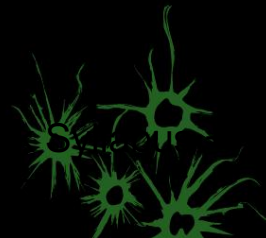


# We need more capacity

R.A. (Rudy) Oude Vrielink MSc B-IT  
PhD research into education logistics

Dynamic scheduling of rooms for education





## “More capacity” is the universal solution

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Every year on September 1: 100% planned. Full!

- More capacity is needed. But..
  - Buy or rent?
  - How much precisely?
  - What types of spaces, and what capacities?

Does your organisation also question itself:

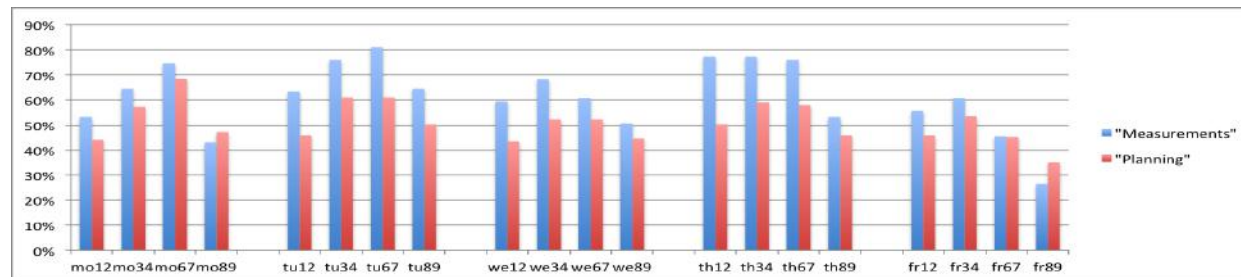
- What is the actual use? Per type of room? (efficiency)
- What is the customer satisfaction? (effectiveness)
- Does it meet the requirements for knowledge transfer, inspiration, team building?
- Who decides?



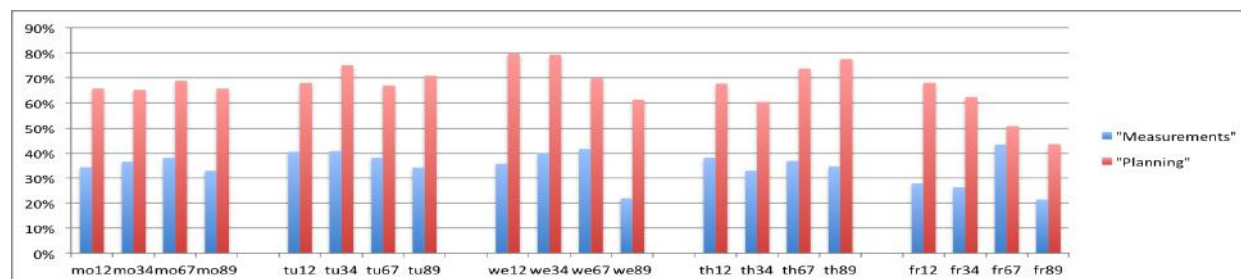
# Manual measurements on efficiency

Averaged over the weeks in which we counted:

1. Not even 50% of the booked rooms were in use (some other rooms were in use)
2. Not even 40% of the seat capacity was in use



