SMART REAL ESTATE MANAGEMENT

Developing a Smart Tool for Demand-Supply Alignment
Contents

- Introduction
- Methods
- Literature Study
- Process Smart Tool Development
  - Progression
- Evaluation
  - Findings
- Conclusion
  - Discussion
  - Reflection
Introduction
Problem Analysis

Dynamic demand

Digitalisation enables students to study virtually everywhere, demand for study space on the campus remains high and students place higher demands on the quality and availability of facilities (Valks, et al., 2016, p. 15).

Utilization information

Campus management still lacks information about the utilization of the campus, including occupancy and frequency ratings (Den Heijer, 2011, p. 111).
“One of the big challenges in corporate real estate management (CREM) is reducing the gap between the high speed of business and the slow speed of real estate, i.e. between the so-called dynamic real estate demand and the relatively static real estate supply.” (Arkesteijn, 2016)
Problem Analysis

Performance measurement

Universities have little insight of user satisfaction (Algemene Rekenkamer, 2016, p. 27).

Missed opportunity for real estate managers to test and prove the effectiveness of real estate interventions (De Vries, 2007, p. 10).

Study space findability

Campus users lack of information about occupancy and aspects of available study spaces. Large part TU Delft students (70%) experiences shortage study space on weekends (ORAS, 2017, p. 7).
Context

- Increased competitiveness in higher education and more international applications (Algemene Rekenkamer, 2016, p. 21).
- Transference presented universities with opportunities to align their real estate to the organisation’s primary processes (Algemene Rekenkamer, 2016, p. 16; den Heijer, 2012, p. 73).
- Dutch universities are planning to invest more than € 3 billion in their real estate (IvhO, 2016).
Hypothesis

By providing information about space aspects and availability through smart tools an improvement in alignment between user and real estate can be achieved both on the short and long term.

By taking user preferences into account, a higher user satisfaction can be achieved.
Main Research Question

“How can a Smart Tool provide information to support the alignment of dynamic user demand with campus space supply more effectively and efficiently on both the long and short term?”
(User) Demand

- Find ways to **quantify dynamic demand** through the use of Smart Tools
- Determine **demands** of smart tools/mobile applications for supporting student activities
(Real Estate) Supply

- Discover new valuable data sources
- Analysation of long term data to discover patterns
- Optimize Real Estate (portfolio)
Methods
## Data Collection

<table>
<thead>
<tr>
<th>Literature study</th>
<th>Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>The role and needs of CREM</td>
<td>User prototype evaluation (and the establishment of (additional) needs) x2</td>
</tr>
<tr>
<td>Current campus management practice</td>
<td>CRE managers (for the establishment of (additional) needs)</td>
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<tr>
<td>Existing smart campus tools</td>
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<tr>
<td>Business intelligence</td>
<td></td>
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<tr>
<td>Privacy concerns</td>
<td></td>
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<tr>
<td>(WiFi) occupancy detection</td>
<td></td>
</tr>
<tr>
<td>Learning space preferences</td>
<td></td>
</tr>
</tbody>
</table>
Prototype Evaluation for User Involvement

● Prototype Testing (Filmed)
  ○ PFM in excel
    ■ Mathematical Function
  ○ Mockup in Balsamiq
    ■ Wireframe model

● Evaluation
  ○ Task Load Index
  ○ Post Experience Interview
## Deliverables

<table>
<thead>
<tr>
<th>Must-have</th>
<th>Should-have</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection model based on preferences,</td>
<td>Net-id integration (Single sign-on)</td>
</tr>
<tr>
<td>requirements (&amp; availability)</td>
<td></td>
</tr>
<tr>
<td>Preference match selection</td>
<td>Campus integration (2 or more faculties in the</td>
</tr>
<tr>
<td></td>
<td>database)</td>
</tr>
<tr>
<td>Dashboard for data visualisation</td>
<td>UI design for mobile app</td>
</tr>
<tr>
<td>User-bound preferences (saved)</td>
<td></td>
</tr>
<tr>
<td><strong>Nice-to-have</strong></td>
<td><strong>Forget-about-it</strong></td>
</tr>
<tr>
<td>Live link for occupancy determination</td>
<td>Events</td>
</tr>
<tr>
<td>Determination availability studyplace level</td>
<td>Way-finding</td>
</tr>
<tr>
<td>Brightspace schedule integration</td>
<td>3D model</td>
</tr>
<tr>
<td>Favourites</td>
<td>Mobile app</td>
</tr>
<tr>
<td>Booking system</td>
<td>Safety</td>
</tr>
</tbody>
</table>
Organisational Performance

