Appendix A: Interview guide

The actual implementation of fault detection and diagnosis in building systems – What is the status in the industry?

First of all - thank you for participating! The interviews are designed to be semi-structured. A semi-structured interview form allows us to use the questions below as a guideline, not in strict order or necessity to fulfill them all. Please also read through the consent form, sign and send it back to one of the interviewers. This can also be performed before the interview starts, we have assigned time for this matter.

This document accounts for the interview guide for Building Management Systems (BMS), Heating, Cooling and Air Condition (HVAC) companies and third-party software (data science and analytics) companies. The overall aim of the interviews is to determine the current actual implementation of fault detection and diagnosis (FDD) in building systems in the industry, the potential barriers, and how to overcome these.

The interviewer is Kamilla Heimar Andersen, Ph.D. Fellow from Aalborg University. The interviewer's assistant is Simon Pommerencke Melgaard, Ph.D. Fellow from Aalborg University. The interviews are a part of the H2020 SATO project: https://www.sato-project.eu/.

Introduction

We will start with a short introduction of the purpose of this study and how we intend to use the results from this study.

1. Can you shortly tell me about what you currently work with and your work experience?

Part I: Company and product-related questions

In this part, we discuss the company you work for and product-related questions.

2. What type of HVAC products do you sell?
3. What does the company sell the most in terms of HVAC products? And why? Price, cost?
4. Does the company specialize in a specific field? Niche?
5. How many employees are there in the company (Denmark/Scandinavia/Europe/world)?
6. What sector do they sell to? Select among the following categories: Private consumers (B2C), Private companies (B2B), Public & Governmental (social housing) (B2G), or Public & Governmental (large public tenders) (B2G)
7. Who are your customers? What do they want? Do they specify what they want for their building on their own, or do you advise them?
8. Are you part of an international company? How much of the Danish market and the global market are you represented? How many countries are you represented in? Which countries are you primarily settled in.
9. KPIs in the company? Values, vision, the goal of the business/company? How do they work to get there?
10. Participation in research projects? Internal (in the company), national, European, international?
11. Have you seen any changes in the market in the last years/decades? Innovation, digitalization, an increase of data, any clear trends or effects?

Extra questions

12. How large is this market(s) in DKK or EUR for the product you sell? How large a part of this market is the company's sales responsible for?
13. How do the sales operate? Supply, demand, balance? Business model?

Part II: General supervision of products

In this part, we would like to talk about the general supervision of products. We have defined what we mean by supervision. However, if you have another definition, you are more than welcome to share this definition with us.

Supervision: General possibility to supervise the status of the products you sell. This for example: operation status (poor, good), integration of sensors (temperature, pressure, humidity, electricity use, etc.), alarms, or similar.

Types of supervision: Integrated within the products, additional service, remote, local, other?

14. Do you have supervision of your products? Or create the possibility to supervise the products? What is the purpose of the supervision? What type of supervision is it?
15. This supervision, do you offer this as an additional service? How?
16. Do you develop the products so their operation mode/parameters can be adjusted in the operation?
17. Do you collect and store data? If yes, what do you use them for? If no, why?
18. Do the customers have access, or are this just for internal use?
19. Can you communicate with the products? How? One-way or two-way communication?
20. Do you provide a service to the customers for optimizing control/performance? How?

Part III: Fault detection and diagnosis (FDD)

In this part, we go deeper into supervision, namely fault detection and diagnosis (FDD). We have defined what we consider a fault and FDD is below. However, we would very much like to hear what you define as a fault, fault detection, and diagnosis if this is relevant for your company and the products you sell.

Fault: "*A fault is an unpermitted deviation of at least one characteristic property (feature) of the system from the acceptable, usual standard condition.*"

Fault detection and diagnosis: "*The primary objective of an FDD process is to detect faults, diagnose their causes, and possibly enable correction before additional damage to the system or loss of service occurs.*"

Fault detection: aims to discover faulty operations in a system

Fault diagnosis: aims to identify the physical fault factors in the systems (type, location, severity, and time)

21. Does your company want to work with FDD? Why?
22. Are you familiar with the concept of "FDD"? What do you mean / can you elaborate? Is your definition different than the above?
23. Does your company work with products concerning FDD? Can you specify which products? Type? System? How?
24. What is the product focus in your company? How large part does the FDD focus have?
25. Have your customers inquired about FDD in components/stand-alone products or full systems?
26. What is the FDD type/approach of the systems? For example: Manual, model-based or data-driven? Can you specify?
27. How do you set up the requirements for FDD for the customers? Do they request a type of setup?
28. What is delivered in terms of FDD, and how is it used by the customers that buy it? Is it preinstalled in components/systems, or is it add-ons for later implementation?
29. Is your company participating in development and research projects regarding FDD? Internationally? Nationally?
30. Or any development projects? Internal / external?
31. Which building systems are leading the FDD movement? Ventilation system, heating, cooling? Why? Are they ahead or behind other companies in the sector?
32. Which future do you see with FDD? What are the requirements from the producers? What business field(s) are they dependent on? Competencies?

Part VI: Barriers and opportunities

In this part, we would like to discuss barriers and opportunities for FDD.

Barrier definition: *"A fence or other obstacle that prevents movement or access (can be both physical and non-physical)."*

33. Do barriers exist for buildings to operate with an implemented FDD system? Time-horizon for overcoming these barriers? What is necessary to initiate to overcome these barriers? Examples of categories of barriers: Infrastructure (software/hardware), Data sharing, data flow and security, Implementation, Human factors, Business models, Costumers.
34. Opportunities you see using FDD? Full-stand alone? Decentral systems? Integrated?
35. Based on what the customers ask for, do you see any worldwide need or trend?
36. What do they think is/are the requirements missing? Contract, building, design? Phase in production?
37. What are their drivers for the use of FDD? Data? Research? Paris-agreement? Income?

Ending

38. Do you have a personal opinion regarding FDD? Attitude towards FDD in building systems?
39. With no limitations, can you describe your dream scenario or building and how it would be operated?
40. Anything you want to elaborate on?
41. Something I have not asked about?