Occupation  
wk41



Utilization  
wk41

# 2015 wk 19



Gebouw en zaalnummer	OW cap.	ma12	ma34	ma67	ma89	di12	di34	di67	di89	wo12	wo34	wo67	wo89	do12	do34	do67	do89	vr12	vr34	vr67	vr89	Gemiddelde benutting van de Bezetting geboekte uren [%]	
HB 2A (met GW-apparatuur)	28	0%	0%	0%	0%	32%	29%	29%	4%	0%	0%	54%	0%	0%	0%	0%	0%	46%	29%	39%	0%	35%	8,40
HB 2B (met GW-apparatuur)	24	0%	0%	0%	0%	79%	38%	33%	46%	0%	33%	50%	46%	0%	0%	46%	46%	0%	0%	54%	0%	35%	8,43
HB 2C (met GW-apparatuur)	16	0%	106%	0%	106%	44%	94%	69%	31%	0%	0%	0%	119%	0%	56%	0%	88%	31%	81%	0%	0%	40%	10,13
HB 2D (met GW-apparatuur)	24	0%	0%	0%	0%	0%	25%	42%	13%	42%	63%	29%	50%	0%	29%	0%	54%	0%	21%	75%	0%	15%	7,67
HB 2E (met GW-apparatuur)	16	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	100%	88%	88%	0%	106%	0%	0%	44%	0%	50%	3,50
HB 2F (met GW-apparatuur)	35	0%	51%	0%	40%	0%	69%	0%	0%	0%	0%	74%	66%	0%	80%	3%	49%	63%	0%	54%	40%	5%	28,00
CR 2G (CR2173)	42	0%	40%	48%	0%	0%	31%	0%	67%	0%	79%	64%	60%	0%	0%	0%	5%	0%	0%	31%	17%	35%	13,71
CR 2H (CR2175)	54	0%	37%	0%	0%	0%	41%	72%	57%	0%	39%	0%	81%	61%	65%	31%	0%	0%	0%	41%	0%	45%	24,56
CR 2K (CR2183)	84	0%	11%	15%	15%	15%	51%	0%	2%	61%	61%	8%	0%	50%	12%	44%	0%	0%	0%	23%	48%	60%	24,42
CR 2L (CR2178)	50	0%	0%	26%	26%	0%	70%	0%	0%	76%	62%	0%	0%	0%	38%	40%	0%	28%	72%	24%	0%	40%	21,13
OH 215	126	63%	66%	8%	6%	60%	47%	3%	0%	2%	73%	27%	44%	0%	5%	2%	0%	61%	13%	2%	1%	80%	24,94
OH 218	144	22%	0%	79%	79%	26%	34%	2%	57%	0%	0%	35%	21%	0%	8%	0%	6%	0%	49%	0%	0%	50%	51,70
RA 1501	93	23%	0%	0%	0%	0%	0%	66%	0%	22%	0%	58%	0%	0%	0%	55%	0%	0%	0%	53%	0%	20%	39,00
RA 2231	32	0%	0%	0%	0%	84%	13%	63%	0%	34%	16%	0%	0%	34%	41%	0%	0%	0%	0%	0%	34%	15%	6,67
RA 2237	32	0%	0%	0%	0%	0%	13%	0%	0%	41%	9%	59%	0%	56%	56%	0%	0%	0%	0%	0%	0%	25%	14,20
RA 2334	32	0%	0%	0%	0%	41%	41%	0%	0%	59%	78%	59%	0%	0%	0%	113%	0%	0%	0%	84%	0%	35%	12,71
RA 2336	32	0%	0%	0%	0%	0%	0%	0%	0%	0%	59%	56%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0,00
RA 2501 (Lagerhuisopstellir)	87	0%	0%	0%	33%	0%	30%	18%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	20%	0%	0%	25%	18,80
RA 2502	72	0%	0%	38%	0%	13%	28%	15%	24%	0%	21%	36%	29%	0%	0%	0%	0%	0%	31%	0%	60%	20%	11,00
RA 2503 (Lagerhuisopstellir)	51	0%	51%	59%	53%	0%	78%	59%	0%	0%	0%	0%	0%	47%	67%	0%	0%	0%	0%	0%	0%	40%	23,00
RA 2504	72	0%	35%	36%	0%	35%	8%	32%	0%	47%	0%	49%	0%	0%	47%	39%	15%	32%	0%	0%	0%	35%	17,86
RA 3231	32	13%	47%	0%	53%	0%	63%	0%	72%	34%	38%	0%	0%	0%	16%	0%	0%	28%	41%	56%	0%	40%	11,13
RA 3334	32	0%	0%	0%	0%	0%	25%	0%	0%	0%	0%	0%	0%	0%	47%	0%	0%	0%	0%	0%	0%	5%	8,00
RA 3336	32	0%	0%	0%	22%	56%	53%	72%	0%	41%	3%	16%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	9,50
RA 4231	32	0%	0%	0%	19%	0%	44%	0%	0%	0%	0%	59%	0%	0%	0%	91%	0%	0%	0%	0%	0%	10%	16,50
RA 4237	32	50%	25%	0%	0%	0%	0%	0%	0%	0%	0%	50%	47%	0%	0%	16%	16%	0%	0%	0%	0%	40%	5,13
RA 4334	32	0%	0%	0%	19%	0%	44%	0%	0%	41%	47%	0%	0%	56%	56%	47%	0%	0%	0%	0%	0%	40%	11,63
RA 4336	32	0%	0%	0%	0%	69%	113%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	0,00
SP 1	250	0%	38%	0%	0%	20%	21%	18%	0%	0%	9%	21%	0%	0%	4%	0%	0%	0%	20%	0%	0%	30%	44,33
SP 2	220	30%	0%	0%	0%	28%	0%	19%	19%	17%	13%	39%	4%	0%	6%	0%	10%	0%	0%	3%	0%	35%	41,29
SP 3	110	0%	0%	16%	2%	0%	0%	24%	24%	0%	0%	5%	0%	0%	35%	21%	0%	0%	0%	0%	0%	30%	23,00
SP 4	96	0%	34%	42%	0%	34%	0%	81%	0%	0%	0%	29%	23%	29%	0%	0%	0%	0%	0%	0%	0%	50%	26,20
SP 5	96	0%	74%	0%	0%	0%	34%	28%	0%	0%	0%	0%	0%	0%	17%	0%	0%	0%	0%	0%	0%	30%	24,50
SP 6	75	0%	0%	0%	0%	35%	40%	36%	0%	0%	0%	0%	0%	0%	56%	24%	0%	0%	0%	49%	0%	40%	13,50
SP 7 (VC)	40	70%	0%	0%	40%	0%	75%	60%	30%	0%	3%	0%	33%	0%	0%	40%	0%	0%	15%	0%	0%	40%	16,13
Vrijhof Audiozaal	80	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0,00
WA 1 (Van den Kroonenbei)	477	0%	33%	0%	5%	0%	8%	9%	0%	0%	0%	0%	0%	0%	8%	7%	4%	0%	0%	0%	0%	35%	50,71
WA 2 (Breedveldzaal)	307	0%	0%	44%	0%	8%	29%	0%	1%	0%	10%	0%	0%	0%	0%	0%	16%	0%	0%	0%	0%	5%	0,00
WA 3 (Van Hasseltzaal)	135	0%	31%	0%	49%	0%	0%	19%	0%	31%	13%	43%	0%	51%	0%	33%	0%	0%	0%	0%	0%	25%	37,80
WA 4 (Berkhoffzaal)	151	0%	42%	44%	0%	0%	46%	15%	24%	12%	0%	44%	5%	0%	0%	0%	0%	0%	0%	1%	3%	15%	50,33
																						30%	23,4

Occupation

Averaged utilization of booked hours [%]

