Apparent Temperature Optimisation for Commercial Operations in Portable Buildings

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The tropical climate of Darwin, Northern Territory of Australia, is notorious for unbearable temperatures exceeding 32C (90F) daily. Often felt in indoor environments, this leads to heat exhaustion and hyperthermia which affect the productivity of students and employees alike. Apparent temperature optimisation utilises the International Standard Organisation's mathematical models and ASHRAE Standard-55 Comfort Model to combine air-conditioners and ceiling fans to simulate a lower apparent temperature mitigating energy consumption and carbon emissions. This experiment was conducted in a universally applicable portable building. Six air-conditioning settings (24C-29C in 1C increments) were complemented with maximal ceiling fan settings to simulate different environmental conditions. After a stabilisation period, the four required measurements of apparent temperature calculation (radiant temperature, globe temperature, relative humidity, and wind velocity) were recorded in 40 evenly-spaced locations across the portable building. Over 4,000 measurements were generatively modelled on contour maps to represent the predicted mean vote (PMV) changes and identify the subsequent cool and hot spots. Ultimately, the optimal combination of air-conditioner setting at 28C (82F) and maximum fan speeds simulated an apparent temperature between 27.65C-28.02C, yielding a PMV of -0.15 (closest to zero) and universal predicted dissatisfaction proportion of 6.65%. With a current 23.5C (74F) legal temperature for official buildings in Australia, this new optimal combination could save $300 AUD ($200 USD) annually in one portable classroom; and when applied to the 8,300 portable classrooms in the LA Unified Schools District, could conserve 7.6m kWh, $1.7m USD and 8,234 tonnes of CO_2 per annum.