



DEPARTMENT OF THE BUILT ENVIRONMENT
AALBORG UNIVERSITY

Session summaries from: Study circle on The Use of Data in The Built Environment – Challenges and opportunities

By alphabetical order of authors,

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Aalborg University
Department of the Built Environment
Division of Sustainability, Energy & Indoor Environment

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Thank you

The Ph.D. study circle was lucky to host experts from different parts of the world to share their valuable experiences and relevant projects with us gladly. A huge thank you from the Ph.D. Fellows.

In addition, we would like to thank Tine Steen Larsen, Section leader at AAU BUILD, for financially supporting the Ph.D. study circle. At last, thank you for your guidance and for sharing your network with us, our supervisor, Associate Professor Anna Marszal-Pomianowska.

Ph.D study circle presenters

- Thomas Hede Jensen, Senior Business Analytics Architect (Aalborg Forsyning, Denmark)
- Christian Byrjalsen, Center leader (Aalborg Forsyning, Denmark)
- Per Printz Madsen, Special Consultant (Aalborg University, Denmark)
- Sverre B. Holøs, Senior Scientist (SINTEF Community, Norway)
- Thomas B. Moslund, Full Professor (Aalborg University, Denmark)
- Zoltan Nagy, Assistant Professor (Texas AM University, USA)
- Liam O'Brien, Full Professor (Carleton University, Canada)
- Sara Månsson, Product Manager (UtiliFeed, Sweden)
- Nikos Kyriakoulis and Team, Managing Partner (CORE, Greece)
- Pierre Vogler-Finck, R&D Senior Data Scientist (Neogrid, Denmark)
- Christian Ulrik von Scholten, CEO (NorthQ, Denmark)

Ph.D study circle eager discussants

- Henrik N. Knudsen, Associate Professor (Aalborg University, Denmark)
- Hicham Johra, Associate Professor (Aalborg University, Denmark)
- Michael Pomianowski, Associate Professor (Aalborg University, Denmark)
- Rasmus L. Jensen, Associate Professor (Aalborg University, Denmark)

Ph.D study circle guests

- Martina Mudra, PhD Fellow (Slovak University of Technology in Bratislava, Slovak republic)
- Kristyna Schulzova, PhD Fellow (Czech Technical University in Prague, Czech Republic)
- Mathilde Lenoel, MSc student (INSA Lyon, France)

Faithful cake distributor

- Markus Schaffer, "The Baker" PhD Fellow Aalborg University, Denmark

The Ph.D. study circle

Four Ph.D. Fellows created this Ph.D. study circle at the Department of the Built Environment at Aalborg University (AAU) under the supervision of Associate Professor Anna Marszal-Pomianowska. The overall aim of the study circle was to dive deeper into selected topics. Moreover, facilitate networking and create a platform for vital discussions with experts in selected fields, both from a research and industry perspective.

The study circle was organized as ten sessions grouped into five days in Spring 2022. Each session consisted of an expert presenting a selected topic, followed by a discussion. The sessions were held as hybrid events and open for AAU employees and other invited people. The experts were invited based on relevance to the topic.

Keywords: built environment, machine learning, deep learning, internet of things, occupant-centric control, fault detection and diagnosis, building data, HVAC systems, open data, labeled data

Head of the study circle

Associate Professor Anna Marszal-Pomianowska - <https://vbn.aau.dk/da/persons/118608>

PhD Fellows:

Kamilla Heimar Andersen - <https://vbn.aau.dk/da/persons/150811>

Daniel Leiria - <https://vbn.aau.dk/da/persons/daniel-leiria>

Simon Pommerencke Melgaard - <https://vbn.aau.dk/da/persons/140310>

Markus Schaffer - <https://vbn.aau.dk/da/persons/151947>

Summary of sessions

Overview of the topic title, date and place

Session	Session title	Date	Responsible PhD Fellow
1	<p>Challenges and opportunities of Aalborg Forsyning in the light of smart heat meters</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Get a better understanding of what the challenges are for the industry for in utilizing the potential of smart meter data. • Get insight into the opportunities the industry sees in relation to smart meter data 	2 nd March 2022	Markus Schaffer
2	<p>Initial data treatment for data analysis</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Why is initial data treatment important? • What are the challenges for initial data treatment? • What can we, from the building sector, learn from other research areas where initial data treatment is more established? 	2 nd March 2022	Markus Schaffer
3	<p>Machine learning in the built environment: A research perspective</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Obtaining an overview of the evolution of the neural networks (NN) research field • Understanding the current research state of the implementation of NN algorithms in the built environment • Presenting the NN projects in which AAU is involved • Determining possible synergies between the presented topic and the different Ph.D. projects 	8 th April 2022	Daniel Leiria
4	<p>Occupant detection with IEQ sensors in buildings</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Obtain an understanding of the possibilities and limits of using IEQ sensors for occupant detection • Gain knowledge on the practical challenges of using the different methods • Gain knowledge on the most important variables to consider when selecting sensors for deployment 	19 th April 2022	Simon Melgaard