**Context**
- Human resources
- Technology
- Information
- Capital
- Real estate

**Organisation**

**Input**

**Process**

**Output**
- Products
- Services

**Organisational performance**
- Productivity
- Profitability
- Competitive advantage
# Adding Value

## 12 ways to add value through real estate

<table>
<thead>
<tr>
<th>1. Increasing real estate value</th>
<th>7. Supporting image</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Controlling risk</td>
<td>8. Supporting culture</td>
</tr>
<tr>
<td>3. Decreasing costs</td>
<td>9. Stimulating collaboration</td>
</tr>
<tr>
<td>4. Increasing flexibility</td>
<td>10. Stimulating innovation</td>
</tr>
<tr>
<td>5. Supporting user activities</td>
<td>11. Improving quality of place</td>
</tr>
<tr>
<td>6. Increasing user satisfaction</td>
<td>12. Reducing footprint</td>
</tr>
</tbody>
</table>

## Types of real estate interventions

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Functional adjustment</th>
<th>Reshuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>(partial) Renovation</td>
<td>New building</td>
<td></td>
</tr>
</tbody>
</table>
Competitive advantage  
Performance (output)  
Profitability  

REAL ESTATE INTERVENTIONS  
(Input)

1. Increasing real estate value
2. Controlling risk
3. Decreasing costs

Quality ambition
Budget in euros

CREM

# users involved
Types of m2

6. Increasing user satisfaction
5. Supporting user activities
4. Increasing flexibility

Productivity  
Performance (output)  
Sustainable development
DAS Frame
Current Campus Goals

Goals scoring the highest, thus on average having the highest priority were (Den Heijer, 2011, p. 144):

1. Support user goals more effectively

2. Support identity university/ attract more students & staff members

3. Achieve minimum quality for use permit

4. Accommodating growth

5. Increase occupancy and frequency rates
Smart Tool Development
ER Model
Mission Statement

1. The Proposed Smart Tool will help students/users find an available study space meeting their requirements and selecting based on the highest match with their preferences.

2. Simultaneously this search data is stored to inform management with the actual dynamic demand (after analysis).
Design Objectives

- Provide the user with match based on the highest match with preferences
  - By adding weight to each preference criteria
- Store study space search information
  - (incl a timestamp)
- Allow search iteration
  - (if the match does not comply allow changes to search input and show which preferences were not met)
- Store user preferences (settings)
Internship LoneRooftop

- Good technical basis for further development
  - Occupancy detection
- Many similarities
- Understanding of problems, opportunities & objectives
- 1-on-1’s e.g. Privacy, UX Design, Database Modelling
Smart Tool Progression

- Preference Function Modelling (PFM) Tool in Excel
- Mobile application mockup in Balsamiq
- Database modelled in MySQL Workbench
Models
Evaluation
Prototype Testing (Version 1)

- Difficult to understand initially
  - Lot of guidance required
- Long duration input (approximately 15 min.)
- Results seemed to be satisfactory
  - Stimulated iteration
Prototype Testing (Version 2)

- Difficult to understand initially
  - Guidance provided improved understandability
- Decreased duration input (approximately 8 min.)
- Results easier to understand
Findings

- High mental demand PFM
- High levels of frustration
  - Will lead to users abandoning the tool
- By informing users on the purpose of the data, willingness (to give feedback) might be increased
- PFM is most likely not suitable for daily use
  - Strain
  - Users will ‘learn’ spaces
Findings

- Enough ways to communicate their demands, but daunting and difficult to find
  - Integration for leaving feedback FM
- Occupancy and distance to current location most important factors for choosing where to study (functionality)
  - E.g. an interactive map with filters
- Higher levels of granularity is required
CRE Management (DAS Frame)

1. Assess the current situation:
   - Better representation of demand
   - Can give indication user satisfaction
   - Supports current methods

2. Explore the future demand:
   - Accumulation of quantitative data
   - Discover patterns for the long term
DAS Frame

3. Generate future models:
   Generated with information former steps
   Can provide inherent suggestions
   Pilots and innovative projects can act as experimentations

4. Define projects:
   Problems and Popularity can be determined among spaces
   Business cases can be supported with the quantitative data
Verdict

● PFM is capable of executing the function
  ○ Not Ideal
● Differences bike between non-bike
● Profiles can be distinguished
Conclusion
Answer Research Question

“How can a **Smart Tool** provide information to support the alignment of dynamic user demand with campus space supply more **effectively** and **efficiently** on both the **long** and **short term**?”

- **Effective alignment**
  - Short term findability of preferred space
  - Accumulated data to find patterns

- **Efficient alignment**
  - Shorter time to find study spaces
  - Increased findability is needed for more efficient use
Conclusions

- Better representation of demand
  - Supports current methods
  - More user involvement
- Provides a new way to passively generate data
- Smart Tool promises improved findability
  - Higher efficiency requires higher findability
- Modular (i.e. if other criteria become more relevant they can be implemented)
Discussion

● Cognitive effort

● Data is dependent on smart tool use

● Smart tool use is dependent on usability
  ○ Some functionalities dependent on technologies (occupancy detection, localisation, wayfinding etc.)

