

An aerial photograph of Los Angeles, California, showing the city skyline with several prominent skyscrapers in the background. In the foreground, the Dodger Stadium is visible, featuring its distinctive blue and white seating and the baseball field. The stadium is surrounded by parking lots and some commercial buildings.

# Smart Stadium Tools

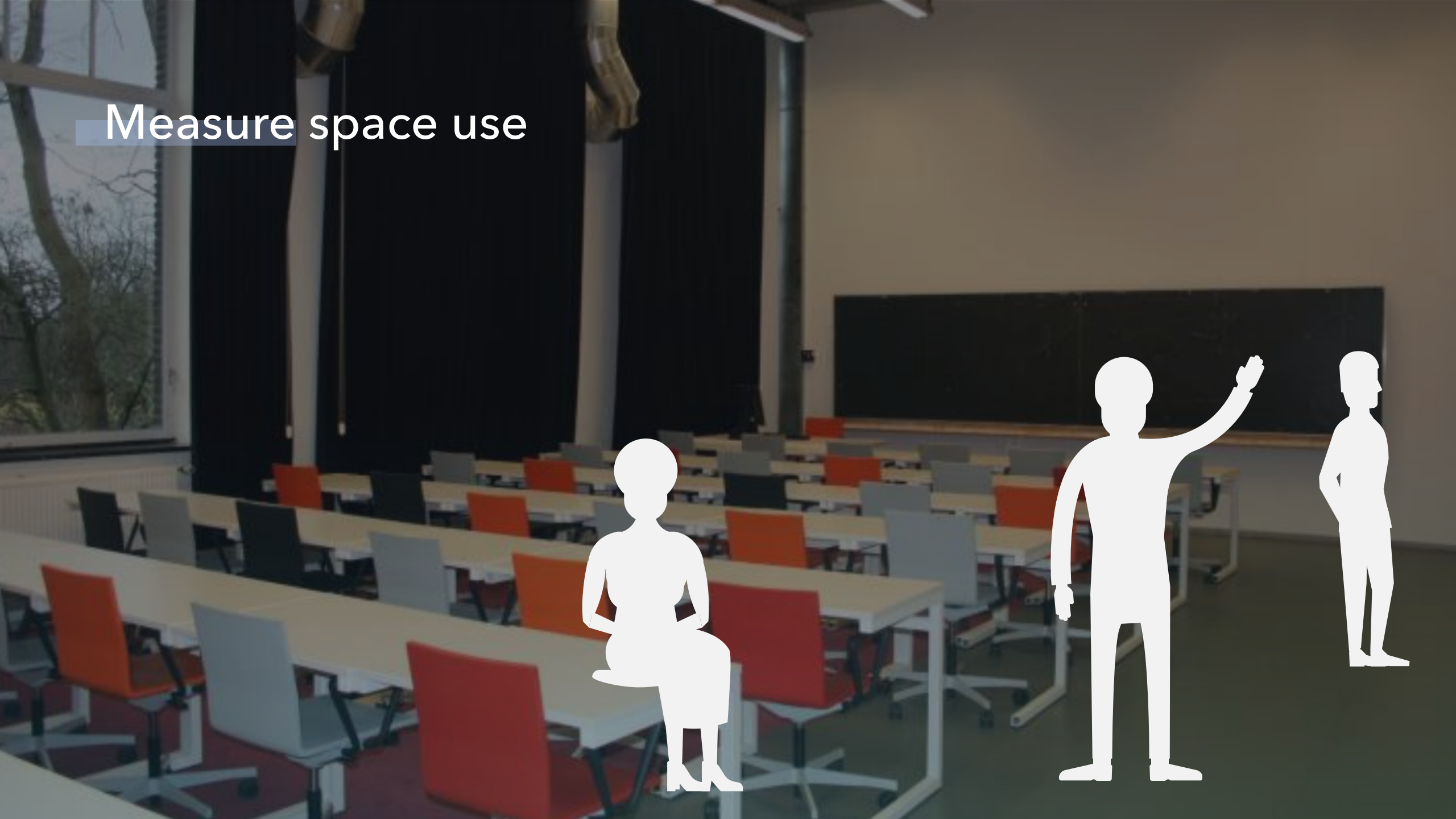
Exploratory case study of the Johan Cruijff ArenA:  
identification and optimization of smart tools

Student Simon van Heck  
Graduation Lab (Public) Real Estate Management  
Project duration February - June, 2019  
Graduation committee Prof. dr .ir. A. Den Heijer, TU Delft, 1st mentor  
Dr. ir. P. Koppels, TU Delft, 2nd mentor  
Ir. B. Valks, TU Delft, 3rd mentor  
Ir. W. Leenslag, KPMG, company mentor  
S. Steenbruggen, TU Delft, delegate examiner

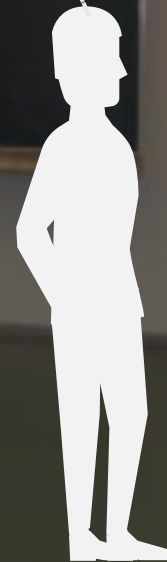
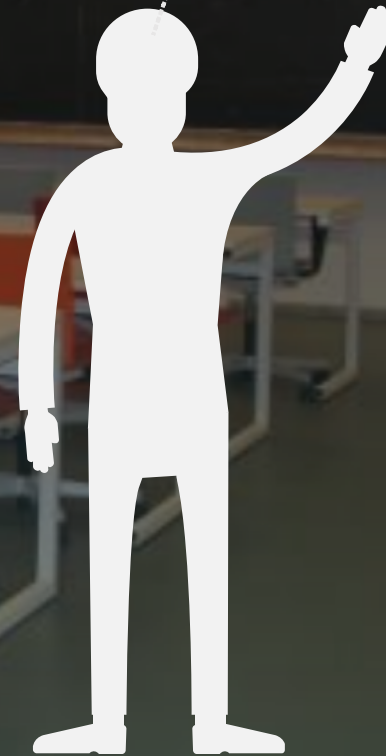
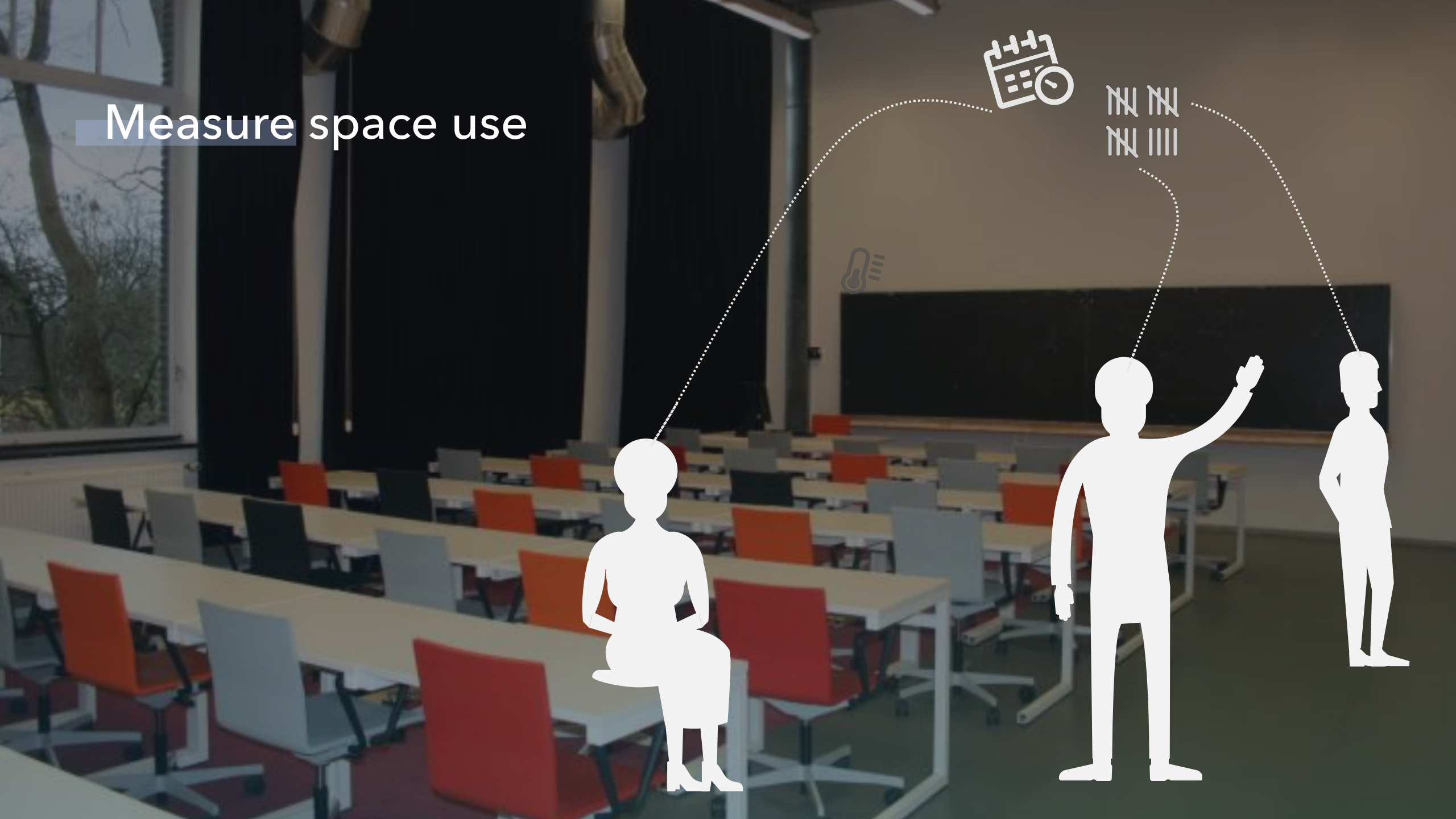
# Measure space use



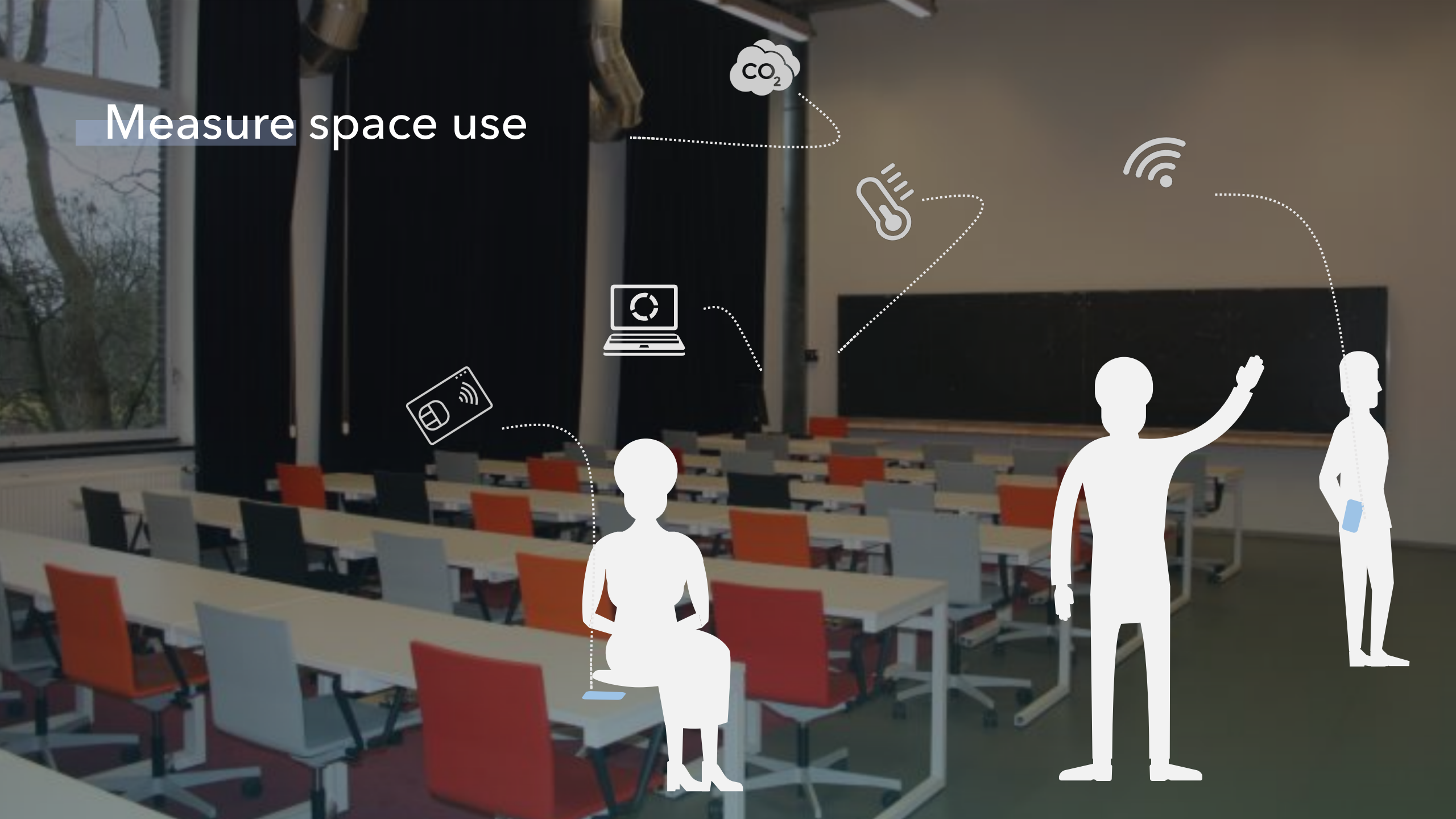
# Measure space use



# Measure space use



# Measure space use



# Smart tool

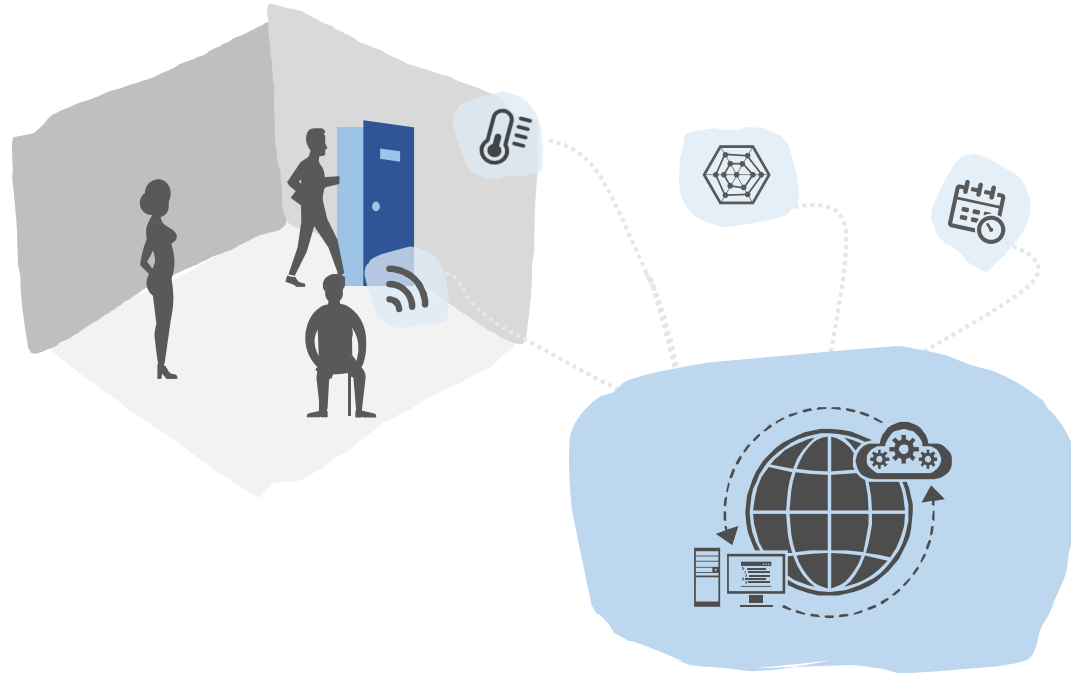
“Service or product which collects real-time information on space use to improve the space use on the current campus on the one hand, whilst supporting decision making on the future space use on the other hand”

(Valks, Arkesteijn, Den Heijer & Vande Putte, 2018, p. 23)





**1. (Real-time) data** is obtained from different sources (such as sensors, raw data)



1. (Real-time) **data** is obtained from different sources (such as sensors, raw data)

2. The data is place in an integrated platform, also named a **data lake**. In this data lake, **analytics** are done in order to turn the data into **information**. Also, data can be stored in a **data storage**.





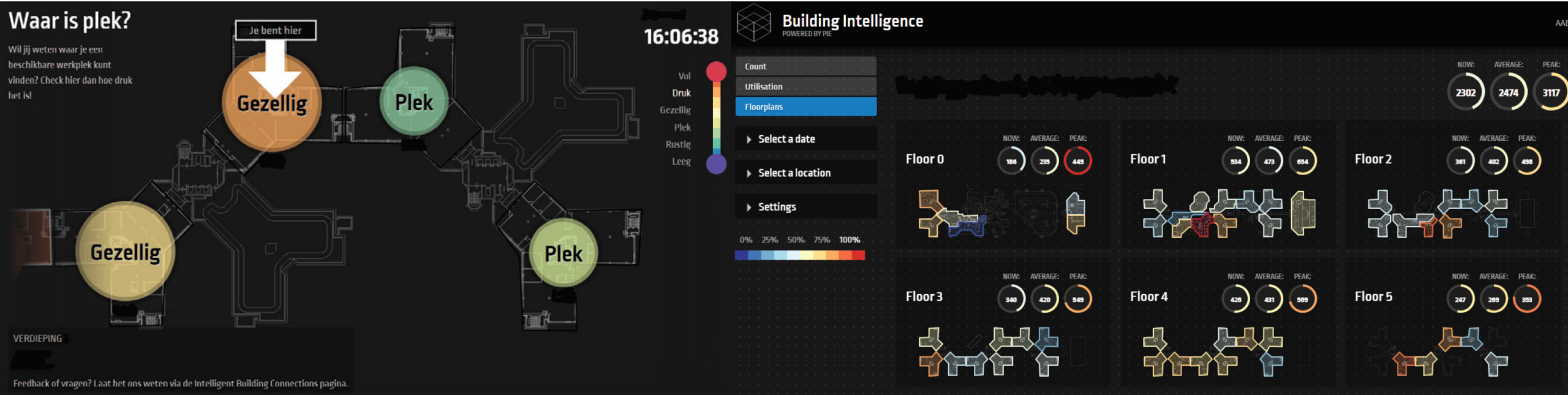
1. (Real-time) **data** is obtained from different sources (such as sensors, raw data)

2. The data is place in an integrated platform, also named a **data lake**. In this data lake, **analytics** are done in order to turn the data into **information**. Also, data can be stored in a **data storage**.

