Erasmus School of Health Policy & Management

Health Service Operations Management of Units

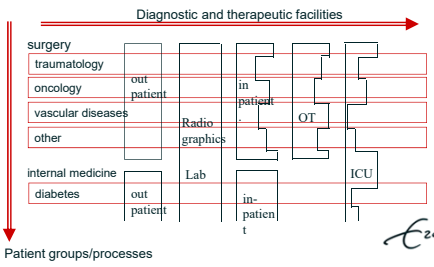
Dr. ir. drs Sylvia Elkhuizen
elkhuizen@eshpm.eur.nl

Prof.dr.ir. Jan Vissers
Erasmus University Rotterdam

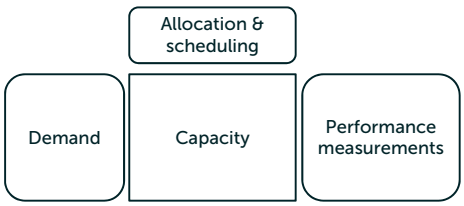
Unit – Process/Chain - Network

- Unit
  - a department in a health organization that performs operations of the same operation type
- Process/Chain
  - series of operations that need to be performed to produce a particular service for a specific patient group
- Network
  - combination of units and chains performing operations for services for several groups of clients

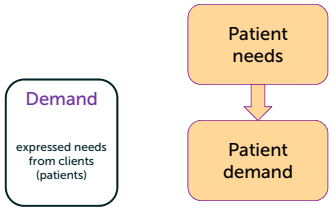
Units, chains and network



Operations Management of Units



Unit Operations Management



Measuring and defining Demand

Demand

expressed needs from clients (patients)

- Patient groups & characteristics
  - Scheduled/unscheduled
  - Urgency
- Arrival patterns
  - Average amounts
  - Variation
  - Predictability
- Arrangements with other units

Unit Operations Management

DEMAND
Patient groups & characteristics
Arrival patterns
Arrangements with other units

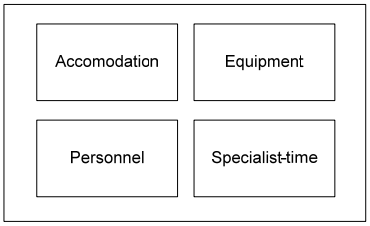
CAPACITY
access to resources that are required for the operations of the unit

Defining and measuring Capacity

DEMAND
Patient groups & characteristics
Arrival patterns
Arrangements with other units

CAPACITY
Resources & characteristics
Available capacity

Workstation = constellation of resources



Characteristics of resources

- Dedicated and shared resources
- Leading and following resources
- Continuous or intermittently available resources

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Availability of resources

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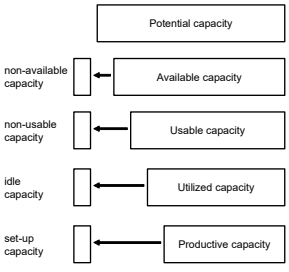
Resource use



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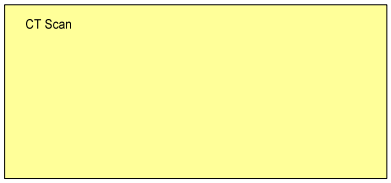
Example availability: potential capacity



Potential capacity
52 weeks
7 days
24hours

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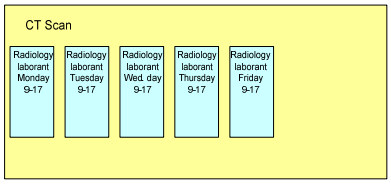
Available capacity



Potential capacity
52 weeks
7 days
24hours

Available capacity
50 weeks
5 days
8 hours

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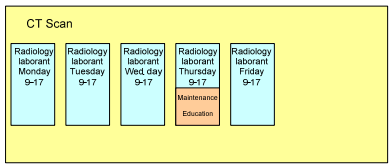
Usable capacity



