Operation Research Simulation Coursework

We constructed a model of the hospital based on the assumptions stated in the coursework brief and these additional assumptions:

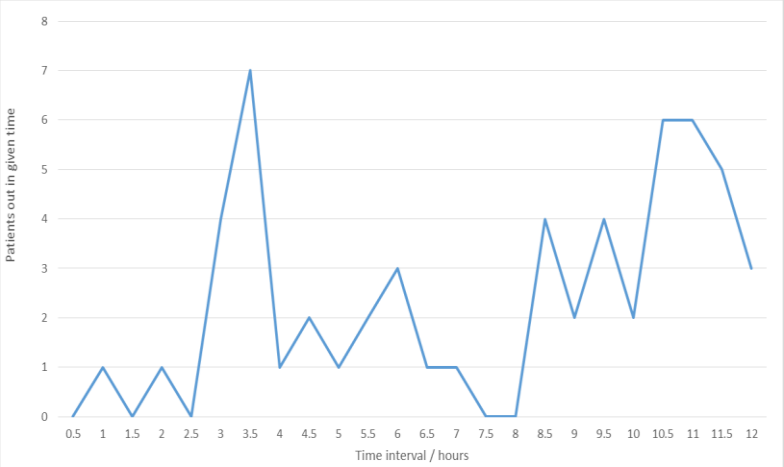
- The travel time between all rooms is negligible for all patients and resources, we set the times to zero to replicate this.
- The order of additional tests is X-ray then CT scan then Labs.
- That lab patients stay in the lab room while they wait for their results.
- The External staff that are needed for the X-ray and CT scan can never be too busy e.g. X-ray room and CT Scan Room can never be starved of a resource.
- That a patient will have a maximum of 1 X-ray, 1 CT Scan, and 1 Lab test.

We also simplified the problem by:

- Having waiting rooms specifically for people that have been examined and are just waiting for an X-ray, CT scan, or labs. This is plausible as these external tests could have their own waiting rooms.

Warm up times and replications

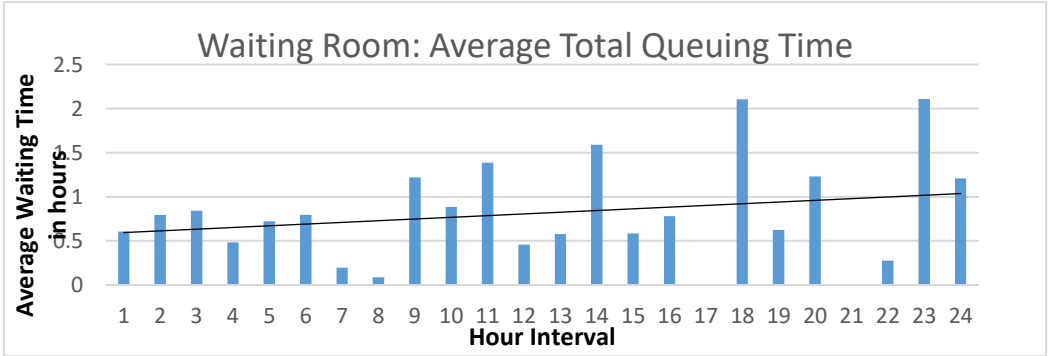
To determine the warm up time we ran the simulation for 30 minute intervals and noted the amount of patients who had exited the system. We then plotted the following graph.



We concluded that the warm up time was 4 hours as the graph looks to level off and therefore incorporated that into the results for our simulation. We ran a series of 5 trials and took the average of them for all of our following results.