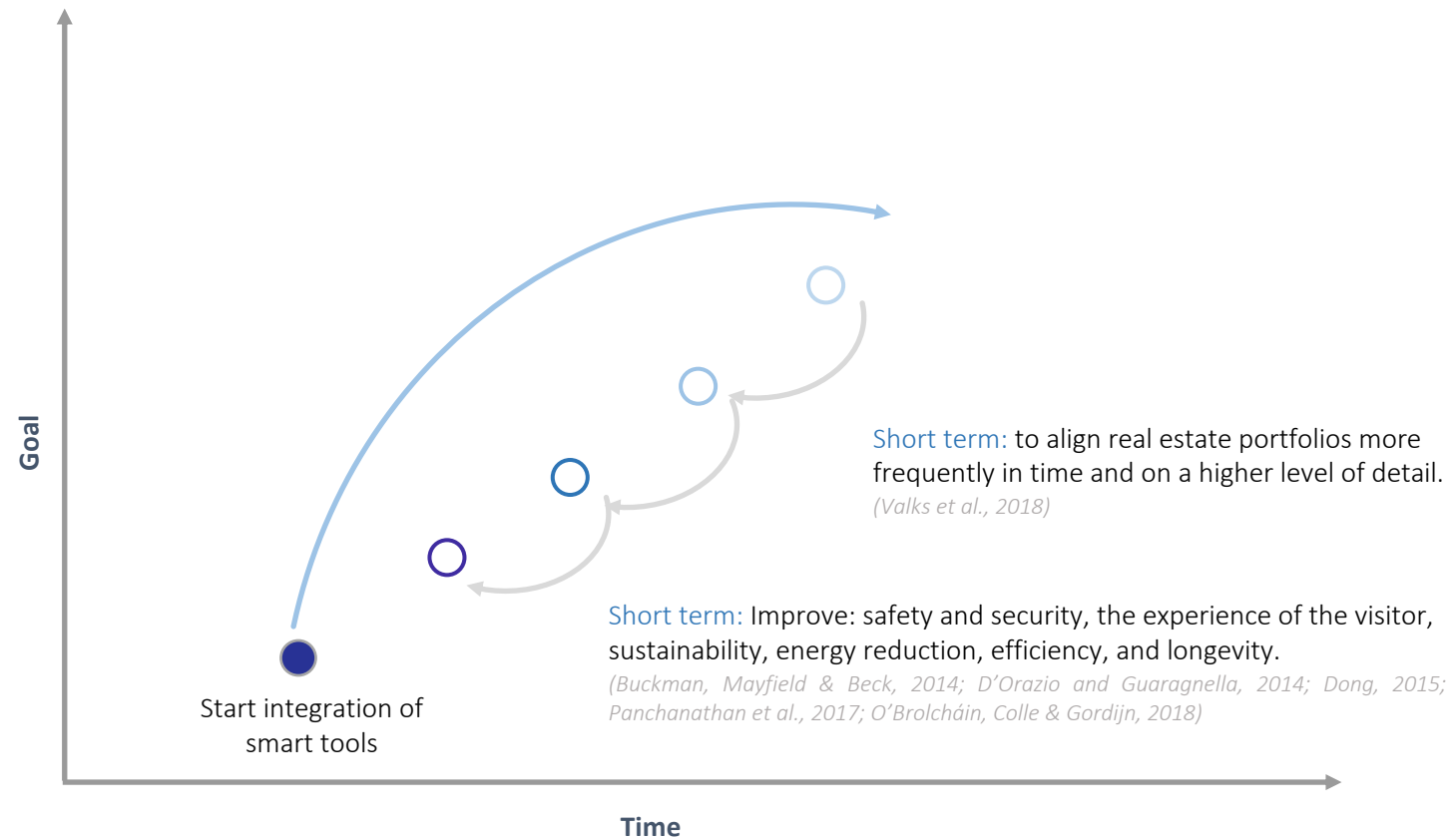
3. The information is visualized: **dashboard** or **apps**, which can be accessed by users.



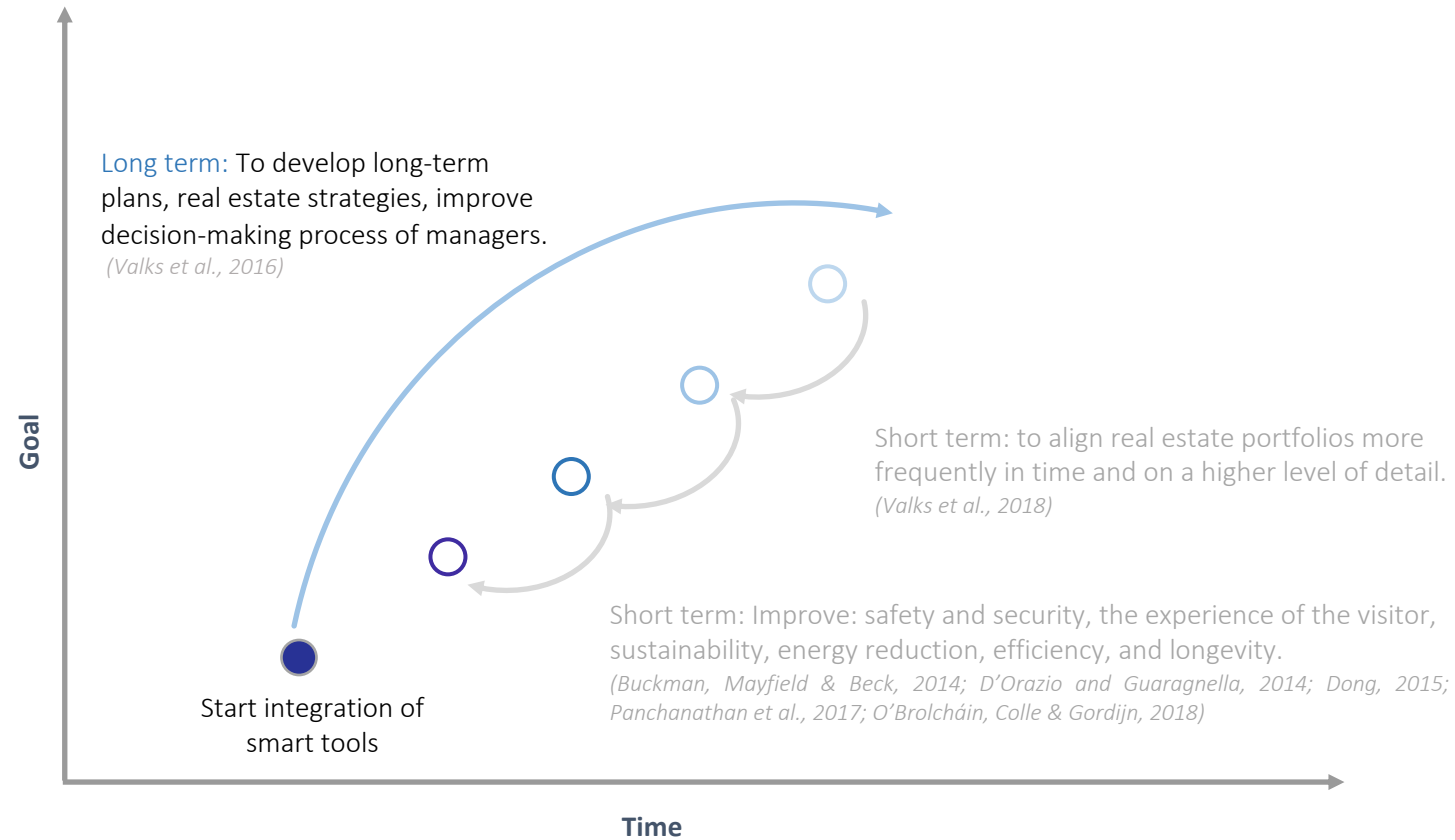
# ABN AMRO - Lone Rooftop



# Hypothesis of smart tools



# Hypothesis of smart tools



Stadiums are an important part of our society; the first known stadium was built in the ancient Greeks in the 8th century BC.





A lot of people are gathered during a specific period of time: high peak in space use (Sartori & Nienhoff, 2013).



The physical environment of the stadium has a significant effect on the extent to which spectators will desire to stay and return to the stadium (Wakefield, Blodgett & Sloan, 1996, p. 15).





Today's stadiums face increasing competition from home-viewing options, powered by better camera angles and multiplatform, multimedia experiences (Giorgio, Dewese, Reichheld, & Ebb, 2018, p. 3).

Today's smartphone owner carries a device with processing power that would have required a computer the size of a stadium fifty years ago (Campbell & Giorgio, 2018, p. 2).





**Concepts:**  
Research Questions &  
Methodology

Which smart tools can be identified in stadiums, and how can the use of these smart tools be optimized?

Which smart tools can be identified in stadiums, and how can the use of these smart tools be optimized?

Which smart tools can be identified in stadiums, and how can the use of these smart tools be optimized?

1 | Smart tools

2 | Stadiums

3 | Optimized

# Sub-questions



Smart tools

1 What are smart tools?

How is the integration of smart tools related to real estate management theories?



Stadium

2 What are the characteristics of a stadium and how is this related to the need for smart tools?

What is a 'smart stadium'?

Which smart tools are integrated within stadiums and what are the objectives for integrating them?

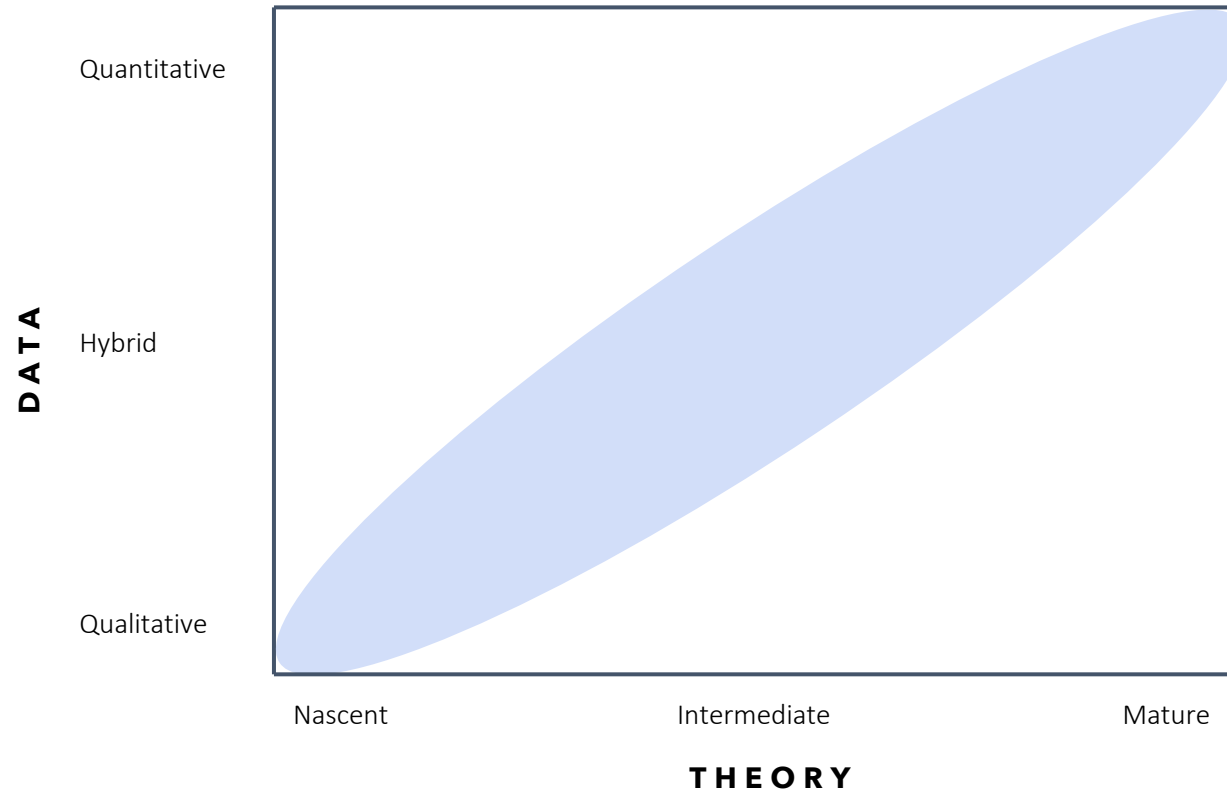


Optimize

3 What is the progress since the integration of the smart tools and how can this be improved?

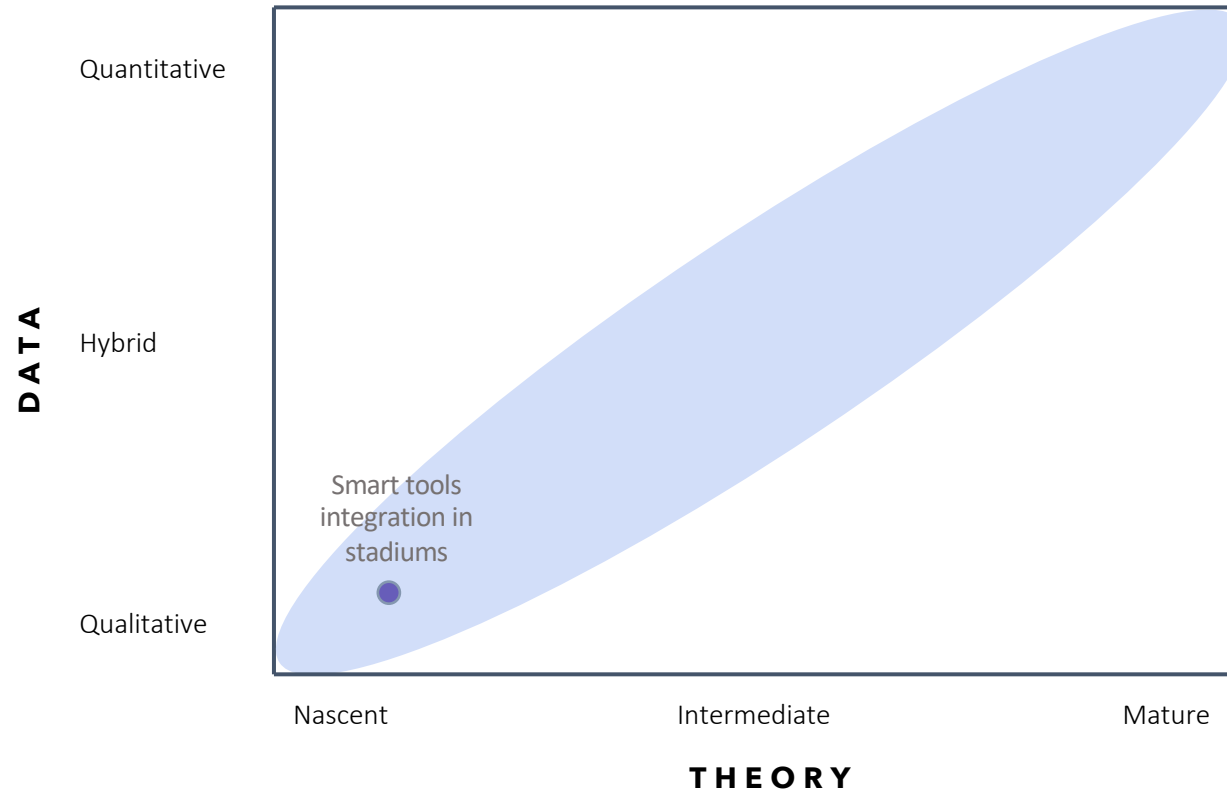
What interventions can be recommended to improve the use of the smart tools?

# Methodological fit





# Methodological fit



# Methodology

- **Qualitative research method:**

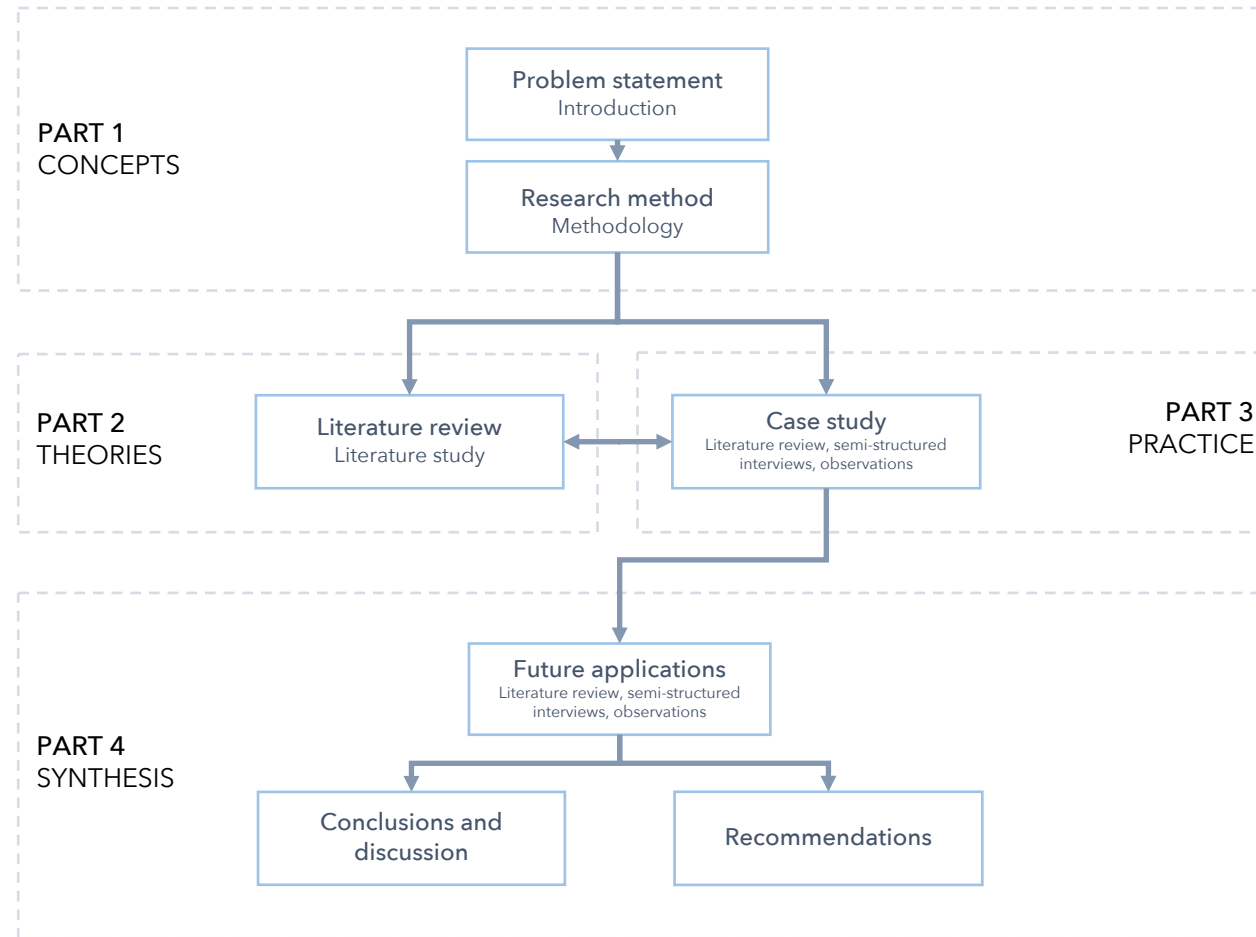
Useful for (nascent) theories that do not exist yet

- **Exploratory case study and literature review:**

Investigate a contemporary phenomenon within its real-life context (Yin, 2014)

Suitable method due to the contemporary character of integrating smart tools in stadium

# Methodology





## Part 2: Theories

Corporate Real Estate  
Management

# Real estate management theories



## Corporate Real Estate Management (CREM)

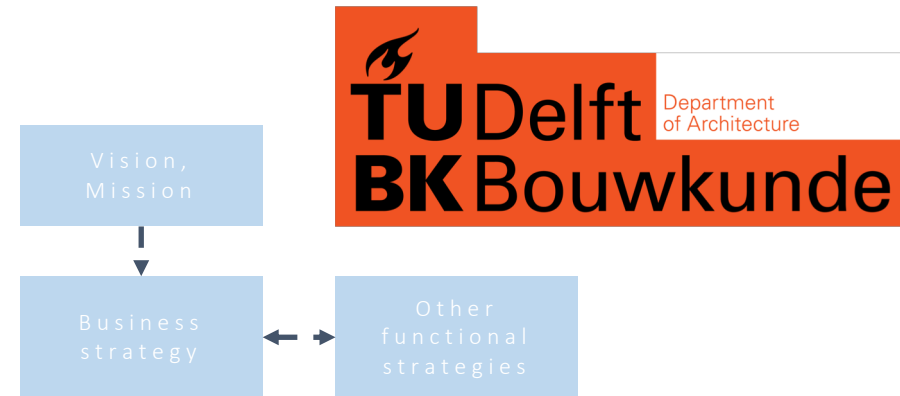
“[...] **aligning the portfolio** and services to the **needs of the core business**, in order to maximize **the added value** for the business and to optimally **contribute to the overall performance** of the corporation” (Dewulf, Krumm & De Jonge, 2000).

