International Commission on Illumination
Commission Internationale de l'Eclairage
Internationale Beleuchtungskommission

DEVELOPMENT OF AN EVALUATION METHOD FOR VIEW QUALITY IN OFFICE BUILDINGS

Ohki, C., et al.

DOI 10.25039/x051.2025/kouub2

This article is also published as part of:

Proceedings of the CIE 2025 Midterm Meeting Vienna, Austria, July 4-11, 2025:
Scientific Conference (July 7-9, 2025)

DOI 10.25039/x051.2025

in

Proceedings of the CIE (International Commission on Illumination)

ISSN no. 3061-015X (print), 3061-0168 (online)

The paper has undergone double-blind peer review and its final version has been presented at the CIE 2025 Midterm Meeting, Vienna, Austria, July 4–11, 2025.

CIE Central Bureau
Babenbergerstrasse 9/9A
A-1010 Vienna, Austria
Tel.: +43 1 714 31 87
e-mail: ciecb@cie.co.at — www.cie.co.at

DEVELOPMENT OF AN EVALUATION METHOD FOR VIEW QUALITY IN OFFICE BUILDINGS

Ohki, C.[1], Koga, Y.[2], Kojima, Y.[1], Watanabe, A.[2]

[1] Obayashi Corporation, Tokyo, JAPAN, [2] Kyushu University, Fukuoka, JAPAN

ohki.chikako@obayashi.co.jp

Abstract

Windows that provide daylight and a view are fundamental for creating comfortable and healthy office spaces. This study aims to develop an evaluation method for window view quality for application at the design stage of office buildings. A series of experiments were conducted in several real offices and virtual office spaces. The results confirmed that the quality of a view can be evaluated by the sky view factor, the near view factor indicating the proportion of buildings included in the foreground, and by the presence of greenery, such as roadside trees. Moreover, greenery was found to act as an additional factor in view satisfaction. As a view quality evaluation method, three-dimensional graphs were proposed to express view satisfaction based on the sky view and near view factors, considering the effect of greenery.

Keywords: View, Window, Office, Sky view factor, Near view, Greenery

1 Introduction

Within the envelope of a building, windows play an essential part for daylighting, visual connection with the outdoor environment, and ventilation. Windows are fundamental in achieving performance criteria of the built environment by enhancing the visual, thermal, and the acoustic aspects. The significance of a view out, i.e. a visual connection to the outdoor environment is that it allows occupants to perceive the complex and dynamically changing outdoor environment. However, in designing office buildings, the determining factors for window design are the exterior appearance first, followed by the view out and daylighting. In addition, the line of sight between the building being designed and the opposite building is also taken into consideration. Although there are several design criteria for evaluating daylighting performance of windows, no practical design criteria have been established for their view performance.

To develop a method for evaluating the view quality of windows in office buildings, Koga et al. (2023) first reviewed various evaluation criteria and related research from the 1960s to the present. Standards for windows that take views into consideration are set out in the European daylighting standard EN 17037 (2018), the US's LEED (Leadership in Energy & Environmental Design) (2019) green building certification system, the UK's CIBSE (Chartered Institution of Building Services Engineers) daylighting guide LG10 (2014) and BREEAM (Building Research Establishment Environmental Assessment Method), and Japan's CASBEE (Comprehensive Assessment System for Built Environment Efficiency) for real estate. Among these, the view evaluation criteria of the European standard EN 17037 currently have international influence. Although the recommended numerical criteria for view evaluation given in an Annex (informative) of EN 17037 are not mandatory, many countries refer to these numerical standards. In the view evaluation according to EN 17037, the level of recommendations for view out is ranked as Minimum, Medium, or High based on the numerical criteria related to the horizontal sight angle, outside distance of the view, and the number of layers (sky, landscape, and ground) visible from at least 75 % of the utilized indoor area. The horizontal sight angle is shown as minimum (14 degrees or more), medium (28 degrees or more), and high (54 degrees or more). Outside distance of the view is shown as minimum (6 m or more), medium (20 m or more), and high (50 m or more). Finally, the number of layers is shown as minimum (at least landscape layer), medium (landscape layer and one additional layer), and high (all layers including sky, landscape, and ground).

