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Thesis abstract

Investigation of occupant behaviour in residential buildings

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The present research seeks to characterise occupant behaviours in a residential setting to improve the predictive skill of residential energy simulation models. To date only a handful of studies have been done in Australian residential environments because of the difficulty and cost of building up a large sample size. As a result it has been common to apply adaptive comfort models derived from office building studies in residential settings, despite the expectation that occupants in the latter context would have more adaptive opportunities compared to counterparts in office buildings, given that the degree of control over their environment in office environment is usually quite restricted.

The objective of this thesis is to establish an empirical basis to better understanding occupant behaviours and perception of comfort in the residential context. A longitudinal field observation campaign was conducted in 41 Australian homes in South-East Queensland across a one-year period (2019–21) that spans one summer, one swing season (spring or autumn), and one winter. A custom data acquisition system was developed and deployed in each participant's home to monitor the indoor environment and operations of ACs and windows. Additionally, an online comfort questionnaire was designed and administered to the sample householders via their smartphones throughout the survey period.

This study explores an alternative modelling approach that is capable of predicting diverse behavioural patterns. Statistical analysis was performed to predict occupant actions on AC operations (turning on/off) and window openings (opening/closing) in relation to outdoor and indoor environmental stimuli. The proposed model can be integrated into building simulation software to simulate the average operation pattern of AC and windows, as well as diverse patterns monitored amongst the participating households in the Australian residential context.

The study also examined the perception of thermal comfort and behavioural adaptation of residential occupants living in different climate zones of Australia. Data collected from a previous comfort study carried out in Sydney was utilised to make a comparison between the two different regions — Sydney: warm temperature (zone 5); and Brisbane: warm humid summer and mild winter (zone 2). The residents in the two regions registered different thermal sensations and thermal sensitivities. Probit analysis of TSV with room temperature was performed to define a range of acceptable temperature. The 80% acceptable temperature ranges for the two regions were 14.6–26.2°C in Sydney and 16.3–27.2°C in Brisbane, indicating that the acceptable

temperature range varied depending on the local climates.

Further analysis was performed on a large-scale time-use survey conducted at the national level from the Australian Bureau of Statistics (ABS) to assess occupancy and energy-related behaviours in Australian households. Profiles of occupancy state and energy-related activities were analysed for different seasons, day of the week, and household compositions. The activity sequences were further aggregated to reproduce the total time use for the activities and occupancy states.

The empirical findings from this study provide evidence-based behavioural models and simulation settings to be implemented in building energy performance simulation (BEPS) tools to more accurately predict indoor environmental conditions and energy consumption in residential buildings.

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