Relevant for smart tools due to the hypothesis: to align real estate portfolios more frequently in time and on a higher level of detail (Valks et al., 2018).

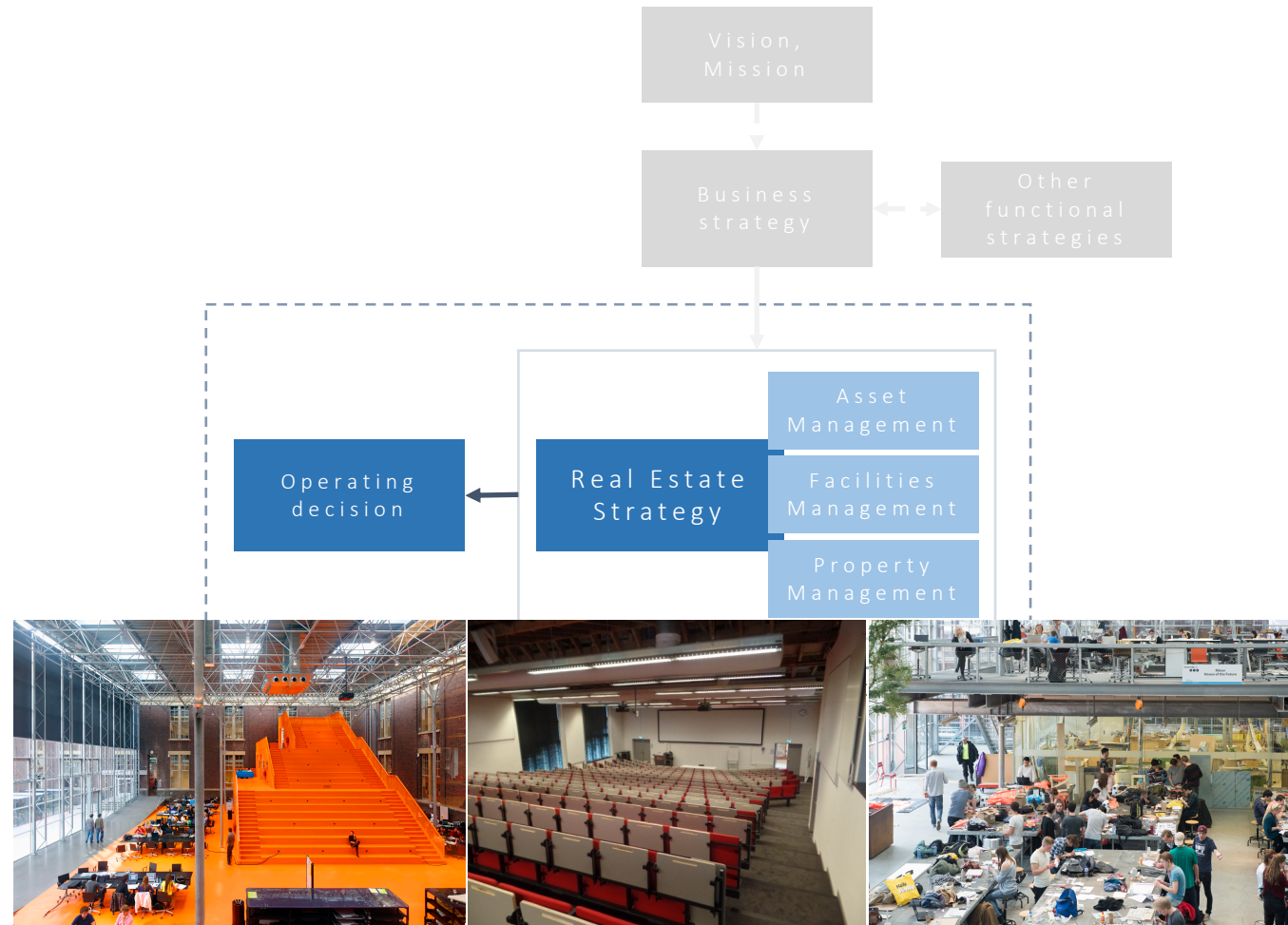
# Principle of added value

# Principle of added value

"[...] every business needs some sort of property in which to carry on its activity." (Edwards & Ellison, 2005, p. 9)

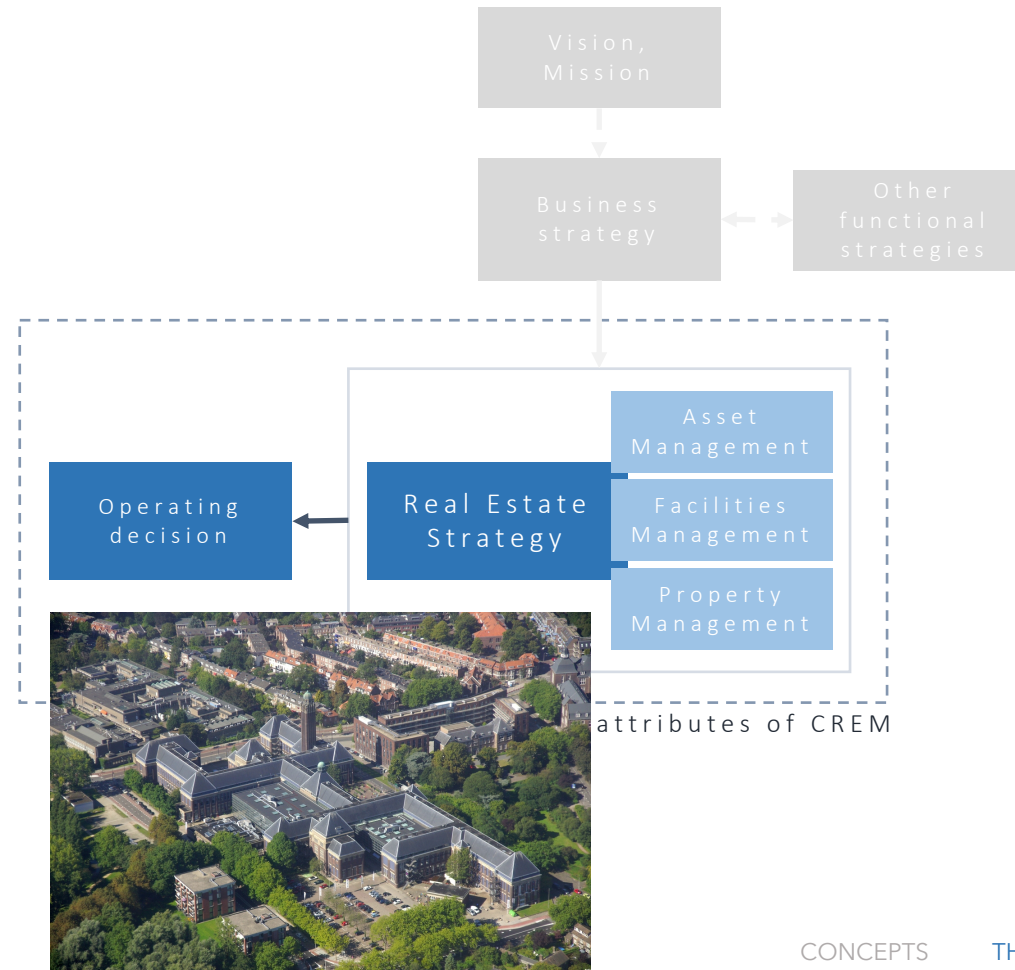


# Principle of added value

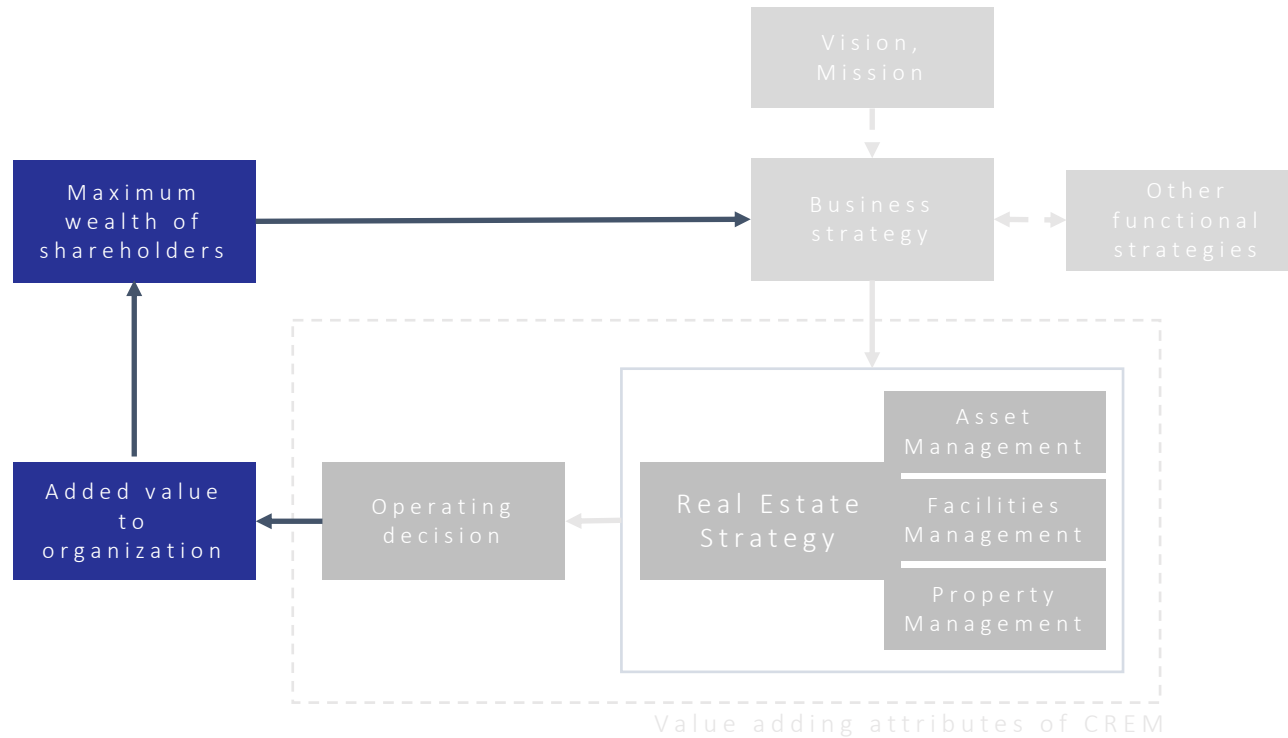




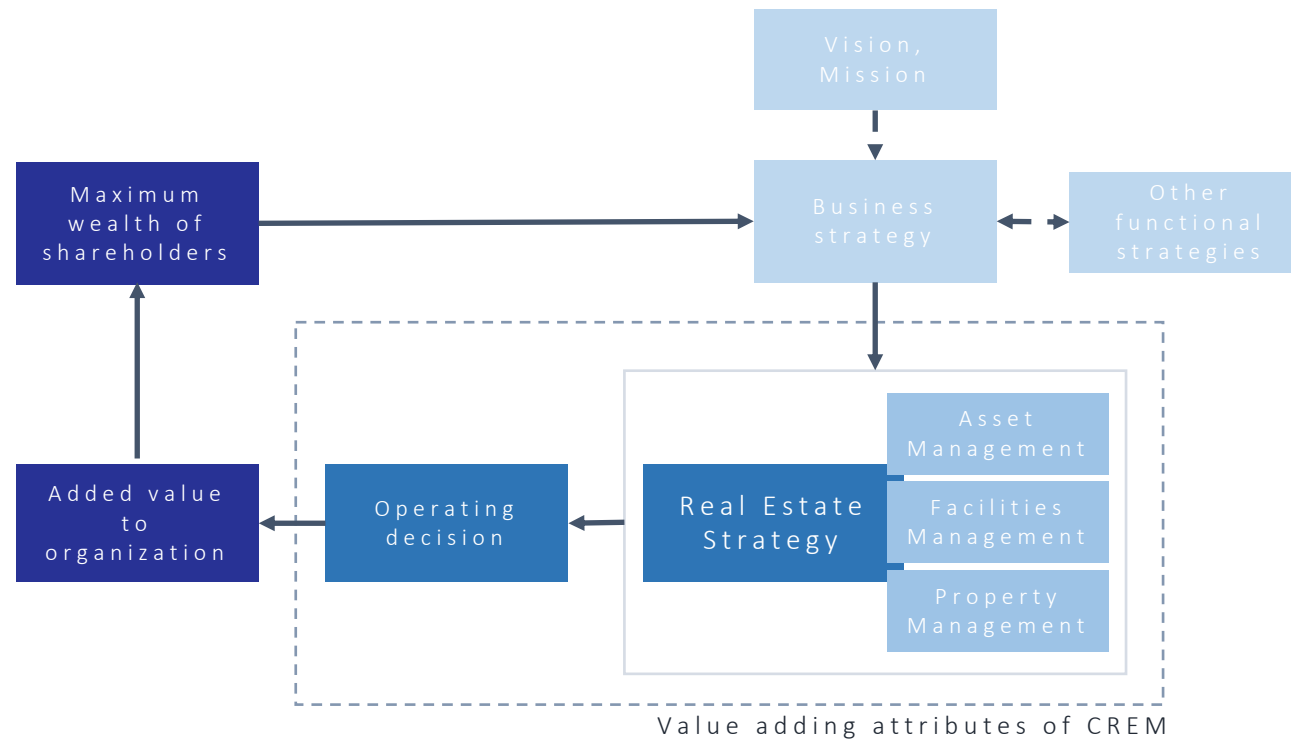
# Principle of added value



# Principle of added value



# Principle of added value



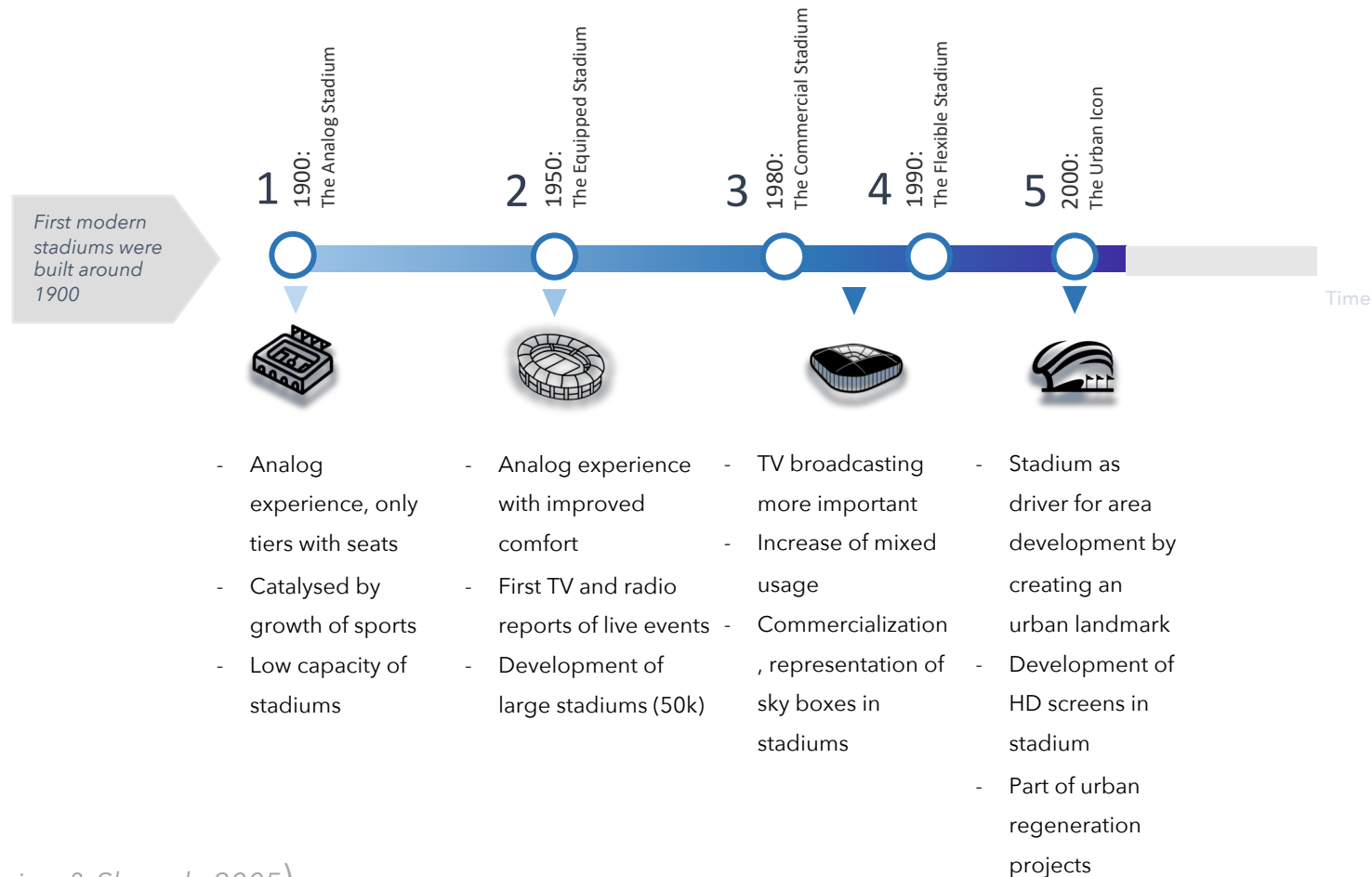
# Added Values

Nourse & Roulac	De Jonge	Lindholm & Leväinen	Scheffer et al.	De Vries	Den Heijer	Van der Zwart	Valks, Den Heijer, Arkesteijn
1993	1996	2006	2006	2008	2011	2011	2018
Occupancy cost minimalization	Reduce costs	Reduce costs	Cost reduction	Reducing costs	Decreasing costs	Reducing costs	Decreasing costs
Facilitate and control production, operations and service delivery	Improve productivity	Increase productivity	Increasing productivity	Increase productivity	Support user activities	Improving productivity	Support user activities
Promote human resource objectives	Improve culture	Increase employee satisfaction	Changing the culture	Increasing satisfaction	Increasing (user) satisfaction	Increasing user satisfaction	Increasing (user) satisfaction
					Improving quality of place		Improving quality of place
Facilitate managerial process and knowledge work	Marketing	Promote marketing and sale	PR and marketing	Supporting image	Supporting culture	Supporting image	Supporting culture
					Stimulating collaboration		Stimulating collaboration
Promote marketing message		Increase Innovation		Stimulating innovation	Stimulating innovation	Increasing innovation	Stimulating innovation
Flexibility	Increase flexibility	Increase flexibility	Increase of flexibility	Enhancing flexibility	Increase flexibility	Improving flexibility	Increase flexibility
Capture real estate value creation	Improve availability of finance (increase of value)	Increase value of assets	Increase of value	Expanding funding possibilities	Increase real estate value	Improving the financial position	Increase real estate value
	Risk management						
				Improving culture	Supporting image	Improving culture	Supporting image
					Reducing ecological footprint		Reducing footprint (m2)
							Reducing footprint (CO2)