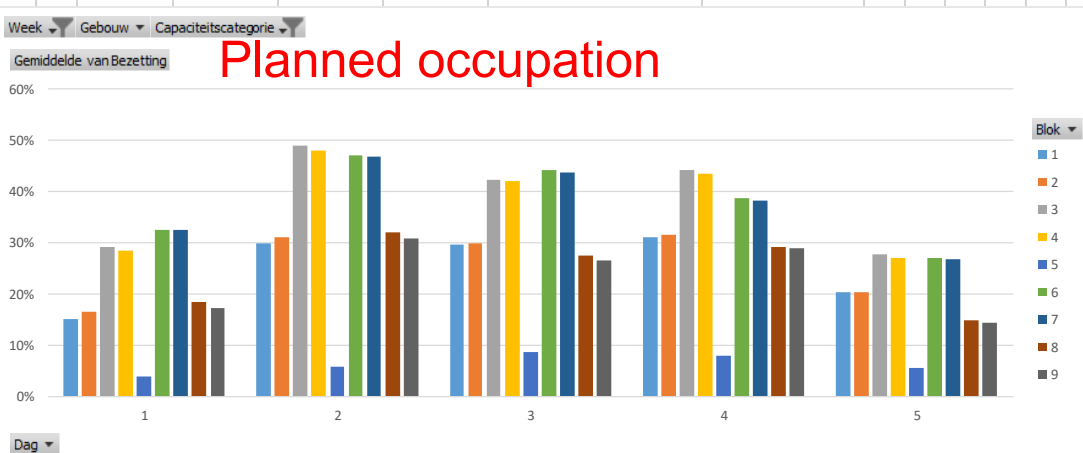
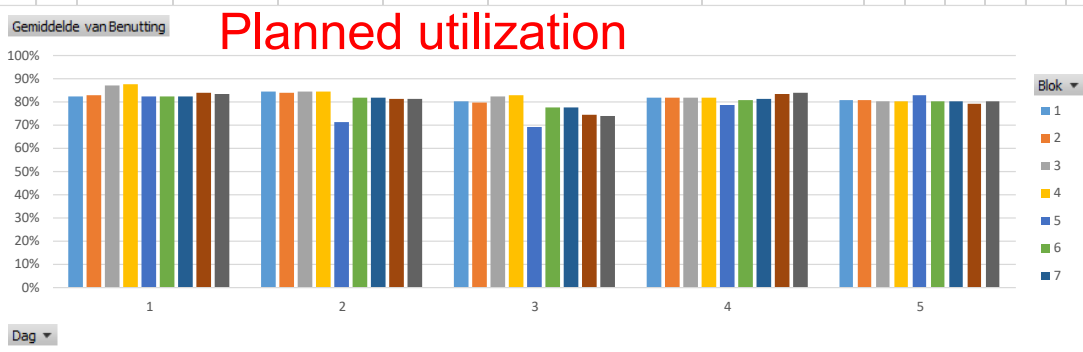
30%

23,4



# Dashboard 2017: planning

Geschiktheid	Kolomlabels			
Rijlabels	04	08	12 Eindtotaal	
AT	81%	63%	79%	79%
BMT	82%	84%	76%	83%
CIT	85%	78%		82%
CRE	83%	85%	79%	84%
CW	79%	87%	92%	84%
EE	88%	86%	88%	88%
EPA	85%	83%	87%	84%
GZW	83%	90%		86%
IBA	79%	83%	84%	80%
IO	82%	84%		83%
PSY	82%	86%		83%
ST	81%	85%	90%	83%
TBK	81%	76%		80%
TG	73%	87%	72%	85%
TI		83%		83%
TN	83%	78%		82%
TW	83%	76%	84%	82%
WB	80%	78%	82%	80%
<b>Eindtotaal</b>	<b>82%</b>	<b>85%</b>	<b>85%</b>	<b>83%</b>



Study

Allocation of suitable rooms



## Challenge

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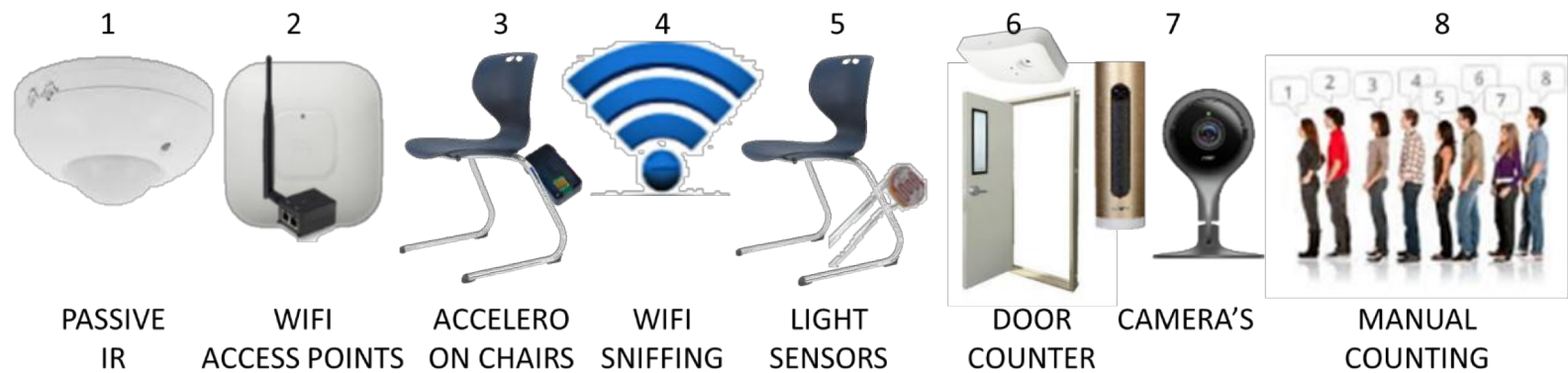
- Measurements from 2014 (manual):
  - All rooms were counted, at a random time in every block hour
  - Occupation <50% (half of the booked rooms were empty)
  - Utilization <40% (over 60% of the seats empty)
- Measurements from 2017:
  - Pilot with sensor-based infrastructure, communal classrooms
  - Same picture: rooms are unoccupied more than half of the time

Is this someone's fault? NO.

