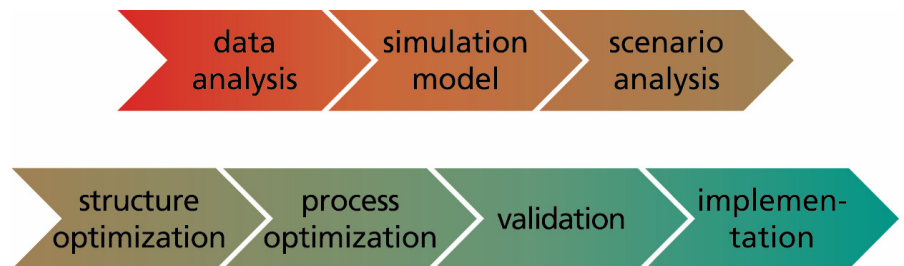

Hospital logistics: optimizing internal transports



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Simulation and optimization in hospitals: process model

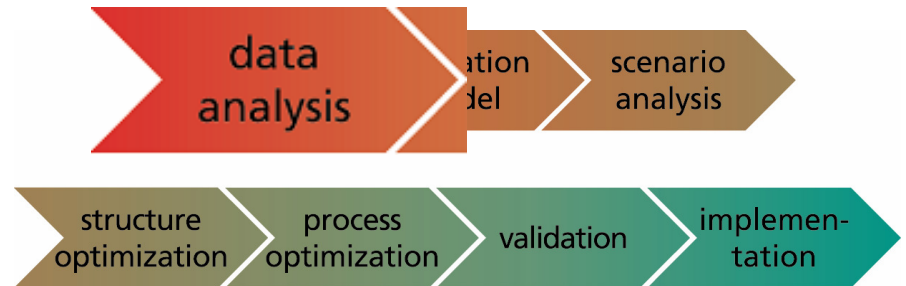


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Simulation and optimization in hospitals: process model

Data analysis

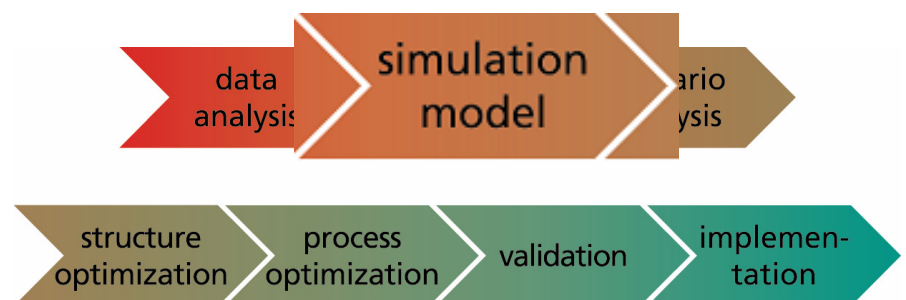
- Number of transportation requests?
- Which hospital wards have many transportation requests?
- Which requests have a long duration?
- ...



Simulation and optimization in hospitals: process model

Simulation model

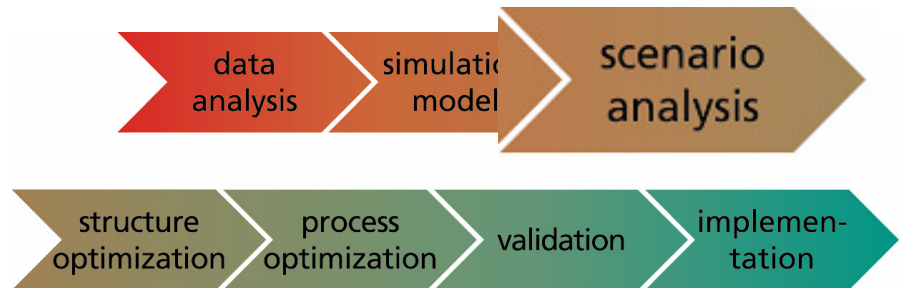
- Simulation of the current schedule of transportation requests