5	<p>Picture/distance-based occupant detection in buildings</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Obtain an understanding of the possibilities and limitations of using cameras and/or laser based technologies for occupant detection • Gain knowledge on the practical challenges of using the different methods 	19 th April 2022	Simon Melgaard
6	<p>Occupant detection with smart meter data in buildings</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Gain general knowledge about occupant centric building control • What are the hurdles for the practical application of occupant centric building control 	27 th June 2022	Markus Shaffer
7	<p>Data-driven behaviour and IEQ preference detection in buildings</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Gain knowledge on the practical challenges of identifying the occupant preferences from the monitoring of their behaviour 	9 th May 2022	Simon Melgaard
8	<p>State-of-the-art on fault detection and diagnosis (FDD) in district heating networks and building systems</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Why FDD deserves attention in district heating networks and building systems? • What is the state-of-the-art of FDD in district heating networks and building systems? • What are the advances and challenges for FDD in the future? 	17 th May 2022	Kamilla Heimar Andersen
9	<p>IT-architecture in real-time building implementation for data analytics</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Increased knowledge of IoT and WoT and possibilities with data transfer using MQTT, presentations of projects where MQTT is used, and presentation on real challenges working with data 	30 th May 2022	Kamilla Heimar Andersen
10	<p>Utilization of data in the built environment: A perspective from the industry</p> <p>Objectives:</p> <ul style="list-style-type: none"> • Learning about the industry's perspective on the application of big data in the construction sector • Discuss the current and future challenges to utilizing these data • Uncover potential synergies between the industry applications and the different Ph.D. projects 	3 rd June 2022	Daniel Leiria

Executive summary

This study circle outlines ten learning goals from a series of sessions to enhance the participants' knowledge in utilizing smart meter data, initial data treatment, neural networks, occupant detection, occupant-centric building control, fault detection and diagnosis (FDD), and IoT, in the building sector. The ten individual sessions aimed to provide insights into the challenges and opportunities in utilizing smart meter data and exploring the potential of occupant-centric building control. The sessions also delve into FDD in district heating networks and building systems, the practical challenges of identifying occupant preferences from behavior monitoring, and the industry's perspective on data application in the building sector. Participants have gained knowledge of these topics' practical challenges and opportunities and explored potential synergies with their respective Ph.D. projects.

Key findings Session 1

Smart meters pose a challenge for district utility companies, but their potential is starting to be utilized

Key findings Session 2

Initial data treatment in the building sector is rarely used, and inspiration can be drawn from other research areas.

Key findings Session 3

Synopsis in the development and fundamentals of neural networks, the importance of good data and steps for supervised learning, and presenting projects using neural networks for energy usage and indoor temperature prediction in buildings.

Key findings Session 4

Occupant detection through IEQ sensors is difficult. The most promising data source is CO₂ sensors, and VOC sensors should never be used, as they are too sensitive to other sources than people.

Key findings Session 5

Occupant detection through cameras currently has no generic method which works for every case. It is, therefore, necessary to select the most appropriate method for the problem based on experience.

Key findings Session 6

Occupant-centric control is, up till now, still a challenge when it comes to actual life implementation due to its complexity and the many stakeholders involved.

Key findings Session 7

When identifying occupant preferences, the major challenges lie in the ethical and data privacy/security areas.

Key findings Session 8

Fault detection and diagnosis in district heating and building systems have many of the same challenges. Generally, to increase the implementation in the systems, demonstrators, taxonomy, knowledge, and expertise of building operators are identified barriers to be overcome.

Key findings Session 9

In general, there is an agreement that fetching data from buildings is frustrating, as each building has a different data structure and protocol. In this session, the MQTT protocol for data transfer was presented and demonstrated as an effective and secure tool for future use.

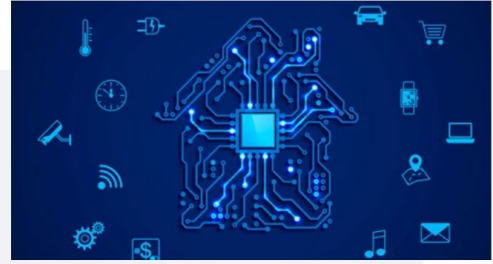
Key findings Session 10

There is a large opportunity for future collaborations with Aalborg University, with companies focusing on data solutions for analysis and forecasting while facing common challenges such as data availability, cost, and quality. Also, there is a need for standardization processes, building trust with customers, and finding ways to reduce energy consumption while maintaining user comfort.

Build Data webpage

BUILDDATA

Data for building research



See the following link (<https://www.en.build.aau.dk/web/builddata>) for more information regarding data-driven research at the Division of Sustainability, Energy & Indoor Environment at Aalborg University. Here news regarding dissemination activities, open access datasets, publications and more.

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