Potential capacity
52 weeks
7 days
24hours

Available capacity
50 weeks
5 days
8 hours

Usable capacity
50weeks
4,5days
8 hours

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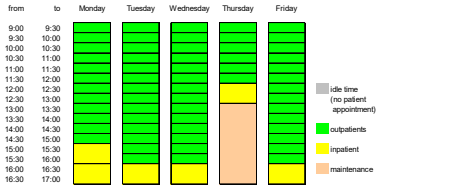
Usable capacity → appointment schedule



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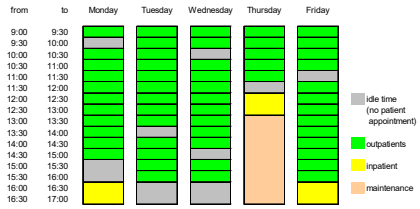
Utilised capacity



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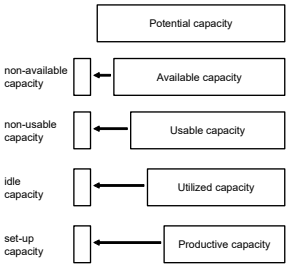
Resource use



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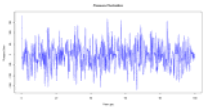
Finding a balance

DEMAND
Patient groups & characteristics
Arrival patterns
Arrangements with other units

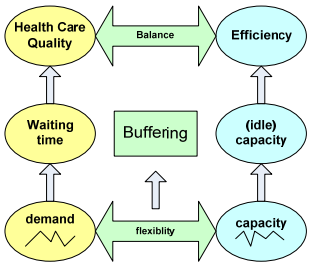
CAPACITY
Resources & characteristics
Available capacity

Uncertainty and flexibility

- Uncertainty
  - demand
  - capacity



- Flexibility
  - the adaptability of the production system to changes in demand



Unit operations management

DEMAND
Patient groups & characteristics
Arrival patterns
Arrangements with other units

CAPACITY
Resources & characteristics
Available capacity

PERFORMANCE MEASUREMENTS

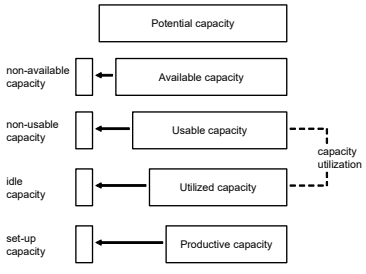
Unit operations management

Provider related performance indicators:
- Utilization
- Workload, overtime
- Satisfaction

Patient related performance indicators:
- Access time
- Waiting time
- Satisfaction

PERFORMANCE MEASUREMENTS

Utilization



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Appointment schedule

		Monday	Tuesday	Wednesday	Thursday	Friday
08:00	08:15					
08:15	08:30					
08:30	08:45					
08:45	09:00					
09:00	09:15					
09:15	09:30					
09:30	09:45					
09:45	10:00					
10:00	10:30					
10:30	11:00					
11:00	11:30					
11:30	11:45					
11:45	12:00					

reserved for emergency patients
outpatient
inpatient

Patients scheduled

		Monday	Tuesday	Wednesday	Thursday	Friday
08:00	08:15		Patient	Patient	Patient	Patient
08:15	08:30	Patient	Patient	Patient	Patient	Patient
08:30	08:45	Patient	Patient		Patient	Patient
08:45	09:00	Patient	Patient	Patient	Patient	Patient
09:00	09:15	Patient	Patient	Patient	Patient	Patient
09:15	09:30	Patient	Patient	Patient	Patient	Patient
09:30	09:45	Patient	Patient	Patient		Patient
09:45	10:00	Patient	Patient	Patient	Patient	Patient
10:00	10:30		Patient	Patient		Patient
10:30	11:00			Patient	Patient	
11:00	11:30	Patient		Patient	Patient	
11:30	11:45		Patient			Patient
11:45	12:00	Patient			Patient	Patient

reserved for emergency patients
outpatient
inpatient
no patient scheduled

Utilization?