Average total waiting time

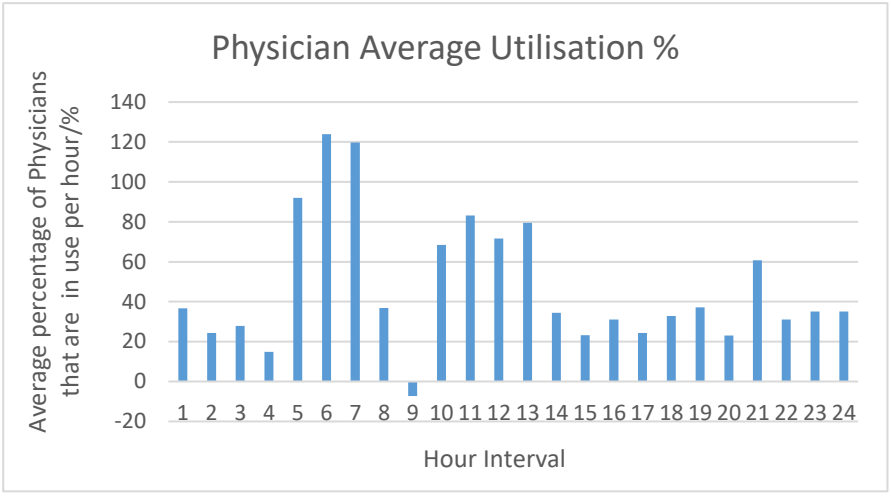
This is simply the average time that a patient will wait in the waiting room to be examined or treated in each hour of the trials.



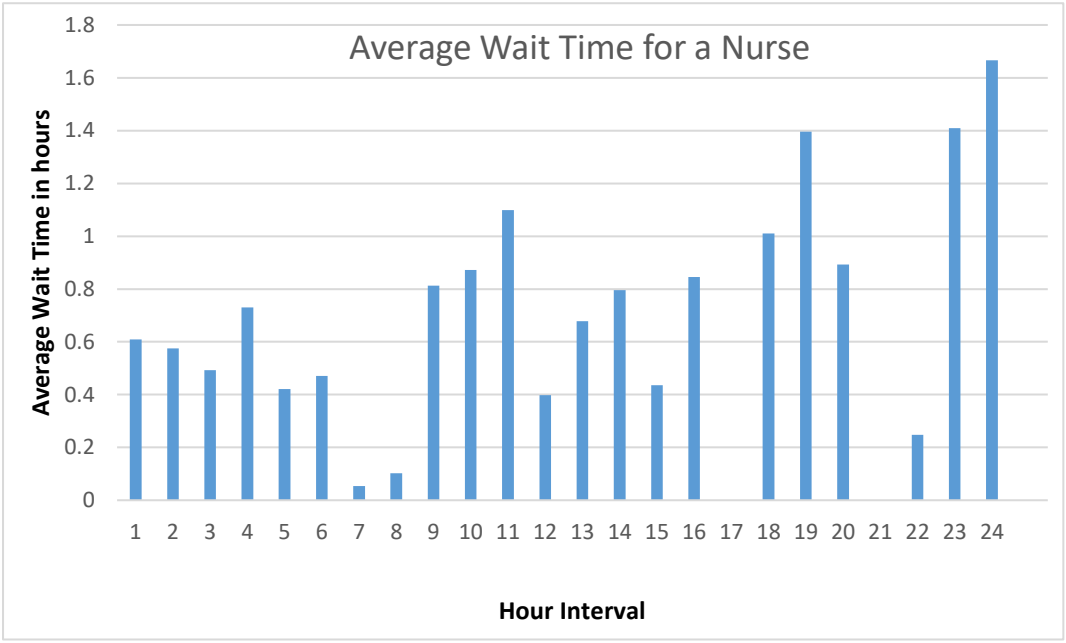
Average waiting time for Physicians

This is the average time a patient in the waiting room or in an examination room is waiting to see a physician. We calculated this using the time that there are no physicians of each type available, and have assumed that there is always at least one patient waiting to see a physician after the warm up period. This means that the time that patients are waiting for a physician is the same as the time that all physicians are being used and none are available.

From the graph we see that the only time intervals in which the physicians are all being used fully are 6-7 and 7-8. Therefore, in all other intervals the average wait time for a physician is zero as there are spare physicians that aren't being used.



