Towards adaptive buildings based on user needs

Researching user behaviour and space usage in Lab42

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ABSTRACT

Hello World

KEYWORDS

Human-Building interaction, Ubiquitous computing, Persuasive technology, Living lab, Smart buildings, User behaviour

METADATA

Thesis Design for the fullfiment of the *Master Thesis* for the Master Information Studies: *Information Systems (IS).*

Institute: Informatics Institute
Faculty: Faculty of Science (FNWI)
Research Group: Digital Interactions Lab (DIL)
Supervisor: Dr. Hamed Seiied Alavi PhD
Mentor: Shruti Rao Ph.D. Candidate

1 INTRODUCTION

This thesis will investigate [...]

1.1 Research questions

In order to achieve this, the following main research question is formulated:

How do alterations in building activity, particularly adjustments in acoustic conditions and occupancy comfort, influence the levels of concentration among students and the establishment of conducive learning environments?

To be able to answer this research question, the following supporting sub-questions are formulated:

- **RQ1:** *What are the characteristics, intentions and goals of the users entering the building? (descriptive)*
- **RQ2:** *How do users of the building currently define and rate their personal comfort in relation to the building? (defining)*
- **RQ3:** *What sensory data about users and the environment is currently being collected in the building and can this be enhanced? (defining)*
- **RQ4:** *How can a ubiquitous computing device (persuasive technology) nudge users into certain desired behavior? (designing)*
- **RQ5:** *Is there a difference in user-behaviour pre-installation and post-installation of the device?*

1.2 Lab42 building

This research will be performed in association with the *Digital Interactions Lab* and uses the recently (september 2022) opened Lab42 [1] building at the UvA Amsterdam Science Park as a case study. Lab42 is a energy-neutral, flexible and adaptable designed faculty building that facilites partnerships between students, researchers and businesses. [1] The layout aims to feature different zones with varying functionalities, from areas where you can sit quietly and focus on work to spaces that allows for collaborative work. The overarching interior theme in the design is 'tech' and 'nature' aiming to create afresh, light and warm comfortable building. Sensing devices are installed throughout the building to automatically adjust lighting, air, temperature so these can be adjusted for overall improvement of comfort [4].

2 RELATED WORK

2.1 Human-building Interaction

2.2 Tangible visualizations (existing systems)

2.3 Ubiquitous computing

2.4 Learning spaces

3 METHODOLOGY

Focus of the methdology is a combination of in-the-wild studies to study user behaviour and space usage and combine it with data gathered from using IoT devices on which both data cleaning, transformation and analysis are performe. In the end a prototype of a persuasive technology will be manufactured and usability tested to see possible change in user behaviour pre-installation and post-installation.

3.1 User studies

Gather information about users within the building. There emotional state. Most likely these will be surveys handout throughout the thesis projects. Potential one-one interviews will be conducted with more open ended questions (open field questionnaire) about further comfort levels of specific users. This includes methods such as creating *personas, empathy maps* and gives an overview of user needs and current behaviour of users within the building. This will most likely also include analysis of surveys using Python and Jupyter notebooks [2] (e.g. data cleaning, sentiment analysis).

[1] https://lab42.uva.nl/
[2] https://jupyter.org/

3.2 Space behaviour

With sensing devices scattered throughout the Lab42 building. This will most likely also involve data analysis, cleaning and transforming using Python and Jupyter notebooks. This includes methods such as *field trails, customer journeys and observation.*

3.3 Prototyping

This includes methods such as creating *ideation, proof of concept and provocative prototyping* to create a design solution for behaviour change and persuasive technology which can be further tested. Usability testing and data analysis of the prototype can be comparative and gives insight in how well user behaviour changes pre-installation and post-installation. Prototyping will most likely consists of three components related to the design challenge:

1) Sensing device using a microcontroller (Ubicomp): sensory data that will measure specific user behaviour in a couple of spaces throughout the building.
2) Storage with Realtime API (Back-end): to store the data for persisent storage in a back-end and display visualizations in a front-end dashboard for furhter use.
3) Tangible visualization (Ambient display): some sort of physical tangible data visualization collectively showing the output of the sensory data with the goal of changing behaviour.

3.4 Existing datasets

There is also existing data about the lab building. The building itself has a spreadsheet of all data collected which has building data about:

- Sound measurement
- Building temperature
- Occupancy

Next to generic building data gather by the building sensors previous studies on the Lab42 performed are a study by Master Student Jan Ramdohr who created a sensig device to get some specific device measurement data [2]. Also a specific survey about users emotion is performed by PhD candidate Shruti Rao and questions were asked pertaining to comfort and emotions across various spaces in the building [3].

4 RISK ASSESSMENT

4.1 Interview and surveys

If no or not enough interviews can be conducted due to time constraints or unavailable interviewees, there will be a lack of information which leads to an absence of information saturation.

4.2 Building sensory data

Access to data building is not property exposed. Which means gathering data about the current building is limited. This can be mitagated by enhancing the already existing sensors with prototype sensing devices to gather data as a proof of concept.

4.3 Installation

Due to construction or administrative reasons it might not be possible to test the eventual design solution in the building at scale. This needs to be discussed with building faculty staff. This can be mitigated by testing the prototype in a different context to test it's usability.

5 PROJECT PLAN

The thesis project will be fulfilled on a part-time basis. This means that preperation for the project started already early november/december 2023 with concepting and ideation. From around the 8th of january 2024 until 30 june 2024 (submission data of the thesis) this research will be investigated.

The first phase of the project will focus on gathering user data and analysing. The second part of the project will mostly focus on prototyping design solutions and iterating. The third phase of the project will most likely consists of usability testing and evaluation. Please refer to figure 1 for a full weekly overview of task completion.

REFERENCES

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[4] UvA. 2022. *LAB42 - Science Park description.* https://campus.uva.nl/en/science-park/lab42/building-lab42.html#Facilities-and-sustainability *Last accessed: 2024-02-27.*