Reflection

Dedication to the architecture design and industry

This research provides a new aspect for architects and engineers to think and analyze the projects under processing. By integrating the future climate forecast and related studies, it is possible to make our living environment more sustainable and future-proof. In practice, the long-term analysis of building performance, both for indoor comfort and energy consumption, can lead to a very different conclusion for the decisions made in design periods. For buildings in the design phase, they can be prepared for the renovation options in the design phase and it is possible to maintain the indoor comfort and reduce energy consumption, cost, and carbon emission in the total building lifespan. And for the constructed buildings, the method of predicting the energy consumption and indoor comfort is provided. On top of this estimation, the discussion of the pros and cons of the renovation options has a wider horizon.

The variation in the results of optimization shows that the regulation and the design approaches suitable for the current weather environment are not necessarily applicable for future conditions. However, climate research is only showing the potential weather conditions in the future. As a result, the results of simulation and optimization based on it can only be used as a reference in the design process and regulating norms. In this regard, the building performance would need to be re-evaluated once in a while. The building regulations also required to be changed with the context.

Further steps and potential for this research

The research on building performance in building lifespan shows some intriguing aspects in both design approaches and the analysis part. To prepare our habitations for the future climate situation, there are more features that need to be discovered under this research direction.

To have a more defined result of the simulation, it is possible to include the interior walls for the design project. In this way, the indoor comfort can be studied in finer mesh and it is possible to compare the results room by room or even in square meters. It is suitable to be considered as a potential next step for this research to understand the difference in detail since this research gives out a result in a bigger scope.

Parallel research of analysis on different building types can be an extent of this paper. The building type determines the facade properties, occupied period, comfort demand, energy usage, and related regulation. In the case of office buildings, it is possible to have distinct results from the residential projects. If the research is based on the same location and same geometry setting, the comparison of building performance with various functions under the climate change influence could be an inspiring research topic.

The other direction that can be taken is the development of a lifespan assessment tool for building performance. In this research, there are five design scenarios used to evaluate the correlation between design and performance. Based on it, a workflow of building performance

can be built up with multiple scenarios optimization, needed to evaluate the existing scenarios in advance, and then produce a tool for numerous climate conditions.

Possible improvements

Due to the time constraint and computer power the research is simplified to some extent in this paper. In the design parameters, the shading system is set with the orientation of the facade to generate the shading geometry directly. Aside from the fixed horizontal shading on the top, and vertical shading on the window sides, there are more shading systems, such as louvers or adjustable shading, that can be integrated with the architecture design and perhaps improve the performance. But to include these design factors, the parametric model of the study object will be more complex and the optimization would need more time.

To improve the accuracy of the energy analysis, the setting of the HVAC system can be further defined. The Ideal Load Air system gives out a theoretical energy demand for ventilation, heating, and cooling. Hybrid ventilation and energy-saving design can reduce the energy consumption to a certain amount with energy strategies, like hybrid ventilation systems and solar rooms in winter. Nonetheless, usually in the early design phase, these design decisions are not made yet.

Difficulty in the process

Unlike the common building performance analysis research projects, this paper spends more content explaining the climate change research and how to integrate it with the performance study. The climate change research is location dependent and there are variant methods that are applied. Generating weather files for building performance analysis has high requirements for the significant categories and amount of information. In the Netherlands, meteorology research has four scenarios of climate change and provides sufficient information. But for projects that do not have enough research can only use the existing climate change generator which has only one scenario applied to make the weather file. Consequently, the research on building environments under climate change conditions is divergent, and it is troublesome to find studies with a common ground that can be used as a comparison.

The energy simulation and comfort simulation are very computationally expensive, especially when it needs to process multi-objective optimization. Design building with a lifespan concept makes the process more complicated and uncertain. The climate change factor scales up (eight times in this paper) the execution and analysis process in the research framework. As a result, the time for multi-objective optimization and result analysis is very high. The time for each optimization taken is at least 50 hours, moreover, the scenarios with renovation options need to be performed in other conditions again. To overcome this problem, sensitivity analysis is applied to reduce the input variables and more computers are used. An additional approach can be used to compare single or some factors together, instead of finding the optimal solutions.