
- High no-show and reschedule rates on Fridays, reducing efficiency

2. Staff Allocation Insights:

- Some staff members are operating at over 85% utilization, indicating potential burnout.
- Others show underutilization, especially in evening shifts
- Shift mismatches increase wait times for high-demand procedures.

3. Room & Equipment Utilization Insights:

- Procedure rooms show significantly higher occupancy than consultation rooms.
- Certain rooms are underutilized (<40% usage) due to scheduling gaps.
- Equipment downtime is highest during weekends, affecting throughput.
- Longer wait times occur during staff shortages or room unavailability,
- Average waiting time spikes during peak hours by 20–30%.

Business Insights

1. Inefficient Appointment Scheduling

- Peak-hour congestion leads to long patient wait times
- Uneven appointment load across the week reduces efficiency
- High no-show rates cause idle time for staff and rooms

2. Imbalanced Staff Workload

- Some staff members are overutilized, causing burnout
- Others remain underutilized, especially in non-peak shifts
- Mismatched staff schedules directly increase wait times

3. Suboptimal Room & Equipment Utilization

- Certain procedure rooms are used above 80%, causing bottlenecks
- Others remain unused for long periods (<40% utilization)
- Equipment maintenance downtime impacts throughput

4. High Operational Costs

- Staffing accounts for the largest share of operational expenses
- Inefficient resource allocation increases overall cost per patient
- Better scheduling could reduce unnecessary cost spikes

Data Preprocessing

- Removed duplicate records from appointment, staff, room, and equipment datasets
- Handled missing values by using Imputer in wait times, shifts, usage durations, and costs
- Standardized date and time formats across all tables
- Corrected inconsistent department, specialty, and room type entries
- Calculated duration fields (room usage time, equipment usage time, staff shift hours)
- Derived patient wait time and appointment delay metrics
- Created utilization measures for rooms, staff, and equipment
- Extracted date components (day, week, month, hour) for trend analysis
- Merged datasets using keys like patient_id, staff_id, room_id, equipment_id
- Detected and treated outliers in wait times, costs, and workload hours

Data Visualization

Appointment Overview

2500

Total_appointment

41.88

Avg wai time

1147

count_completed

6.28

No-Show %

Appointment by department

department

Nursing

Reproductive Endocrinology

Embryology Lab

Counseling

Surgery

Andrology

0 100 200 300 400

Total_appointment

Total_appointment by Year and Month

Total_appointment

Jan 2024 Apr 2024 Jul 2024 Oct 2024 Jan 2025 Apr 2025 Jul 2025 Oct 2025

Year

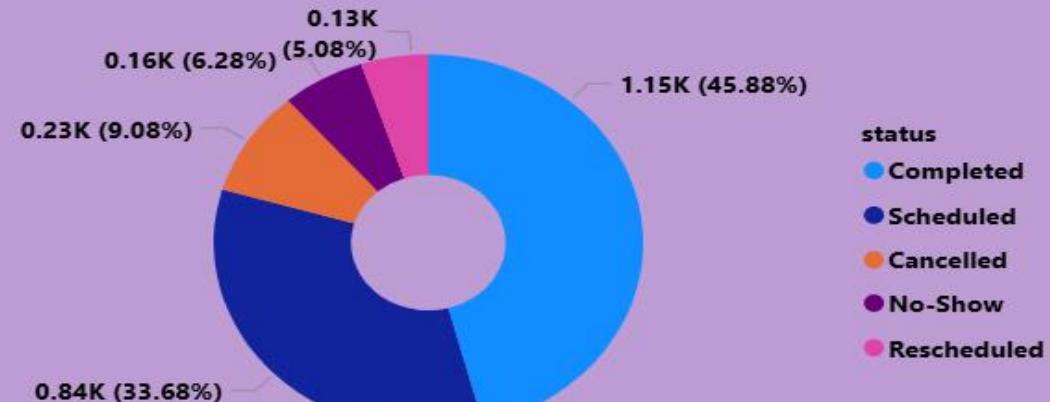
Department

- Select all
- Andrology
- Counseling
- Embryology Lab
- Nursing
- Reproductive Endocrinology
- Surgery
- Ultrasound

