simbox

The role of mathematics in enhancing hospital efficiency and decision-making

Dennis Roubos

Chief Technology Officer,
Simbox

1982

Commodore 64

Liked mathematics

Graduated High school

2001

Graduated MSc. Business Mathematics & Informatics

2006

Developing webapps

Graduated PhD. Operations Research

2010

Interested in healthcare optimization

Developed math models for health care

Founded Simbox BV

2018

simbox

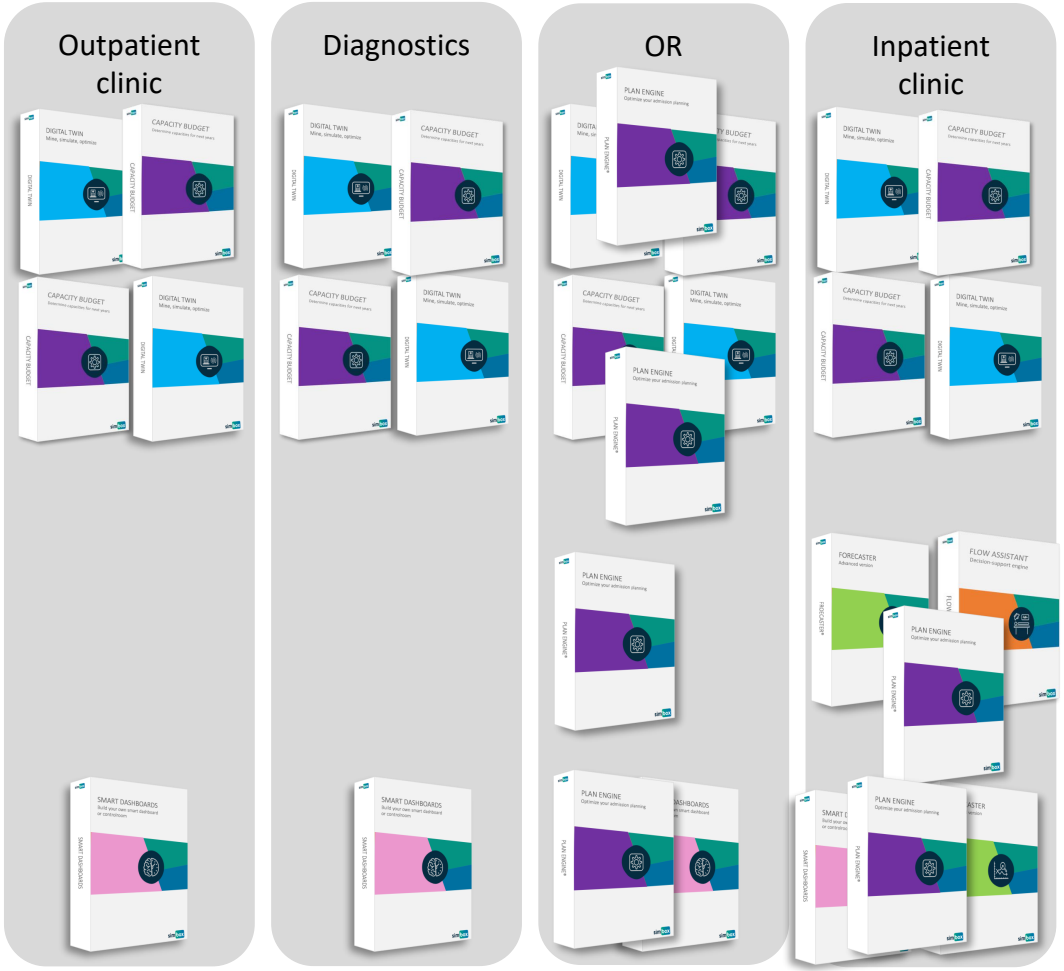
“Bring the unique and advanced mathematics to the hospital in an easy to use way”