● Data use still depends on competence and behaviour campus management
  ○ Including the transformation from data to information (e.g. data visualization/mining)
Discussion

- Possibility Online learning
- Distribution of students across campus
- Feedback (Dissatisfier)
- No solution on ‘reserved’ study places
Reflection

- Good to approach as if actually realizing
- LoneRooftop provided helpful insights
- Usability can be tricky
- Conclusion takes longer than expected
Feedback

Only give feedback when the space is:

- below par or;
- if the space exceeds expectations.

If a space meets the expectations he wouldn’t give feedback.

Resulting in feedback approximately 10% of the time.

Like/dislike preferred over rating (0/5 stars)
Thank you!
Back-up Slides
Definitions

A “campus” is defined as all the land and buildings that are in use by university functions or functions related to the campus, whether leased or owned by the university, and not bound to a single location. A “campus” can thus also refer to a collection of buildings that are scattered across a city, and is not limited to isolated areas.

Campus management is defined as the process of attuning the campus on the changing context of the university, the demands of the different stakeholder groups and contributing to the performance of the university. The campus manager – being in charge of facilities management and/or estates management is responsible for this process.

A smart campus tool is defined as a 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.
Adding Value + KPIs

### Key performance indicators (KPIs) to measure a university’s performance

<table>
<thead>
<tr>
<th>Productivity</th>
<th>Profitability</th>
<th>Competitive Advantage</th>
<th>Sustainable Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>publications per academic FTE</td>
<td>revenue minus costs</td>
<td>international rankings</td>
<td>energy usage per m²</td>
</tr>
<tr>
<td>output per m²</td>
<td>solvency</td>
<td>market share of students</td>
<td>energy usage per user</td>
</tr>
<tr>
<td>students per m²</td>
<td>liquidity</td>
<td>quality of alumni</td>
<td>CO₂ emission per m²</td>
</tr>
<tr>
<td>employees per m²</td>
<td>environmental goals</td>
<td>student satisfaction</td>
<td>CO₂ emission per user</td>
</tr>
<tr>
<td>energy costs per m²</td>
<td>position on innovation index</td>
<td>alumni satisfaction</td>
<td>energy labels of buildings</td>
</tr>
<tr>
<td>total costs of ownership as % of total costs (or turnover)</td>
<td>citation score</td>
<td>employee satisfaction</td>
<td>footprint in m² per user</td>
</tr>
<tr>
<td>etc.</td>
<td>(economic) value of alumni</td>
<td>increased real estate value</td>
<td>etc.</td>
</tr>
</tbody>
</table>
Database Structure
Principle of (Tri)lateration
Effects on WiFi Signals
Anonymisation

\[ 00:eb:2d:ac:d9:b8 \]

\[ \text{SHA2('00:eb:2d:ac:d9:b8', 256)} \]

\[ 2ff33b96538a22de96d1c101da22b68a7a553c7ac47eac5b101506e47c0c582 \]
Preference Measurement

Empirical system E

Mathematical system M

scale s
Lagrange function

\[ P(x) = \frac{(x - x_2)(x - x_3)}{(x_1 - x_2)(x_1 - x_3)} y_1 + \frac{(x - x_1)(x - x_3)}{(x_2 - x_1)(x_2 - x_3)} y_2 + \frac{(x - x_1)(x - x_2)}{(x_3 - x_1)(x_3 - x_2)} y_3 \]
Process PFM

(1) Each decision-maker specifies the decision variable(s) they he/she is interested in.

(2) Each decision-maker rates his/her preferences for each decision variable as follows:

- The decision-maker establishes (synthetic) reference alternatives which define two points of a Lagrange curve.
  - A “bottom” reference alternative is defined, which is the alternative associated with the value for the decision variable that is least preferred, rated at 0. This defines the first point of the curve (x0, y0).
  - A “top” reference alternative is defined, which is the alternative associated with the value for the decision variable that is most preferred, rated at 100. This defines the second point of the curve (x1, y1).

- The preference for an alternative associated with an intermediate decision variable value relative to the reference alternatives is rated. This defines the third point of the curve (x2, y2).

(3) Each decision-makers assigns weights to his/her decision variable. The subject owner assigns weights to each decision-maker.

(4) Each decision-maker determines the design constraints he/she is interested in.

(5) The decision-makers generate design alternatives group wise and use the design constraints to test the feasibility of the design alternatives. The objective is to try to maximise the overall preference score by finding a design alternative with a higher overall preference score than in the current situation.

(6) The decision-makers select the design alternative with the highest overall preference score from the set of generated design alternatives.