- Sometimes we run into 100% planned occupation
- So we need another way of planning!



# Automated measurements



Aim: To find the most cost-effective way of measuring attendance



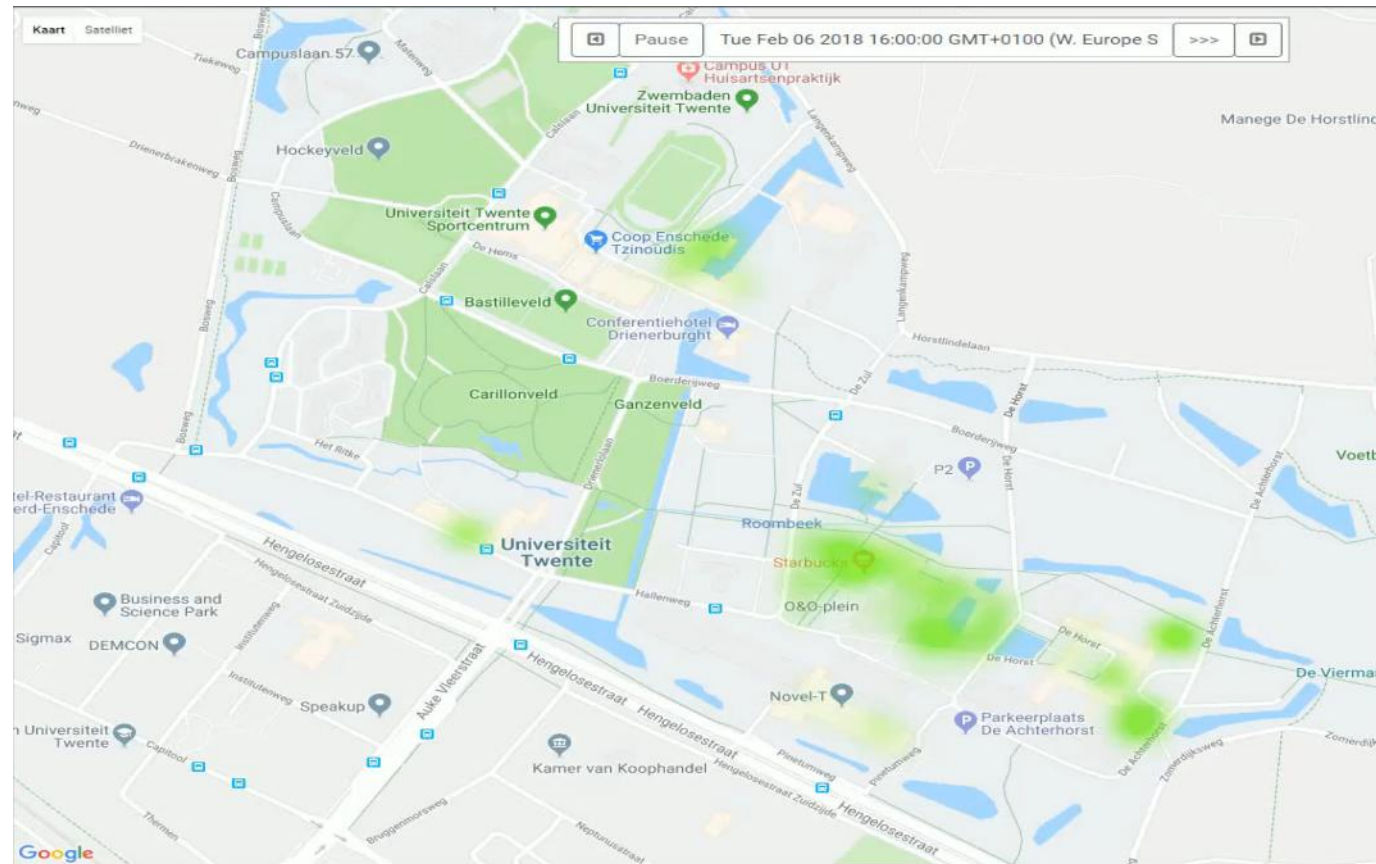
# Heatmap of the university library







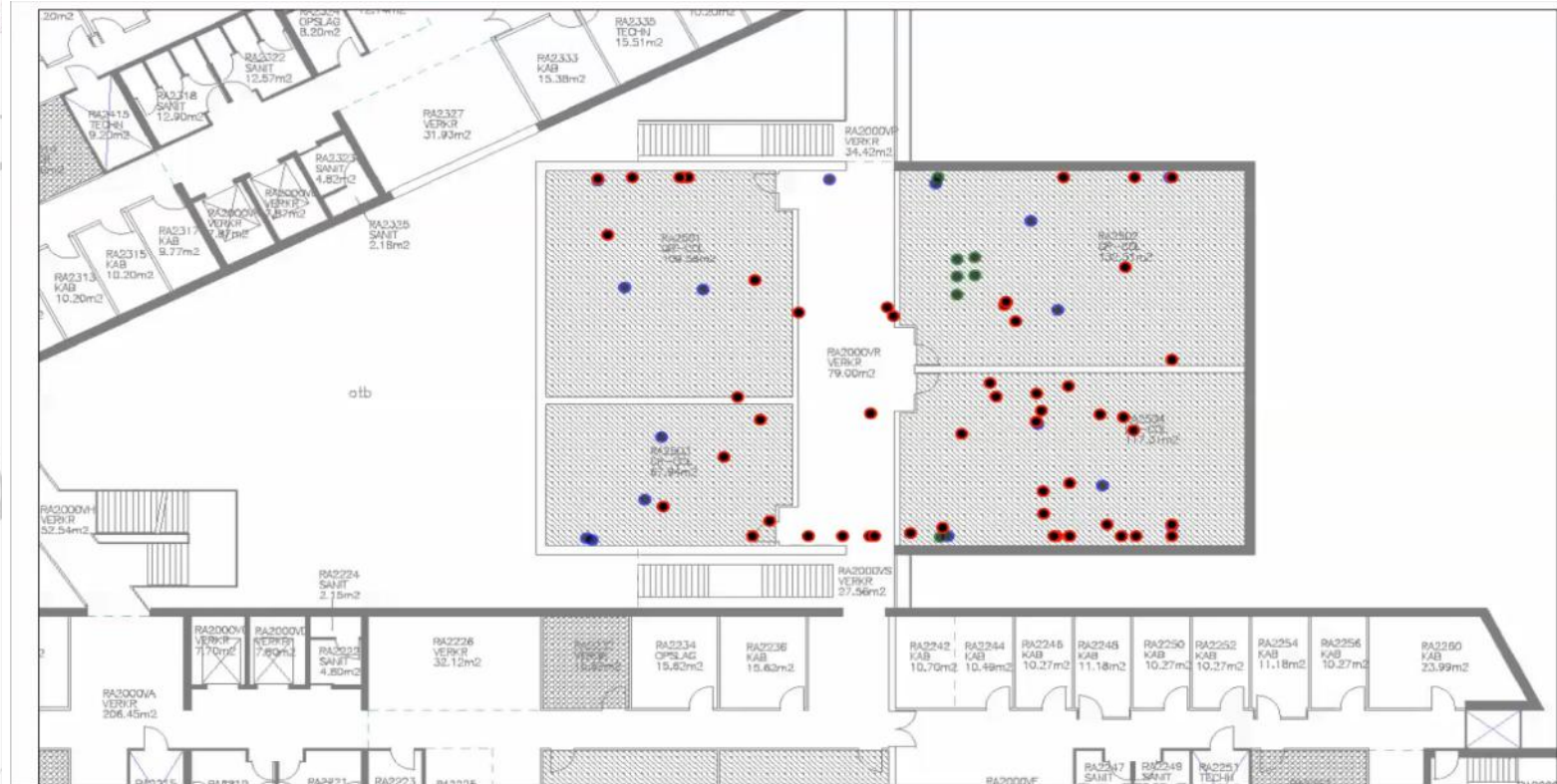
# Heatmap time-lapse of the university campus



UNIVERSITEIT TWENTE.



# Live tracking & tracing





# Live insight into planning vs. actual use of classrooms

## Ravelijn

- Ravelijn 1501: empty  
Scheduled: empty
- Ravelijn 2231: 2  
Scheduled: empty
- Ravelijn 2237: 1  
Scheduled: empty
- Ravelijn 2334: 2  
Scheduled: 32  
(Maintenance: Onderhoud RA 2334 - RA 2336)
- Ravelijn 2336: 1  
Scheduled: 32  
(Maintenance: Onderhoud RA 2334 - RA 2336)
- Ravelijn 2501: empty  
Scheduled: empty
- Ravelijn 2502: empty  
Scheduled: empty
- Ravelijn 2503: empty  
Scheduled: empty
- Ravelijn 2504: empty  
Scheduled: empty

## Spiegel

- Spiegel 1: empty  
Scheduled: empty
- Spiegel 2: empty  
Scheduled: empty
- Spiegel 3: empty  
Scheduled: 96  
(Tutorial: Warehousing 191820120)
- Spiegel 4: empty  
Scheduled: empty
- Spiegel 5: empty  
Scheduled: empty
- Spiegel 6: empty  
Scheduled: empty
- Spiegel 7: empty  
Scheduled: empty

## Waaier

- Waaier 1: empty  