Years
Strategical

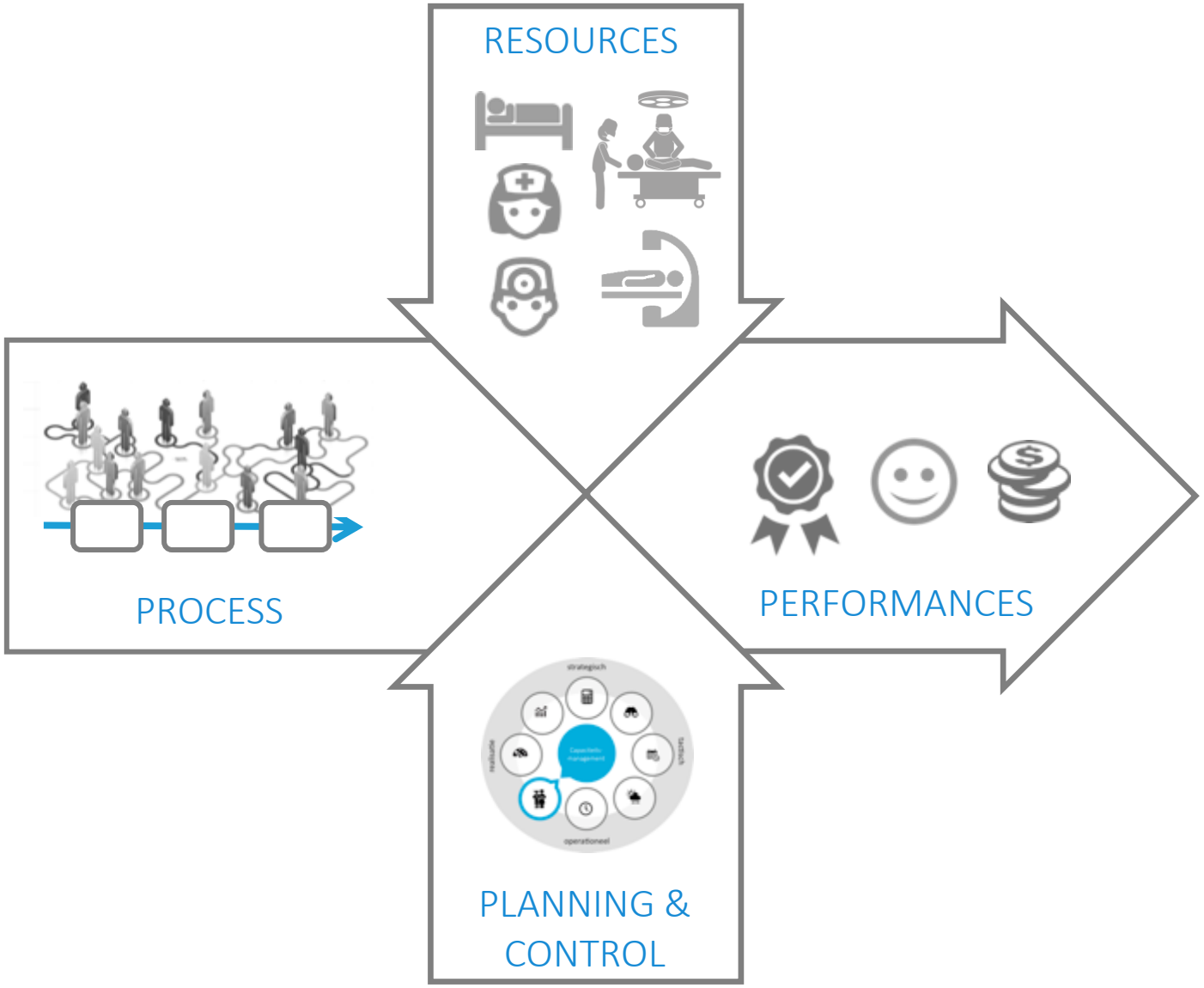
Months
Tactical

Weeks
Operational

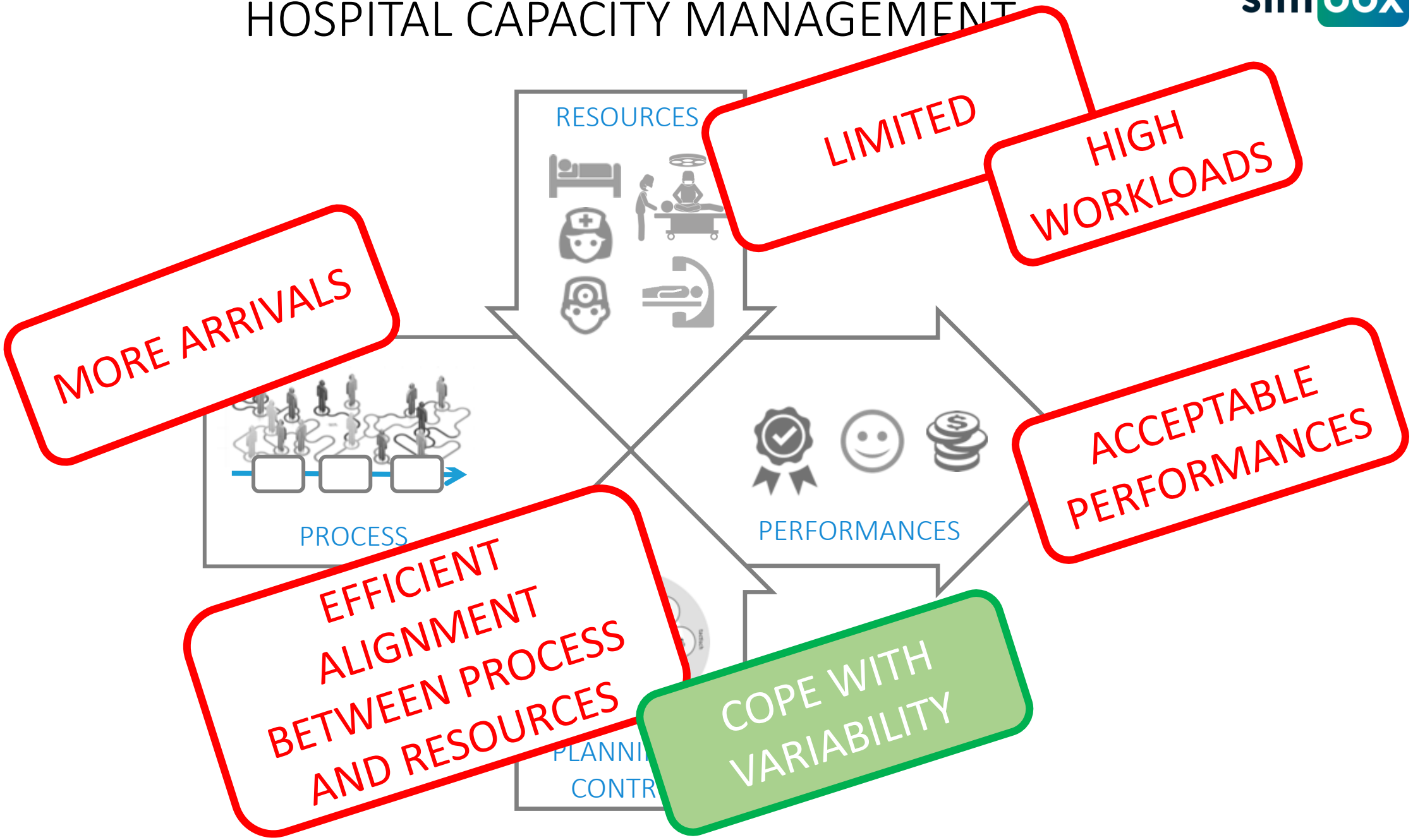
Today



HOSPITAL CAPACITY MANAGEMENT



HOSPITAL CAPACITY MANAGEMENT



CHALLENGE

REDUCE VARIABILITY BY MATHEMATICS

HOSPITAL SYSTEM THINKING
Variability & system performance

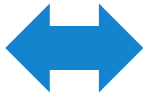
TYPES

ARRIVALS