Simulation and optimization in hospitals: process model

Scenario analysis

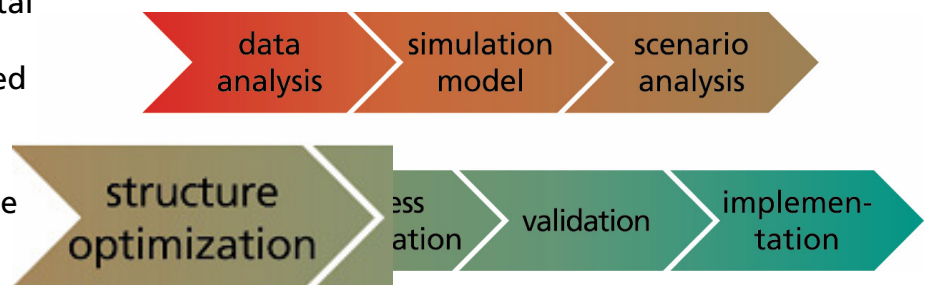
- Personnel: how can lateness be reduced by an increase of manpower?
- Organization: should individual employees be assigned to certain hospital wards?
- Traffic: should some one-way streets be changed?
- ...



Simulation and optimization in hospitals: process model

Structure optimization

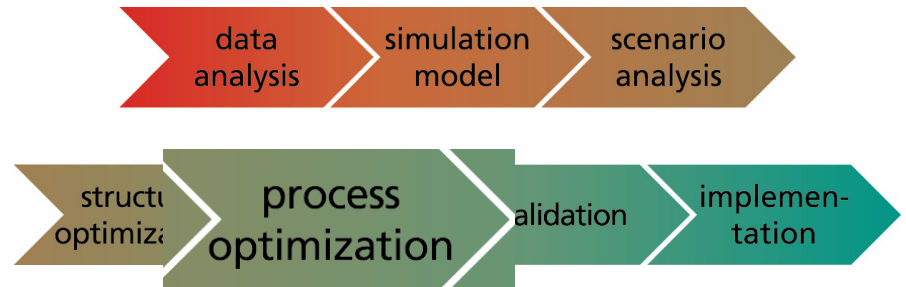
- Optimization of the hospital layout: should specific equipment be concentrated or distributed among different wards?
- Optimization of the vehicle fleet: how should the vehicles be equipped?
- ...



Simulation and optimization in hospitals: process model

Process optimization

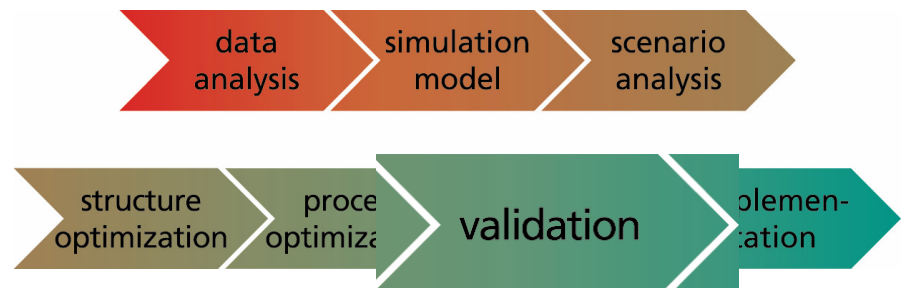
- Optimization of transport requests: which patient is transported by which employee?
- Optimization of personnel utilization: how many employees should be staffed in the individual shifts?
- ...



Simulation and optimization in hospitals: process model

Validation

- Use insight and strategies acquired from previous steps in the simulation model