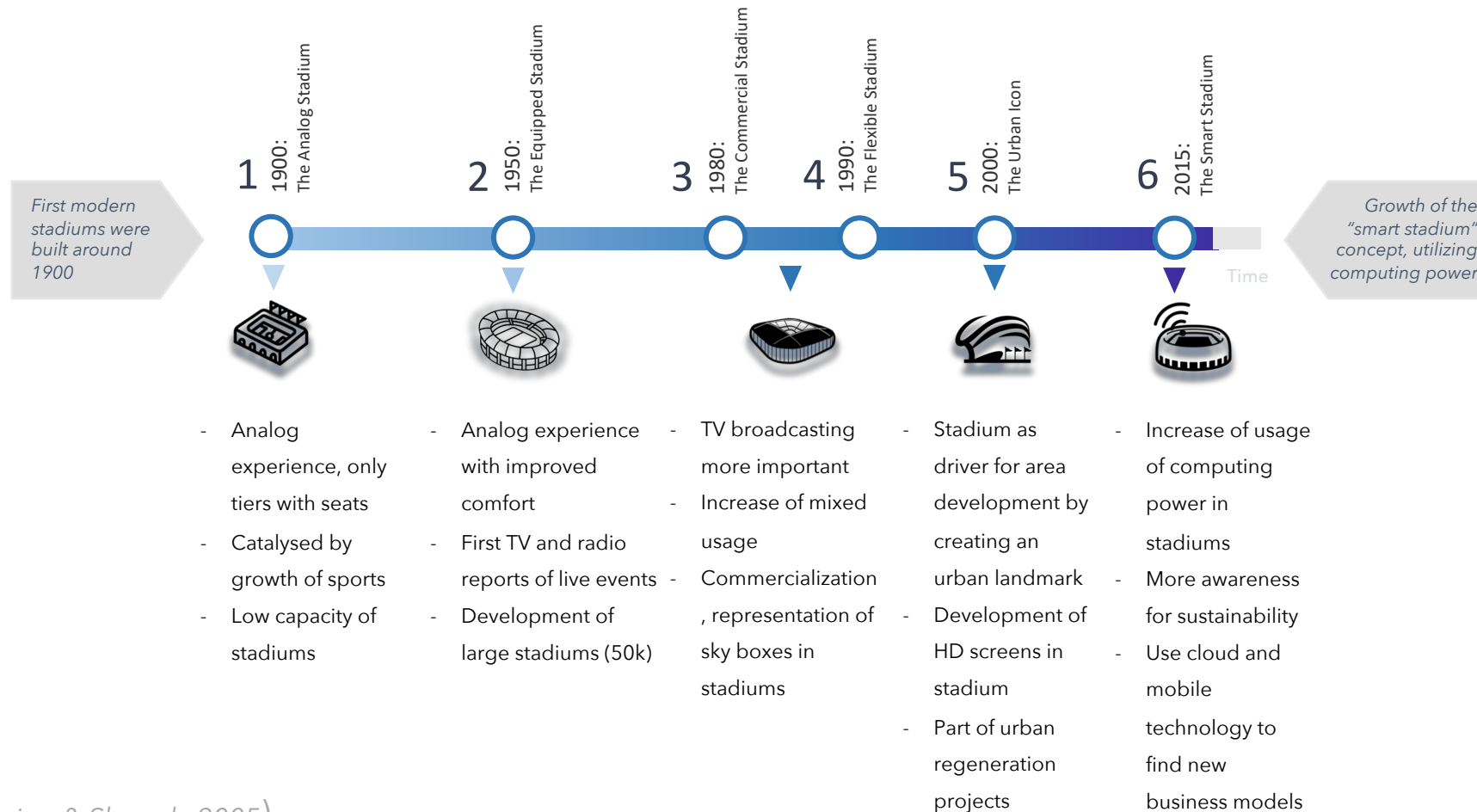
## Theories: The Stadium

# Development of stadiums



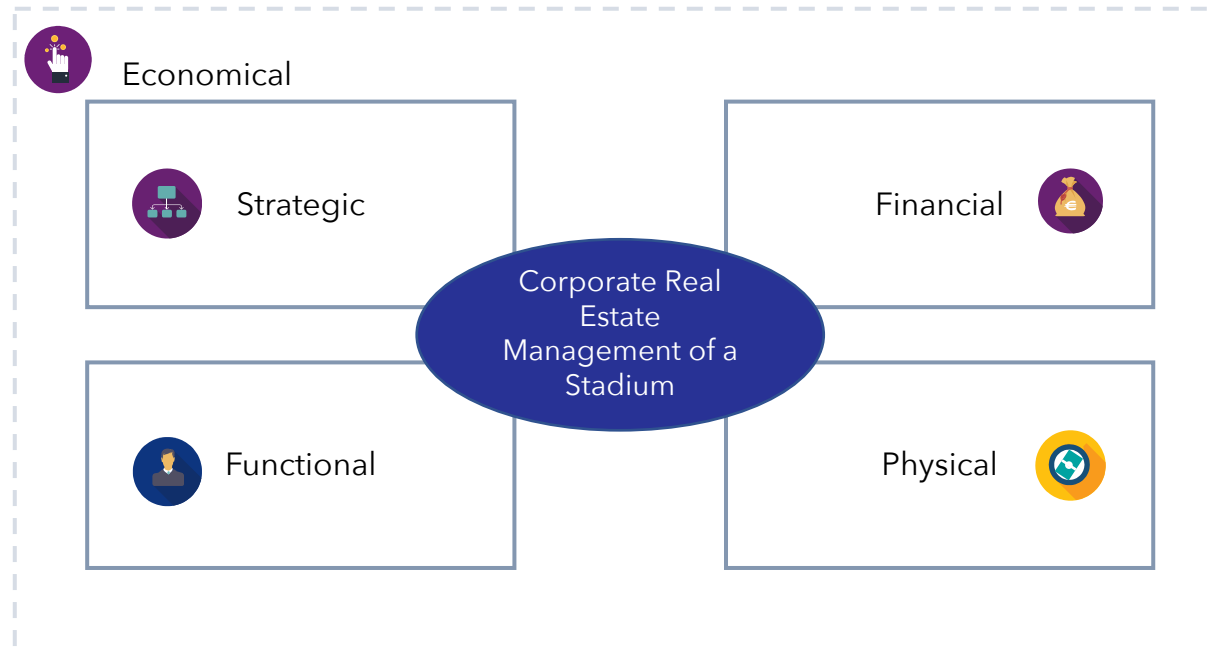
(based on Dunning & Sheard, 2005)

# Development of stadiums



*(based on Dunning & Sheard, 2005)*

# 5 perspectives

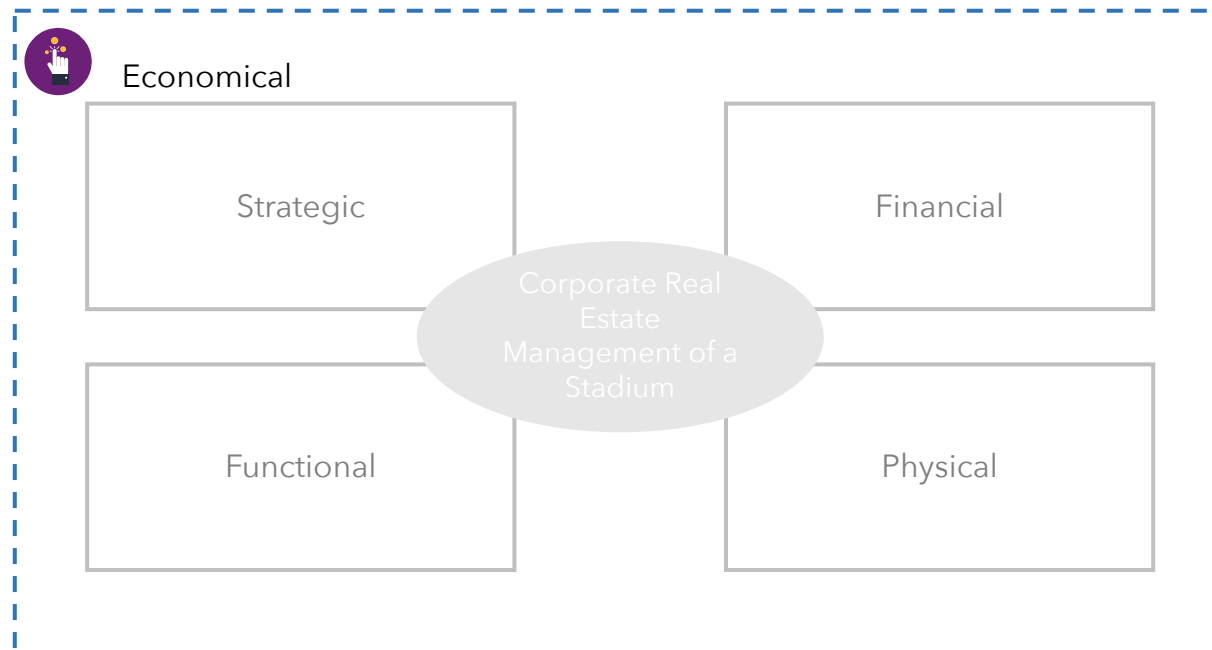


(based on Den Heijer, 2011)



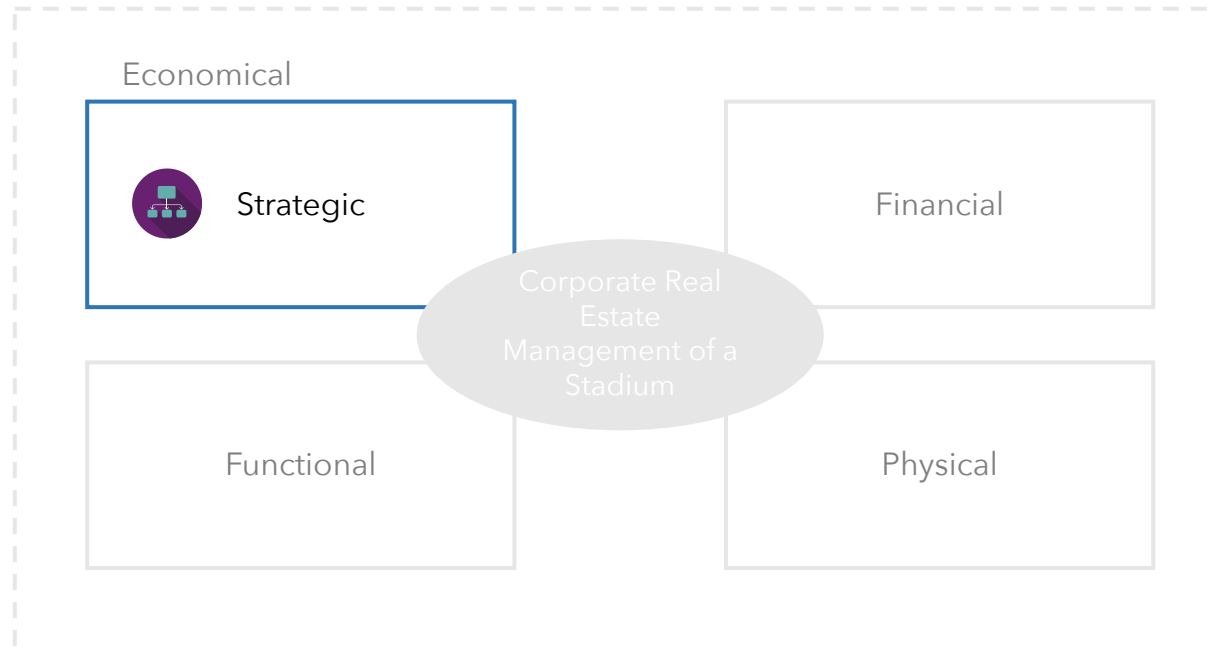
# 5 perspectives

- Stadium developments can have an economic impact on the (local) area.
- Stadium development can be used as a driver for new area developments.
- Justifications for investing with public money.

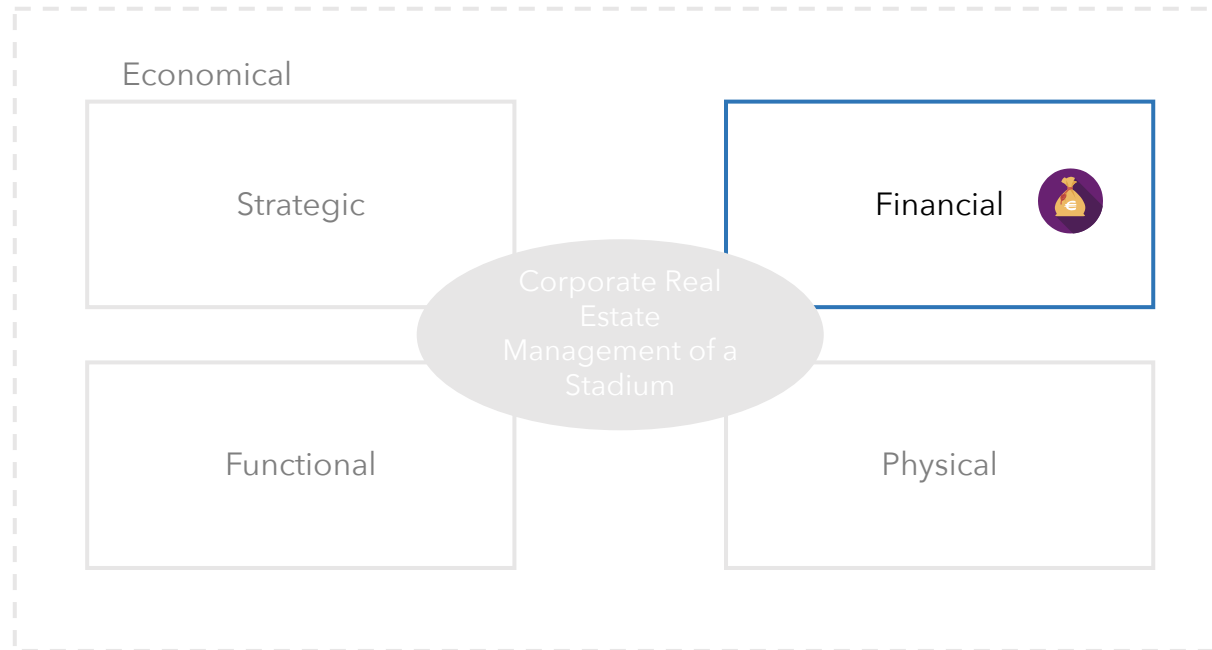


# 5 perspectives

- Stadiums are managed by a separate organization (Limited Partnership)

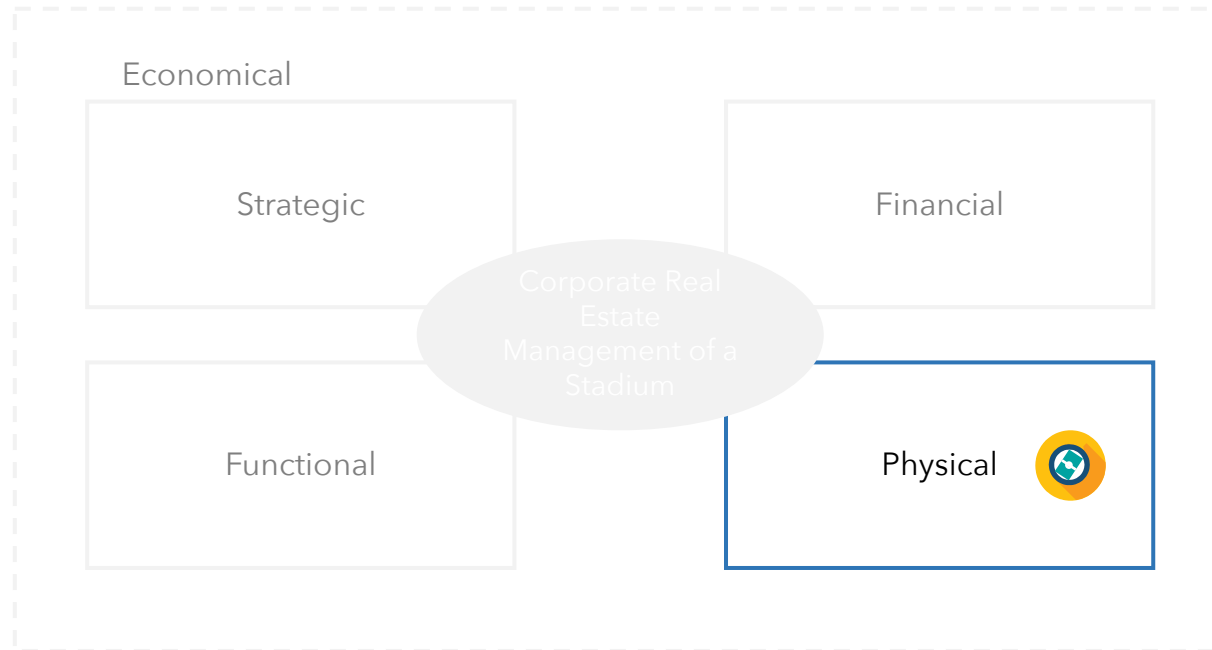


# 5 perspectives



- Investors in stadium developments are often municipalities, sports clubs and banks.
- Income: lease for organizing events
- Costs: operations