$$U = \frac{Utilized\ capacity}{Usable\ capacity}$$

		Monday	Tuesday	Wednesday	Thursday	Friday
08:00	08:15		Patient	Patient	Patient	Patient
08:15	08:30	Patient	Patient	Patient	Patient	Patient
08:30	08:45	Patient	Patient		Patient	Patient
08:45	09:00	Patient	Patient	Patient	Patient	Patient
09:00	09:15	Patient	Patient	Patient	Patient	Patient
09:15	09:30	Patient	Patient	Patient	Patient	Patient
09:30	09:45	Patient	Patient	Patient		Patient
09:45	10:00	Patient	Patient	Patient	Patient	Patient
10:00	10:30		Patient	Patient		Patient
10:30	11:00			Patient	Patient	
11:00	11:30	Patient		Patient	Patient	
11:30	11:45		Patient			Patient
11:45	12:00	Patient			Patient	Patient

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Utilization

		Monday	Tuesday	Wednesday	Thursday	Friday
08:00	08:15		Patient	Patient	Patient	Patient
08:15	08:30	Patient	Patient	Patient	Patient	Patient
08:30	08:45	Patient	Patient		Patient	Patient
08:45	09:00	Patient	Patient	Patient	Patient	Patient
09:00	09:15	Patient	Patient	Patient	Patient	Patient
09:15	09:30	Patient	Patient	Patient	Patient	Patient
09:30	09:45	Patient	Patient	Patient		Patient
09:45	10:00	Patient	Patient	Patient	Patient	Patient
10:00	10:30		Patient	Patient		Patient
10:30	11:00			Patient	Patient	
11:00	11:30	Patient		Patient	Patient	
11:30	11:45		Patient			Patient
11:45	12:00	Patient			Patient	Patient

reserved for emergency patients
outpatient
inpatient
no patient scheduled

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A scheduled day in practice

- Patient 1 is arriving late
- Patient 4 is not showing up
- Patient 5 needs more time
- Patients 7,8 & 10 need less time

- Usable capacity : 4 hours
- Utilized capacity: 2.5 hrs

- Utilization = 2.5/4 = 62.5%

		Thursday	utilized capacity (minutes)	non-utilized capacity (minutes)
08:00	08:05			5
08:05	08:20	Patient 1	15	
08:20	08:35	Patient 2	15	
08:35	08:50	Patient 3	15	
08:50	09:00	No Show		10
09:00	09:20	Patient 5	20	
09:20	09:35	Patient 6	15	
09:35	09:45			10
09:45	09:55	Patient 7	10	
09:55	10:30			35
10:30	10:50	Patient 8	20	
10:50	11:00			10
11:00	11:30	Patient 9	30	
11:30	11:45			15
11:45	11:55	Patient 10	10	
11:55	12:00			5

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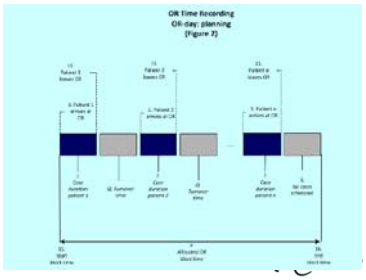
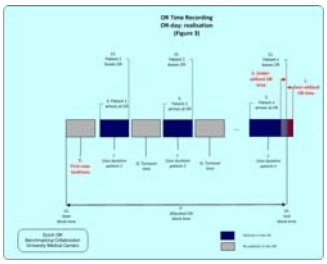
Research project: benchmarking OR utilization



Example: Benchmarking Operating Theatres in UMC's

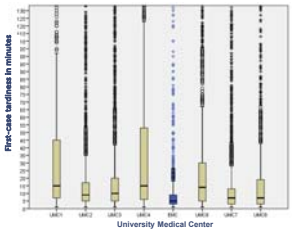


Performance Indicators

- Utilization (net% and gross%)
- First-case tardiness
- Turnover time
- empty OR time at the end of the day
- Over-utilized time
- Case duration accuracy
- Cancellation rate

