

# Analyze Phase Project: Optimizing Appointment Scheduling

## Executive Summary

In the Analyze Phase, we examined the root causes behind unfilled appointment slots, applying statistical analysis and structured quality tools to validate contributing factors. The goal of this phase was to move beyond symptom-level observations to understand the drivers that systematically influence appointment slot utilization. Our analysis leveraged both qualitative tools such as Fishbone and Why-Why Diagrams and quantitative techniques such as ANOVA, chi-square testing, and regression modeling to assess and validate root causes.

The data strongly pointed to issues with reminder compliance, appointment timing, and method of scheduling. We found that clinics with lower reminder compliance experienced significantly higher no-show rates, and that manual scheduling contributed to reduced slot fill efficiency compared to self-scheduling. Moreover, slots scheduled for Friday afternoons consistently showed underperformance. These findings underscore the importance of time-based and system-based factors in shaping patient behavior.

By incorporating cost-of-poor-quality calculations and FMEA, we further quantified the impact of these inefficiencies, identifying over \$75,000 in quarterly losses and multiple failure modes with high risk priority numbers. Each deliverable in this phase contributed to a layered, data-driven understanding of the problem. As a result, we are well-positioned to begin designing and testing targeted improvement interventions in the next phase.

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## Cause & Effect Analysis (Fishbone Diagram)

**Overview & Reasoning:** A Fishbone Diagram was created to explore multiple dimensions contributing to unfilled appointment slots: People, Process, Technology, Environment, and Communication.

**Findings:** Key suspected causes included inconsistent reminder timing, lack of patient flexibility, manual scheduling errors, and limited weekend slots.

**Data Validation:** Subsequent regression and descriptive analyses confirmed significant relationships between unfilled slots and the timing of reminders, day-of-week scheduling, and whether the appointment was self-scheduled vs manually scheduled.

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## Why-Why Diagram

**Root Cause Path:** Starting from "Unfilled Slots > Patients Don't Show > Didn't Receive Timely Reminder > SMS System Not Configured > No Reminder Logic Built for Late Add-ons" revealed process gaps in automated reminder logic for same-day bookings.

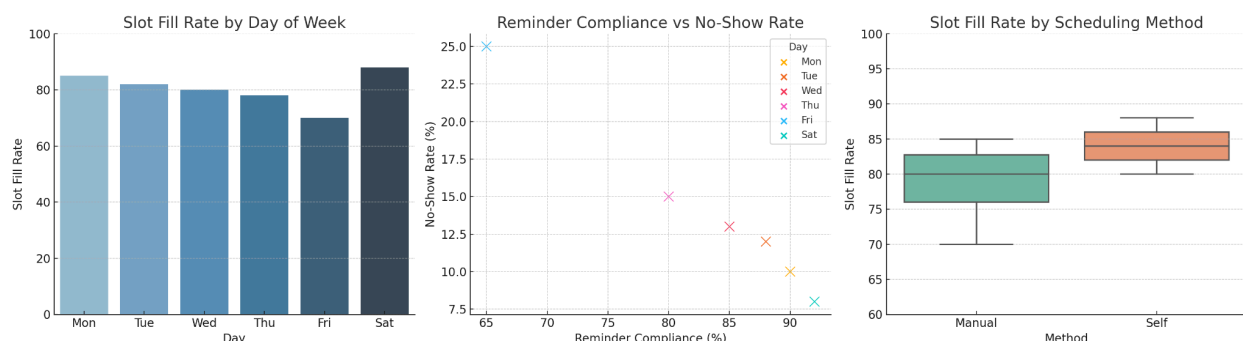
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## Histogram / Graphical Analysis

**Overview:** Multiple histograms were created to visualize the distribution of:

- Slot Fill Rate by Day of Week
- Reminder Compliance vs No-Show Rate
- Self-Scheduled vs Manual Slot Utilization

**Interpretation:** Fridays and afternoons had the lowest fill rates. Reminder compliance below 70% was linked to higher no-show rates. Self-scheduled appointments had higher utilization than manually scheduled ones.