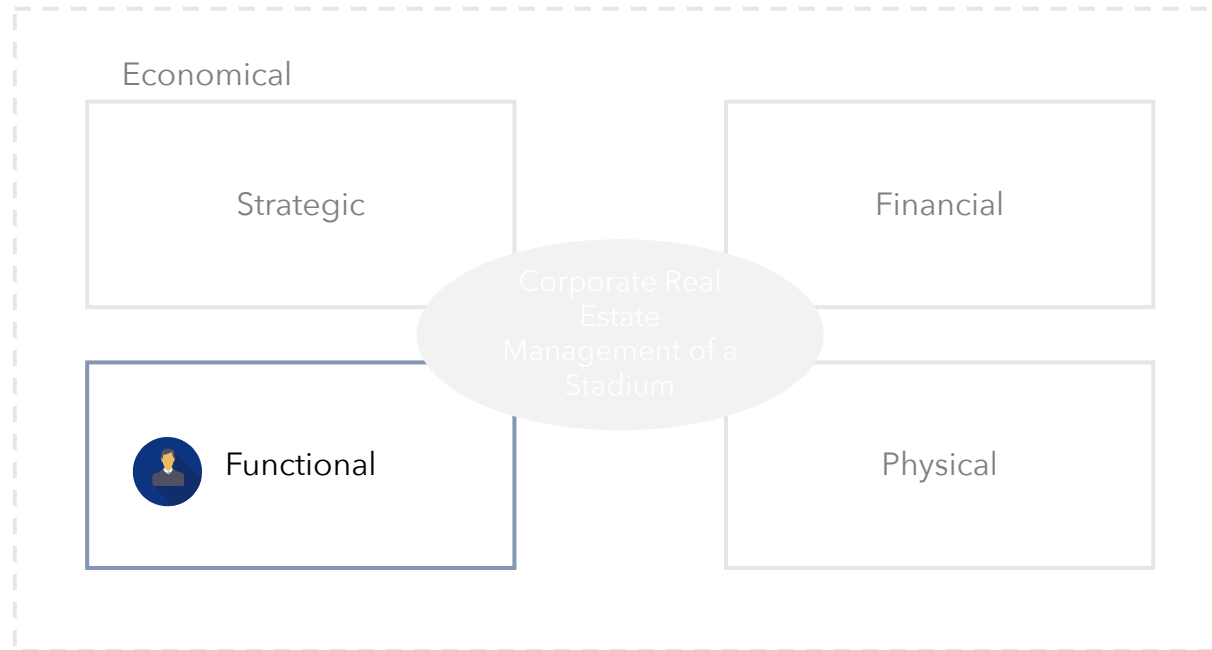
# 5 perspectives



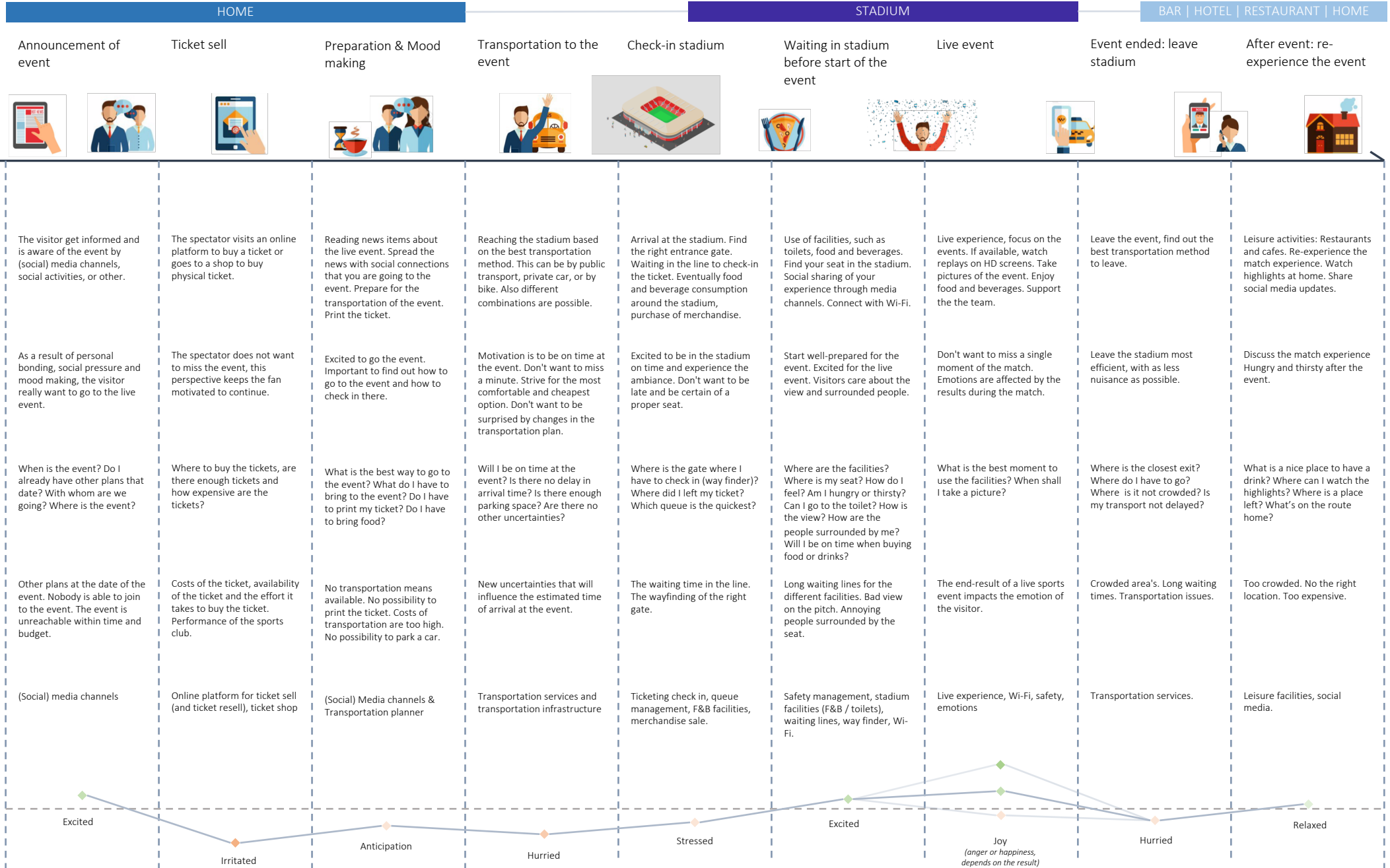
- Tiers of spectators
- Capacity differs
- Mixed functions

# 5 perspectives

- Spectator important user
- Customer Journey Method



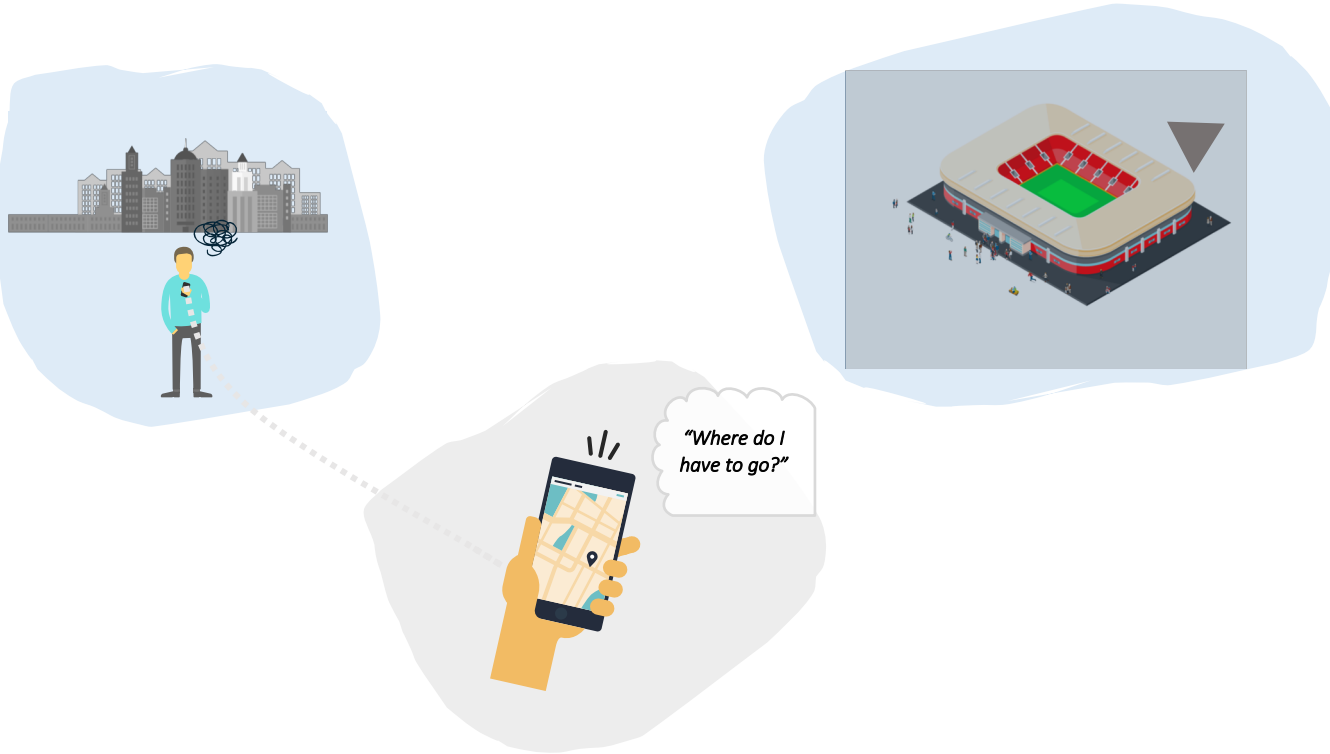
# CUSTOMER JOURNEY SPECTATOR.