Appointment Type

- Select all
- Blood Test
- Counseling
- Egg Retrieval
- Embryo Transfer
- Follow-up
- Hysteroscopy
- Initial Consultation
- IUI Procedure
- Laparoscopy
- Monitoring
- Surgery

Appointment Status Distribution



Data Visualization

Equipment Maintenance & Utilization Dashboard

85

2.28M

Total Equipment

Sum of purchase_cost

2.49

Average_Equipment_Age_Years

70

Working Equipment

5

Maintenance Equipment

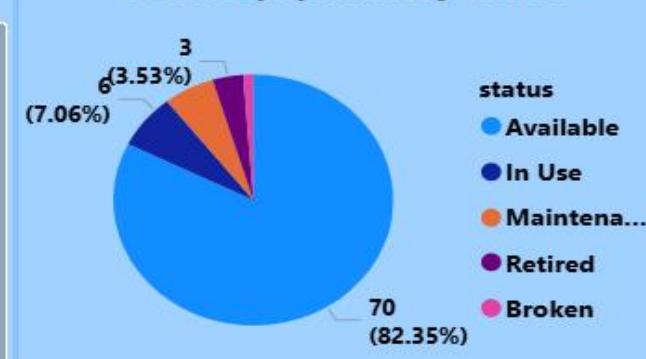
8.01

Average of utilization...

