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WITH RESPECT TO

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Occupants' behaviour is a key factor in the discrepancy between the designed and the real total energy use in buildings, basic knowledge for any agreement about energy savings. In fact on the one hand providing to the occupants control's opportunities on the indoor climate makes them more forgiving about the building's indoor conditions, allowing saving energy, and on the other delegating indoor environment control to the occupants increases the difficulty of predicting the building's performance.

Despite its relevance, the extent of users' influence is still unknown. Occupant's behaviour is usually described by deterministic assumptions, while many researches show that the use of controls by occupants tends to be governed by a stochastic rather than a precise relationship with the physical conditions, following the adaptive principle for which people act in ways to restore their comfort. For these reasons in recent years stochastic models defining occupant's action through statistical input parameters have been developed.

However, a realistic description of occupants' behaviour does not shrink the wide range of energy performances that different occupants can cause in the same building. A possible solution to reduce their influence while maintaining freedom in using controls is designing robust buildings - buildings whose performances show little variations despite of alternating occupant's behaviour.

The main goal of this research is to minimize the difference between the predicted and the actual building energy consumption by evaluating the building envelope design's potential in reducing the impact of occupants' behaviour on energy performances in an Office Reference Building. The analysis is carried on by using a dynamic building energy simulation software able to support stochastic models describing occupants' behaviour, focusing particularly on windows and mobile shadings' use.

In order to illustrate the impact of the design parameters on occupants' behaviour and on energy use, several versions of the basic model of the Office Reference Building are created with alternative design features. To widen the research, five thermal zones, characterized by different design and orientation, are simulated in three weather climates – Stockholm, Frankfurt and Athens – with the aim to investigate how the different building design's options affect the building's performances and robustness when location and orientation are varied.

First, the highest predictive power of probabilistic models respect to the classical deterministic approach is proved, then the envelope features are varied to investigate how they can affect building energy consumption and occupants' behaviour.

Analysing results, it has been proved that having a massive envelope, a closed façade and fixed shadings provides both the lowest heating and cooling energy consumption and the lowest results' fluctuation when switching the occupants' type. Therefore these building's features are the most robust ones, able to centre the simulations' set results respect the average values. This observation is particularly true in Frankfurt and Stockholm in zones with one external wall, where the design significantly influences the building's robustness respect to occupants' behaviour. In Athens the same conclusion can be drawn, but the building envelope's variations have a lower impact on occupants' interactions with windows and shadings. In building zones with two external walls, instead, no common trends are defined when matching different climates, meaning that in zones with a higher external surface/floor ratio the climate has a deeper impact on occupants' behaviour than the building design. Dealing with the influence of weather climate, its contribution in modifying the robustness' degree of the same scenario comes out clearly: in Athens all the investigated scenarios in all zones have lower results' variation than the corresponding models in Frankfurt and Stockholm.
Thus, thesis' results demonstrate that when low and certain energy performances are required, designers should include massive envelope, a closed façade and fixed shadings in the building's design, especially in the coldest climate.
Beside the numerical results, this robustness study shows how dynamic simulation software can be used as tools during the design phase: detailed occupants' behaviour's description will allow better defining the building features' robustness' degree when different design options are compared, in order to obtain the most suitable solution.

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