Scheduled: empty
  - Waaier 2: empty  
Scheduled: 307  
(Other: Afscheidsrede prof. dr. M. Elwenspoek)
  - Waaier 3: empty  
Scheduled: empty
  - Waaier 4: 1  
Scheduled: empty
- ## Carré
- Carré 2A: 10  
Scheduled: empty
  - Carré 2B: 1  
Scheduled: empty
  - Carré 2C: empty

## Hal B

- Hal B 2A: 10  
Scheduled: 28  
(Lecture: Wireless Transceiver Electronics 191211500)
- Hal B 2B: 1  
Scheduled: empty
- Hal B 2C: empty  
Scheduled: empty
- Hal B 2D: empty  
Scheduled: empty
- Hal B 2E: empty  
Scheduled: empty
- Hal B 2F: empty  
Scheduled: empty

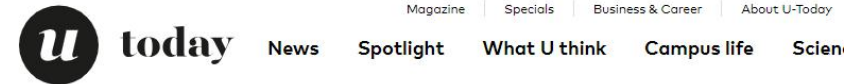


▲ ENSCHEDE - Kick-in Universiteit Twente. © Emiel Muijderman

## Mijlpaal voor UT: meer dan 10.000 studenten

**AUDIO** | ENSCHEDE - Universiteit Twente in Enschede passeerde afgelopen weekeinde de grens van 10.000 studenten. Vooral het aantal buitenlandse

# Highly topical



**NEWS** UREKA DAS OVERVOLLE COLLEGEZALEN

## Uraadspartijen signaleren overvolle collegezalen

22 / 11 / 2018 | [Rense Kuipers](#)

Universiteitsraadspartijen UReka en DAS zien bij de start van de huidige module overvolle collegezalen. Studenten volgen staand in de deuropening of zittend op de vloer college. Het Centre for Educational Support herkent de problematiek.



