Selecting the best configuration for a Hospital Emergency Center

a. Consider the operation of a Hospital Emergency Center (HEC). The process begins when a patient arrives through the *Acceptation* process in the *Entrance Room* of the HEC, and ends when a patient is either *released* from the HEC or *admitted* into the hospital for further treatment.

b. Patients arriving on their own, after *acceptation, sign in*, and then are assessed in terms of their condition (*triage*). Depending on their condition, patients must then go through the *registration* process and through the *treatment* process before being *released* or *admitted* into the hospital.

c. Arriving patients are classified into different codes (levels), according to their condition. With *Red Code*, patients are more critical than with Yellow and Green codes. Indeed, Red Code patients are taken to an *Emergency Room* (ER) immediately after *acceptation*. Once in the room, they undergo their treatment. Finally, they complete the *registration* process before being either *released* or *admitted* into the hospital for further treatment. Patients arriving by ambulance are directly classified with Red Code.

d. Yellow and Green code patients must first *sign in* with an Administrative Clerk. After signing in, their condition is assessed by a *Triage* Nurse, and then they are

taken to an Emergency room. Once in the room, Yellow and Green code patients must first complete their *registration*, then go on to receive their *treatment*, and, finally, they are either *released* or *admitted* into the hospital for further treatment.

e. The *treatment* process consists of the following activities:
   1. A secondary assessment performed by a nurse and a physician.
   2. Laboratory tests, performed by a patient care technician.
   3. The treatment itself, performed by a nurse and a physician.

f. The registration process consists of the following activities:
   1. A data collection activity performed by an Administrative Clerk.
   2. An additional data collection activity performed by an Administrative Clerk, in case the patient has Worker's Compensation Insurance.
   3. A printing of the patient's medical chart for future reference, performed by an Administrative Clerk.

g. Finally, 90% of all patients (regardless of the assigned code) are released from the HEC, while the remaining 10% are admitted into the hospital for further treatment. The final release/hospital admission process consists of the following activities:
   1. In case of release, an administrative clerk fills out the release papers.
   2. In case of admission into the hospital, an Administrative Clerk fills out the patient's admission papers. The patient must then wait for a hospital bed to

become available (*Admission*). Finally, the patient is transferred to the hospital bed.

h. The HEC has the following resources: nurses, physicians, technicians, administrative clerks, Medical and Administrative rooms.

i. Due to cost and layout considerations, hospital administrators have determined that the staffing level must not exceed 7+2 nurses, 3+1 physicians, 4 technicians, and 4+4 Administrative Clerks.

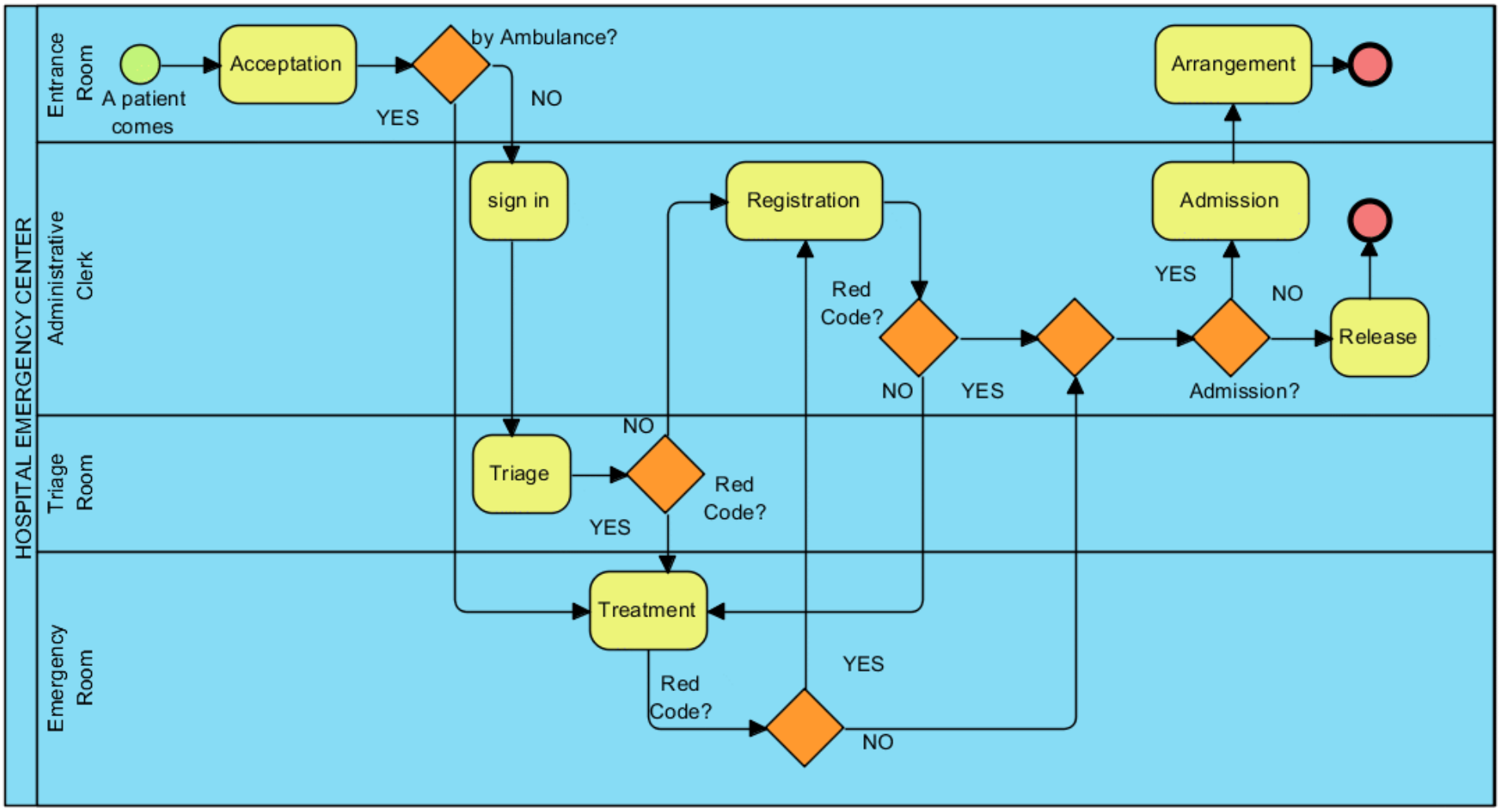
j. Furthermore, the HEC has 7 medical and 13 administrative rooms available; however, using fewer rooms would be beneficial, since other departments in the hospital could use the additional space more profitably. The hospital wants to find the configuration of the above resources that minimizes the total asset cost. The asset cost includes the staff's hourly wages and the fixed cost of each room used. We must also make sure that the **total cost is lower than 300K$** and that, on average, patients do **not spend more than 6 hours** in the HEC.