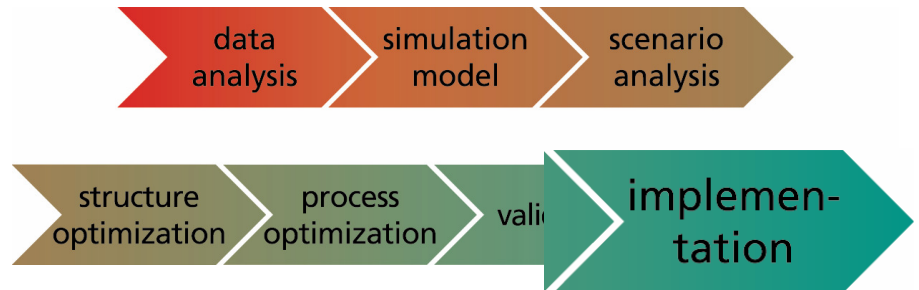


Simulation and optimization in hospitals: process model

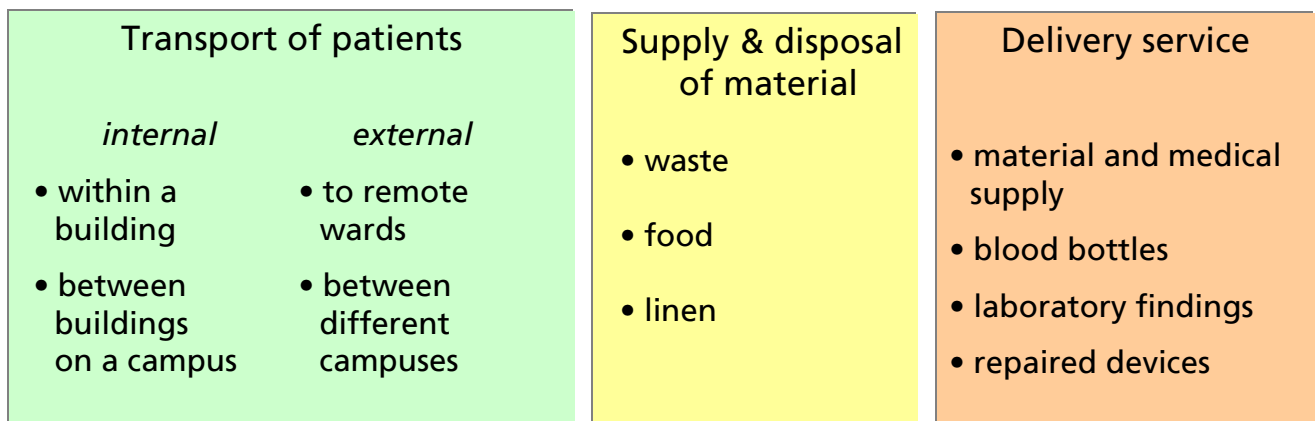
Implementation

- Software implementation and realization of organizational changes

Opti-Trans: a software tool for the optimization of transports in hospitals

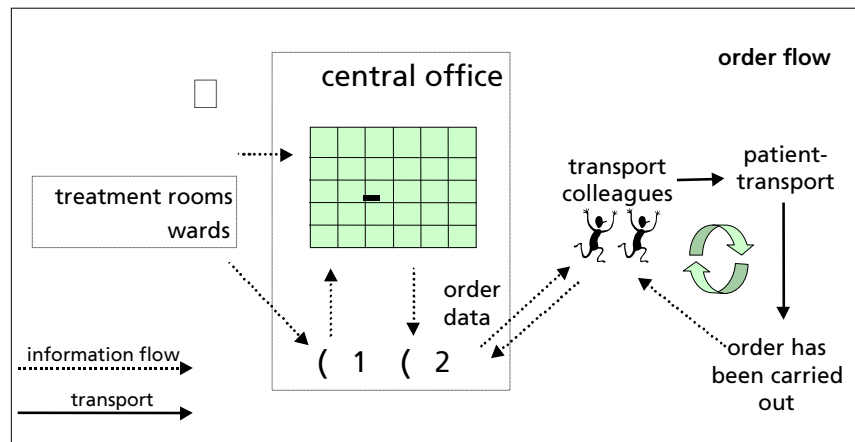


Transports in hospitals



Processing of transport requests for patients

- transport of patients on hospital campus
- several hundred requests for transportation per day
- requests are booked via telephone at the central dispatch office
- manual processing of orders (e.g. First-In-First-Out)
- orders are carried out in batches



Manual dispatching of transport requests

Consequences:

- no planning support → requests are frequently delayed
- no information about current status of requests (e.g. "seeking" the patient)
- employees are overtaxed
- no records of completed journeys → NO quality assurance and a subsequent process optimization