First-case tardiness per UMC 2011

All eight UMC's, merely inpatient surgical cases
Erasmus Medical Center merely OR H-building, 11th floor



	Frequency first-case tardiness
	2011
UMC1	0.79
UMC2	0.71
UMC3	0.62
UMC4	0.55
EMC	0.63
UMC6	0.66
UMC7	0.56
UMC8	0.87

First-case' tardiness was defined by the difference between the scheduled starting time (generally 8:00 AM) and the actual room entry time of the first patient on that day (per operating room). This value was zero if the case entered the OR early or exactly on the scheduled time. The common scheduled starting time was adjusted in case of an intentionally altered starting time. Every minute of FCT was calculated.

Frequency per OR-day can be interpreted as the percentage of ORs (allocated/open that day) starting too late on any given day.

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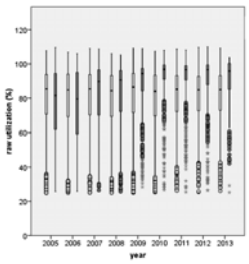
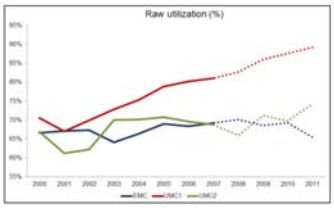
Comparison and learning





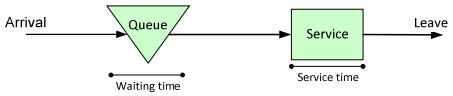
Unit operations management

Provider related performance indicators:
- Utilization
- Workload, overtime
- Satisfaction

Patient related performance indicators:
- Access time
- Waiting time
- Satisfaction

PERFORMANCE MEASUREMENTS

Waiting time model



- Patient arrival pattern
  - Patient decision:
  - Entering the queue
  - Leave direct
  - Leaving the queue after some time

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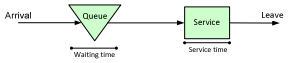
Waiting time model – service characteristics



- Service time distribution
- Number of servers
- Waiting line system
- Queue capacity
- Queuing discipline
  - First Come First Served (FCFS)
  - Last Come First Served
  - Different Priorities

"Age? You mean now or when we first sat down?"

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Waiting time model - notation

A / B / X / Y / Z

- A = arrival distribution
- B = service distribution
- X = number of servers
- Y = system capacity
- Z = queuing discipline

M/M/c

- M: Poisson arrivals
- M: Poisson service time
- c = number of servers
- Y = infinite
- Z = FCFS

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Calculating waiting time M/M/1

λ= arrivals per time unit

μ = services per time unit

$$\rho = \frac{\lambda}{\mu} \qquad W_q = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$W = W_q + \frac{1}{\mu}$$

Example: walk in facility

- Average number of arrivals: 9 patients per hour
- Time per patient: 5 minutes

- λ = ?
- μ = ?

W_q = ?

W = ?

ρ =?

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Some additional calculations

L = average number of patients in the system= $\lambda * W$

L_q = average number of patients in the queue = $\lambda * W_q$

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Example: walk in facility, high utilization

- Time per patient: 5 minutes
- Average number of arrivals: 11 patients per hour

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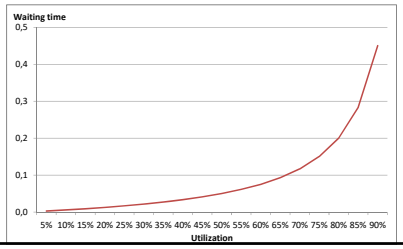
Utilization and waiting time

Utilization ↑ ⇨ Waiting time ↑



Queuing models: 2 servers

M/M/1	2 servers
Number of servers = 1	Number of servers = 2
Arrivals = 9 per hour	Arrivals = 18 per hour
Service = 12 per server per hour	Service = 12 per server per hour

- Utilization: decrease / remain the same / increase ?