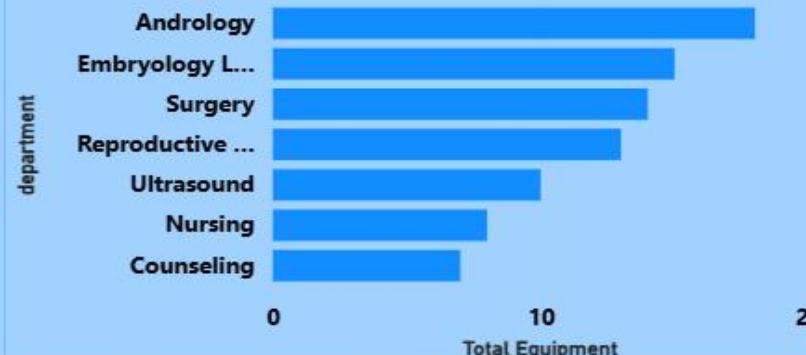
Total Equipment by equipment_type



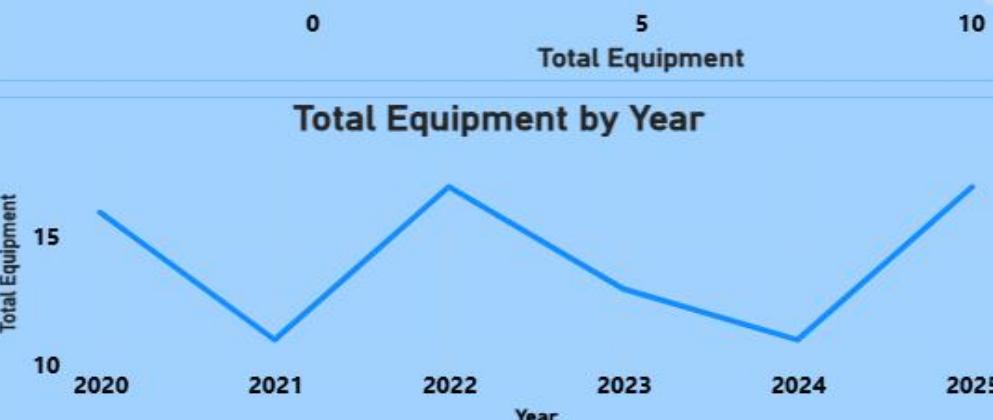
Total Equipment by status



Total Equipment by department



