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Modelling thermal comfort of visitors at urban squares in hot and arid climate using NN-ARX soft computing method

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Abstract Visitors utilize the urban space based on their thermal perception and thermal environment. The thermal adaptation engages the user's behavioural, physiological and psychological aspects. These aspects play critical roles in user's ability to assess the thermal environments. Previous studies have rarely addressed the effects of identified factors such as gender, age and locality on outdoor thermal comfort, particularly in hot, dry climate. This study investigated the thermal comfort of visitors at two city squares in Iran based on their demographics as well as the role of thermal environment. Assessing the thermal comfort required taking physical measurement and questionnaire survey. In this study, a non-linear model known as the neural network autoregressive with exogenous input (NN-ARX) was employed. Five indices of physiological equivalent temperature (PET), predicted mean vote (PMV), standard effective temperature (SET), thermal sensation votes (TSVs) and mean radiant temperature (T_{mrt}) were trained and tested using the NN-ARX. Then, the results were compared to the artificial neural network (ANN) and the adaptive neuro-fuzzy inference system (ANFIS). The findings showed the superiority of the NN-ARX over the ANN and the ANFIS. For the NN-ARX model, the statistical indicators of the root mean square error (RMSE) and the mean absolute error (MAE) were 0.53 and 0.36 for the PET, 1.28 and 0.71 for the PMV, 2.59 and 1.99 for the SET, 0.29 and 0.08 for the TSV and finally 0.19 and 0.04 for the T_{mrt}.

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1 Introduction

It is believed that outdoor thermal environments affect residents' thermal sensations (TSs) in open urban areas; thus, it can play a significant role in utilization of these places. Urban space utilization is a gauge for estimation success of a city (Cheng et al. 2012). Having said that, urban spaces such as squares are exposed to extreme weather conditions, particularly due to climatic change and global warming phenomena (Chen and Ng 2012; Karjalainen 2007; Indraganti and Rao 2010; Parsons 2002; Kariminia et al. 2012; Kariminia et al. 2013; Chen and Ng 2012). Indeed, open urban spaces (i.e. plazas or squares) are vulnerable to the extreme weather conditions. Thus, designers and planers consider it essential to prepare more attractive outdoor spaces which can be better utilized by the residents (Cheng et al. 2012).