k. Summary of parameters and constraints

Resource or Activity	**Data or Constraints**
Admission	90% of all patients are released 10% are admitted for further treatment

By Ambulance	5.6 % of all patients
RED code	14.8 % of all patients
Available Nurses	7+2
Available Physicians	3+1
Available Technicians	4
Available Administrative Clerks	4+4
Available rooms	20 (using fewer rooms would be beneficial)
Staff's hourly wages ($):	Nurse: 54.10 Physician: 78.70 Technician: 36.54 Admin: 29.03
Fixed Cost of each room used ($)	55800 (Medical Room) 13200 (Administrative Room)
Max Average Time spent per patient	Less than or equal to 2h 24 m
Acceptation	30s / 0.24$ (1 Admin.)
Sign in (average duration/cost)	3m 12s / 1.55$ (1 Admin.)
Triage (average duration/cost)	5m 24s / 11.95$ (1 Nurse + 1 Phys.)
Registration (average duration/cost)	9m 30s / 4.59$ (1 Admin.)
Admission (average duration/cost)	3m 42s / 1.79$ (1 Admin.)
Release (average duration/cost)	2m 12s / 1.06$ (1 Admin.)
Treatment (average duration/cost)	25m 54s / 80.69$ (2 Nurses + 1 Phys.)
Arrangement (average duration/cost)	21m 15s / 10.28$ (1 Admin.)

1. An example of BPMN process layout:



Exercise:

a. Create all scenarios according to the above constraints, for 100 patients.

b. Try the following configuration, and compute the average patient cycle time.

N. of Lanes	**Related Activities and required resources**
1 Entrance	Acceptation, Arrangement: 1 Admin Clerk + 1 Admin Room
3 Administrative Service	Sign in, Registration, Admission, Release: 1 Adm Clerk + 1 Adm Room
1 Triage	Triage: 1 Nurse + 1 Physician + 1 Medical Room
2 Emergency	Treatment: 2 Nurses + 1 Physician + 1 Techn + 1 Med Room

c. Discover other configurations, able to decrease the average patient cycle time

d. Redesign some features of the model to improve the cycle time of patients. In the new model, we assume that patients can go through the treatment process and the registration process in parallel. That is, we assume that, while the patient is undergoing treatment, the registration process is being done by a surrogate or whoever is accompanying the patient. If the patient's condition is very critical, someone else can provide the registration data; however, if the patient's condition allows it, then the patient can provide the registration data during treatment.

e. Compute the Total Asset Cost for this configuration, and discover some optimal solution that minimizes the average patient cycle time.