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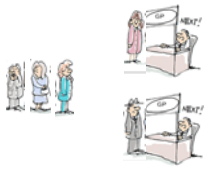
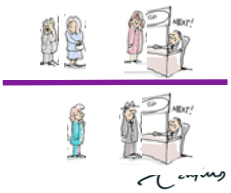
Queuing models: 2 servers

- One shared waiting line



- Two separate waiting lines

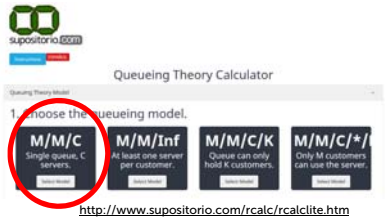


Queuing models: compare the systems

M/M/1	2 servers
Number of servers = 1	Number of servers = 2
Arrivals = 9 per hour	Arrivals = 18 per hour
Service = 12 per server per hour	Service = 12 per server per hour

Go to https://www.menti.com/ use code: 741861

Queuing calculator



http://www.supositorio.com/rcalc/rcalclite.htm

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Unit operations management

ALLOCATION & SCHEDULING

DEMAND
Patient groups & characteristics
Arrival patterns
Arrangements with other units

CAPACITY
Resources & characteristics
Available capacity

PERFORMANCE
Provider related indicators
Patient related indicators

Resource allocation and scheduling

- Resource allocation:
  the allocation of resources to departments and specialties at tactical level
  (lump sum allocation)

- Resource scheduling:
  the scheduling of resources for providing services at operational level
  (the detailed allocation in time)

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Resource scheduling methods

- Walk-in
- Appointment scheduling
- Waiting list

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Resource scheduling methods

- Walk-in
- Appointment scheduling
- Waiting list

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Research Project: Allocation of capacity for combining walk-in and appointment scheduling for Pre-Operative Screening

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DEMAND
Patient characteristics:
- (expected) complexity
- distance
- timing

CAPACITY
walk-in hours
appointments
telephone calls

PERFORMANCE
patient satisfaction
utilization

Challenge: optimal scheme to adapt capacity to demand

Monday	Tuesday	Wednesday	Thursday	Friday
Appointments	Appointments	Appointments	Appointments	Appointments
Walk-in	Walk-in		Walk-in	Walk-in
Telephone calls	Telephone calls	Walk-in		Telephone calls
Appointments	Appointments	Appointments	Telephone calls	Appointments
Walk-in	Walk-in	Walk-in	Appointments	Walk-in
			Walk-in	

Unit operations management

ALLOCATION & SCHEDULING

DEMAND
Patient groups & characteristics
Arrival patterns
Arrangements with other units

CAPACITY
Resources & characteristics
Available capacity

PERFORMANCE
Provider related indicators
Patient related indicators

Erasmus School of Health Policy & Management

Working group assignments

Erasmus University Rotterdam

Assignments, part 1

Study the data on patients in the file.
For this working group, we only will use the data about the inpatient part, from 'admission date' until 'discharge date'.

You will perform a 'demand and capacity'-analysis concerning the demand for beds in a patient ward. We limit the calculations to 2016 (1 jan -31 dec)

Part 1, basic calculations.
- Calculate:
  - Minimum, maximum, average total number of beds used
  - Days with a shortage, and number of beds used in other wards
  - Utilization
- Frequencies: make a table and diagram

Assignments, part 2 & 3

Part 2: What-if analyses.
- Use your model to find out the number of beds needed if
  - a shortage is never allowed
  - the maximum number of days with a shortage is 5%
  - the utilization must be at least 90%
- Reflect on the results. How many beds would you advice for this ward?

Part 3: Improvement
- Think about relevant options to improve the performance of this ward.
- Perform what-if analysis for at least one improvement option