Murachi et al. (2019) defined the psychological effect of the external view through a window as “view quality” and used the evaluation grid method to derive the factors that determine “good view”. Based on this, they used covariance structure analysis to present a quantitative model of evaluation, and showed that "good views" are determined by three factors, such as "clarity", "width", and "landscape evaluation". These are latent variables that cannot be directly observed as physical quantities, and their values are estimated from each observable variable based on a path diagram. However, it is practically difficult to measure these observable variables at the design stage, and there are still challenges to overcome before this can be put into practical use.

Ko et al. (2022) proposed a framework for a comprehensive evaluation of view quality and View Quality Index (VQI) by integrating architectural (daylighting) standards, green certification systems, and scientific literature from all fields related to views. VQI is expressed by three variables, "Content," "Access," and "Clarity," and is quantified and evaluated. Each variable is assumed to be equally weighted and is evaluated by multiplying each variable, which ranges from 0 to 1. "Content" uses view layers (sky, ground, landscape, nature), but does not take into account the impact of the proportion of each elements in the overall view on the evaluation. "Access" is defined as the amount of window view that can be seen from a particular point in the indoor space and varies depending on the size of the window and the viewpoint from the window surface. "Clarity" indicates how clearly can the outside be seen when considering visual obstructions attached to windows including shading systems or glazing materials.

Authors of this paper have conducted a series of experimental studies on window view quality since 2020. At the beginning of the study, it was assumed that the view quality was expressed by the product of evaluation functions for view quantity and view contents, similar to the VQI by Ko et al. (2022). However, experimental results in 2020 led to an immediate rethinking of this idea. In 2021 studies (Koga et al. Ohki et al., 2022), a view quality index was proposed and examined, assuming that views are evaluated by two functions of the view quantity and the view contents. It was suggested that the evaluation function of the view quantity is expressed as a logarithmic function of Window-to-Wall Ratio, defined as the ratio of the total glazing area to the wall area seen from indoors.

In 2022 studies (Koga et al. Kojima et al. Okamoto et al. Ohki et al., 2023), based on the view evaluation function proposed in 2021, experiments were conducted in VR space and real space to improve the evaluation function of the view quantity and to examine the impact of the proportion of view elements. As a result, a quadric function of the sky view factor was proposed for view satisfaction based on two relationships: view satisfaction and satisfaction with the proportion of sky visible, and view satisfaction and the degree of bother with the opposing buildings. It was also shown that satisfaction with views including greenery can be calculated by adding points to the evaluation results for views without greenery. The experimental results showed that the evaluation method that scores points according to the view contents (Hellinga and Hordijk, 2014) does not adequately reflect the actual view evaluations. Therefore, it was concluded that the view evaluation needs to consider not only the inclusion of specific view elements, but also their proportions. In addition, a system was developed to estimate the sky view factor and the proportion of buildings within 60 m from a window for this evaluation (Majima et al., 2023). The system measures the ratio of area of each element of the view content using 3D city data.

In 2023 studies (Koga et al. Ohki et al., 2024), experiments on view quality evaluation were conducted in actual offices to verify the results of 2022 studies (Koga et al. Ohki et al., 2023). The outcomes of the experiment in real space were generally consistent with that of the VR experiment. It was concluded that the sky view factor and the proportion of buildings in the foreground were the primary variables in the view evaluation, and greenery had an additive effect. A near view factor was newly defined to express the proportion of buildings within 30 m from a window.

In this study, satisfaction with the view quantity and the view quality are considered independently quantifiable. This paper shows an evaluation method for the view quality. It is proposed based on the results of a series of experiments conducted from 2022 to 2024.

 DOI: 10.25039/x051.2025/kouub2

2 Experiments on satisfaction with the view out

2.1 Method

The view quality evaluation experiment was conducted six times from 2022 to 2024 (Table 1). Experiments to evaluate views from actual offices were conducted in three locations: suburban Tokyo, central Tokyo, and Fukuoka. Experiments using virtual reality (VR) were conducted in three locations: Yokohama, central Tokyo, and Fukuoka.