# Improved visitor navigation

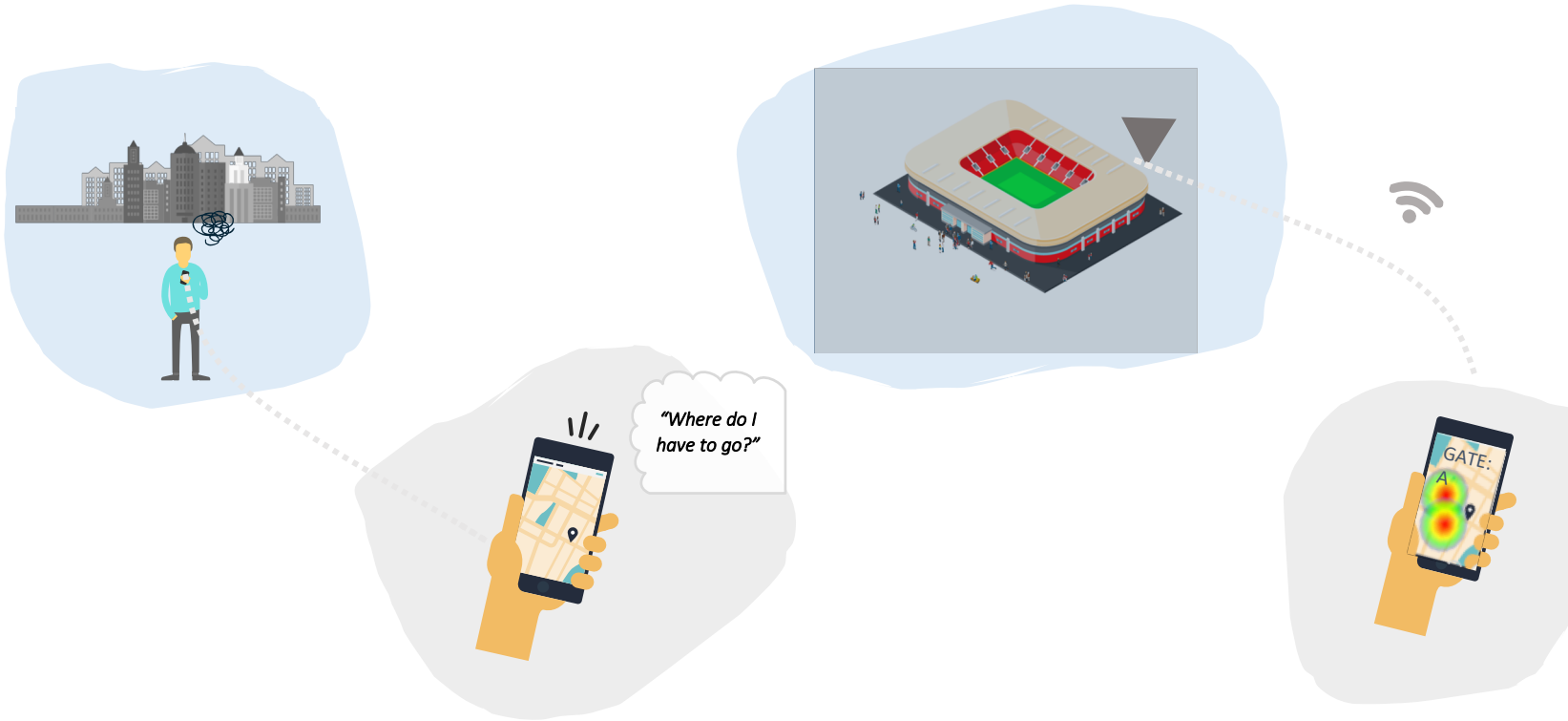


# Improved visitor navigation

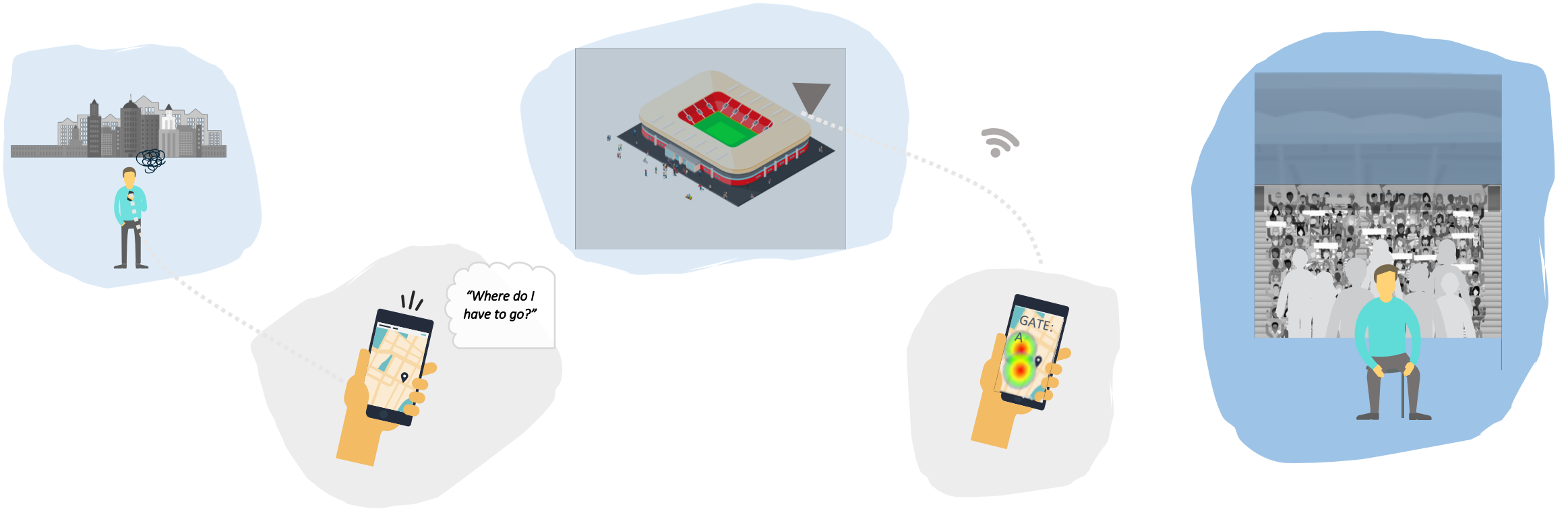




# Improved visitor navigation



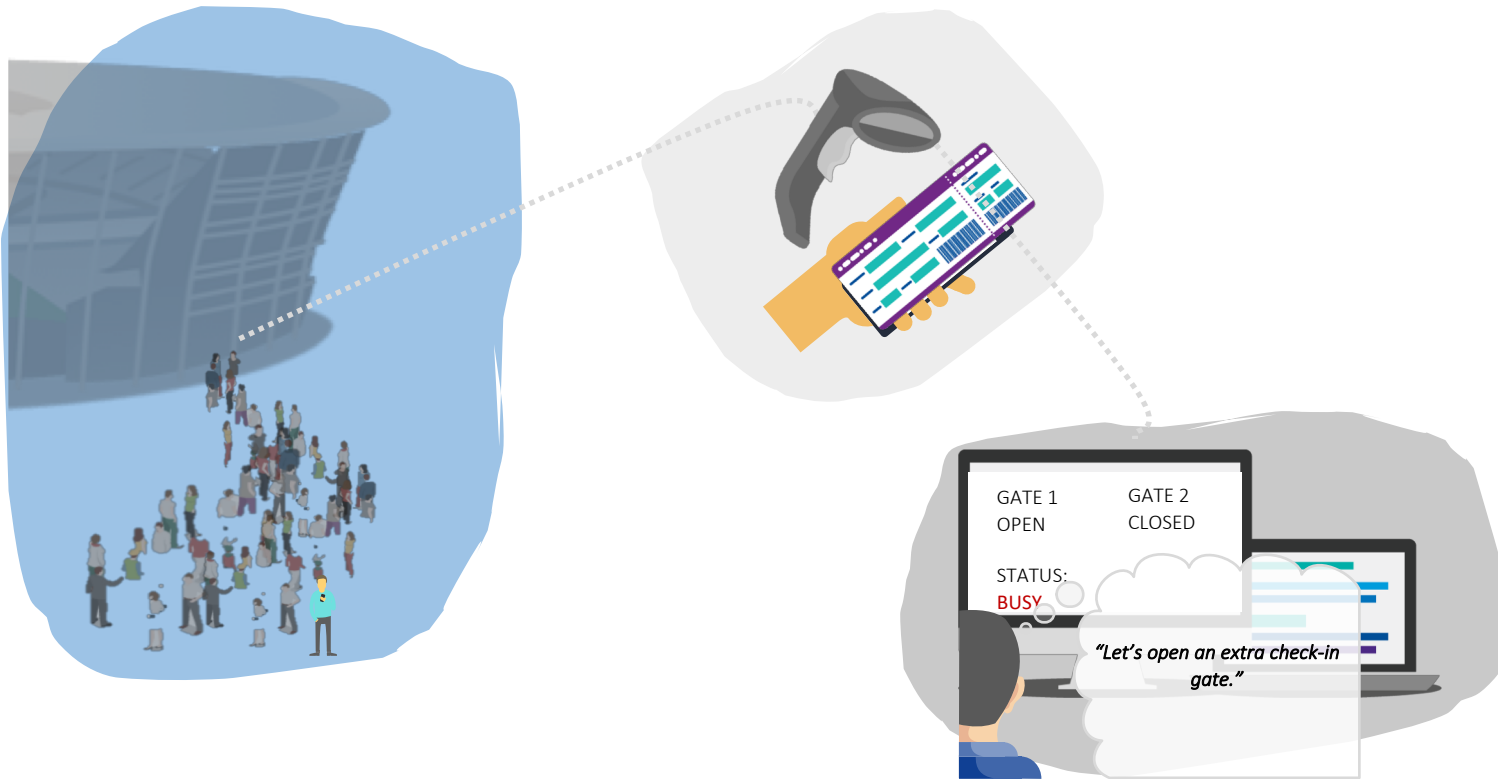
# Improved visitor navigation



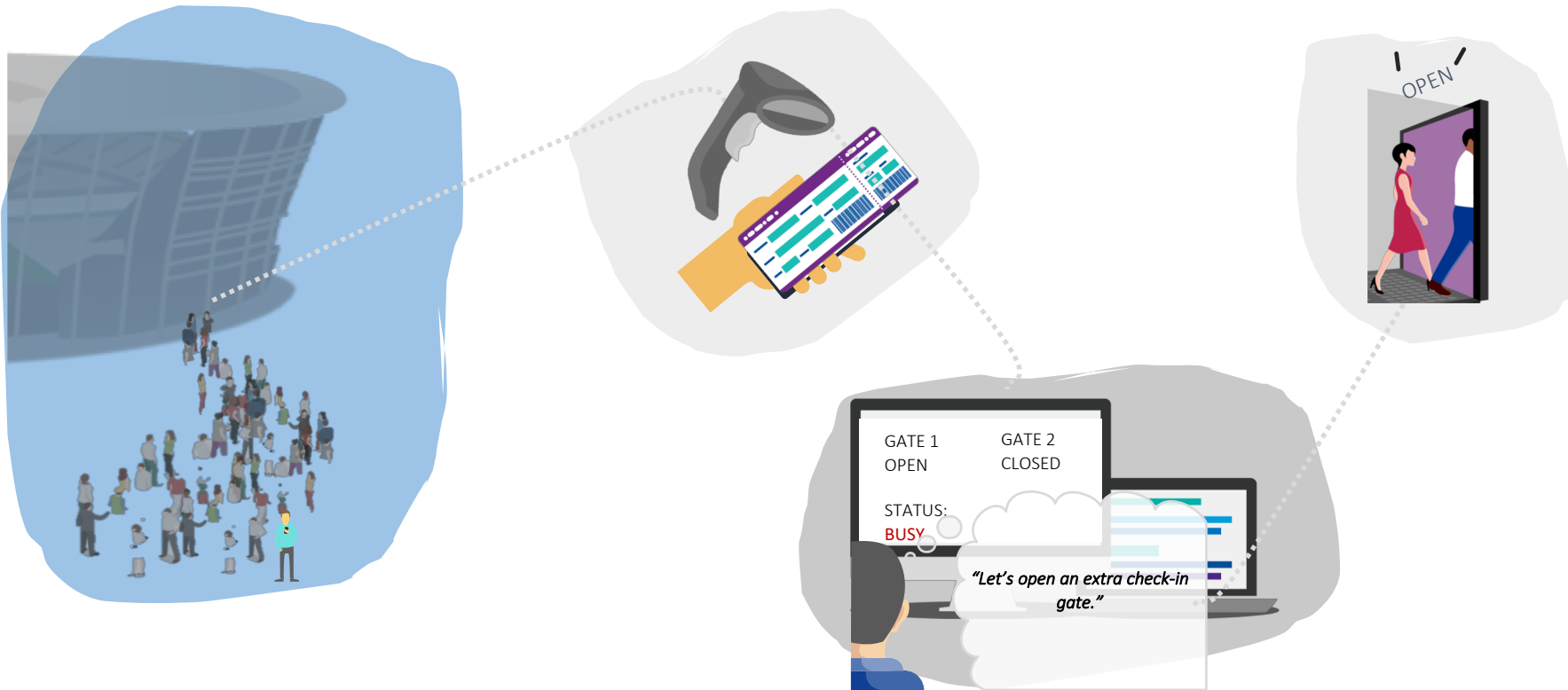
# Speeding up the entry



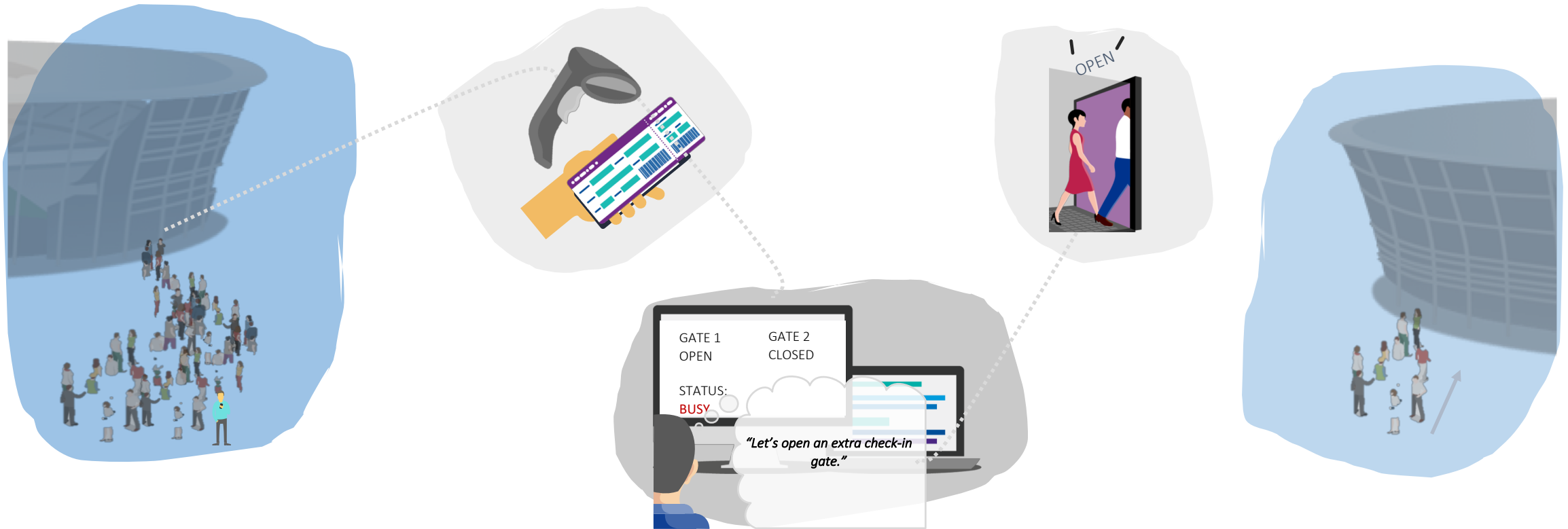
# Speeding up the entry



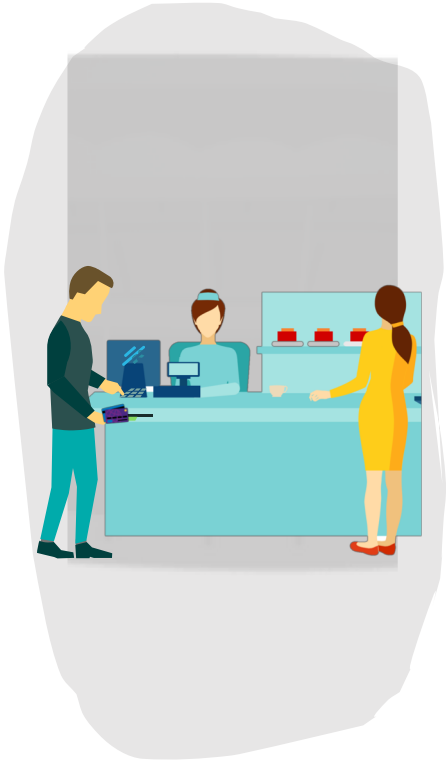
# Speeding up the entry



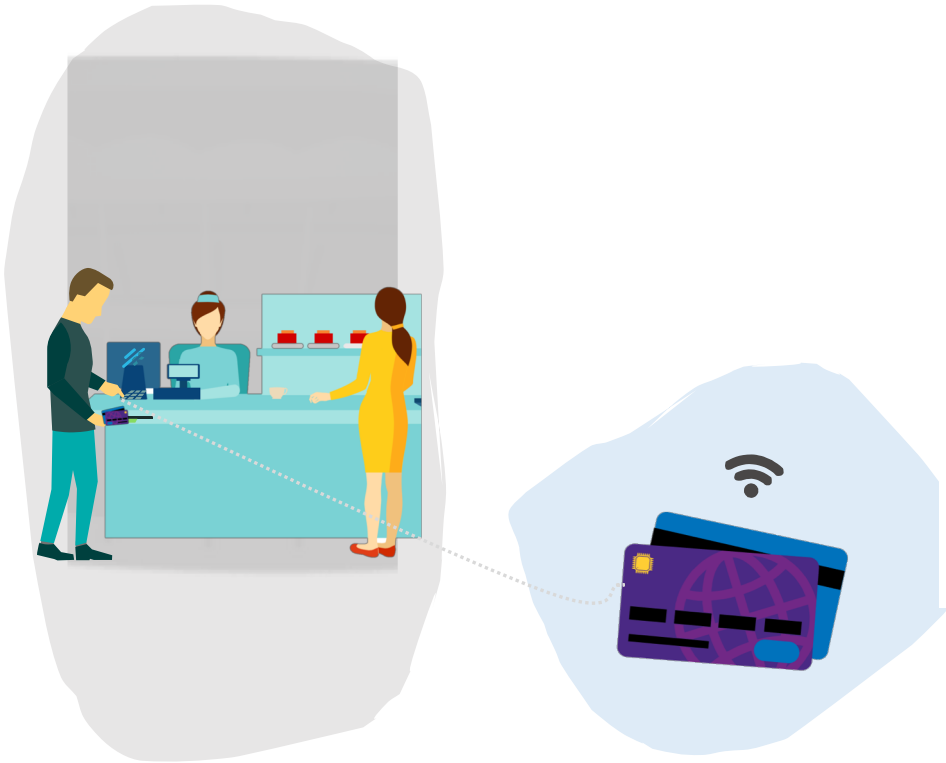
# Speeding up the entry



# Optimize commercial opportunities

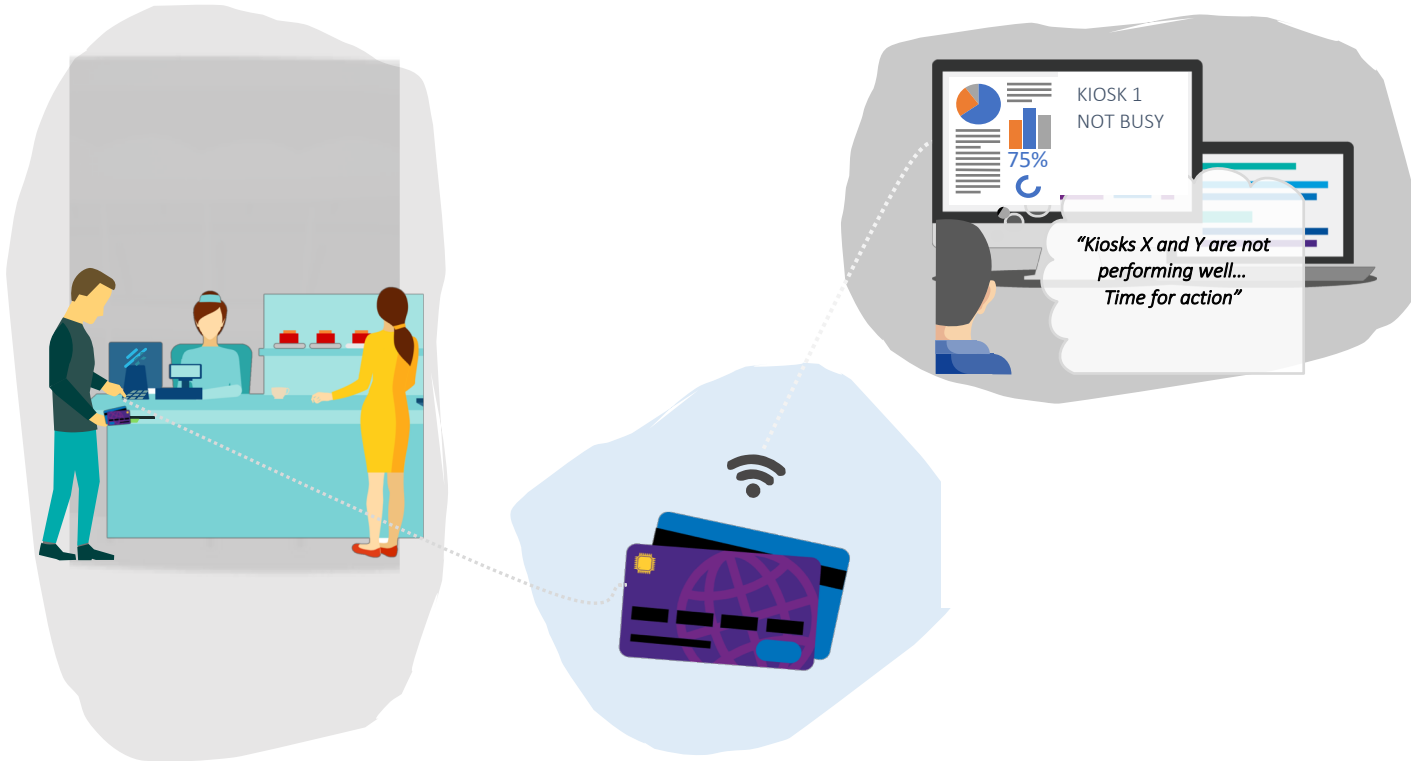


# Optimize commercial opportunities

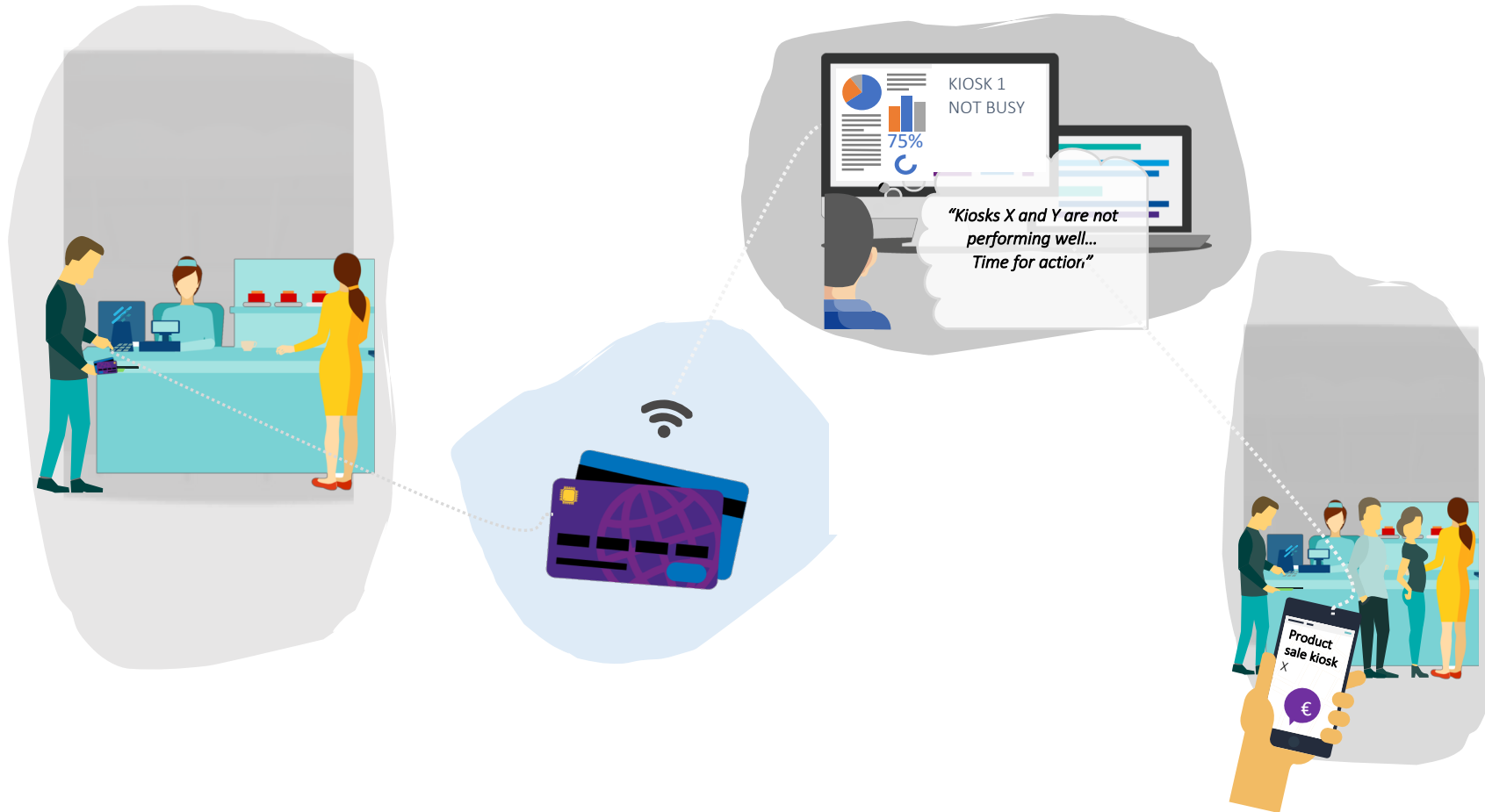




# Optimize commercial opportunities



# Optimize commercial opportunities



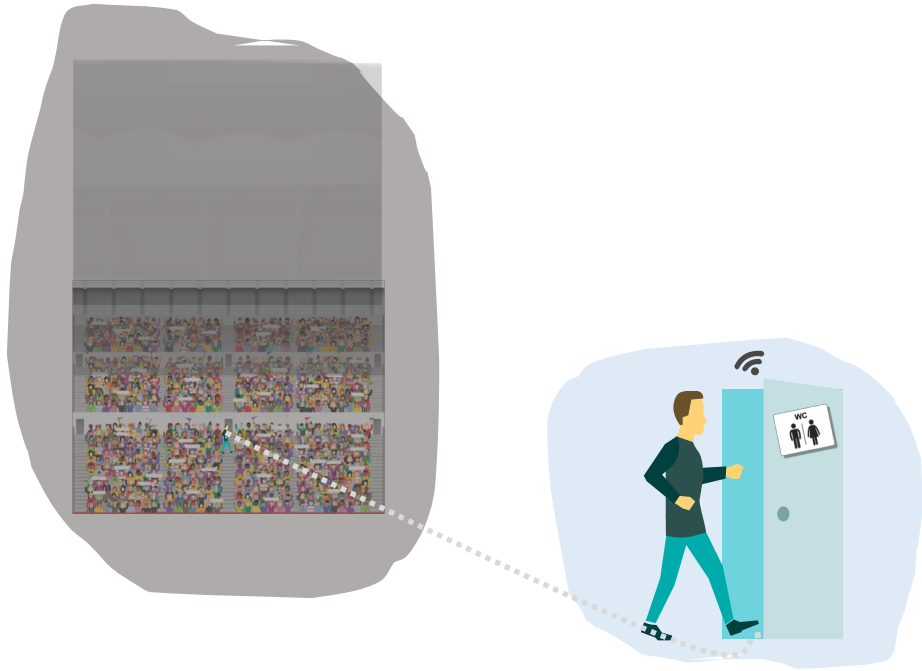
# Optimize commercial opportunities



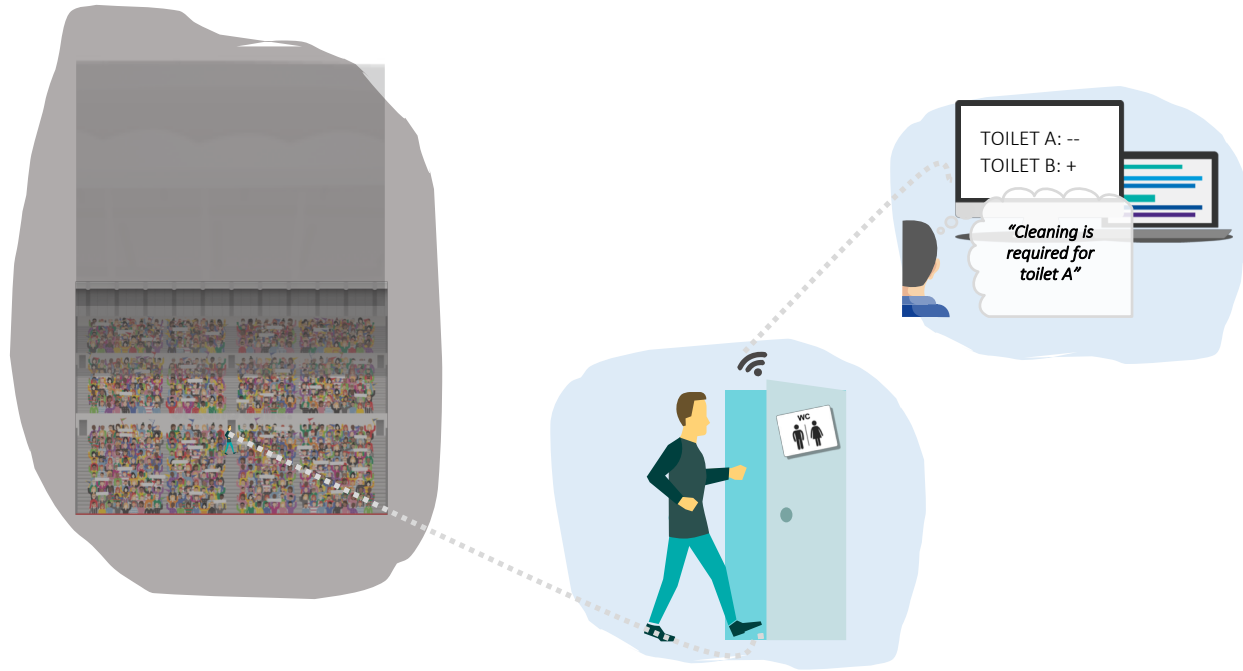
# More efficient operations



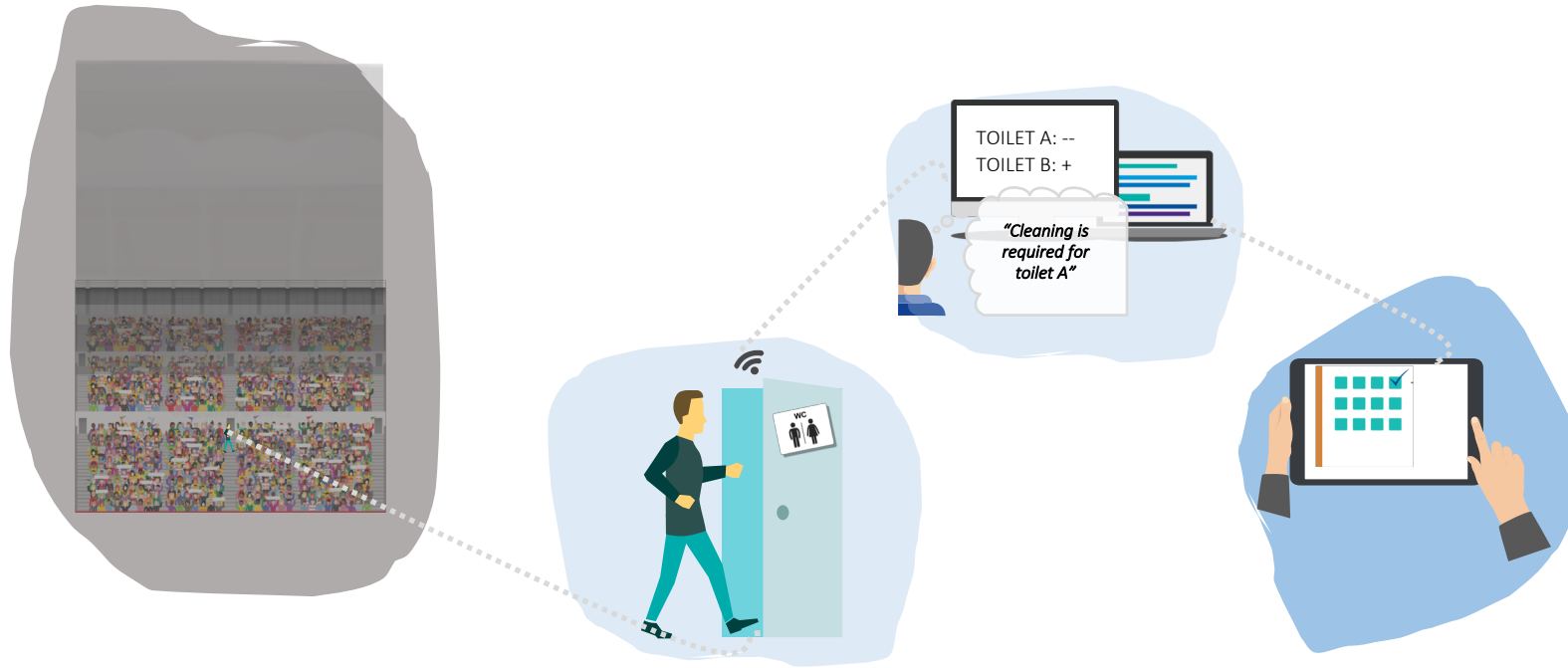
# More efficient operations



# More efficient operations



# More efficient operations



# More efficient operations







PART 2  
PRACTICES



**Case Study:**  
The Johan Cruijff ArenA

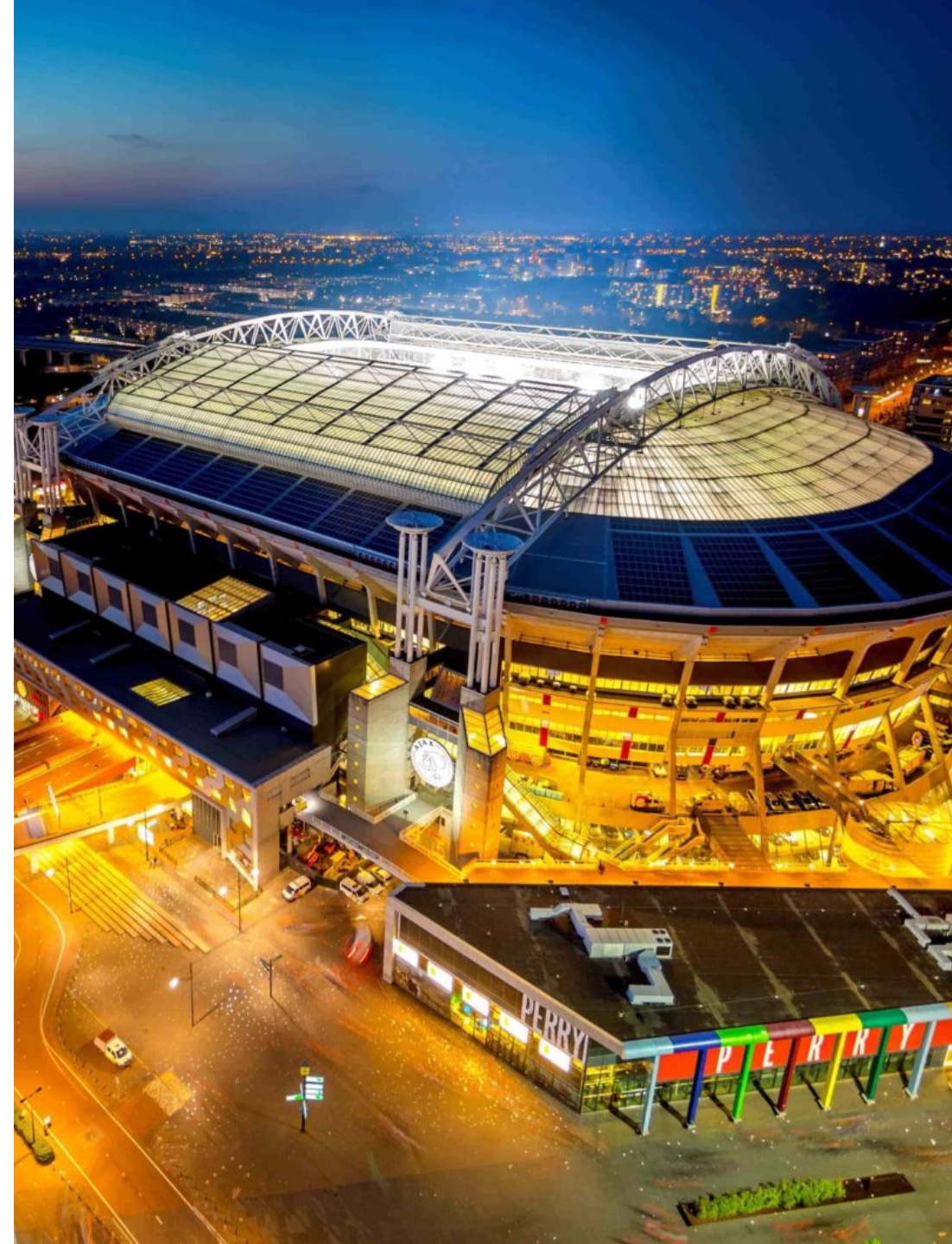
# Case: Johan Cruijff ArenA

## Why?

- In 2015, the Johan Cruijff ArenA opened an innovation centre in the stadium
- “[...] by 2020 the Johan Cruijff ArenA must be the most innovative stadium in the world” (Johan Cruijff ArenA, 2017)