VARIABILITY IN THE ARRIVALS / DEMAND FOR CARE

CAPACITY
VARIABILITY IN THE AVAILABILITY OF CAPACITY

ROUTING
VARIABILITY IN THE ROUTING OF PATIENTS

PROCES
VARIABILITY IN THE DURATION OF THE PROCESS

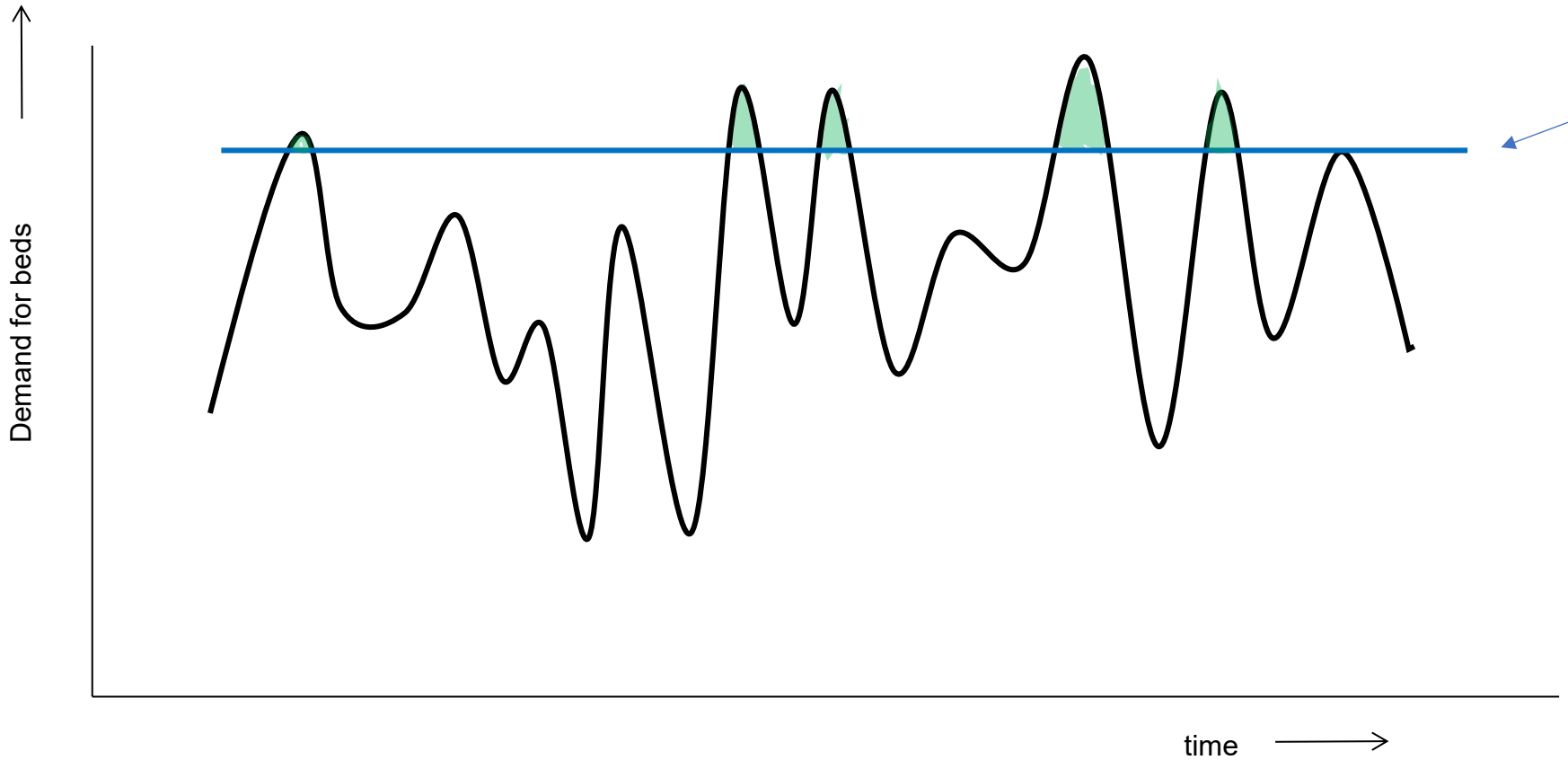


PROPERTIES

PREDICTABILITY
PREDICTABLE, NOT PREDICTABLE

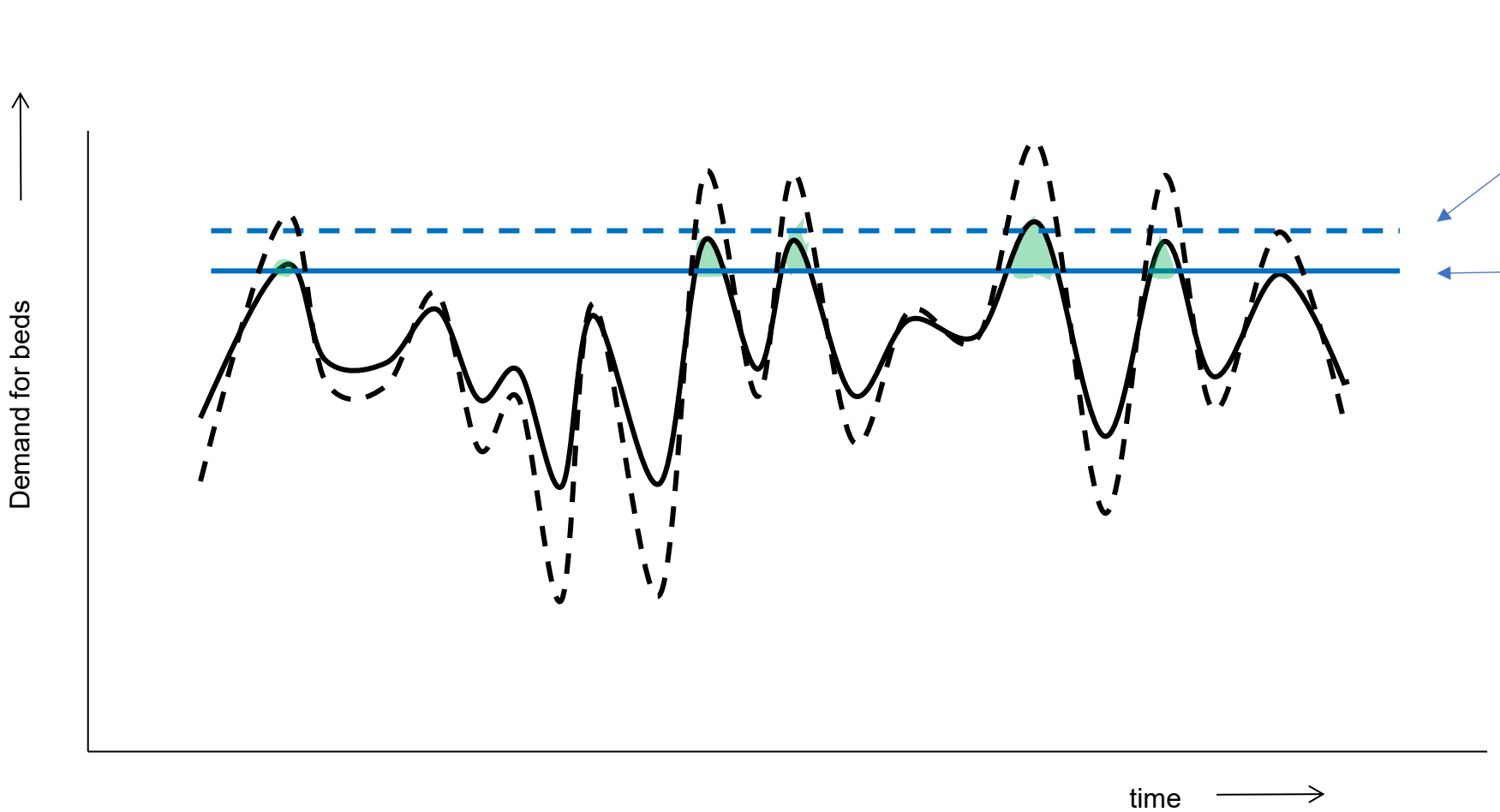
INFLUENTIAL
(NATURAL, UNNATURAL)