Table 1 – Outline of the experiments

Experimental space	Number of Rooms	Number of view conditions	Number of participants
Office (Suburb of Tokyo)	4	10	12
Office (Center of Tokyo)	4	4	12
Office (Fukuoka)	2	12	27
VR (Yokohama)	3	6	15
VR (Center of Tokyo)	1	12	11
VR (Fukuoka)	1	12	23

The participants in the Fukuoka experiments were Asian men and women in their 20s for Office, and Japanese men and women in their 20s to 50s for the others. The participants were asked to evaluate (1) satisfaction with the view, (2) satisfaction with the range of the view, (3) satisfaction with the proportion of greenery visible, (4) satisfaction with the proportion of sky visible, and (5) degree to which buildings in the view bothered them on a scale of 0–100 points. A four-point scale (1: Bad, 2: Acceptable, 3: Good, 4: Excellent) was also used for the four experiments conducted in the suburb and the center of Tokyo, Fukuoka, and the virtual environment of Fukuoka.

In this study, the sky view factor (SVF) and the near view factor (NVF) were defined as the ratio of the total area of the sky and buildings in the foreground (excluding greenery) to the transparent glazing area, respectively. The foreground was defined as a space within 30 m parallel to the window surface. An image of the foreground boundary is shown in Figure 1.

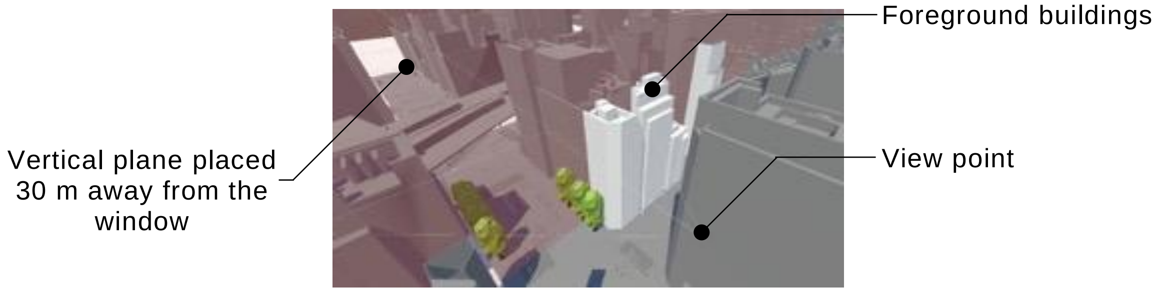


Figure 1 – Foreground image

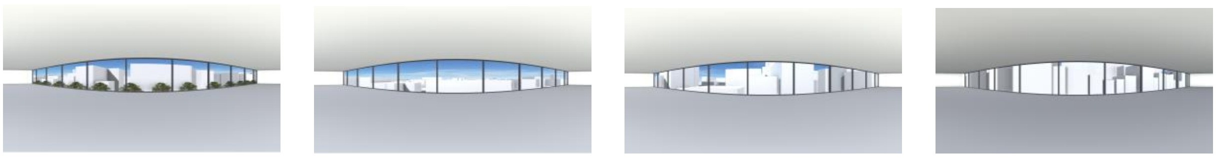
In the office experiments, participants were divided into four groups, which evaluated window views while moving among rooms. Participants were asked to evaluate window views on a 4-point scale and a 100-point scale. The experimental procedure was as follows: enter a room → take a seat → 2-min evaluation (4-point evaluation) → 3-min light work → 2-min evaluation (100-point evaluation) → move to another room. In the VR experiments, participants were asked to evaluate the view using a head-mounted display (Meta Quest 2 or Meta Quest 3). Some of the view images used in these experiments are shown in Figure 2.

(a) Office (Suburb of Tokyo)

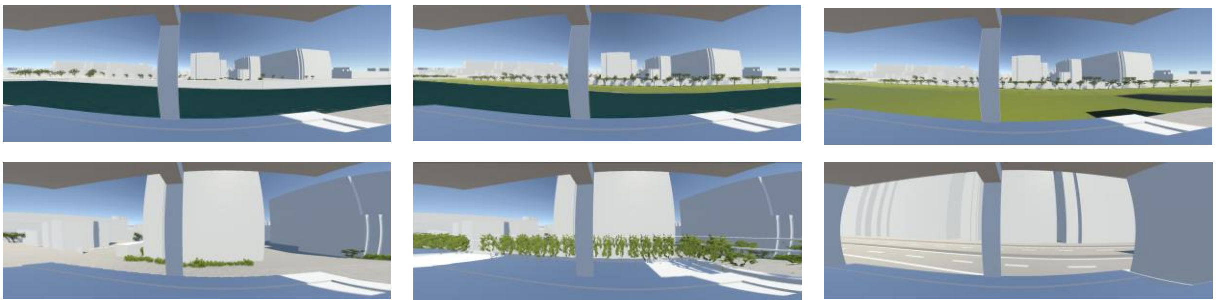
(b) Office (Center of Tokyo)