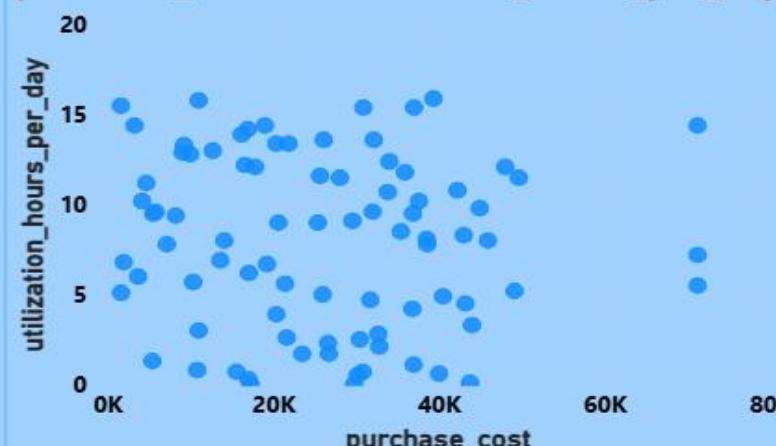
Total Equipment by Year



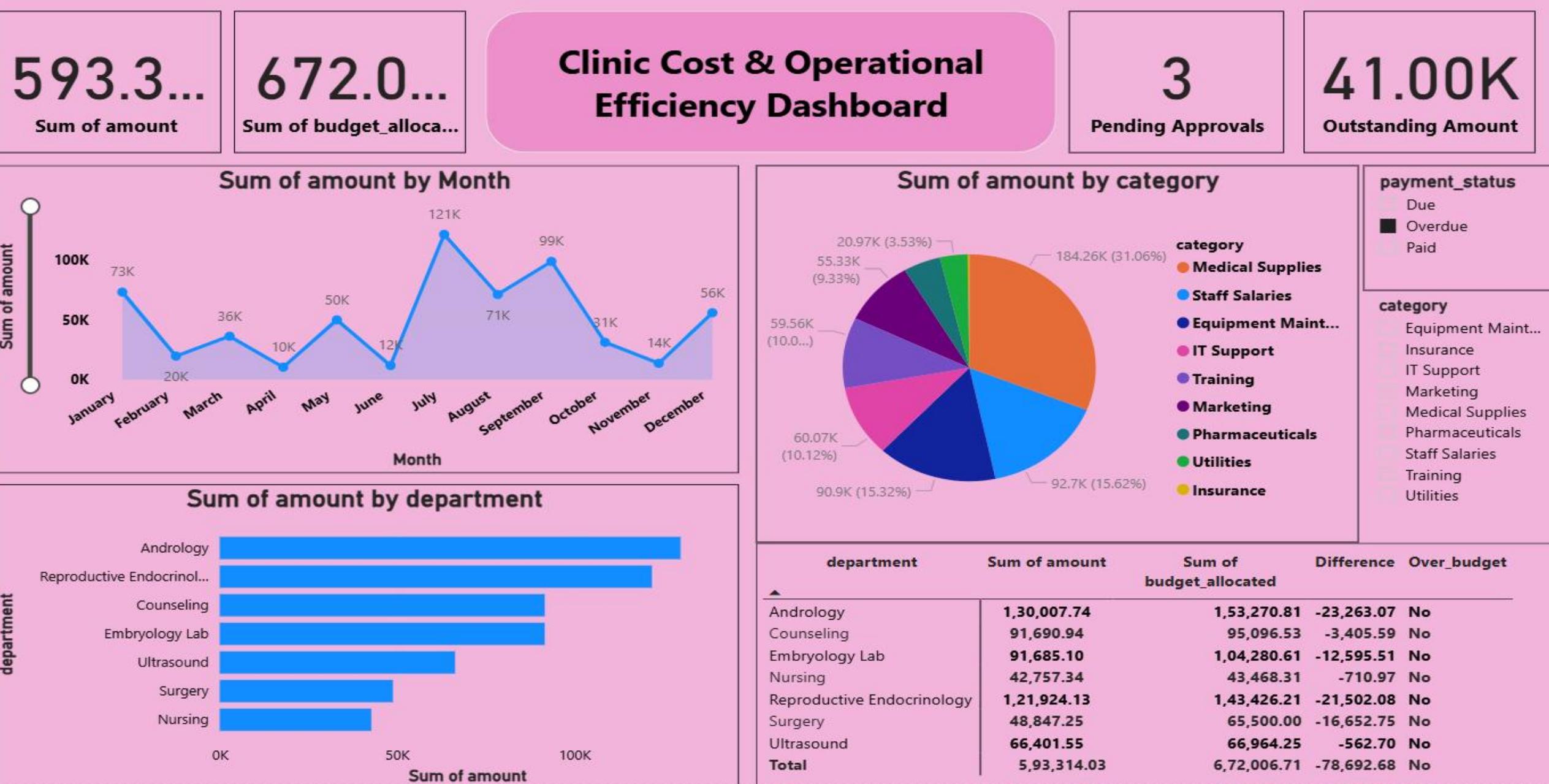
equipment_id department Sum of purchase_cost

