Abstract

1. Motivation, specific objective

In recent years, because of the high efficiency of LED lighting, the window design method which relies solely on metrics for building energy performance by using daylighting have been difficult to be employed in some cases. Therefore, there is a greater demand for useful view metrics as performance evaluation of windows. There are already some view metrics in LEED (Leadership in Energy and Environmental Design) and EN17037: European Daylight Standard, however, the relationship between daylighting and view has not been fully examined. Because both factors are caused by the same windows, there will certainly be some relation between them, and if this relation can be clarified, more efficient guideline for designing windows could be proposed in future. In this study we focus on the psychological effects of view and daylighting in some residential spaces and examined the evaluation structure on the visual environment related to windows, using the data from questionnaire survey which was conducted in Tokyo metropolitan area.

2. Methods

A web-based questionnaire survey was conducted through a market research company to collect the data necessary for the analysis. The main purpose of this questionnaire was to survey the adjustment actions to the environment caused by windows in houses, but evaluation items, which related to visual environment, were extracted and analysed in this study. The number of responses to this questionnaire was 900, in which 866 were valid responses. Respondents were aged 25 to 60, with approximately 1.62% of them in their 20s, 18.9% in their 30s, 41.9% in their 40s, and 37.5% in their 50s and older. Of the total respondents, 62.9% of the respondents lived in detached houses and the rest of them in apartments. In this study, covariance structure analysis was used to organize the relationship between daylighting and view quality, as well as the relationship among occupants’ overall satisfaction with the visual environment in living spaces and other evaluation items related to daylighting and view. Covariance structure analysis can quantify the relationship among ‘observed variables’, which are directly measured variables, and ‘latent variables’, which lie behind them and cannot be directly observed. It is possible to visually express the relationship among observed and latent variables by using path diagrams.

3. Results

To create a path diagram, we first conducted a factor analysis with ten observed variables, such as ‘not being seen from outside’, ‘outdoor visibility’, ‘preference of landscape’, ‘spaciousness’, ‘satisfaction with view’, ‘daylight sufficiency’, ‘daylight control’, ‘satisfaction with light environment’, and ‘privacy’, and extracted three common factors (latent variables): ‘View Quality’, ‘Daylighting Quality’, ‘Privacy’. At first, we made a path diagram, in which the causal relationship from ‘View Quality’ to ‘Daylighting Quality’ and ‘Privacy’, and from these three latent variables to ‘Overall Satisfaction with the Window’ was assumed. ‘Overall Satisfaction with the Window’ (observed variable) was regarded as the comprehensive evaluation and positioned at the highest in the evaluation structure. The result of the
covariance structure analysis on this model showed that the goodness of fit, GFI (Goodness-of-Fit Index): 0.939 and RMSEA (Root Mean Square Error of Approximation): 0.100 was not enough to accept this model as a statistically reliable evaluation structure ("usually the model with GFI > 0.95 and RMSEA < 0.1 can be evaluated as acceptable). The latent variable ‘Privacy’ included the evaluation other than those related to the visual environment of the window, therefore, we excluded this latent variable from the model, and instead included the observed variable ‘not being seen from outside’ directly to the evaluation structure. Then, we created the second path diagram, in which the causal relationship from ‘View Quality’ to ‘Daylighting Quality’ and ‘not being seen from outside’, and the causality from these two latent variables to ‘Overall Satisfaction with the Window’ was assumed. As correlation/partial correlation analysis showed that ‘not being seen from outside’ had no strong relationship with ‘Overall Satisfaction’, we did not link these two variables directly in this path diagram. The result of the covariance structure analysis on the second model showed that the goodness of fit, GFI: 0.969 and RMSEA: 0.084 was high enough to accept this model as a reliable evaluation structure. The standardised path coefficient from ‘View Quality’ to ‘Daylighting Quality’ was 0.91, and that from ‘Daylighting Quality’ to ‘Overall Satisfaction with the Window’ was 0.38. The path coefficient directly from the ‘View Quality’ to the ‘Overall Satisfaction with the Window’ was 0.46. As a positive causal relationship was found from ‘View Quality’ to ‘Daylighting Quality’, the ‘Overall Satisfaction with the Window’ can be guaranteed to some extent by ensuring ‘View Quality’ from the window.

4. Conclusions

In this study, we constructed an evaluation structure for the visual environment provided by windows in residential spaces based on the web-based questionnaire survey conducted in Tokyo metropolitan area in Japan. As a result, it was clarified that ‘Daylighting Quality’ in living spaces is influenced by ‘View Quality’ evaluation and leads to the ‘Overall Satisfaction with the Window’, which indicates that ‘View Quality’ could be the basis for evaluating the comprehensive visual environment owing to windows. In the future, we would like to examine some quantitative and easy-to-use indexes to evaluate ‘View Quality’.