**UNIVERSITY COUNCIL PARTIES IDENTIFY OVERCROWDED LECTURE HALLS**

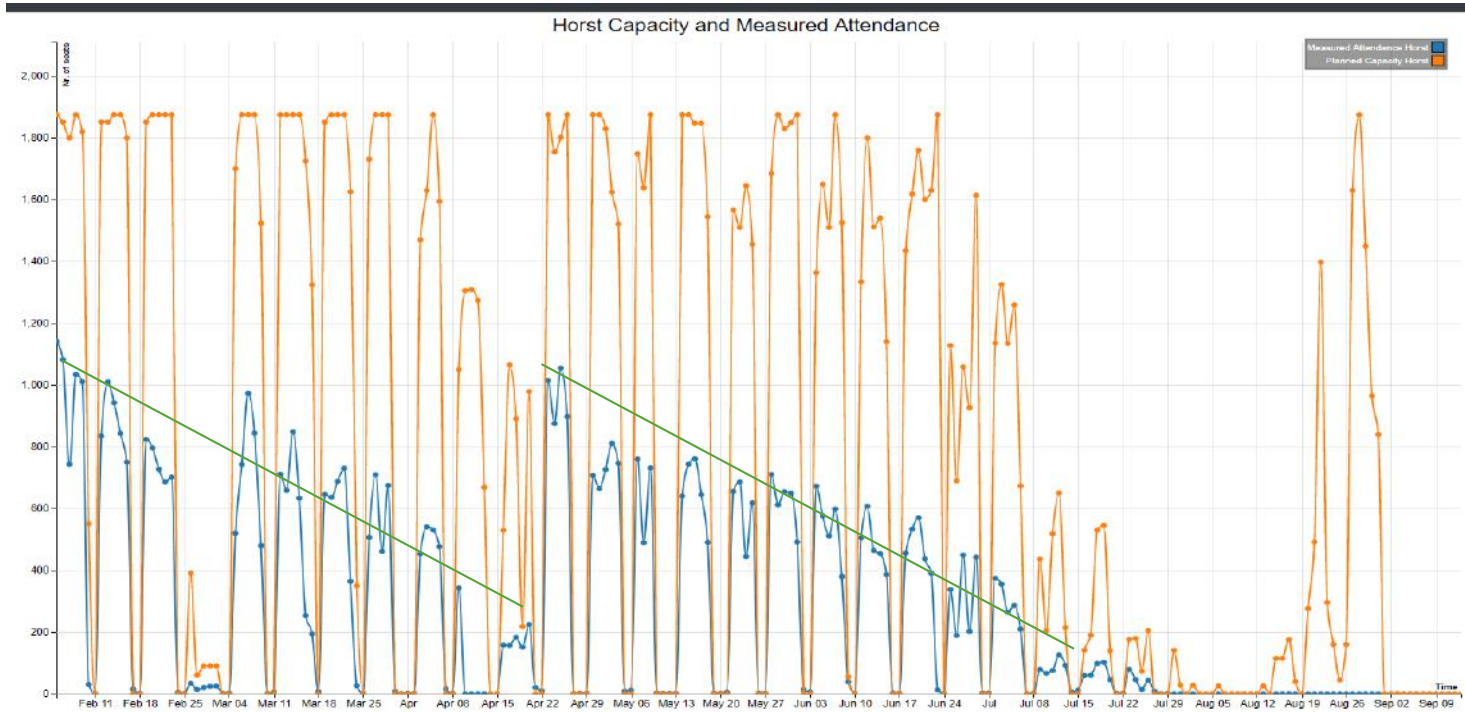
University council parties UReka and DAS see overcrowded lecture

UNIVERSITEIT TWENTE.