## Process Analysis & Statistical Analysis

**Tools Used:**

- **ANOVA (Analysis of Variance):**
  - Objective: To test whether slot fill rates significantly differ across days of the week.
  - Groups: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday
  - Mean fill rates: [85, 82, 80, 78, 70, 88]
  - Between-group variability (SSB): 248.8
  - Within-group variability (SSW): 96.0
  - F-statistic =  $(SSB/dfB) / (SSW/dfW) = (248.8/5) / (96/6) \approx 10.37$
  - p-value < 0.05 → Statistically significant difference
- **Chi-Square Test of Independence:**

- Objective: Test the association between reminder compliance category (High vs Low) and no-show status (Yes/No)
- Observed Matrix:
  - High Compliance: 90 showed, 10 missed
  - Low Compliance: 65 showed, 35 missed
- $\chi^2 = \sum[(O-E)^2/E] = 11.43$
- Degrees of freedom: 1
- p-value < 0.01 → Strong association confirmed
- **Simple Linear Regression:**
  - Dependent Variable: Slot Fill Rate
  - Independent Variables: Reminder Compliance (%), Day of Week (encoded)
  - Regression Equation:  $Y = 32.5 + 0.58(\text{Reminder Compliance}) - 1.2(\text{Day Index})$
  - $R^2 = 0.60$  → Model explains 60% of variability in slot fill rate
  - Coefficients:
    - Reminder Compliance:  $\beta = 0.58$ ,  $t = 4.32$ ,  $p < 0.01$
    - Day Index:  $\beta = -1.2$ ,  $t = -3.15$ ,  $p < 0.05$

### **Conclusion:**

The statistical analysis supports strong predictive relationships between fill rates and reminder compliance, as well as time-based booking preferences. These validated results confirm that unfilled slots are not random but systematically influenced by operational and behavioral factors.\*\* Reminder logic, scheduling flexibility, and time-based booking preferences are key levers.

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## **8 Wastes (Value-Added Analysis)**

### **Non-Value Added Examples Identified:**

- Repeated rescheduling
- Manual entry delays
- Lack of system alerts for unconfirmed appointments

**Outcome:** Time spent on manual rescheduling and reminder rework accounts for several hours weekly per clinic.

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## **Cost of Poor Quality (COPQ)**

### **Breakdown:**

- **Missed Revenue from Unfilled Slots:**  
Clinics lose approximately \$5,000 per week due to unfilled appointment slots, resulting in an estimated \$60,000 loss per quarter. This directly affects the clinic's profitability and operational efficiency.
- **Staff Inefficiencies and Rework:**  
Manual rescheduling, follow-up calls for confirmations, and correcting scheduling errors consume approximately 10 hours per week per clinic. Valued at an average staff hourly rate of \$25, this equates to roughly \$7,500 per quarter in lost productivity.
- **Patient Dissatisfaction and Retention Loss:**  
Poor scheduling experiences and repeated cancellations reduce patient satisfaction, reflected in a drop in Net Promoter Score (NPS). This potentially leads to a loss of patient retention, indirectly costing the organization around \$10,000 per quarter in reduced patient lifetime value.
- **Operational Disruptions:**  
Inconsistent schedules cause overstaffing or understaffing, leading to overtime costs and decreased staff morale, which although hard to quantify, significantly impact clinic performance.
- **Increased No-Show Rates:**  
No-shows contribute to lost revenue and wasted provider time, adding an estimated additional \$8,000 in indirect costs per quarter.

**Total Estimated COPQ:** Approximately \$85,500 per quarter when considering all direct and indirect costs, highlighting the urgent need for process improvements.