- Smart tools and other innovations in the Johan Cruijff ArenA are among the frontrunners










## How?

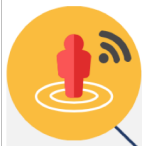
- Data collection: semi-structured interviews, observations, documentation.
- Interview protocol based on smart tool research of Valks et al. (2016) & (2018)



# 9 smart tools are identified



-  1. Smart tool: Cash register
-  2. Smart tool: Cleaning
-  3. Smart tool: Crowd control
-  4. Smart tool: Energy consumption and battery
-  5. Smart tool: Mobility portal
-  6. Smart tool: Smart turf monitoring system
-  7. Smart tool: Staffing
-  8. Smart tool: Technical maintenance
-  9. Smart tool: Ticketing check-in



# Smart tool: Crowd Control

PHASE

Research and product development  
December 2018

DURATION

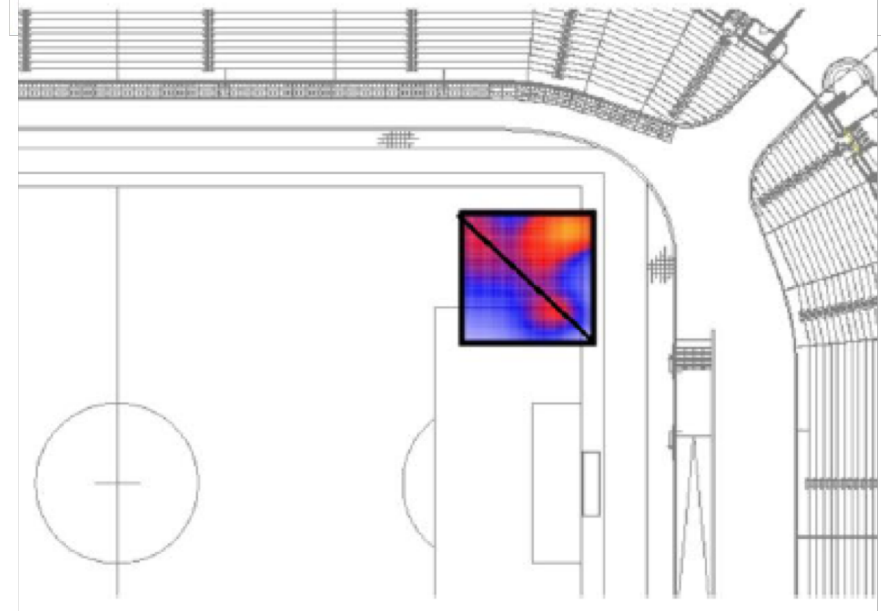
STAGE

Monitoring

ACTUALITY

Near real time

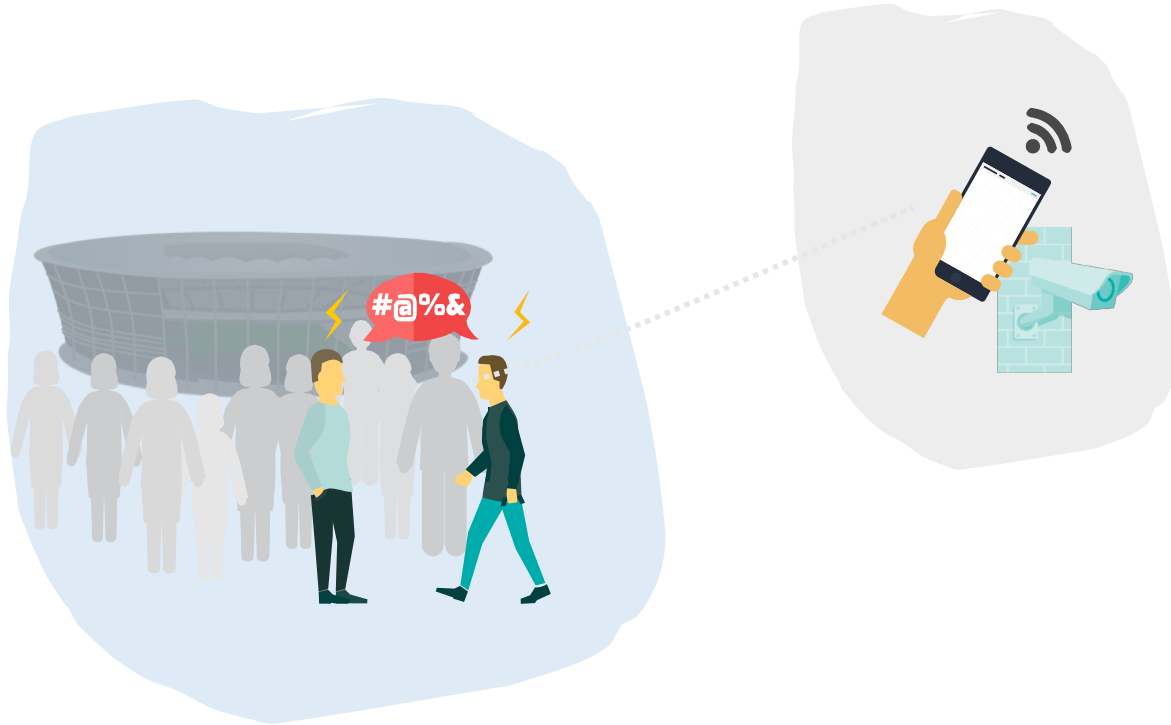
- The crowd density is estimated by anonymous, non-participatory, indoor Wi-Fi localization of smart phones.
- By detecting the MAC addresses by Wi-Fi access points (API's).
- The Wi-Fi signals that are transmitted from phones are captured by Wi-Fi access points.
- Based on this information, an estimation of the coordinates of a visitor can be given.
- The Wi-Fi tracking is done inside the stadium, the 'ring' around the stadium, and close around the stadium.



