SMU Senior Project

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# Summary

Concentra presented the problem of cross-staffing some of its employees throughout its centers. The problem addresses a potential decision of staffing methods of which the options were to staff to the market or create a cross-staffing model. These decisions relied upon the variability of patient visits among the centers and the ability to schedule based on future forecasted patient visits. Ultimately, the question was to find if there is an opportunity to staff across all centers or must it be dynamically adjusted based on forecasting by center. A solution to this problem would potentially decrease patient wait times and turnaround times (a patient’s check-in time to checkout time), idle times in which staff members are not performing any duties, and times in which centers experience a heavier traffic flow. In analyzing the issue presented, many models were considered. The data provided covered a month’s pay period and the number of visit types in the month of January for fourteen Concentra centers in the Dallas/Ft. Worth area. Initially, trends were sought and developed by the data. We used a mapping tool to cluster centers that were close to each other in order to seek a potential relation between number of visits and geographical area. Then, we used a moving average to forecast number of visits and decided that although there is a strong potential that forecasting might be accurate enough to base scheduling of staff around it, the degree of variance of patient visits per day for each center within each cluster was too large at times. We feel that in order to maintain customer satisfaction, a combination of using forecasting to schedule staff and a cross-center staffing method will be better suited. This would allow to staff in a more efficient manner but also be flexible enough to adjust to any unforeseen patient visit number.

# Problem

The Carrollton Concentra center is experiencing a rush. Scheduled appointments are waiting forty-five minutes, and walk-in drug screenings are continuing to pile up. The center has a room full of patients in the lobby and being serviced, so all staff members are busy. The center is looking at an approximate overtime schedule of two hours per employee, totaling about fifteen hours.

On the other hand, the Addison Concentra center is experiencing a normal flow of traffic. Turnaround times are averaging fifteen minutes, depending on the service required, and only five drug screens have been performed. There is a physician sitting idle, along with three other assisting staff. The distance between these centers is less than ten miles, and approximately ten to fifteen minutes. Why aren’t some of the staff members from Addison Concentra traveling to Carrollton Concentra to perform their services there?

The scenario described is the problem Concentra presented. Overall, a higher customer satisfaction rate is motivating the study, but there is also an area of opportunity in which the company can save money by cutting down on payroll costs with the decrease in overtime. In studying the situation, the most flexible staff member needs to be determined, and in doing so, their qualifications of duties performed, hours available to work, and willingness to travel must also be decided. Assuming that all the employees are available and willing to be cross-staffed, questions establishing the centers with the most need must be answered, and through close analysis of the data, some conclusions can be made.

# Analysis of the Situation

Upon investigation, the real problems seem to lie in the centers with the highest number of unscheduled visits, mainly drug-screens, highest number of employees getting paid for overtime and total overtime paid per center within a given pay period, and centers with the highest turnaround times. A DEA model is the most useful in analyzing the optimality of each centers, and how they are currently performing, but the data can also be analyzed by simply sorting through the numbers in an excel file. Once trends are generated, assignment models, an AMPL algorithm creating optimal routes for cross-staffing, and a forecasting model can be developed to describe the situation and potential solutions. Ultimately, a forecasting model will be the most beneficial in finding a solution to Concentra’s problem of cross-center staffing.

# Technical Description of the Model

The most important task was to decide a proper manner in which to group centers together. We decided that it was best to cluster centers based on geographical location to one another. Therefore, we clustered the centers in to four different groups in relation to the distance to other centers in the cluster. We used online mapping software to map the centers and calculate the distance between them.

**Cluster 1:**

Center 4528 in Plano

Center 4536 in Addison

Center 4525 in Carrollton

Center 4519 in Las Colinas

**Cluster 2:**

Center 4520 on Stemmons

Center 4530 on Live Oak

Center 4526 in Mesquite

Center 4518 in Garland

**Cluster 3:**

Center 4517 in Grand Prairie

Center 4521 in Arlington

Center 4535 in Fort Worth

**Cluster 4:**

Center 4533 on Fossil Creek

Center 4531 in Forrest Park

Center 4524 in Fort Worth South

# Patient Forecasting Model

The forecasting model we developed predicts weekly patient visits using the following relationship for each center:

Where,

**= number of periods in the moving average**

**= patients seen during period**

To estimate future patient visits per center in each cluster, we assumed that the number of patients that were scheduled and not scheduled maintained a constant qualitative pattern throughout the week. In other words, we assumed that when a patient was scheduled the same criteria to schedule the patients were consistent throughout the scheduling process among all centers in each cluster. For example, to schedule a visit by a patient, the staff member in charge of scheduling might consider the time block available for appointment, the type of visit in relevance with block of time available, the number of staff that would be available that day and so on.