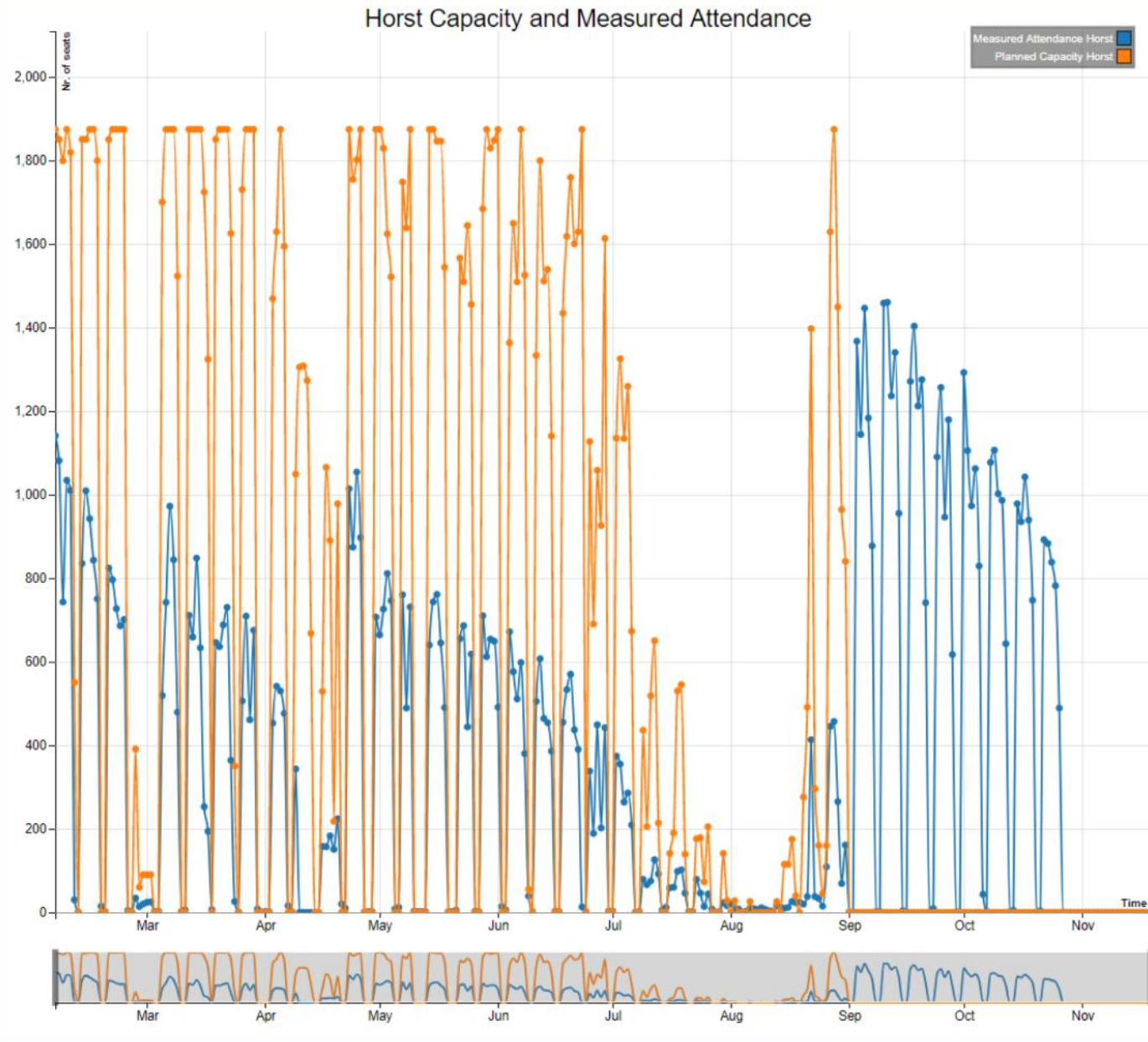


# Timetable visualization: planned vs actuals





# Timetable visualization: planned vs actuals



— Planned capacity  
— Measured attendance

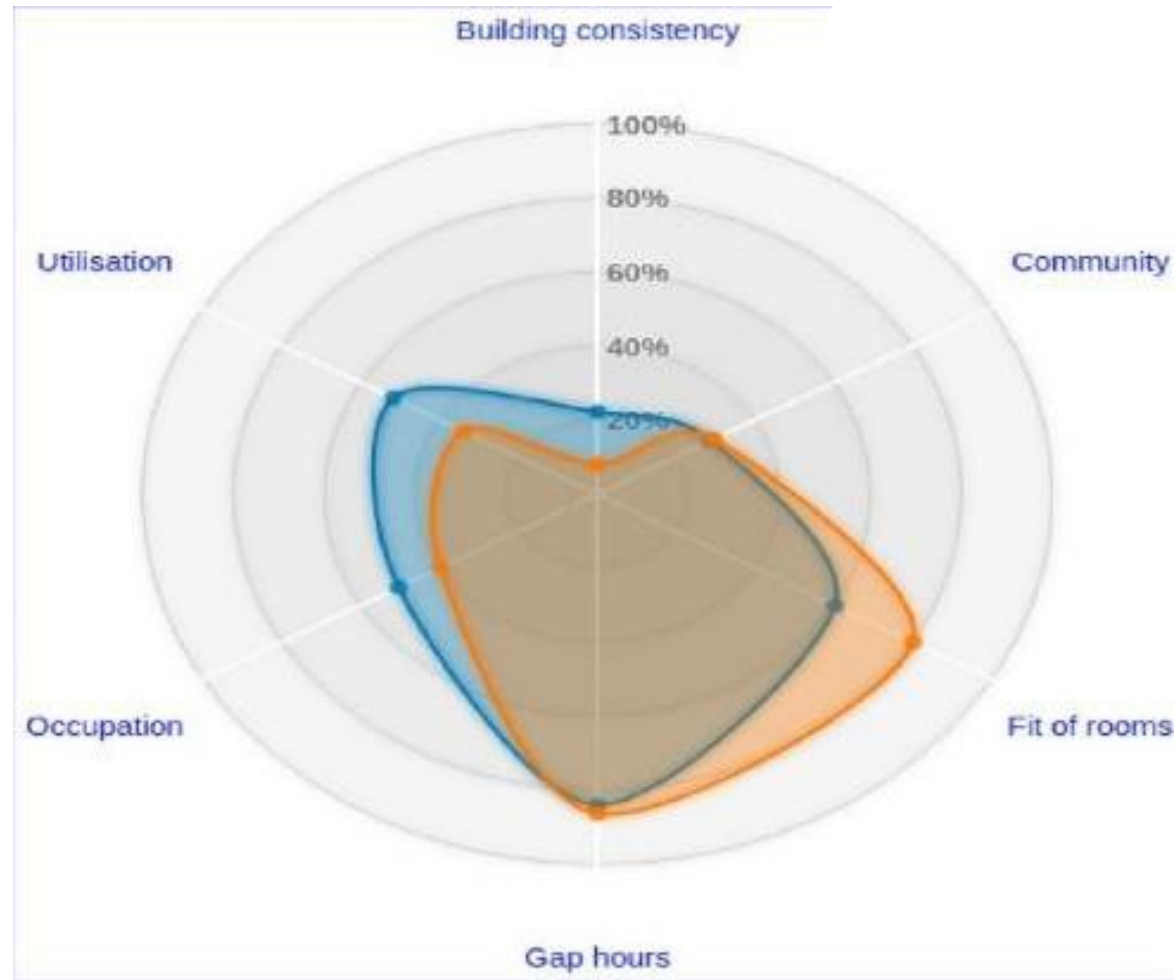
High reliability in the measuring of attendance (# of people)