EQP0001	Andrology	3,316.01
EQP0002	Counseling	20,431.81
EQP0003	Reproductive Endocrinology	14,143.36
EQP0004	Andrology	48,047.15
EQP0005	Ultrasound	43,247.94
EQP0006	Reproductive Endocrinology	19,048.09
EQP0007	Embryology Lab	26,015.54
FOP0008	Reproductive	28,090.03
Total		22,79,027.91

purchase_cost and utilization_hours_per_day



Data Visualization



Data Visualization

Avg Wait Time

41.88

Wait > 30 mins %

1084

Patient Wait Time & Satisfaction Analysis – IVF Clinic

Count of Wait_id

2000

Wait > 30 mins %

54.20%

Sum of patient_satisfaction_score and %GT Sum of wait_time_minutes by department

time_of_day_category

Afternoon

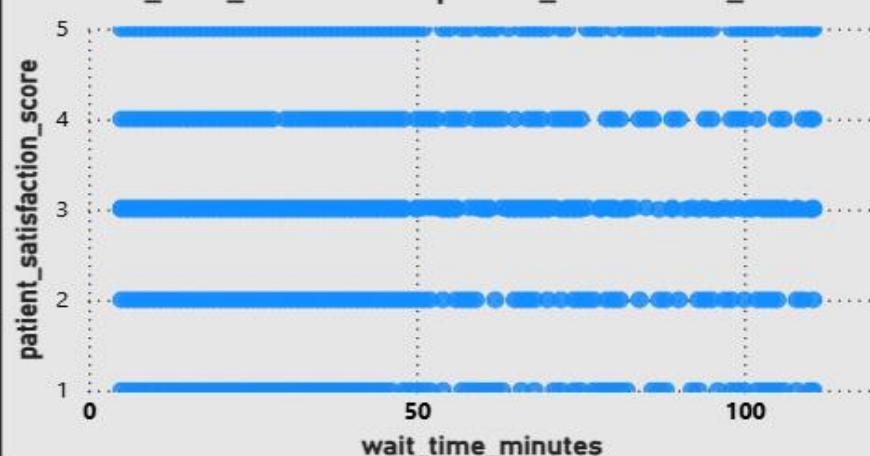
Evening

Morning

Avg wai time by day_of_week



wait_time_minutes and patient_satisfaction_score



department

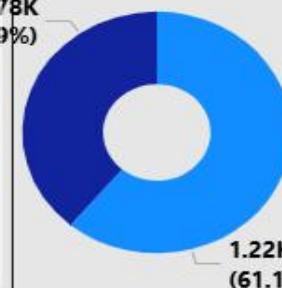
- Andrology
- Counseling
- Embryology Lab
- Nursing
- Reproductive Endocrinology
- Surgery
- Ultrasound

