REFLECTION

MSc thesis – AUBS track Building Technology

Studio information

Theme: Façade & Products and Energy & Climate
Graduation supervisors: 1) Thaleia Konstantinou 2) Eric van den Ham
PhD consultant: Prateek Wahi
Topic MSc thesis: Framework for the Decision Making Process of Low-Temperature Renovations

Vera Koster

4368789
26-05-2024

Reflection

What is the relation between your graduation project topic, your master track, and your master programme?

The master track of Building Technology consists of four main pillars: façade design, climate design, computational design and structural engineering. The first two of those pillars have a very explicit link with this master thesis. The topic of graduation involves decision support for energy renovations, specifically supporting the decision-making process of selecting a low-temperature heating (LTH) renovation scenario for multi-family buildings. LTH renovations are complex since there are often multiple solutions to the design problem, multiple ways to assess the suitability of a design solution and multiple actors with different interests influencing the relative importance of certain design aspects. This topic relates to the Building Technology master since it requires technical expertise on climate design and façade design to comprehend the LTH requirements when developing the decision support framework. Identifying and developing a smart but simple way to assess the environmental, economic and social performance of a renovation scenario requires not only technical expertise, but also academic and design skills which are developed in-depth during the BT master courses. Besides that, developing a framework with a decision support tool that aids complex decision-making makes use of the skillset learned in parametric design courses, where all the factors are organized in a set of rules to find the optimal solution to a complex problem.

This graduation project also fits the wider AUBS master programme. The decision support framework contributes to accelerating the residential heat transition in the Netherlands, providing a structured approach to the urban energy renovation challenges that lies ahead. The framework provides a way to incorporate and balance the interests of actors like project leaders, program managers and energy experts, displaying the diverse nature of the thesis. By combining knowledge and skills with design and engineering from all tracks, this thesis is stepping out of the usual BT framework. This interdisciplinary approach promotes innovation in building science, contributing to a more sustainable built environment.

How did you research influence your design/recommendations and how did the design/recommendations influence your research?

The main method of the graduation process has been a design by research approach. Gathering information on LTH, energy renovations and decision-making methods has been the base of the developed framework. After a draft development of the framework, additional research was done to make the framework specific to LTH renovations. The draft framework thus identified the areas that required additional research, like stakeholder identification to determine the target audience and research the methods of quantification to be able to assess the performance of renovation scenarios. After additional research, the framework is revised. Based on this research and framework, the aim and requirements for the decision-support tool were acquired, leading to the development of the decision-support tool. Applying the framework and tool to a case study, obtained through collaboration with a company specializing in residential energy renovations, provided practical insights. This application, along with stakeholder interviews and a workshop, validated the framework's decision support function and usability, offering valuable feedback for improvements. While these improvements have not yet been implemented due to time constraints, they point to future enhancements for the framework and tool.

How do you assess the value of your way of working (your approach, your used methods, used methodology)?

My approach for the graduation process has been more chaotic than my usual way of working, which is due to personal circumstances which involve the loss of cognitive abilities and an overall loss of capacity to function like a normal student. This has hindered my graduation process massively. Short-term memory loss, concentration issues and severe energy deficiency are examples which have obstructed my capacity to do things like reading literature, retain, process and organize information, and making somewhat accurate plannings. I have tried many different approaches to progress the graduation process, including monthly, weekly and daily plannings, making Todo lists, creating mindmaps, using an external brain (like atlas.ti) and getting support from professionals. These approaches had varying impacts on progressing the graduation, of which the mindmaps and professionals had the most impact. Even though those approaches had an impact, it was insufficient to manage the graduation process within the given timeframe. What is required for graduation is a working brain, but apparently regaining brain capacity takes a couple of years, so willpower and perseverance had to do for the major part of the graduation process. Fortunately, during the last three months of the graduation process there has been noticeable improvement in these personal circumstances, which also reflected in progressing the graduation.

The used methods for this research consisted of literature review, prototyping (framework + tool development), case study application and a workshop with semi-structured interviews. This approach worked well to gather all relevant information to answer the research question.

This graduation project is very research focussed, leading to a highly informed design (framework). The complexity of the topic required a very structured approach. However, due to this complexity in combination with my limited cognitive abilities, it was a struggle to separate the graduation method and methodology from the method of decision support, especially in the beginning. Focussing on the development of a framework is quite an abstract way of doing research, which is not very common in the BT-master. The choice to focus on the development of a framework with a decision support tool originates from the identified problem statement, which is the lack of decision support, the lack of a good strategy on how to select a renovation scenario. Many researches on energy renovations concluded by proposing several approaches or solutions that fitted a certain energy performance within budget constraints, but a direction on which of those suitable solutions would be the most optimal in a given context is not discussed. This led to the abstract research into how the optimal can be determined and how the selection process (decision-making) could be supported. The from a holistic perspective developed decision support framework and tool as answer to the question could definitely be considered a novelty, and contributes to innovation.

One of the challenges of this graduation was getting access to a case study with enough data for energy simulations while also motivating stakeholders involved in that case study to participate in a workshop. Since there was no funding available, the participants of the workshop were hesitant with their time availability due to making unbillable working hours. This made communication in the preparatory phase difficult, however, no difficulties arose during the actual workshop. The data of the provided case study was plentiful to do a thorough analysis.

How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

Specifying the research to low-temperature heating renovations contributes to solving some of the more complex challenges given by the energy transition. Although this also provides a limitation in terms of applicability of the research, within that limitation a high level of adaptability can be found. The tool is easy to tailor to a specific context as well as specific needs of its users. The research has the potential to be used in practice with a wide range of decision-support applications, from selecting a scenario based on performance, to balancing stakeholders interests or even reflecting on existing

policy. However, before that point is reached, the framework and tool definitely are in need of some fine-tuning and further validation.

The research also significantly contributes to sustainable development by focussing on renovations that aim to improve energy efficiency while maintaining or improving thermal comfort. The reduction of greenhouse gas emissions is supported by the focus on transitioning to renewable energy sources, which can be achieved through renovating buildings for low-temperature heating.

Adopting a holistic approach for the decision-support leads to the making of a more informed decision, promoting sustainable decision-making. By incorporating this approach the users of the framework are encouraged to reflect on all decision aspects at an early stage of the project, reducing the risk of overlooking important elements for a sustainable project.

The use of MCDM methods in the decision-support tool guides transparent and inclusive decision-making. However, when renovating a multi-family building there is often a representative for all tenants involved in the decision-making. This layer of organisation can dilute their needs and wishes, potentially presenting moral dilemmas when tenants among themselves have different requirements. These challenges are not represented in the framework or tool.

Overall, this research encourages the integration of LTH systems into the existing building stock, enhancing the energy performance and promoting sustainable development. It aids in the complex challenge of the energy transition by supporting the decision-making process of selecting the optimal renovation scenario with respect to unique project requirements and stakeholders' preferences, preparing buildings for gas free heating and mitigating climate change.