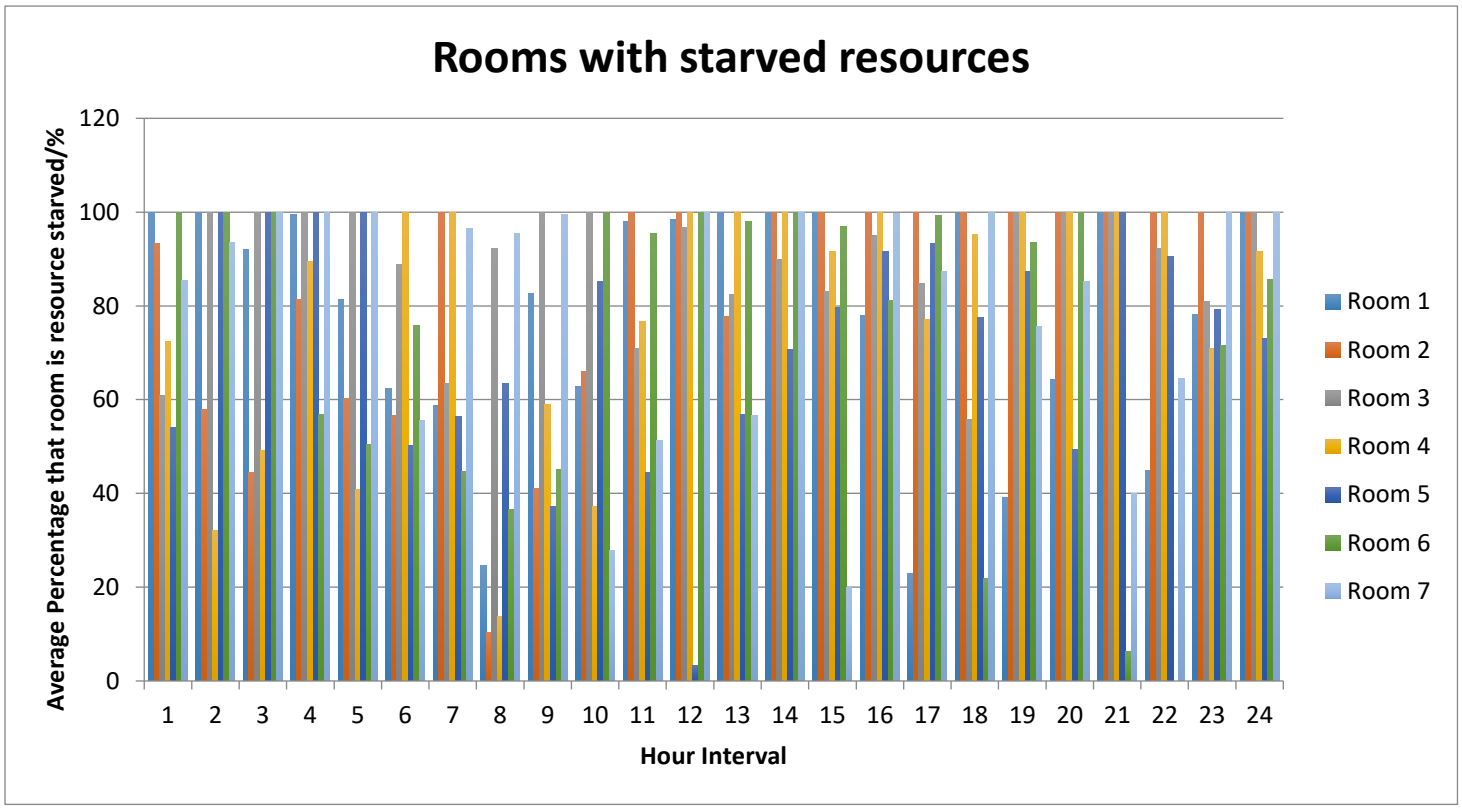
Average waiting time for Nurses



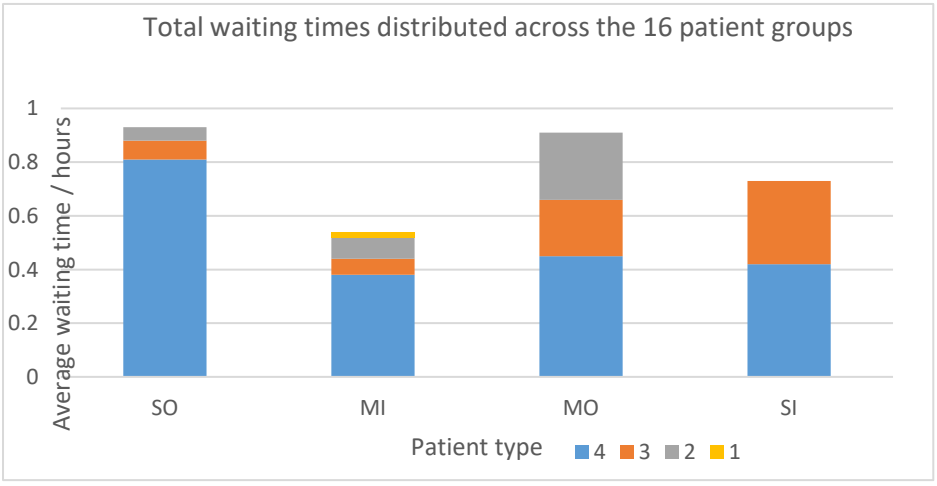
This is simply the average time that patients that are waiting to be examined or treated by a nurse wait in the waiting room each hour.

Average Waiting Time for Rooms

We determined the average waiting time for a room by equating it to the average time that a room was resource starved as it shows that someone wants the room but isn't in there as they are waiting for a resource. The graph below shows the percentage of each hour that a room is starved of a resource.