- depending on the technology



# Performance of the timetables on 6 (\* 2) KPIs

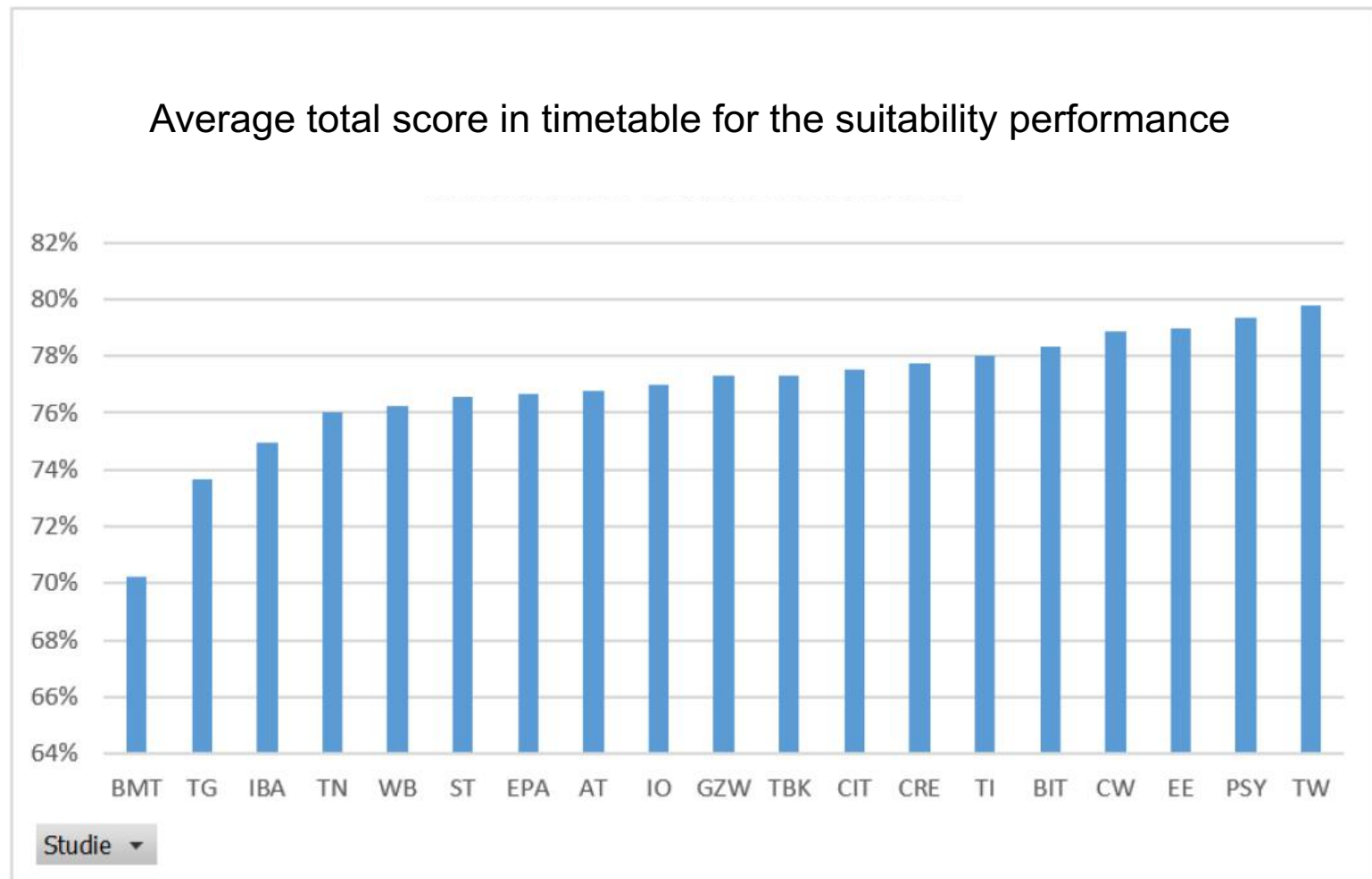
## Twiqel timetable visualization radar: planned vs measured





## Case study suitability of rooms

The average total score for the timetable in 2015-2016 was 77%.







# Build-in smart triggers

Space Occupancy < 10%

Space Occupation < 10%

[Restore](#) [Delete Workflow](#)

Graphical workflow overview for  [+ Create State](#)

```
graph LR; New[New] -- New --> OccupationAlert[Occupation Alert]; OccupationAlert -- Inform --> Finished[Finished];
```

Issue summary [New](#)

[New](#) [+ Create Transition](#)

[+ Add Widget](#)



## What does it mean?

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1) If we don't act now, we may build extra capacity which stays empty.

Adaptive scheduling:

- Saves 10 – 30% (imagine for a university:  $\geq$  €500k every year)
- Enhances the quality of the primary process:
  - Contributes to the forming of communities of students
  - Allocates rooms based on suitability

2) If we give the user a voice, the support staff does not have to invent everything themselves.

- We organise the voice from the user:
- Smart processes based on continuous feedback and continuous improvement

3) The aim is to have the \* *Adaptive Scheduling tool* \* ready mid 2019.

## More information?

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e-mail: [r.a.oudevrielink@utwente.nl](mailto:r.a.oudevrielink@utwente.nl)

or [r.a.oudevrielink@twiqel.nl](mailto:r.a.oudevrielink@twiqel.nl)

Short movie (in Dutch):

[https://www.cisco.com/c/m/nl\\_nl/digitale-versnelling-nederland/education/digitale-versnellers/video.html](https://www.cisco.com/c/m/nl_nl/digitale-versnelling-nederland/education/digitale-versnellers/video.html)