Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 142 (2017) 2734–2739

Energy Procedia

www.elsevier.com/locate/procedia

9th International Conference on Applied Energy, ICAE2017, 21-24 August 2017, Cardiff, UK

Household Electricity Consumption Prediction Under Multiple Behavioural Intervention Strategies Using Support Vector Regression

Meng Shen[a], Huiyao Sun[a,b], Yujie Lu[a,*]

[a]*Department of Building, School of Design and Envrionment, National University of Singapore, 117566, Singapore*
[b]*Institute of Systems Science, National University of Singapore, 119615, Singapore*

Abstract

Household electricity consumption influenced by various behavioural intervention strategies is difficult to predict due to the uncertainty arises from involved human behaviours. Based on an energy conservation experiment conducted in Hangzhou, China, this paper firstly proposes a variable selection approach to determine the best subset of consumption predictors using Akaike Information Criterion (AIC). 18 of the 48 initial variables have been considered as the critical predictors including energy behaviours, personality trait, demographic/building features, weather indicators and the last month consumption in this research. Moreover, this research also introduces the interaction effect between the energy behaviour predictors and other variables to the prediction model. The study has developed an energy behaviour based Support Vector Regression (SVR) model that is capable of predicting household electricity consumption under multiple intervention strategies. In particular, Gaussian radial basis function (RBF) is applied as the kernel function of SVR model. The result shows that the proposed model has the best and robust performance on the next month prediction and time-series forecasting.

Peer-review under responsibility of the scientific committee of the 9th International Conference on Applied Energy.

Keywords: Electricity Consumption Prediction; Energy Behaviour; Intervention Strategy; Support Vector Regression; Personality Trait.

* Corresponding author. Tel.: +65-6516-5894; fax: +65-6775-5502.
E-mail address: luy@nus.edu.sg

1876-6102 © 2017 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the scientific committee of the 9th International Conference on Applied Energy.
10.1016/j.egypro.2017.12.218

1. Introduction

As existing studies failed to consider and quantify the impact of occupant behaviour changes in residential sector, the performance of behaivoural interventions may not be assessed and predicted accurately [1]. In addition, prior research on the linkage between personal characteristics (such as demographic factors etc.) and the intervention effects rarely explained the underlying logic of why uniform intervention may have different impacts on occupants, which personality traits actually lead to observed differences [2,3]. That is, personality being an important motivation of our attitudes, values, and beliefs, may be a significant predictor of the energy behaviour and energy consumption [4]. Moreover, energy related behaviours are not easily to be measured as they are influenced by a wide range of factors which interacts one another. Besides, there is a growing need to identify key energy behaviours for predicting the household energy consumption under different intervention strategies. With this in mind, this paper starts with the following questions: Can we use household energy related behaviours and their personality traits to predict their energy consumption? How to measure the interaction effect between behaviours and other personal characteristics on consumption prediction?

Based on an experiment conduct to infer the effects of eco-feedback via different delivered methods on household monthly electricity consumption in Hangzhou, China, this paper has proposed an optimal SVR model for predicting household consumption under multiple intervention strategies. The improved model is designed to incorporate energy related behaviours, personality traits, demographic/building features and the weather data, into behavioural interventions to predict electricity consumption for the households. In particular, the interaction effect between behaviours and other variables has been introduced to the household electricity consumption prediction.

2. Data collection and processing

The data was collected from an electricity conservation experiment conducted in 5 different residential complexes in Jiang Gan district Hangzhou, a capital of Zhejiang Province in east China. The tailored information with eco-feedback was adopted as the main intervention strategy in this study. Various types of delivery, such as through paper, mobile application and face-to-face interactions, were also tested in the experiment. These elements were integrated in the design process and come up with five treatment groups and one control group. More specifically, treatment group 1 and group 2 both received paper energy saving tips such as leaflet/sticker, while only group 1 received monthly feedback in paper format. Treatment group 3 and 4 received online energy savings tips through WeChat which is a leading social platform in China, whereas only group 3 received online feedback through WeChat on a monthly basis. Treatment group 5 not only received the paper stickers and feedback forms, but also were provided with monthly face-to-face consultation. The control group 6 did not receive any interventions or feedback. All interventions were carried out from April to June 2016. The questionnaires consisting energy behaviours, big five personality traits, demographic profile and building features, were given to all of the participants from February to June 2016 (see Table 1). In this study, 240 households were initially targeted at 40 samples per group. But there were 235 households participating remaining in the end of the experiment. In addition, due to missing the survey data, there were 179 households remained as eligible for further analysis. Note that we impute some of the missing or ambiguous values in the survey according to the data trend and conventional rules for handling missing values. Monthly electricity consumption data in kWh of the subjects during the year of 2015 and 2016 were collected from the Department of Energy of Zhejiang University, or through the electricity bill sent by the residents from February to August 2016. Eventually, the electricity consumption data collected from 166 households during February to June of 2016 were qualified for building the prediction model. As there is a likely influence on electricity consumption due to varying weather conditions, the daily forecasted weather information from the year of 2015 to July 2016 is retrieved from Hangzhou Meteorological Bureau. For this research, the Heating Degree Days (HDD) and Cooling Degree Days (CDD) calculations were made on a monthly basis.

Table 1. Description of the questionnaires in Hangzhou experiment.

Survey Name	Numbers of Items	Information Collected	Collection Period	Frequency