Furthermore, we did not include weekend patient visits when calculating moving average. We decided to do this because not all centers were open during the weekend and in general weekend staff might be scheduled in basis of preference and rotation as observed in the general medical center industry.

Finally, to forecast our prediction, a moving average of 2 days was used for the first two weeks. This allowed for a better adjustment to change based on previous data and also was the best model because trends were not readily observed. The patients seen per day in each center did show a slight decrease of visits during the middle of the week, but still had a high degree of difference between visit numbers in different weeks. Then, we plotted and compared the predicted forecast with the actual data we obtained.

# Analysis and Managerial Interpretation

Over the four week span of the month of January. Our moving average model appeared to be viable enough to base future patient visits per center. In some instances, the prediction was right on target when compared to historical data provided. However, there are also plenty of instances where patient visits increase dramatically the following day and sometimes the following week on the same day. Due to the unpredictable nature of accidents, emergencies and any scenarios that might cause a sudden influx of patients, this was to be expected. Below is an example where the forecast displayed reliable accuracy:

Next you will find an example of a forecast that had mix results in terms of accuracy:

The first occurrence was less prevalent. Most centers per cluster displayed the behavior that the second example showed. The results of all the other centers can be found in the appendix.

Therefore, based on the close analysis of the projected data and the degree of potential error in accuracy of the forecast, we came to the conclusion that staffing across centers is not viable. We believe that due to the degree of unpredictability of unscheduled appointments and other outside factors not readily observed with the data we received, the moving average was overall moderately successful in predicting future patient visits. So, a dynamic staffing scheduling should be combined with forecasted patient visits in order to allow greater room for flexibility. By using forecasted patient visits, the center can accommodate enough staff to meet the minimum projected number of visits for the next week or even longer depending on the desired scheduling length. However, by having flexible staff that can move across-centers on a need based basis, any potential overflow of patients can be quickly addressed. An optimization model that minimizes distance traveled can be used in each cluster to decide which staff goes where based on proximity. If record of such situations is kept, the Company can use the data to decide whether the cross-staffing method is a cheaper alternative than hiring new staff at a center.

## Conclusions and Recommendations

We recommend that Concentra considers the option to dynamically assign with the following considerations: Develop an assignment model that staffs across centers and a cost-benefits analysis that compares costs incurred from cross-staffing to costs of current scheduling, in order to determine if staffing across centers is cost effective in the long-run. Furthermore, with a mix of forecasting and dynamic scheduling, staff scheduling efficiency can be improved based on reliable predictions but with the flexibility of adding staff as unpredicted changes in patient visits occur. **See Appendix.**

# APPENDIX

As several factors can be considered, one factor in particular that potentially creates a lack of coverage is the number of urgent care and injury visits that occur each day. Since they have a smaller window to pre-schedule in (normally a same-day scheduling window), as a result, it is easy for bottle-necks to occur, where the number of patients waiting to be seen began to increase resulting in higher waiting times and customer dissatisfaction.

This model would make the following assumptions:

* The number of urgent care visits and injury visits is the data being considered to determine the need for coverage on a given day.
* It is not including the following non-urgent services: drug screens, therapy, specialist visits, physicals, recheck visits
* Non-urgent services may also create an excess of patients waiting due to the amount of time it takes to perform that particular service, and thus bottle-neck the system For example, physicals provided for military personnel can take over two hours and the clinic must accommodate group scheduling for that particular service.
* The doctors being scheduled consist of those who are not in the regular schedule for that day but are on call to be staffed as needed (we will refer to them as floaters).
* The floaters being scheduled are not be taken from other centers (can be considered in the future).
* Though a the total of urgent care and injury care visits may be low at a given time, that may not indicate that the center is experiencing a lull and therefore there is an excess of doctors not being utilized.
* Period 1 will be pre-staffed with full-time doctors from an independent scheduling system that is not integrated with this system.
* Floaters will provide coverage for periods 2 and 3 in order to release bottlenecks resulting from excessive backups in periods one and two.
* A workday will consist of three periods in five-hour increments:

Period 1 - 7am-12pm (1 center opens at 7am, the other 13 at 8am)

Period 2 - 12pm-5pm

Period 3 - 5pm-10pm (only remaining centers open: 4519, 4520, 4531, 4536)

* Period 1 will have pre-scheduling of full and part-time physicians
* Part-time floaters will provide coverage for periods 2 and 3 in order to release bottlenecks that occur from excessive urgent care and injury visits in periods 1 and 2.
* This model provides coverage for Monday-Friday only.