	Jäger	Nett
Fahrdienst	Col- Endos (Edeli) LW	Col- Endos Iso (Knopp) SW
Schmitt Ute	Reith	Grab
H2- Kard. i. d. Amb	H3- Sono	+H3- Sono
(Knopp) läuft	8 ¹⁵ (Sejkat) Zeit	8 ²⁰ (Fegor) SW
Engel	Schuchall	Sierke
36- Endos	W3- Dial	W3- Dial
10 ⁴⁵ (Kehl)	(Sejkat) SW	(Finn) SW
CG- Amb	E1- NeOP	A36- Dial
(Kehl)	(Fegor)	(Felix)
Reichmann	Grab	Ebert
H1- Sono	H3- UroOP	K2- Sono
8 ⁴⁵ (Sejkat) läuft	(Knopp) Zeit	13 ¹⁵ (Edeli) Zeit

The patients transport problem from a mathematical viewpoint

Classification

Vehicle routing problem / Dial-A-Ride problem with time windows (VRPTW)

Additional hospital inherent aspects

- Online-problem: only a small number of transportation requests is known in advance
- duration of transport not known in advance
- different types of transports (i.e. bed, wheelchair, on foot), transport aids
- accounting for transport priorities (especially in case of emergencies)
- special qualification of the personnel



Objectives

single objectives

- keeping the schedules / minimization of delays
- minimization of waiting periods (patients, employees)
- minimization of distances
- reduction of deadhead trips
- minimization of throughput times
- load balancing (across day, among employees)

multiple objectives

ranking of criteria - example:

1. criteria: minimization of delays
2. criteria: minimization of traveled distances
3. criteria: ...

weighting of criteria - example:

1. criteria: minimization of distances for patients (40%)
2. criteria: minimization of distances for employees (60%)



The case of Mainz University Hospital



Klinikum der
Johannes-Gutenberg-
Universität Mainz

1574 beds
approx. 60 buildings

- 115 requests / day
- 25% known in advance
- up to 2 transportation teams on foot
- up to 9 sub-contracted ambulances
- 1 own ambulance
- infectious patients
- manual processing & planning of transport requests

Data set 1

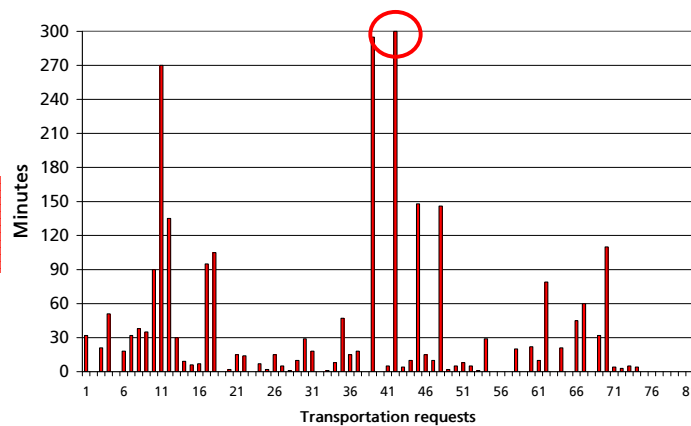
- 81 requests
- 23% known in advance (8.6% from previous day)
- service period from 7 am to 9:45 pm
- 6 priority classes
- max. 7 ambulances
- 1 transportation team on foot
- at most 1 patient per vehicle



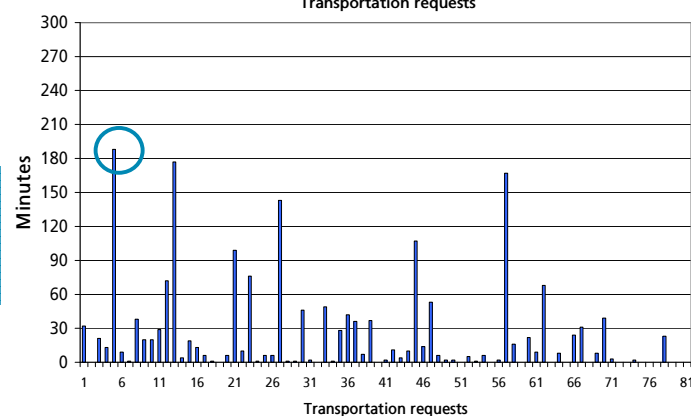
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Patient waiting times for data set 1