VARIABILITY



- **Large buffer**
- **Low occupancy percentage**

VARIABILITY – STABILIZATION / OPTIMIZATION

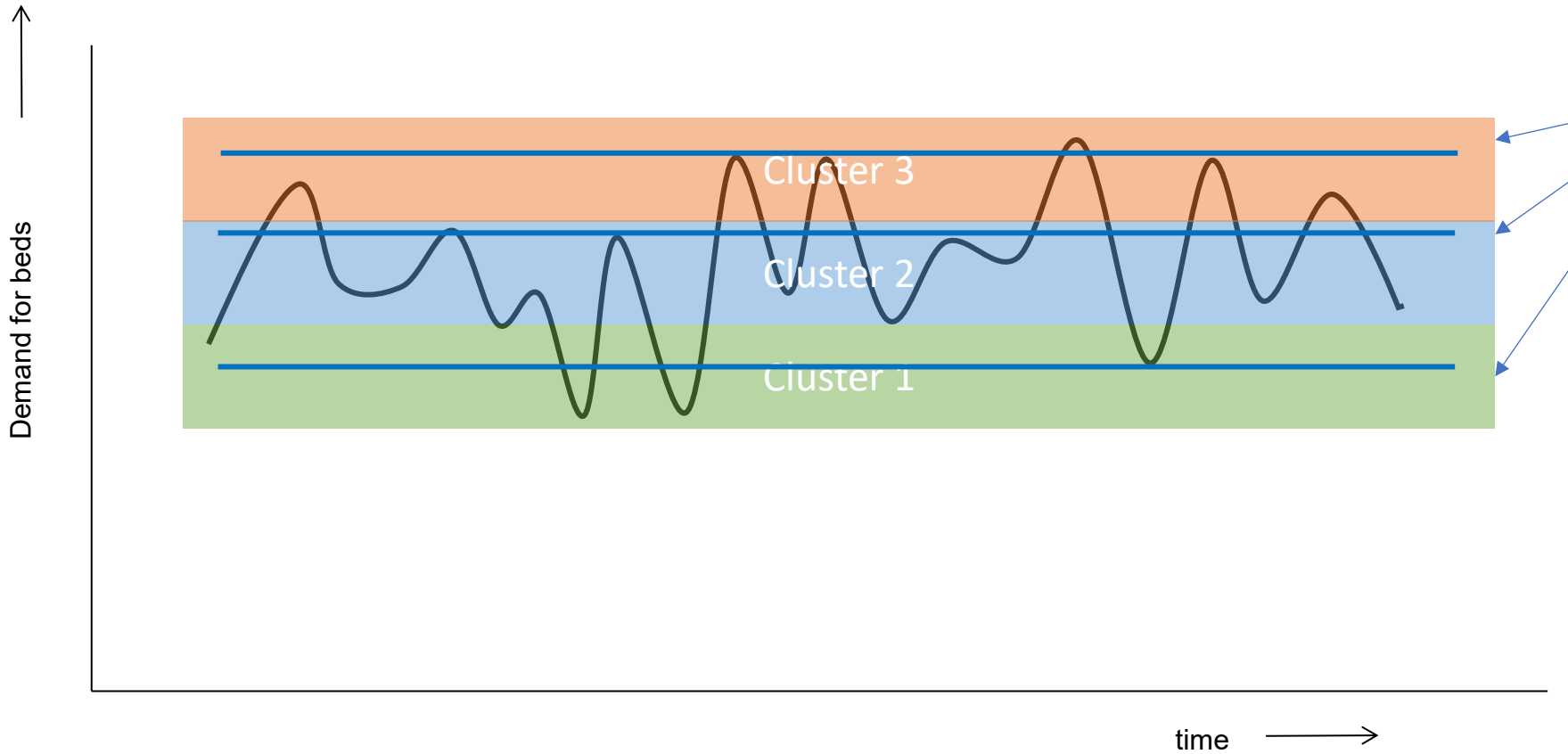


Previously required capacity

Required capacity

- **Smaller buffer**
- **Higher occupancy percentage**

VARIABILITY - FORECASTING

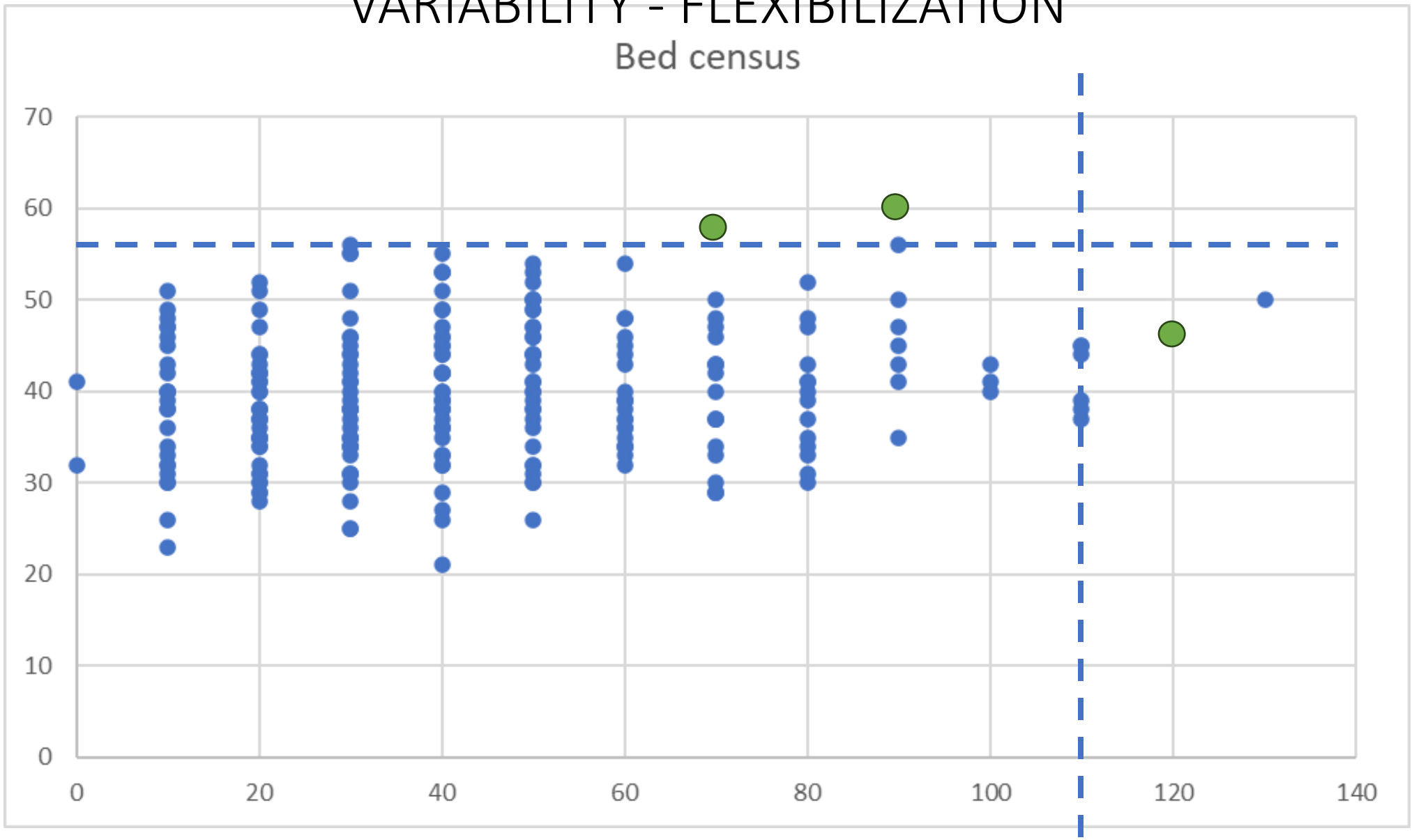


Amount of variability within cluster reduces

Need to forecast / seasonality

Overall required capacity reduces and improved occupancy percentage

VARIABILITY - FLEXIBILIZATION



HOSPITAL SYSTEM THINKING
Methods to cope with variability

STABILIZE

reducing avoidable variability to create a more predictable flow of patients.

- Master OR-schedule
- Streamlining workflows
- Standardizing procedures
- Admission blueprints

PREDICT