To show a minimized example of a general linear programming model for an assignment problem with *m* floaters and *n* centers, we would use the following notation:

X*ij* = { 1 if floater *i* is assigned to a center *j*

0 otherwise

Where *i* = 1,2,3,… and *j* = 1,2,3,…

F1 = Floater 1

F2 = Floater 2

F3 = Floater 3

F4 = Floater 4

C1 = Center destination node 1

C2 = Center destination node 2

C3 = Center destination node 3

C4 = Center destination node 4

a = costs incurred from staffing the floater

Min aX11 + aX12 + aX13 + aX14 + aX21 + aX22 + aX23 + aX24 + aX31 + aX32 + aX33 + aX34 + aX41 + aX42 + aX43 + aX44

s.t.

X11 + X12 + X13 + X14 <= 1 (Floater 1 assignment)

X21 + X22 + X23 + X24 <=1 (Floater 2 assignment)

X31 + X32 + X33 + X34 <=1 (Floater 3 assignment)

X41 + X42 + X43 + X44 <=1 (Floater 4 assignment)

X11 + X21 + X31 + X41 = 1 (Center 1)

X12 + X22 + X32 + X42 = 1 (Center 2)

X13 + X23 + X33 + X43 = 1 (Center 3)

X14 + X24 + X34 + X44 = 1 (Center 4)

Additional inputs could constrain the distance being traveled by the floater by clustering the centers:

Cluster 1

Plano (4528)

Addison (4536)

Carrollton (4525)

Los Colinas (4519)

Cluster 2

Stemmons (4520)

Live Oak (4530)

Mesquite (4526)

Garland (4518)

Cluster 3 = D3

Grand Prairie (4517)

Arlington (4521)

Red Bud (4535)

Cluster 4 = FW

Fossil Creek (4533)

Forest Park (4531)

Fort Worth South (4524)

To apply the model, a system could be developed included the following:

Run for period 2:

Part 1 – User Interface (manual or automated)

1. Input – number of urgent care and injury visit patients checked in but not seen being treated by a doctor.
2. Output – list of on call floaters assigned

Part 2 – Programming performed in knowledge Engine

1. Looping computation that keeps a tally of the number of patients waiting to be seen
2. Output “passed/failed” message (passed = urgent care/injury visit count not exceeding a pre-determined acceptable number of patients waiting; failed = count exceeds pre-determined number, which triggers the assignment model to run)

Part 3 – Assignment Model

1. Access list of part-time floaters
2. Assigns floater to center
3. Send floater assignment info to physician database

Part 4 – Database

1. Access and outputs list of on-call floaters to assignment model
2. Inputs floaters assigned
3. Updates status of available floaters for the next period
4. Stores updated list for period 3 run.
5. Refreshes list at the end of period 3

As the purposes of this summary of a system is to provide a view of the flow of data in order to consider the possibility of moving towards assigning floaters in real time, it is only meant to be viewed at a high level and would require extensive requirements gathering in order to integrate and implement it.

Other factors that could also trigger the assignment model to run could include an effective forecasting model, and a patient scheduling model that addresses the number of patients being scheduled (particularly accommodating the scheduling of large numbers physicals for military patients.

**DECISION SUPPORT SYSTEM FOR SCHEDULING FLOATING PHYSICIANS**

PHYSICIANS

Database

KNOWLEDGE

ENGINE

(COMPUTATIONS)

PATIENTS

Models

PHYSICIAN ASSIGNMENT

dd

PATIENT FORECASTING

PATIENT SCHEDULING

SHORTEST PATH

**Forecasted Data Comparison per Center within each Cluster**

**CLUSTER 1:**

**CLUSTER 2:**

**CLUSTER 3:**

**CLUSTER 4:**