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Influencing factors regression analysis of heating energy consumption of rural buildings in China

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Abstract

The heating energy consumption in rural residential buildings is increasing in recent years. The 181 influencing factors which influence heating energy consumption mainly includes five parts: family basic information, rural residential building features, building envelope information, indoor air quality in winter and building heating energy consumption. Multiple linear regression analysis and logistic regression analysis were used to analyze the significant factors which affect rural building heating energy. Suitable and validated multiple regression model can use less variables to describe, explain and predict the heat energy consumption of rural residential buildings. Comparing different multiple linear regression models, one interactive exponential model which has goodness of fit, less predictive relative error and less influencing factors is optimal. This exponential model can be applied to predict heating energy consumption and annual heating energy consumption of per degree-days heating area of rural buildings. Logistic regression analysis can predict heating energy consumption from high, medium or low probability prediction classification and can evaluate the heating energy consumption level. Two regression analysis methods present a reliable, valid, and economical instrument for in-depth rural building energy saving research.

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Keywords: Multiple linear regression analysis; Logistic regression analysis; Heating energy consumption; Rural building

1. Introduction

The building sector uses around 30% of the total annual energy consumption and it gradually increasing to nearly

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40% in China [1]. The rural population constitutes over 60% of the total population. The rural living area accounts for 60% of Chinese total living area. The rural building energy consumption is about 37% of total building energy consumption. The heating energy consumption of northern rural building accounts for over 60% of the total building energy consumption. The high heating energy consumption of northern rural building is mainly due to the cold winter and long heating period.

Based on the questionnaires which inquire the actual energy consumption of the target residents in China [2], the correlation analysis and multiple regression analysis through SPSS software were produced.

Investigated items in Chinese northeastern rural area focus on structures, dimensions, types, envelope materials in rural buildings. Rural building energy consumption covers heating, cooking, hot water, lighting, ventilation, household appliances and so on.

2. Methods

2.1. Multiple regression analysis and logistic regression analysis

Based on the preliminary work, many factors which affect rural building energy consumption were collected and grouped [3]. The independent-samples t test and variance analysis were used to analyze 54 factors which affect energy consumption of rural buildings in cold areas [4]. Selected 15 affecting factors which reach 0.05 level of significance were as following: the grouping of family population, economic income level, floor area, heating area, the northern window to wall ratio, with or without covers on the external windows, layer of exterior door, with or without roof insulation, wall material, the grouping of average indoor temperature, indoor thermal comfort, household heating commodity duration, household heating non-commodity duration, heating and cooking combined type and heating energy type.

2.2. Dummy variable regression

Regression analysis treats all independent variables in the analysis as numerical. Numerical variables are interval or ratio scale variables whose values are directly comparable. However, an attribute or nominal scale variable such as ‘thermal comfort’ or ‘economic income level’ might be included in the study. Say there are three types of economic income level, numbered ‘1’, ‘2’ and ‘3’. The numbers here are used to indicate or identify the levels of ‘economic income level type’ and do not have intrinsic meaning of their own. A dummy variable is an artificial variable created to represent an attribute with two or more distinct levels.

The low level is used as the control group at the dummy variable setting of multiple ordered independent variables. For example, the economic income level is divided into three levels, low, middle and high level. The low level is set the control group and the dummy variable (DV) of economic income level is listed in Table 1. The independent variables from the independent-samples t test and variance analysis will be set as dummy variables according to method. The 15 affecting factors are set as 29 dummy variables which listed in Table 1.

Table 1. Dummy variables based on 15 affecting factors

Dummy variable	Level		
	1~2	3~5	5~11
Family population _ DV 1	0	1	0
Family population _ DV 2	0	0	1

	low	middle	high
Economic income level _ DV 1	0	1	0
Economic income level _ DV 2	0	0	1

	<80 m ²	80-120 m ²	>120 m ²
Floor area _ DV 1	0	1	0
Floor area _ DV 2	0	0	1

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