Manual
planning



Planning
with
optimization



Reduction of

- waiting time of
26%

- max. waiting time
of **37%**

The case of Mainz University Hospital



Klinikum der
Johannes-Gutenberg-
Universität Mainz

Data set 2

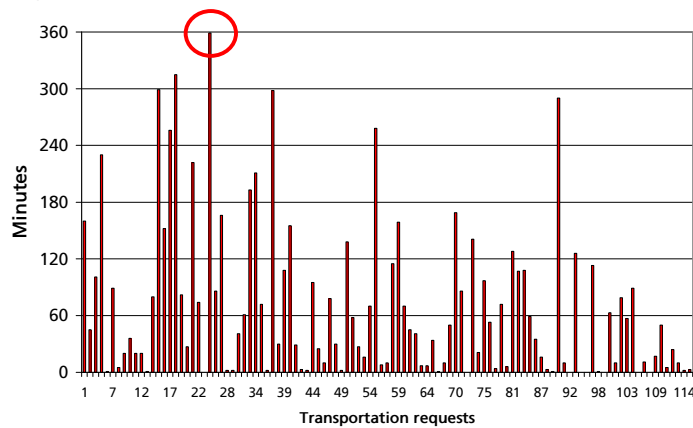
- 115 requests
- 26% known in advance (12% from previous day)
- service period from 7 am to 9:45 pm
- 6 priority classes
- max. 8 ambulances
- 2 transportation teams on foot
- at most 1 patient per vehicle



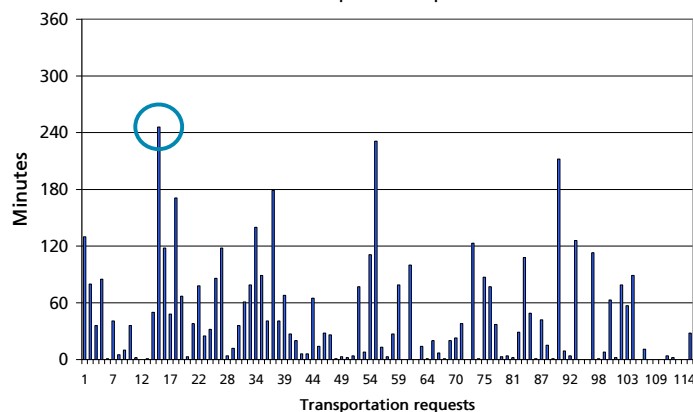
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Patient waiting times for data set 2

Manual
planning



Planning
with
optimization

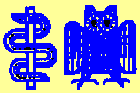


Reduction of

- waiting time of
38%

- max. waiting time
of **31.5%**

The case of Saarland University Hospital, Homburg



Universitätskliniken
des Saarlandes,
Homburg / Saar

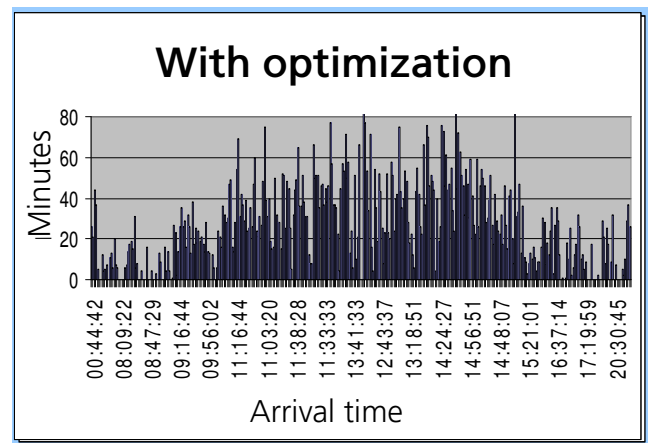
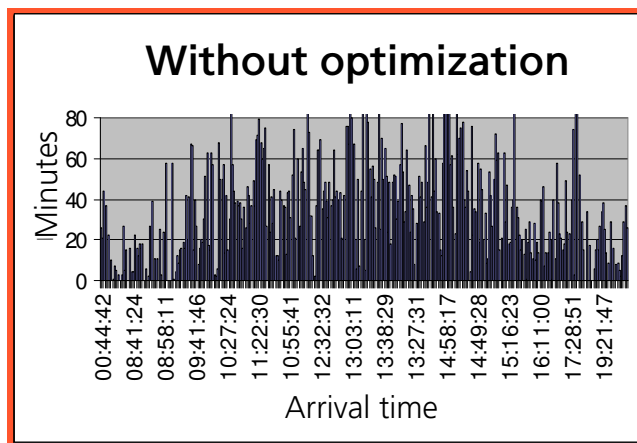
1500 beds
Campus with approx.
100 buildings