patient_id	department	Year	Month	Day	Year	Month	Day	Year	Month	Day	Sum of wait_time_minutes	Count of wait_id by complaint_logged
PAT000001	Reproductive Endocrinology	2025	April	13	2025	April	13	2025	April	13	44.00	78K (78%)
PAT000001	Ultrasound	2025	October	5	2025	October	5	2025	October	5	42.00	9% (9%)
PAT000002	Andrology	2024	July	27	2024	July	27	2024	July	27	110.50	110.5K (110.5%)
PAT000008	Andrology	2025	February	22	2025	February	22	2025	February	22	49.00	49K (49%)
PAT000010	Reproductive Endocrinology	2024	April	21	2024	April	21	2024	April	21	26.00	26K (26%)
PAT000010	Ultrasound	2025	March	8	2025	March	8	2025	March	8	23.00	23K (23%)
PAT000011	Reproductive Endocrinology	2024	January	2	2024	January	2	2024	January	2	38.00	38K (38%)
Total	-	-	-	-	-	-	-	-	-	-	83,756.00	1.22K (61.1%)

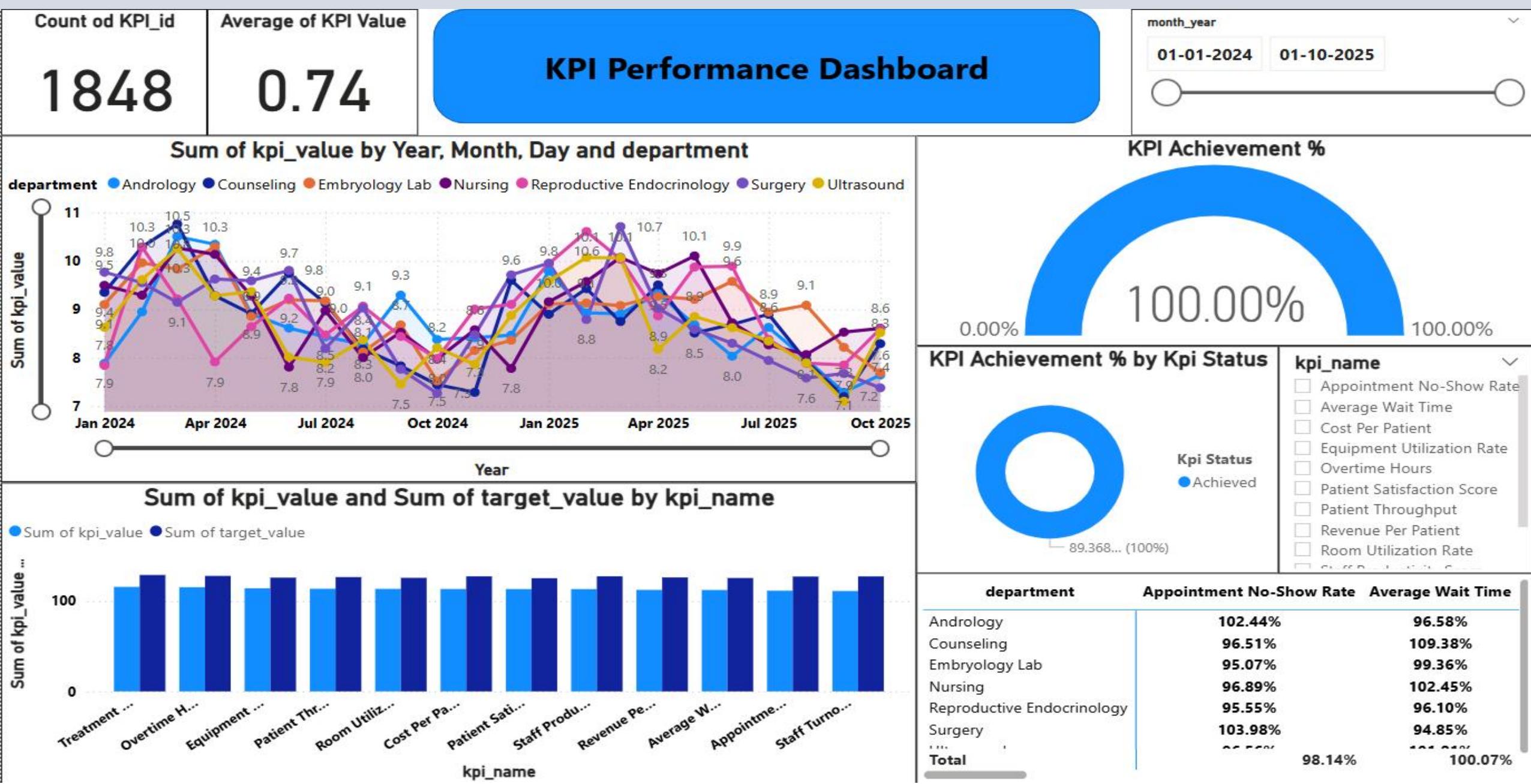
complaint_log...