using data-driven forecasting to anticipate demand peaks, staffing needs, and resource constraints, enabling proactive planning.

- Demand forecasting
- Bed occupancy forecasting
- Flu-season forecasting

FLEXIBILIZATION

ensuring that staff, equipment, and spaces can be rapidly reallocated or scaled up and down to adapt to changing conditions.

- Staffing
- Bed capacities

DECISION-SUPPORT

Helping in making better evidence-based decisions by offering recommendations or alerts.

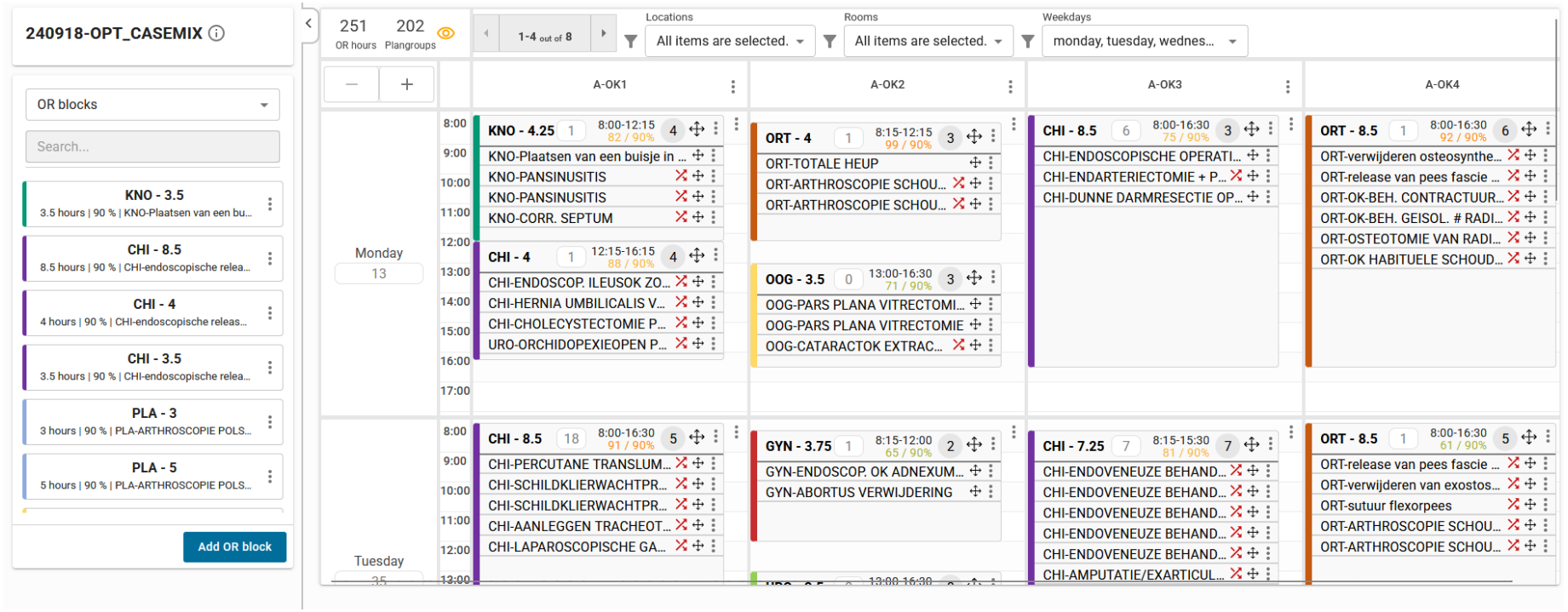
- Admission planning
- Early warnings

BUFFER

safety margins to absorb sudden spikes in demand without compromising care quality

- Reserve beds
- Time buffer in schedules
- Reserve staff

EXAMPLE STABILIZATION / OPTIMIZATION OF OR-MASTER SCHEDULE



Decision variables:

the number of surgeries of each group to be placed in a session

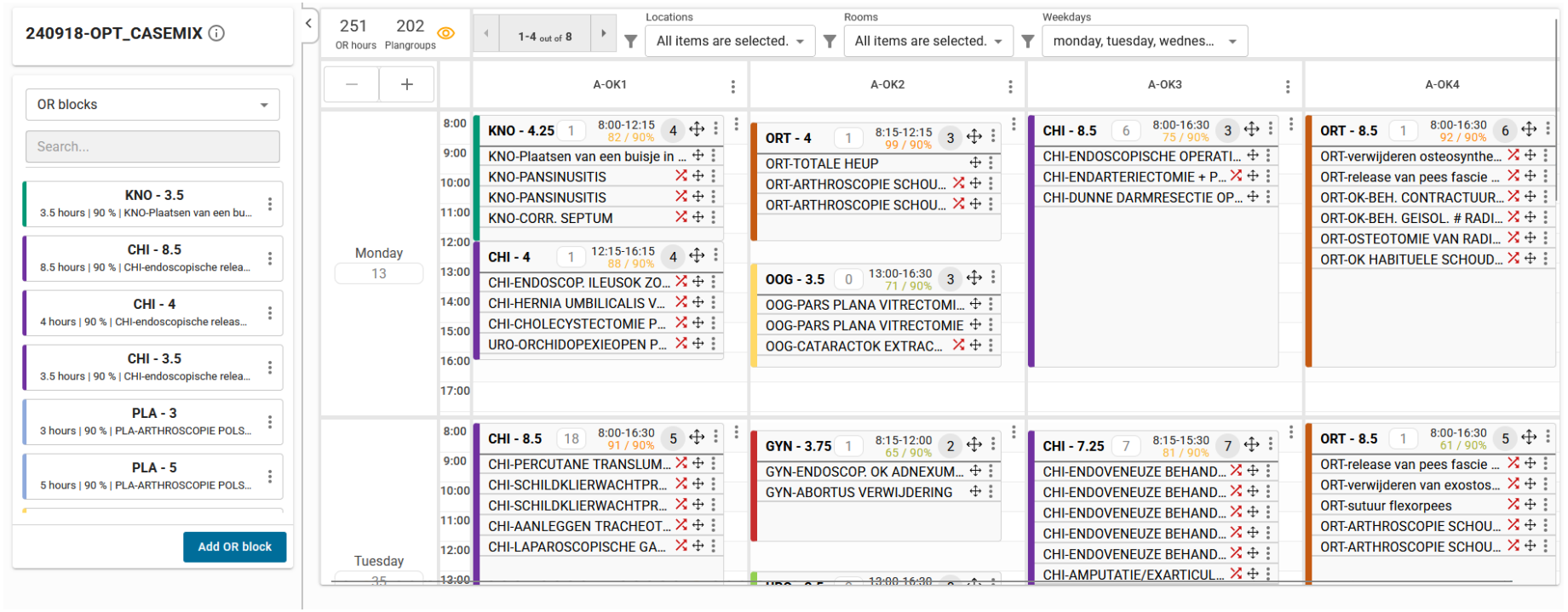
Objective function:

minimize the weighted sum of the difference between maximum and minimum occupancy of all departments

Contraints:

- Session length / occupancy
- Allowed to be placed in a session
- Locked groups
- Available bed capacity
- Number of groups
- Max number of changes

EXAMPLE STABILIZATION / OPTIMIZATION OF OR-MASTER SCHEDULE



Decision variables:

the room and weekday for each session

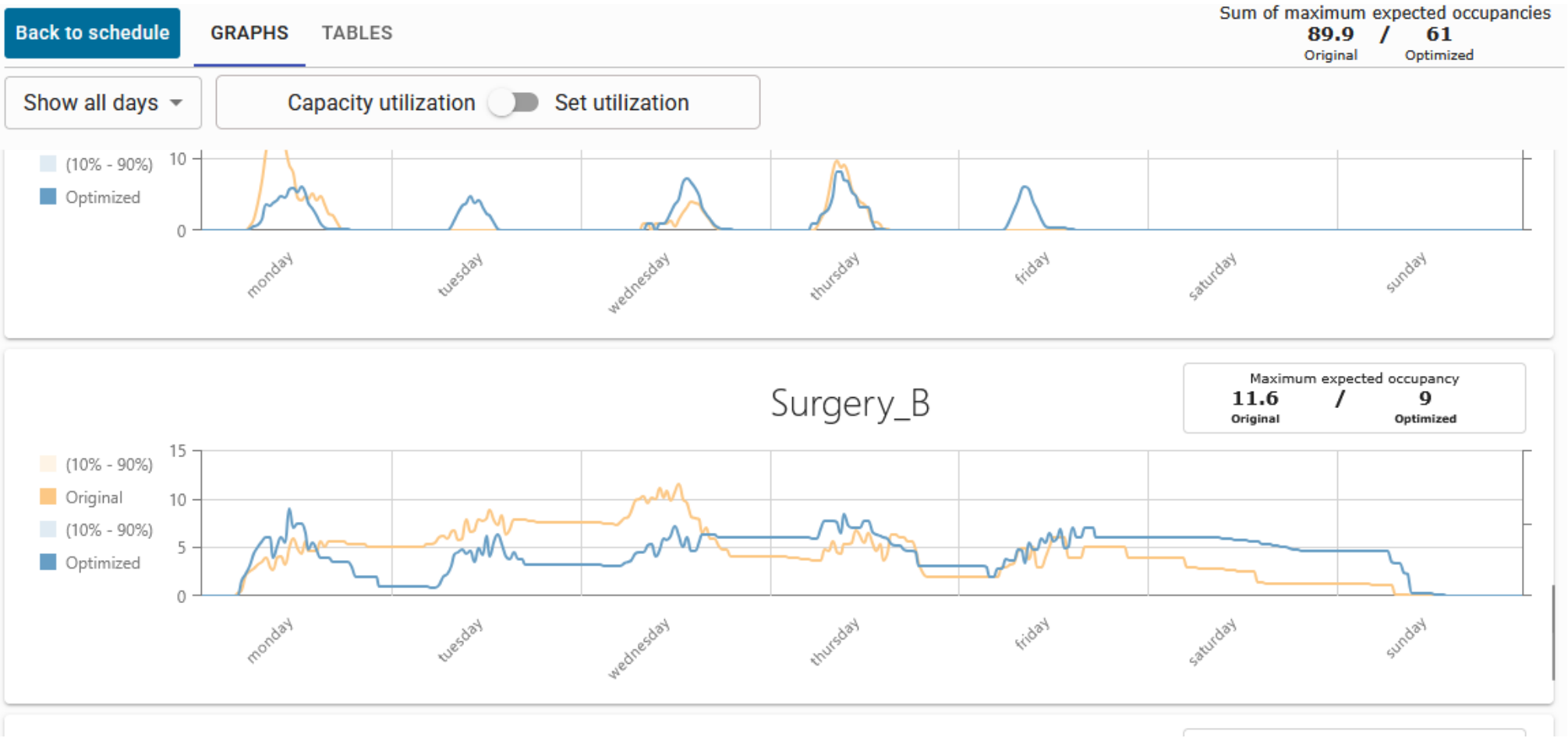
Objective function:

minimize the weighted sum of the difference between maximum and minimum occupancy of all departments

Contraints:

- Opening hours weekday/room
- Allowed to be placed in weekday/room
- Locked sessions
- Available bed capacity
- Number of sessions
- Max number of changes

EXAMPLE STABILIZATION / OPTIMIZATION OF OR-MASTER SCHEDULE



Challenge:
Change management?