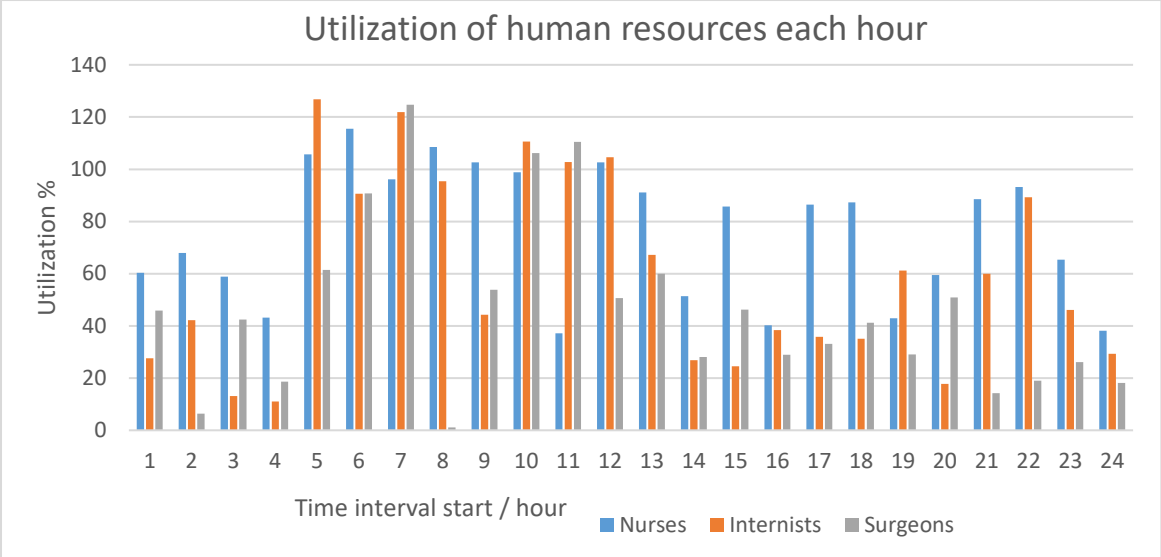


Total Waiting time across different patient groups



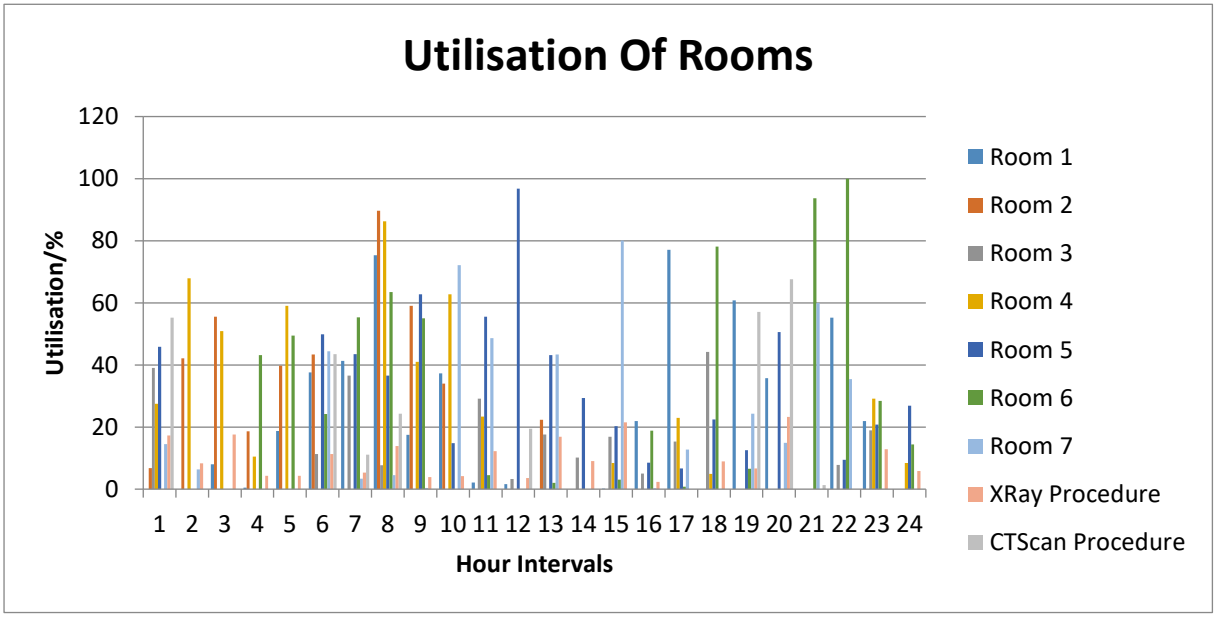
This stacked bar plot shows how the waiting times are distributed across the 16 patient groups. It is clear that Priority 1 patients have the lowest wait times, and in general the wait time increases as the priority goes from 1 to 4.