(c) Office (Fukuoka)

(d) VR (Yokohama)



(e) VR (Center of Tokyo)



(f) VR (Fukuoka)

Figure 2 – View images

 DOI: 10.25039/x051.2025/kouub2

2.2 Results

For each level of the 4-point scale evaluation, the corresponding scores on the 100-point scale varied. Overall, however, low scores tended to distribute for “bad” evaluation and high scores for “excellent” evaluation. Figure 3 shows the relationship between the 100-point scale and the 4-point scale evaluations for each experiment. Figure 4 shows the correspondence between the 4-point and the 100-point evaluations for the four experiments. From the interquartile range shown in Figure 4, the view satisfaction scores could be categorized as “bad” (30 points or less), “acceptable” (30 to 60 points), “good” (60 to 80 points), and “excellent” (80 points or more). Therefore, the view quality was considered to be classified into four levels.

(a) Office (Suburb of Tokyo) (b) Office (Center of Tokyo)

(c) Office (Fukuoka) (d) VR (Fukuoka)

Figure 3 – 100-point scale and 4-point scale evaluations

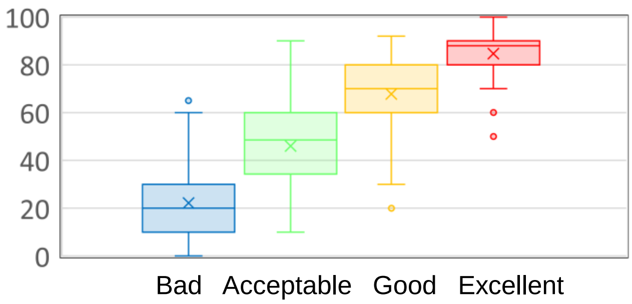


Figure 4 –View satisfaction score classification

Next, for each of the SVF and NVF, the relationship with the view satisfaction scores was examined separately for the presence or absence of greenery. Past studies have shown that the presence of greenery has the added effect of increasing satisfaction when the green view factor (GVF; the ratio of the area of greenery to the glazing area) is 0,1 or more. Therefore, in this study, a green view factor of 0,1 or more was defined as "With greenery", and a green view factor of less than 0,1 was defined as "Without greenery". Figure 5 shows the average view satisfaction scores for the SVF and NVF.

