**OR 531 Fall 2022: Simulation Optimization Project Report**

**Project Members**

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In order, to accommodate the anticipated daily patient volume, a hospital in a city's high development area plans to expand. Currently, the hospital has ten daily attending doctors and 20 patient beds that may be utilized by patients throughout the day or overnight. The hospital is thinking of expanding its hospital section, adding more beds, or employing more doctors or adding a new wing.

**AIM:** Finding out the optimal solution to increase the profit to at least 200$ per month and minimal referral to military, which can be an average of 1 per day.

We were given 60 days data on the number of patients arriving per day and percentage of patients who needs the bed. Although the number of patients arriving each day has a discrete distribution, our Excel program was unable to handle the poisson distribution because the normal distribution is practically identical to the discrete distribution in this situation. To handle the normal distribution, we used Excel's norm.inv function.

**Formula Used:**

**=NORM.INV(RAND(),24.8167,2.50079)**

When a patient arrives for a visit, the hospital processes them. Some patients don't need a bed, therefore they receive the bare minimum of care. The remaining patients are either directed to a local military medical hospital if there are no beds available or assigned a bed. The hospital must pay the military institution $5000 for each patient. The 10 doctors attend to the patients allocated to the beds. On average, a doctor may see 2.5 patients every day. There are fewer beds available the next day because patients in beds where a doctor cannot visit them are compelled to stay overnight. Additionally, 20% or so of patients in a bed need to stay over. The daily earnings of doctors total $1500 per doctor on average. The hospital also calculates that empty beds cost them around $1000 per day, however this figure does not account for empty beds over night. Additionally, the hospital makes $1200 per patient each bed and an extra $2500 per patient per bed overnight in income.

The hospital expects a 20–30% increase in patients (for the average only not the deviation). The hospital has three options for meeting the rising demand: adding a new hospital wing with 15 extra beds for $500,000; increasing the number of doctors to a maximum of 14; or increasing the number of beds to a maximum of 26.

Assume that the increase in the patients is 25% (mean for 20-30%).

**The mean and standard deviation are** 24.8167 and 2.50079 respectively for the patients arriving per day. Increase the mean by 25% with no change in standard deviation.

**Cost per overnight patient who needs a bed = $3700**

**Each doctor income per day = $1500**

**Cost incurred for Military referrals for each patients = $5000**

**Cost per patient during day time = $1200**

**Unused bed cost = $1000**

**Revenue = (Cost per overnight patient who needs a bed + Cost per patient during day time) – (Unused bed cost+ Each doctor income per day+ Cost incurred for Military referrals for each patients)**

**CASE 1: Increase the number of doctors to 15**

Though the number of doctors are increased to 15, the available number of beds remain unchanged i;e 20. So excess number of patients are referred military treatment facilities which cost around $5000 per each patient. The expected profit $108756.00.

**CASE 2: Increase the number of beds to 26**

Though the number of beds are increased to 26, the available number of doctors remain unchanged i;e 10. So if the doctors are not available the patients were assigned beds overnight for their treatment. As the number of beds were increased this doesn’t seem like a big challenge and it’s manageable to accommodate the patients. Also if the patients couldn’t be accommodated they can be referred to the Military services which is very rare in this case.

The revenue incurred in this case is $1402287.47 and this can be considered as the optimal solution.

**CASE 3: Construct a new unit with 15 additional beds**

Although the new unit is constructed with 15 additional beds there won’t be enough doctors to serve the patients and the beds which were left unoccupied were more in this case. Each unoccupied bed would cost $1000 per day, which is reflected in the decrement of the revenue. It also takes $500,000 to construct a new unit. The revenue incurred in this case is $10560.00.

Chart, funnel chart

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The same procedure was followed for 2nd case where, it is considered that only 10 beds were available on the day1. The optimal solution considering this case has also resulted in increasing the number of beds.

Chart, histogram

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