- 400 requests / day
- 10% known in advance
- transportation teams on foot
- up to 12 ambulances
- infectious patients
- hospital information system
- manual planning

Data set

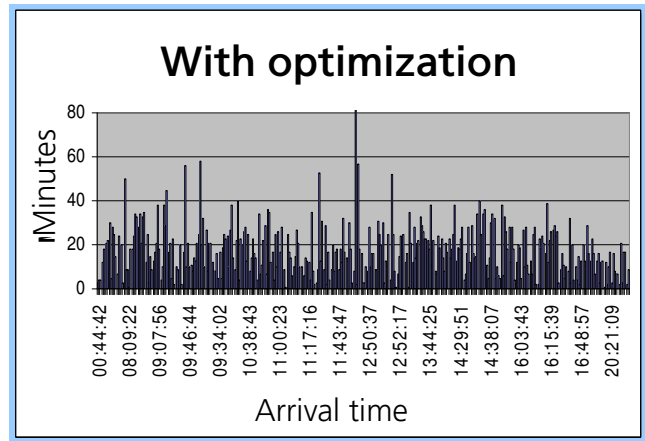
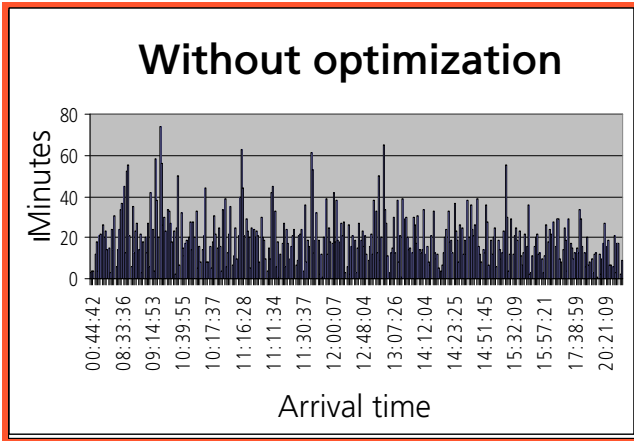
- 353 requests
- 10% known in advance (from previous day)
- 2 priority classes (emergency, standard)
- max. 12 ambulances
- ambulance capacity:
 - up to 2 beds
 - up to 5 seats
 - up to 1 wheelchair

Patient waiting times



Waiting time
reduction: **21%**

Driving times



Driving time reduction: **11%**


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Opti-Trans: A software tool for the optimization of transports of patients and materials in hospitals

Opti-Trans Add Patient Transport Task

Entered by
 User: Administrator, System Phone Number: 055/4510540

Patient
 Patient-No.: 3412 * Name: Smith, Peter * Weight: 85 [kg]
 Case-No.: 198 Birthday: 20.02.1960

Source / Destination
 From: Op - Room 2 ... Cost Center: Kostenstelle 1
 To: HNO - Room 1 ...

Date/Time
 pickup Priority: normal not earlier than: 11:15 A h
 deliver Date: in 2 days 12/5/04 not later than: 12:15 P h

Transport Information
 Mobility: legend Aux. Devices: [none] [available]
 Infection Risk: MRSA Escort: [none] [available]
 Single Transport Devices: Monitoring [available]
 [none] [available]

Comment:

Save Cancel

Development partners:


Fraunhofer Institut
 Techno- und
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 SIEDA GmbH
 Kaiserslautern

 COMEXAR
 Engineering AG
 Schweiz

Hospitals

 University
 Hospital
 Homburg

 STÄDTISCHE KLINIKEN
 FRANKFURT A.M.-HÖCHST

Benefits of an optimized patient transport

quantitative improvements

- minimization of waiting times
- work load balancing

qualitative improvements

- avoiding delays / cancellation of appointments
- improving patient satisfaction
- increasing operational safety
- generating database for further process optimization




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Techno- und
Wirtschaftsmathematik

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