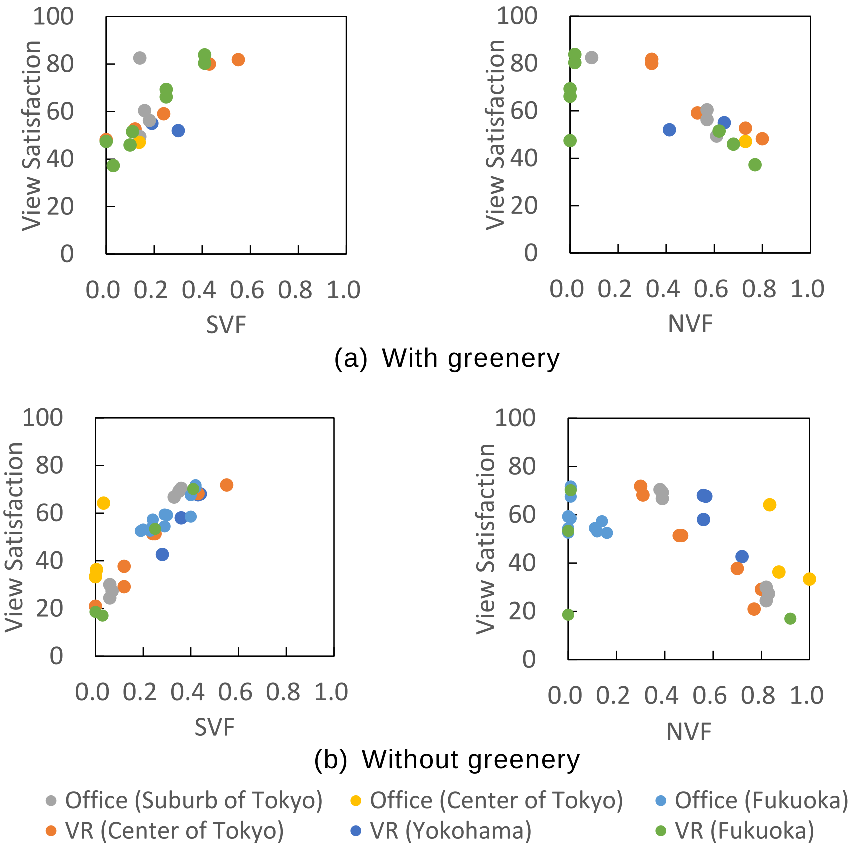


Figure 5 – Relationship between SVF/NVF and the average view satisfaction scores

The higher the SVF, the higher was the view satisfaction. This study confirmed that the presence of greenery provides higher view satisfaction than the absence of greenery. But this study did not consider cases where the SVF was 0,6 or higher. Such conditions are rare in general offices, but they are the subject of future research. For the NVF, the smaller the value, the higher was the view satisfaction, except when it was close to zero. The satisfaction level varied significantly depending on other view conditions, especially when the NVF was 0,2 or less. For the office (Fukuoka) and VR office (Fukuoka), there was a large river in front of the building and no buildings in the immediate view from the windows. Thus, by definition, the NVF was zero. However, some of the participants in the actual office experiment recognized an apartment complex across the river as a nearby building. Since the area surrounding the river was rather open and only the apartment complex across the river occupied a large portion of the view, this may have reduced the view satisfaction. Or the lack of depth in the composition of the view may have reduced the view satisfaction.

Based on the results shown in Figures 4 and 5, the average view satisfactions regarding the SVF and the NVF were provisionally classified as shown in Figure 6.

For "With greenery" condition, the range of SVF was classified into three levels: “excellent” (0,4-0,6), “good” (0,2-0,4), and “acceptable” (0,2 or less). Since there were no results below 30 points of the view satisfaction, it was assumed that there would be no range rated as "bad" under the “With greenery” condition. The range of NVF was, taking into account the classification of SVFs, classified as follows: “excellent” (0,6 or less), “good” (0,8 or less), and “acceptable” (1,0 or less).

For "Without greenery" condition, the range of SVF was classified into three levels: “good” (0,3–0,6), “acceptable (0,1–0,4)”, and “bad” (0,2 or less). Since there were no results above 80 points of the view satisfaction, it was assumed that there would be no range rated as "excellent" under the “Without greenery” condition. The range of NVF was, taking into account the classification of SVFs, classified “good” (0,6 or less), “acceptable” (0,8 or less), and “bad” (1,0 or less).

