Renovation wave implementation through renovation passport development for detached houses in Estonia

Summary

In Estonia, there is a significant need for increased renovation activity, particularly among detached houses, in order to achieve a decarbonized building stock. Around 30% of the detached housing stock in Estonia was constructed prior to World War II. These houses were often built by the residents themselves or local craftsmen, resulting in a wide range of structural variations and varying quality. To effectively plan and implement a national renovation strategy, it is crucial to have a thorough understanding of the expected volume of renovation work and the construction materials involved. To assist and guide homeowners throughout the renovation process, it is recommended to develop the Building Renovation Passport (BRP). The BRP would provide a customized long-term renovation and maintenance plan for each building. Since the BRP preparation is a big job, it requires a lot of input and work. Since there are not enough human resources for this, it is necessary to implement artificial intelligence, expert systems, knowledge systems and configuration systems. Implementation of these systems requires knowledge-based input data, analyses, and results.

Research field:	Building and civil engineering and architecture
Supervisors:	Prof. Dr. Targo Kalamees Prof. Dr. Ergo Pikas
Availability:	This position is available.
Offered by:	School of Engineering Department of Civil Engineering and Architecture
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

The main objective of this study is to collect essential knowledge and do analyses, while also developing a prototype for a digital twin-based renovation strategy tool for different types of detached houses

Research objective 1:

Acquisition and enrichment of building data for structure classification in detached houses

- **Knowledge gap:**

Building properties play a critical role in energy performance calculations and determining appropriate renovation measures. However, national building registers often lack detailed design documentation necessary for accurate calculations. Therefore, this study aims to propose a new method for establishing building structure properties that can be used for energy performance calculations and renovation measures specific to detached houses.

- **Method:**

Evaluate the accuracy of using data from the Estonian Building Register to establish building structure properties. Identify potential sources and methods for enriching the data and compare their accuracy with a representative sample of buildings.

- **Expected results:**

Development of a data acquisition and enrichment method that provides the most accurate and efficient structure classification for energy performance calculations.

Research objective 2:

Establishing the relevancy of a buildings' geometry and the hygrothermal properties of existing structures in the determination of renovation packages to achieve energy performance in detached houses

- **Knowledge gap:**

Optimizing the renovation process for homeowners requires the identification of appropriate renovation packages for achieving carbon neutrality. However, the current availability of energy auditors, particularly in Estonia, may not meet the demand. This study aims to explore a (semi)automated approach to address this gap.

- **Method:**

Calculate the energy performance and carbon emissions of representative reference buildings with different structure types. Establish renovation packages for each variation and compare the differences.

- **Expected results:**

- Information on renovation measures necessary to achieve adequate energy and emission savings for reference buildings.
- Identification of key parameters influencing the selection of renovation packages..

Research objective 3

Establishing renovation lock-in effects and compensation options in renovation packages for obtaining energy performance in detached houses

- **Knowledge gap**

Renovation lock-in occurs when a structure is renovated without implementing energy conservation measures, which can be a widespread issue among detached houses in Estonia. This problem hinders the successful implementation of renovation initiatives. Therefore, this study aims to analyze the effects of renovation lock-in and propose potential solutions.

- **Method**

Examine common renovation solutions and their combinations that result in lock-in effects. Calculate renovation packages that can mitigate and compensate for the effects of renovation lock-ins on representative reference buildings. Analyze the impact of renovation lock-ins on achieving energy performance at both the national and individual building levels.

- **Expected results**

- Description of the most common combinations of lock-ins in renovation, their causes, and their impact.
- Solutions for renovating stand-alone houses with lock-ins to achieve sufficient energy efficiency.

Research objective 4

Evaluating the accuracy of LOD2 geometry for energy modelling of individual stand-alone houses in order to determine appropriate renovation strategies.

- **Knowledge gap**

LOD2 geometry has the potential to provide data that can be used to calculate the building geometry of individual buildings necessary for energy performance and carbon emission calculations. However, the accuracy of this data source has not been studied specifically with stand-alone houses.

- **Method**

Selecting a representative sample of different reference building types, calculating the surface areas needed for energy calculations, and comparing these with the LOD2 geometry data provided by the Estonian Land Board.

- **Expected results**

A comprehensive understanding of the limitations and capabilities of using LOD2 data for conducting energy calculations at the individual building level, enabling the identification of tailored renovation strategies.

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