

Reflection

The research approach is reflected on through a swot analysis presented in table 1.

Table 1. SWOT analysis research approach.

Swot analysis	
Strengths There was a clear vision on the goal of the research. The structure of the literature review provided valuable insight in the topic, and helped answering the research question in a structured way.	Opportunities The research approach allows for contribution to research in the field of renovation that focuses on renovations performed in steps.
Weaknesses The research contained many separate subjects, and was complex to conduct. The assessment required data from different sources, and the reliability of sources is hard to validate. Due to time constraints the data gathered could not be fully integrated in the tool.	Threats Due to developing databases, and the use of static data, the relevance of the results are affected over time.

Societal impact

The results of the study are applicable in renovation practice regarding terraced houses, mainly built in the 60s or buildings with similar characteristics to terraced houses built in the 60s. It is thus not applicable to other building typologies. The results are especially interesting for cases where the house owner isn't the resident of the building, as in these cases renovation planning becomes more important, as well as financial planning and clear communication on renovation plans. Therefor the designed tool is in particular interesting for decision makers with large building portfolios that contain multiple terraced houses. The tool is restricted for use in the concept design phase, and can not be used to estimate the actual performance after renovation of a building, it rather gives an indication of the performance of a renovation for a specific time frame in comparison with other renovation solutions. As terraced houses are common in Europe, the tool could be used in other countries, if similar climate conditions as to the Netherlands are present and the building characteristics are similar. As the data related to carbon emissions and costs could differ for different countries, the tool offers the possibility to insert context specific data regarding these subjects, to on one side extend the applicability of the tool, as well as reduce uncertainties in the results. The tool is applicable for renovations performed in a single step and in steps. Furthermore, in case of a step by step renovation the tool provides insight in the costs, and predicts at which year these costs will occur.

A limitation of the tool is that it is considered envelope insulation as a renovation measure that is performed in one go. Claiming that the roof, ground floor, windows, and external walls are insulated/replaced within a year. Due to time constraints the calculation of single insulation measures is not obtained in the tool, however the tool does contain the data in the rough data section.

Multiple tools are available to assess the performance of a renovation. However limited tools exist that offer simplified assessment of strategies and provide insight in the performance on multiple criteria taking into account renovation planning. The tool distinguishes itself from other tools by providing a comprehensive assessment, that considers renovation planning, total carbon emissions, energy performance and costs. The tool is specifically designed to address challenges in renovation decision making obtained from literature that could increase renovation rate. Within available tools that calculate the performance or emissions of a strategy, tools often do not specifically target renovation, therefor the output does not address challenges in renovation effectively.

The study contributes to sustainable development by avoiding new construction and supporting decision making in renovation, in a way that contributes to the climate targets. Furthermore, the study stimulates research in the field of renovation by addressing the challenges in renovation, in a practical matter. Lastly the study puts available data into perspective, and helps in further defining the approach in renovation to reach the set climate targets.

The study impacts sustainability by taking into account budget limitations of residents and their energy needs, while offering insight in how to reduce the environmental impact through renovation and in this way stimulates future prosperity.

As the climate targets are set, and renovation is inevitable, renovations could come at a high cost if not planned well. The research specifically addresses budget limitations for renovations, and aims to provide a method that takes into account this limitation, to mitigate the investment needed of building owners. The study affects the built environment, in the sense that it stimulates maintaining existing structures, while providing solutions that improves the performance of existing buildings, in terms of energy and carbon emissions.