True

False



Data Visualization



Data Visualization

48.79K

Total Duration (min)

100.0...

%GT Room Utilization...

100.0...

%GT Staff Utilization %

Room Utilization Dashboard

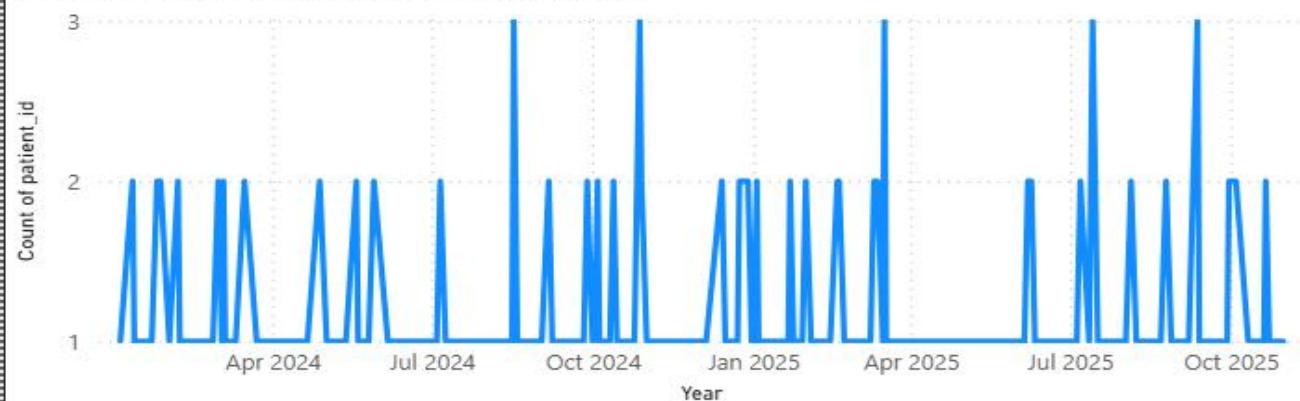
0.66

Average of occupancy_rate

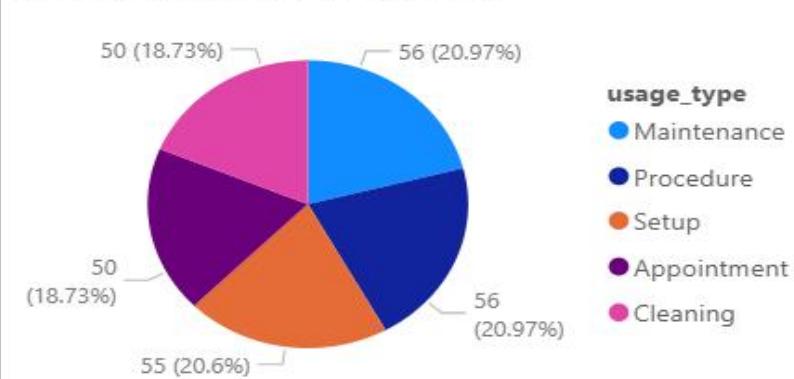
267

Count of usage_id

Count of patient_id by Year, Month and Day



Count of usage_id by usage_type

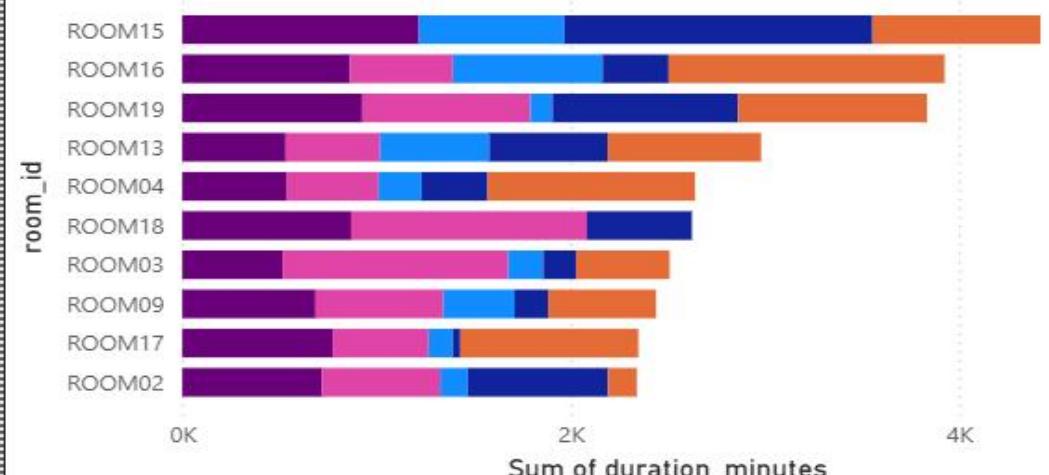


room_type

Consultation
Lab
Operating Room
Procedure
Recovery
Ultrasound

Sum of duration_minutes by room_id and usage_type

usage_type ● Appointment ● Cleaning ● Maintenance ● Procedure ● Setup



Staff Workload (Minutes) by staff_id_assigned



room_id	2024	2025	Total
ROOM01	2.19%	1.51%	3.69%
ROOM02	2.77%	2.03%	4.80%
ROOM03	1.89%	3.25%	5.14%
ROOM04	4.93%	0.48%	5.41%
ROOM05	2.79%	0.45%	3.24%
ROOM06	1.47%	1.77%	3.24%
ROOM07	1.65%	2.33%	3.97%
ROOM08	0.37%	2.83%	3.20%
ROOM09	3.07%	1.93%	5.00%
ROOM10	2.40%	2.01%	4.40%
ROOM11	2.43%	1.87%	4.30%
ROOM12	2.22%	1.49%	3.71%
ROOM13	1.25%	4.86%	6.11%
ROOM14	2.63%	1.52%	4.16%
Total	50.95%	49.05%	100.00%