Results:
An average, reduces amount of beds by 10 – 20%

November 2025

iconcare@work

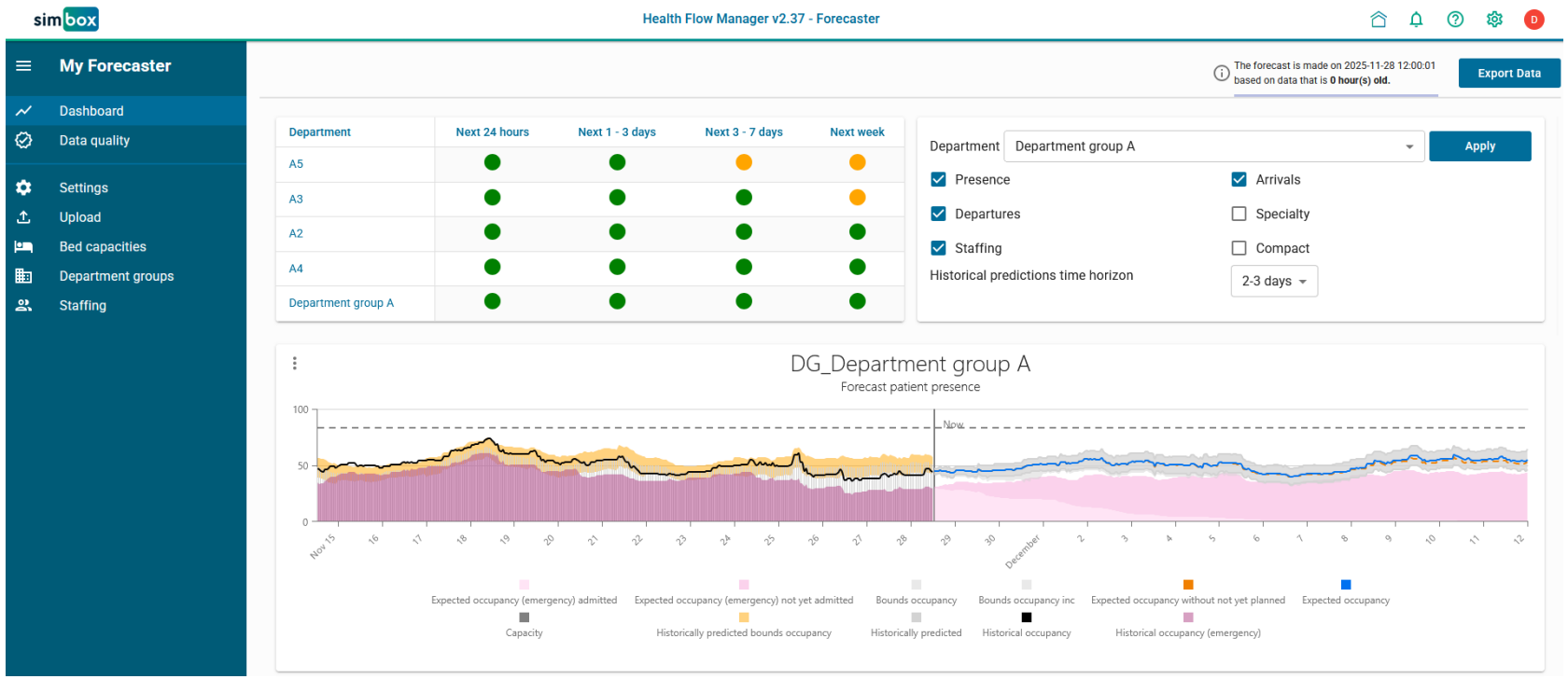
Tipp des Monats

20 % weniger Bettenbedarf bei gleicher Leistung
durch Simulation alternativer OP-Programme!

DAS PROBLEM

Die Planung des OP-Programms innerhalb vorgegebener Saalkontingente wird weitgehend den Fachabteilungen überlassen. Die Zuordnung von geplanten Eingriffen auf einzelne OP-Zeitslots im

EXAMPLE FORECASTING



Challenge:

How to convince the hospital that the predictions are accurate?

Data quality?

Results:

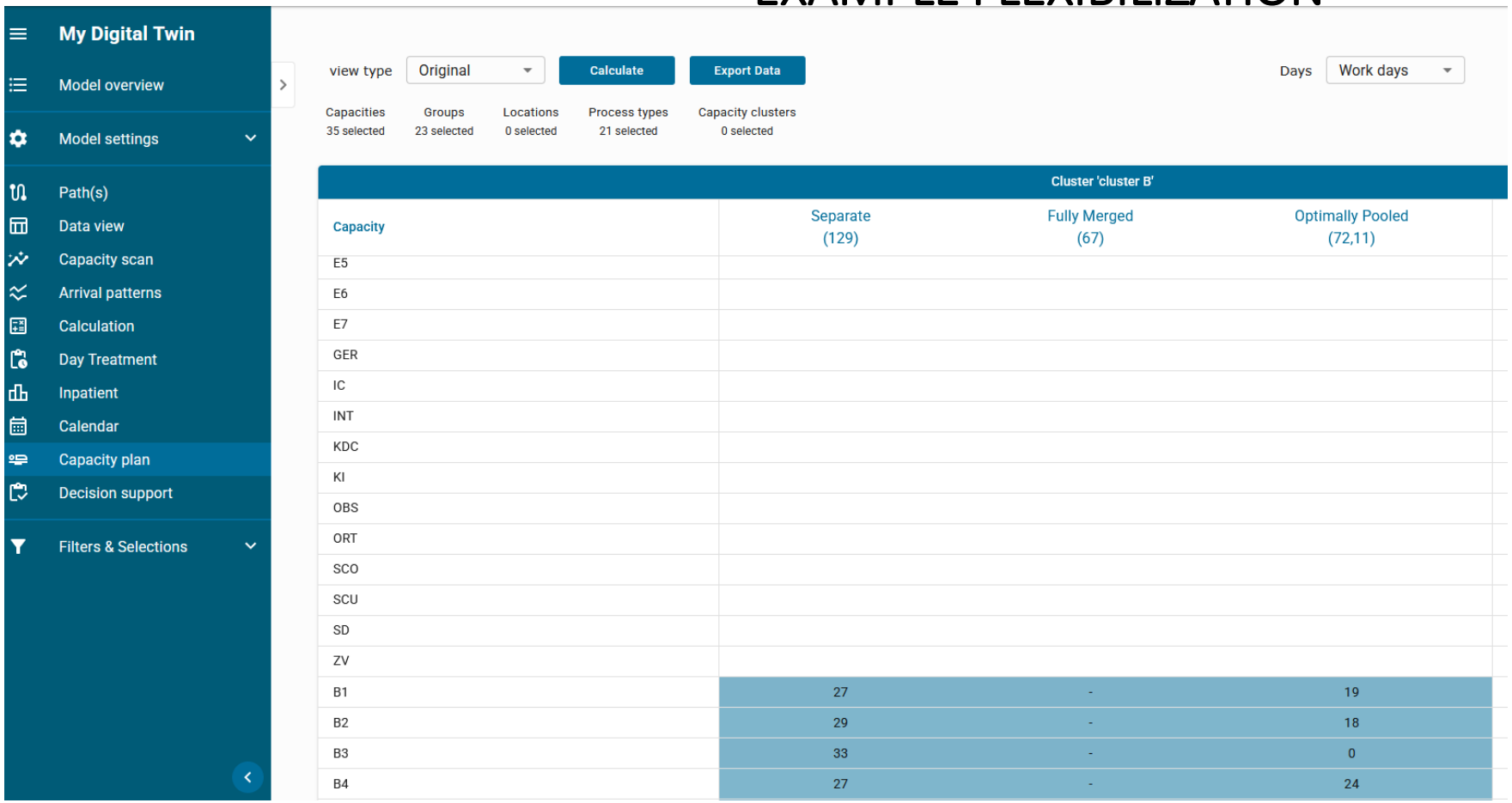
Well-formed decisions can be taken in advance