Idle Times



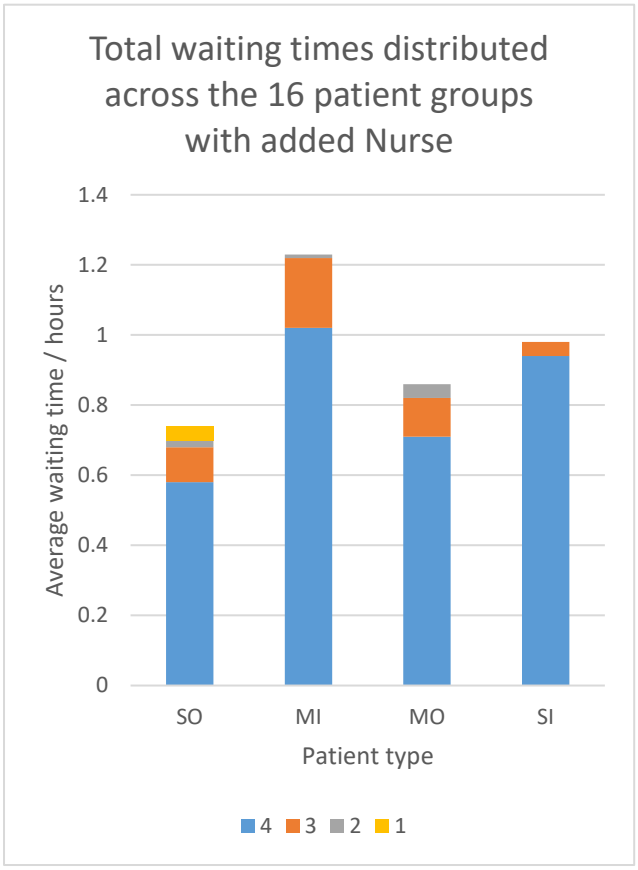
Utilisation of Rooms

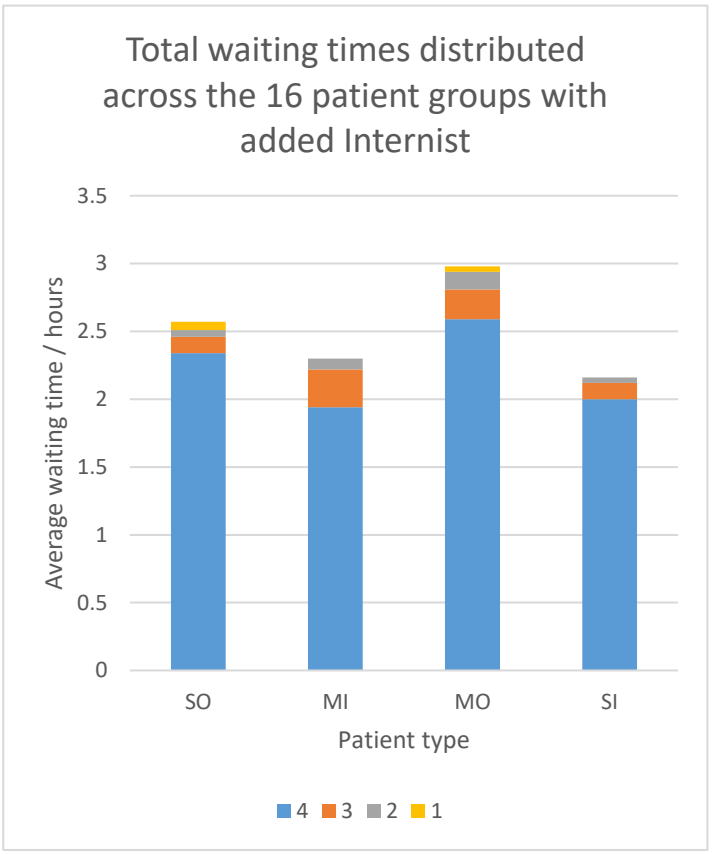
We have left off labs due to the infinite capacity of the laboratory preventing us from getting a utilisation percentage.



Possible efficiency improvements

From the graphs below we can conclude that introducing an extra nurse reduces the average wait times for all patients significantly more than the introduction of an internist, even for medical patients.





Extensions

For the model:

- We feel that it is very unlikely to have the same rate of patients coming in throughout the day, for example I highly doubt that the same number of patients come into the hospital at 5am as they do at 7pm. So we suggest that a more realistic model would include different rates and distributions of people entering the hospital at the different times in the day.
- We assumed that there was zero travel times whereas in reality it will take different amounts of time for different members of staff to reach certain places. We would need to create a floor plan and determine travel times between all the rooms.

For the analysis:

- We would have liked to analysis the difference in waiting time before being examined and after being examined but waiting to be treated to see if there is a preference between patients that have already been examined and those that haven't. This is because once they have been examined they will not leave the hospital as that is our assumption.
- We also would have liked to analyse the waiting time for the X-ray machine and the CT Scan Machine as it would give us information about whether the hospital needs to invest in additional machines to cope with demand and reduce waiting times.