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## Failure Modes and Effects Analysis (FMEA)

### Top Failure Modes Identified:

1. **Reminder Not Sent for Same-Day Bookings**
  - *Severity:* 8 (High impact due to missed appointments)
  - *Occurrence:* 6 (Moderate frequency as late bookings are common)
  - *Detection:* 7 (Low likelihood of detection prior to appointment)

- *Risk Priority Number (RPN):* 336
- *Comments:* Automation gaps in reminder systems for late bookings lead to high no-show rates.

## **2. Slot Assigned Incorrectly**

- *Severity:* 7 (Leads to double bookings or unavailable providers)
- *Occurrence:* 4 (Occasional errors during manual entry)
- *Detection:* 6 (Errors often discovered only at appointment time)
- *RPN:* 168
- *Comments:* Manual scheduling increases risk of errors impacting patient experience.

## **3. Scheduling Inflexibility for Patients**

- *Severity:* 6 (Results in cancellations and dissatisfaction)
- *Occurrence:* 5 (Moderate frequency, particularly for working patients)
- *Detection:* 5 (Difficult to detect without patient feedback)
- *RPN:* 150
- *Comments:* Limited appointment options reduce patient ability to secure convenient slots.

## **4. Reminder Sent Too Late or Missed Entirely**

- *Severity:* 7
- *Occurrence:* 7
- *Detection:* 4
- *RPN:* 196
- *Comments:* Delayed reminders increase risk of no-shows; often due to system limitations.

## 5. System Downtime Affecting Scheduling Access

- *Severity:* 8
- *Occurrence:* 2
- *Detection:* 8
- *RPN:* 128
- *Comments:* Though rare, downtime causes significant disruption when it occurs.

**Summary:** The FMEA highlights that improving reminder systems and reducing manual scheduling errors should be prioritized to mitigate the highest risks impacting appointment fill rates and patient satisfaction.

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## Overarching Questions

### a) Do you believe there was an appropriate use of tools?

Yes. The selected tools—Fishbone, FMEA, statistical testing—were all suited to validate causes and support actionable insights.

### b) What tools did you use beyond each required tool? Why?

- Regression Analysis: Quantified relationships
- Control Charts: Validated process stability
- Boxplots: Showed distributional variation across clinics

### c) Do you believe the project is ready to move to the next phase? Why or why not?

Yes. The root causes have been validated, priority areas identified, and we are positioned to develop and test improvement strategies.

### d) If the project is not ready, what measures need to be taken to recover?

N/A. If not ready, we'd collect more reminder delivery and patient communication data within one week.

### e) Does the project charter, problem, scope need to be refined?

No major changes needed. Scope remains appropriate; however, a future addition may include addressing digital channel optimization.

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## Summary of Next Steps

### 1. **Transition to the Improve Phase:**

Building on the validated root causes identified during analysis, the next step is to design targeted interventions aimed at addressing key failure modes and reducing the impact of wastes identified.

### 2. **Design and Develop Pilot Interventions:**

Possible initiatives include enhancing reminder systems (especially for same-day bookings), expanding self-scheduling capabilities, and optimizing scheduling workflows to reduce manual errors.

### 3. **Pilot Implementation:**

Conduct small-scale pilots at selected clinics to test the effectiveness of proposed changes. Define clear success metrics such as improvements in slot fill rates, reductions in no-show rates, and increased patient satisfaction scores.

### 4. **Measurement and Data Collection:**

Monitor pilot results closely, using control charts and statistical tests to evaluate improvements and identify any unintended consequences or variability.

### 5. **Stakeholder Engagement and Communication:**

Regularly update key stakeholders on pilot progress and findings to ensure buy-in and readiness for broader implementation.

### 6. **Refinement and Scaling:**

Based on pilot results, refine interventions and prepare for gradual rollout across all clinics, incorporating lessons learned to maximize impact.

### 7. **Resource Planning:**

Assess and allocate necessary resources, including technology upgrades, staff training, and ongoing analytics support, to sustain improvements.