# Enhance safety and security



# Enhance safety and security



# Enhance safety and security






# Enhance safety and security



# Analysis

									
Name smart tool	Smart turf monitoring system	Crowd control	Mobility portal	Technical maintenance	Cash registers	Cleaning	Staffing	Ticketing check-in	Energy consumption & battery
Priority goal (4 perspectives)	Strategic	Functional	Functional	Functional	Financial	Financial	Financial	Financial	Physical
Phase	Implementation	Research and Product development	Implementation	Product development	Implementation	Product development	Product development	Implementation	Implementation
Goal of the tool	"Higher quality of the pitch & higher utilization of the pitch"	"To understand and possibility to control the behaviour of people within the stadium" "Safety"	"Better travel experience for visitors to the area" "Reduce motorized transport"	"To realize a cost reduction for energy consumption, maintenance, facility management" "Improve quality of living areas"	"Increase revenues, better service, cost reductions, more certainty and less risks."	"Reduce cleaning costs"	"Higher efficiency in communication and better idea of the time registration "	"A more efficient ticketing check-in"	"To reduce energy consumption"
Progress since implementing the tool	"The pitch only needs replacement ones a year instead of multiple times a year"	The tool is not implemented yet.	"750.000 travel advices given to people"	The tool is not implemented yet.	"Based on the current information it can be confirmed that the extension on the second ring are generating more revenues."	The tool is not implemented yet	The tool is not implemented yet	"Better insights in the attendance of visitors during events".	"Better insight in the energy consumption" "Sustainable energy production"
Specific points of improvement and ambitions to achieve the goal	"Historical data"	"Historical data"	"Better real-time response"	Not available	"Historical data" "Better real-time response" "Connect to ticketing check-in"	"Better real-time response"	"Connect to a digital check-in" "Historical data"	"Historical data" "Better real-time response"	"Connect to the building management system"
Points of attention	"Measurement method"	"Privacy" "Measurement method" "Technical layer"	"Measurement method" "Collaboration with partners" "Privacy"	"Technical layer"	"Collaboration with partners (suppliers)" "Privacy"	Not available	Not available	Not available	Not available










CONCEPTS

THEORIES

PRACTICE

SYNTHESIS

# Analysis

									
Name smart tool	Smart turf monitoring system	Crowd control	Mobility portal	Technical maintenance	Cash registers	Cleaning	Staffing	Ticketing check-in	Energy consumption & battery
Priority goal (4 perspectives)	Strategic	Functional	Functional	Functional	Financial	Financial	Financial	Financial	Physical
Phase	Implementation	Research and Product development	Implementation	Product development	Implementation	Product development	Product development	Implementation	Implementation
Goal of the tool	"Higher quality of the pitch & higher utilization of the pitch"	"To understand and possibility to control the behaviour of people within the stadium" "Safety"	"Better travel experience for visitors to the area" "Reduce motorized transport"	"To realize a cost reduction for energy consumption, maintenance, facility management" "Improve quality of living areas"	"Increase revenues, better service, cost reductions, more certainty and less risks."	"Reduce cleaning costs"	"Higher efficiency in communication and better idea of the time registration "	"A more efficient ticketing check-in"	"To reduce energy consumption"
Progress since implementing the tool	"The pitch only needs replacement ones a year instead of multiple times a year"	The tool is not implemented yet.	"750.000 travel advices given to people"	The tool is not implemented yet.	"Based on the current information it can be confirmed that the extension on the second ring are generating more revenues."	The tool is not implemented yet	The tool is not implemented yet	"Better insights in the attendance of visitors during events".	"Better insight in the energy consumption" "Sustainable energy production"
Specific points of improvement and ambitions to achieve the goal	"Historical data"	"Historical data"	"Better real-time response"	Not available	"Historical data" "Better real-time response" "Connect to ticketing check-in"	"Better real-time response"	"Connect to a digital check-in" "Historical data"	"Historical data" "Better real-time response"	"Connect to the building management system"
Points of attention	"Measurement method"	"Privacy" "Measurement method" "Technical layer"	"Measurement method" "Collaboration with partners" "Privacy"	"Technical layer"	"Collaboration with partners (suppliers)" "Privacy"	Not available	Not available	Not available	Not available

CONCEPTS


THEORIES

PRACTICE













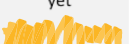
SYNTHESIS

# Goals

- The tools clearly express two goals **reducing costs** and **supporting the user activities**.
- Specific numbers / targets were not clearly stated and available.
- Some strategic and physical goals.

Smart Tool 	Priority 	Strategic 						Functional 		Financial 		Physical 	
		Stimulating innovation	Stimulating collaboration	Supporting image	Supporting culture	Improving quality of place	Supporting user activities	Increasing user satisfaction	Increasing flexibility	Decrease costs	Increasing real estate value	Controlling risks	Optimize m2 footprint
Cash registers	Financial	👍					👍	👍	👍			👍	
Cleaning	Financial						👍		👍				
Crowd control	Functional						👍	👍	👍				
Energy consumption & battery	Physical		👍	👍	👍				👍		👍		👍
Mobility Portal	Functional		👍				👍	👍					👍
Smart turf monitoring system	Strategic	👍				👍	👍		👍				
Staffing	Financial						👍		👍		👍		
Technical maintenance	Functional					👍	👍	👍	👍				👍
Ticketing check-in	Financial	👍					👍	👍	👍			👍	

# Analysis

									
Name smart tool	Smart turf monitoring system	Crowd control	Mobility portal	Technical maintenance	Cash registers	Cleaning	Staffing	Ticketing check-in	Energy consumption & battery
Priority goal (4 perspectives)	Strategic	Functional	Functional	Functional	Financial	Financial	Financial	Financial	Physical
Phase	Implementation	Research and Product development	Implementation	Product development	Implementation	Product development	Product development	Implementation	Implementation
Goal of the tool	"Higher quality of the pitch & higher utilization of the pitch"	"To understand and possibility to control the behaviour of people within the stadium" "Safety"	"Better travel experience for visitors to the area" "Reduce motorized transport"	"To realize a cost reduction for energy consumption, maintenance, facility management" "Improve quality of living areas"	"Increase revenues, better service, cost reductions, more certainty and less risks."	"Reduce cleaning costs"	"Higher efficiency in communication and better idea of the time registration "	"A more efficient ticketing check-in"	"To reduce energy consumption"
Progress since implementing the tool	"The pitch only needs replacement ones a year instead of multiple times a year"	The tool is not implemented yet. 	"750.000 travel advices given to people"	The tool is not implemented yet. 	"Based on the current information it can be confirmed that the extension on the second ring are generating more revenues."	The tool is not implemented yet 	The tool is not implemented yet 	"Better insights in the attendance of visitors during events".	"Better insight in the energy consumption" "Sustainable energy production"
Specific points of improvement and ambitions to achieve the goal	"Historical data"	"Historical data"	"Better real-time response"	Not available	"Historical data" "Better real-time response" "Connect to ticketing check-in"	"Better real-time response"	"Connect to a digital check-in" "Historical data"	"Historical data" "Better real-time response"	"Connect to the building management system"
Points of attention	"Measurement method"	"Privacy" "Measurement method" "Technical layer"	"Measurement method" "Collaboration with partners" "Privacy"	"Technical layer"	"Collaboration with partners (suppliers)" "Privacy"	Not available	Not available	Not available	Not available

CONCEPTS

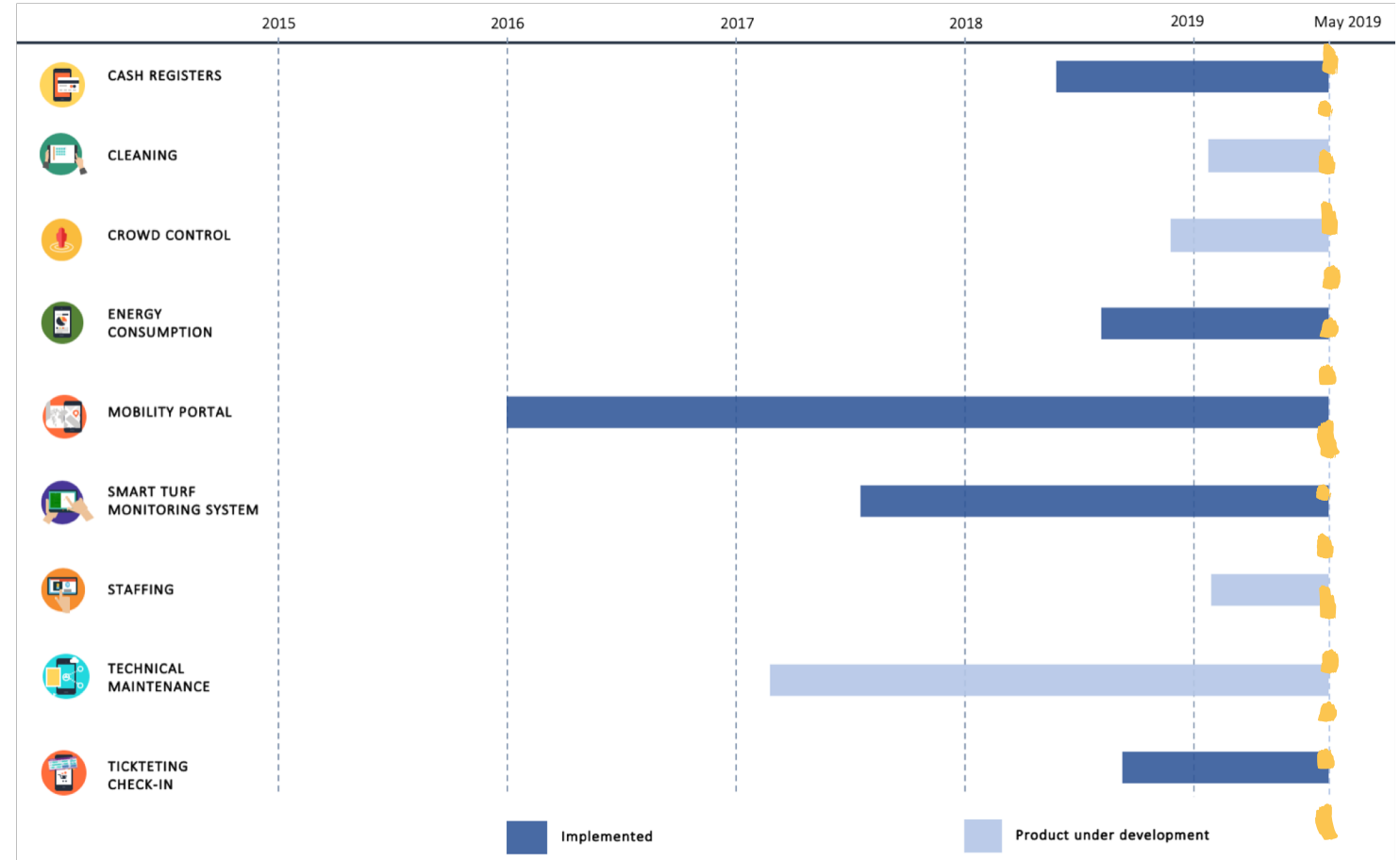
THEORIES

PRACTICE










SYNTHESIS

# Progress

- Only five of these tools were operational at the time of the interviews.
- Specific numbers of the progress since integrating the tools were not available.
- Progress was not monitored well.
- Also, monitoring was difficult due to immature character of the tools



# Analysis

									
Name smart tool	Smart turf monitoring system	Crowd control	Mobility portal	Technical maintenance	Cash registers	Cleaning	Staffing	Ticketing check-in	Energy consumption & battery
Priority goal (4 perspectives)	Strategic	Functional	Functional	Functional	Financial	Financial	Financial	Financial	Physical
Phase	Implementation	Research and Product development	Implementation	Product development	Implementation	Product development	Product development	Implementation	Implementation
Goal of the tool	"Higher quality of the pitch & higher utilization of the pitch"	"To understand and possibility to control the behaviour of people within the stadium" "Safety"	"Better travel experience for visitors to the area" "Reduce motorized transport"	"To realize a cost reduction for energy consumption, maintenance, facility management" "Improve quality of living areas"	"Increase revenues, better service, cost reductions, more certainty and less risks."	"Reduce cleaning costs"	"Higher efficiency in communication and better idea of the time registration "	"A more efficient ticketing check-in"	"To reduce energy consumption"
Progress since implementing the tool	"The pitch only needs replacement ones a year instead of multiple times a year"	The tool is not implemented yet.	"750.000 travel advices given to people"	The tool is not implemented yet.	"Based on the current information it can be confirmed that the extension on the second ring are generating more revenues."	The tool is not implemented yet	The tool is not implemented yet	"Better insights in the attendance of visitors during events".	"Better insight in the energy consumption" "Sustainable energy production"
Specific points of improvement and ambitions to achieve the goal	"Historical data"	"Historical data"	"Better real-time response"	Not available	"Historical data" "Better real-time response" "Connect to ticketing check-in"	"Better real-time response"	"Connect to a digital check-in" "Historical data"	"Historical data" "Better real-time response"	"Connect to the building management system"
Points of attention	"Measurement method"	"Privacy" "Measurement method" "Technical layer"	"Measurement method" "Collaboration with partners" "Privacy"	"Technical layer"	"Collaboration with partners (suppliers)" "Privacy"	Not available	Not available	Not available	Not available



# Specific points of improvements



## 1 Use of historical data

Save the data in order to predict different types of events

*"[...] van de historische evenementen die we hebben gehad dan kunnen we die gegevens opslaan en daar een soort van basisprofiel van gebouwd. Op basis van die historische gegevens kunnen we eigenlijk al zeggen dat is te verwachten"*

W. Hegen (personal communication, April 15, 2019).

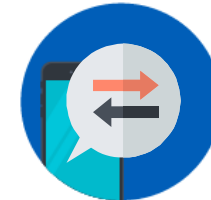


## 2 Better real-time response

Only one of the tools is accessible for the user

*"[...] maar als men onderweg is hebben we niet zoveel mogelijk om nog te benaderen Dat is iets waar we nog heel hard aan willen werken"*

M. van Hövell (personal communication, April 10, 2019).



## 3 Link with other systems

Link the tools to each other or to automated processes

*"[...] ambitie om personeel te koppelen een het incheckstelsysteem [...]"*  
W. Hegen (personal communication, April 15, 2019).



A wide-angle, high-angle photograph of a large outdoor concert venue at dusk. The sky is a deep, dark blue with some lighter clouds. The stadium seating is filled with a massive crowd of people, extending far into the background. In the center, a large stage structure is visible, featuring a tall metal scaffolding tower. To the left, a large, dark, curved structure, possibly a stage backdrop or part of the venue's architecture, is prominent. The overall atmosphere is that of a major music festival or concert event.

PART 3  
SYNTHESIS



## **Synthesis:**

Future applications:  
optimize the smart  
potential of stadiums

# Approach

## What to be improved?

- 1) To improve the use of historical data
- 2) A better real-time response to visitors
- 3) Linking the tools

## How?

Compare with other 'smart system' - Edge Olympic

New innovations that are available - 'Change the Game' Open Innovation Challenge

# EDGE OLYMPIC AMSTERDAM



# Smart system: EDGE Olympic



## Historical data saved?

Collected data is saved which turns it into historical data. Used on the long-term for cleaning and different lay-out.



## Real-time response?

Preferences as selected by the user through an mobile application are used for input in the data lake.



## Linking of the tools?

Compared to performance goals, automate different processes.



# Smart system: EDGE Olympic



## Historical data saved?

Collected data is saved which turns it into historical data. Used on the long-term for cleaning and different lay-out.



## Real-time response?

Preferences as selected by the user through an mobile application are used for input in the data lake.



## Linking of the tools?

Compared to performance goals, automate different processes.



# Innovation Challenge

Change the Game' innovation challenge:

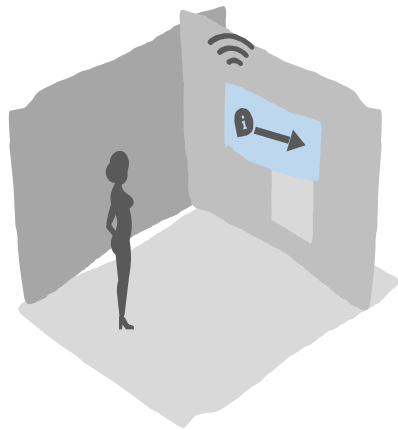
- ✓ Innovative start-ups, scale-ups and enterprises could submit their solutions
- ✓ 198 solutions were submitted from 32 countries
- ✓ January 2019 till April 2019



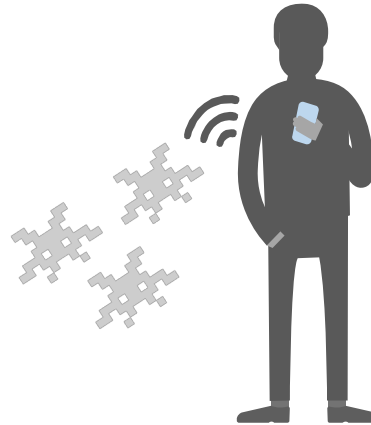
# Innovation Challenge



Mobile ordering platform



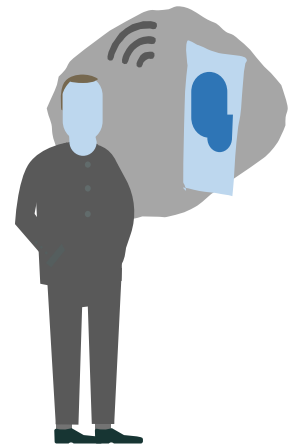
Pro-active and adaptive  
visual communication



Guide users throughout a  
venue by using innovative  
features (such as  
Gamification, Augmented  
Reality, and Virtual Reality



Smart map solutions



Facial recognition  
technology





Conclusion;  
Discussion;  
Recommendations.

Which smart tools can be identified in stadiums, and how can the use of these smart tools be optimized?

## Which smart tools can be **identified** in stadiums, and how can the use of these smart tools be optimized?

- Theories emphasizes the potential of smart tools
- 9 smart tools are identified and analysed based on different theoretical frameworks.
- At the moment of the research five smart tools were in use.
- Only one had open access for visitors (the mobility portal).
- Integrated current tools did cause some progress, concrete numbers were lacking.
- Focus of the tools is reducing costs and improve user activities.

## Which smart tools can be identified in stadiums, and how can the use of these smart tools be optimized?

- Basic technology infrastructure (technical layer) is very important.
- Make a profile for different type of events.
- Steer the visitor and other users more real-time (see 5 innovation challenges)
- Link the tools with each other.
  - Integrate performance levels
  - Proper technical layer
  - Automation
- Take into account importance of partners, privacy, technical layer and accuracy of measurement method

# Discussion

1

## On Theory

Added values

Smart tools - campus. Definition not clear in interviews

Smart stadium: limited scientific body of knowledge

2

## On Practice

Traditional organisations: need for innovation

Users mainly the stadium management

3

## Limitations of the research

The research focusses on only one case, external validity

Delimited period of the research: tools are currently integrated.

Neutrality of the research: only Johan Crujff ArenA specialists

# Recommendations for practice

Smart tools have a lot of potential for stadiums:

- State clear objectives and goals that have to be achieved by the smart tools: what adds value to the stadium
- Assess clearly which data is needed in order to achieve these goals
- Monitor the progress of the smart tools
- Integrating smart tools require new capabilities in organisation
- Potential to connect to 'smart city concepts'
- Visitors are focussing on a live experience; smart tools can disrupt this experience

# Partner ecosystem



# Points of attention



## Privacy

Some of the tools can be limited due to the ethical challenge of violating the privacy of visitors



## Importance of technical layer

Importance that the technical layer, which is the process to obtain and process the data into information for the end-user, is properly constructed.

6FTE for data governance and management



## Accuracy of measurement methods

Some of the measurement methods of some of the tools cause for problems, which makes the data not totally reliable



# Recommendations for further research

- Conduct research with multiple case studies: improve the external validity
- And with other types of real estate
- Conduct the same research in a few years (when all the tools are integrated)
- Confirm theories by quantitative research: exact effects of the tools

Thank you!  
Questions?

 **TU Delft**

 **KPMG**