Data Visualization

35

13.43

Count of staff_id

Average of experience_years

IVF Staff Dashboard

122.22K

Weekly Staff Cost

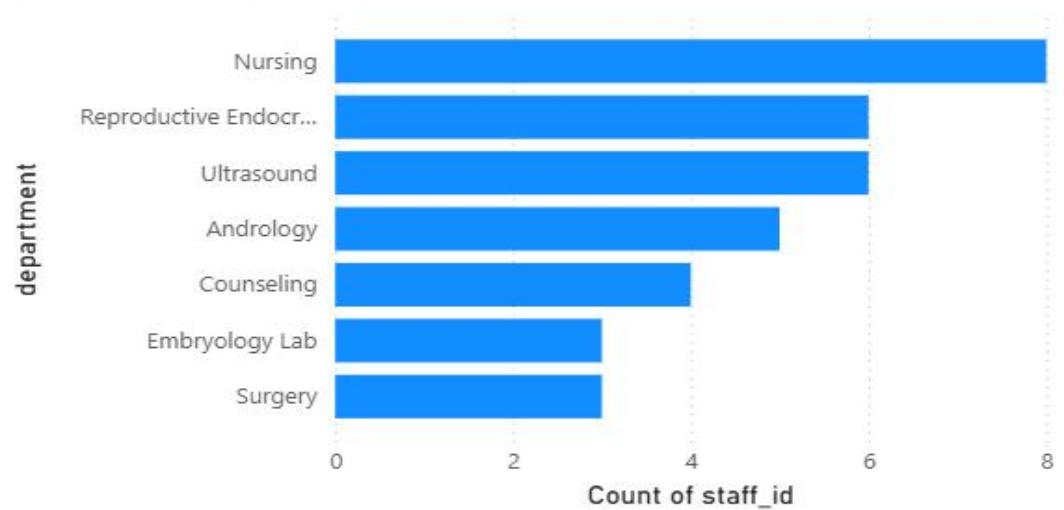
5

Staff with Expired Certificati...

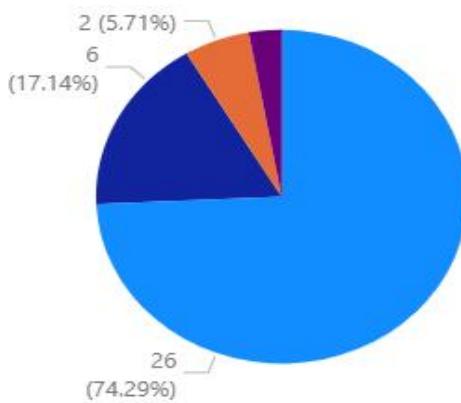
%GT Count of department by hire_date



Count of staff_id by department



Count of staff_id by employment_status



specialty

- Andrologist
- Anesthesiologist
- Counselor
- Embryologist
- Lab Technician
- Nurse Practitioner
- Registered Nurse
- Reproductive Endocrinologist
- Ultrasound Technician

488.87K

Monthly Staff Cost

staff_id Expired Valid Total

staff_id	Expired	Valid	Total
DOC018	1	1	1
DOC034		1	1
STF001		1	1
STF002		1	1
STF003	1	1	1
STF004		1	1
STF005	1	1	1
STF006	1	1	1
STF007		1	1
STF008		1	1
STF009	1	1	1
STF010		1	1
STF011		1	1
STF012	1	1	1
STF013	1	1	1
STF014	1	1	1
Total	5	30	35

Recommendation & Conclusion

Recommendations:

1. Reduce appointment clustering during peak hours to minimize patient waiting time.
2. Implement doctor and staff rotation algorithms to balance workload and avoid burnout.
3. Use predictive wait-time alerts to inform patients and improve transparency.
4. Introduce automated maintenance reminders to prevent equipment downtime.
5. Optimize room allocation by analyzing room-usage patterns and improving utilization.
6. Reprioritize budget allocation based on high-impact operational areas.
7. Track operational KPIs weekly for continuous performance improvement.

Conclusion:

- Data-driven optimization greatly enhances IVF clinic efficiency.
- Reduced delays lead to higher patient satisfaction and improved service quality.
- Balanced resource allocation increases overall throughput of the clinic.
- Predictive models enable better planning for appointments, staff, and equipment.
- Interactive dashboards provide real-time decision support to clinic management.