EXAMPLE FORECASTING

Challenge:
How to determine “equal” months/weekdays?

Results:
The amount of required capacity for each combination of month and weekday.

EXAMPLE FLEXIBILIZATION

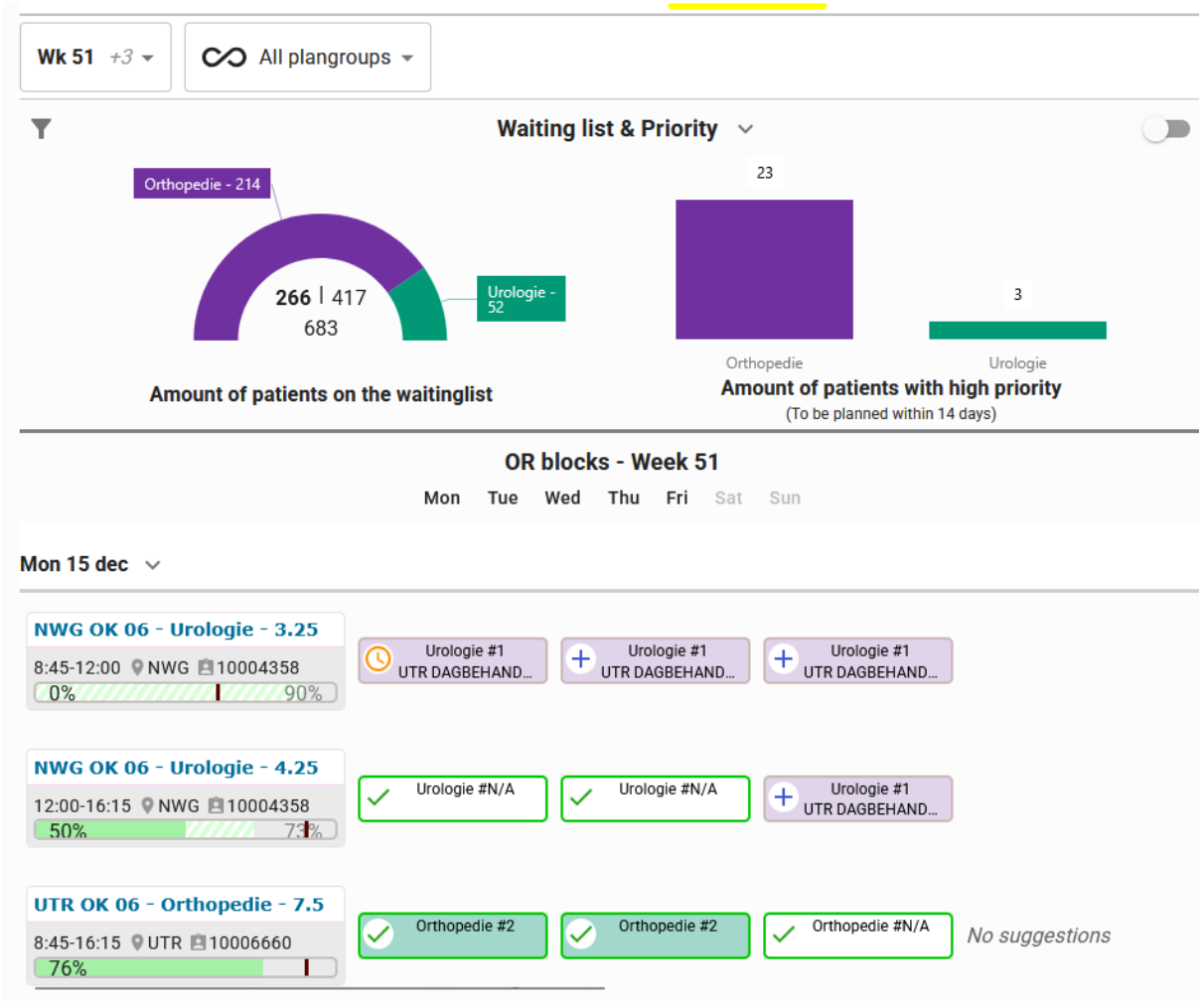


Cluster 'cluster B'			
Capacity	Separate (129)	Fully Merged (67)	Optimally Pooled (72,11)
E5			
E6			
E7			
GER			
IC			
INT			
KDC			
KI			
OBS			
ORT			
SCO			
SCU			
SD			
ZV			
B1	27	-	19
B2	29	-	18
B3	33	-	0
B4	27	-	24

Challenge:
What is “optimally pooled”? We looked at the kneepoint.

Result:
11 flexible beds of 72 beds (15%) is “optimal”. In general we see that 10 – 20% of flexible capacity is sufficient.

EXAMPLE DECISION-SUPPORT



Challenge:

Quick calculations
Realtime
Optimization of suggestions
Detection of length of stay clusters

Result:

(Not yet) plannable suggestions in OR sessions to optimize a combination of session occupancy, urgency and variability on departments / wards.

CONCLUSION

A BROAD FIELD OF MATHEMATICS IS APPLIED IN HEALTH CARE TO HELP HOSPITALS TO USE RESOURCES MORE EFFICIENTLY

simbox

Thank you for your attention.

Contact information:
dennis@simbox.ai