 DOI: 10.25039/x051.2025/kouub2

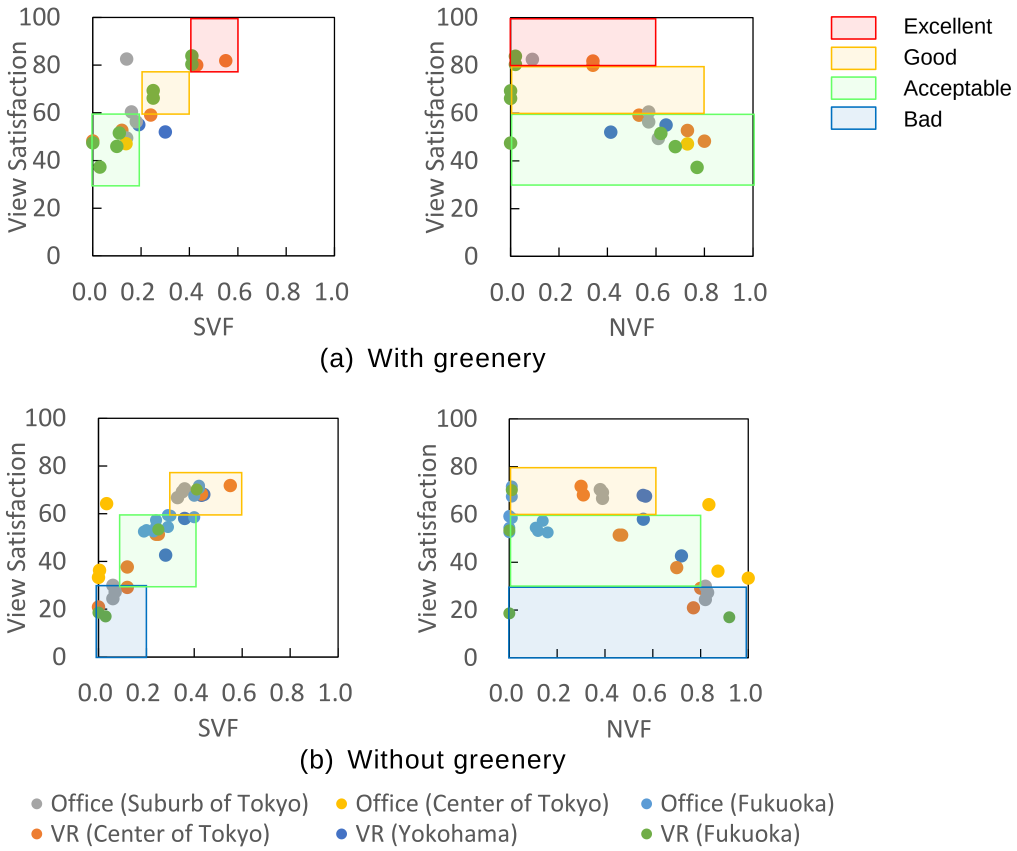
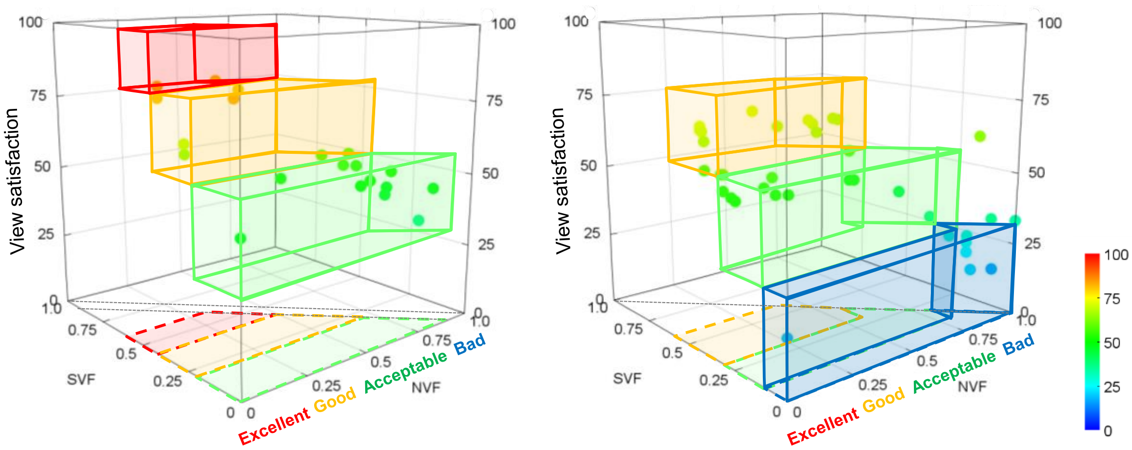


Figure 6 – Classification of the view evaluation

From the results shown in Figures 4 and 6, three-dimensional graphs were created to evaluate the view satisfaction with two variables, SVF and NVF, dividing the cases into “With greenery” and “Without greenery” conditions (Figure 7). The view satisfaction is rated as “excellent”, “good”, or “acceptable” when the view includes greenery (GVF ≥ 0,1). The view satisfaction is rated as “good”, “acceptable”, or “bad” when the view does not contain greenery (GVF < 0,1). Moreover, when the SVF is close to zero, the additive effect of greenery on view satisfaction is large; when the SVF is higher, the additive effect is small.



(a) With greenery (b) Without greenery

Figure 7 – View quality assessment method

This study proposes a view evaluation method based on these two variables, SVF and NVF. This method makes it possible to predict the satisfaction with views from office windows. This method can be used at various stages of building design: site layout planning, façade design, and window planning for occupant comfort.

3 Discussion and outlook

In this study, six experiments were conducted in actual offices and VR environments, and the view satisfaction evaluations were analyzed. A method of evaluating the view quality using this two-variable approach was proposed. As a result, view satisfaction was expressed by a 3D graph regarding SVF and NVF, depending on the presence or absence of greenery.

This study had few limitations. First, when the NVF was close to zero, view satisfaction varied. When buildings occupied the view, as in the central Tokyo case, view satisfaction was low even when they were far away. In the Fukuoka case, there was a large river in front of the building and many buildings across the river looked small. This may have made the apartment complex in the front of building seem closer than it actually was. For these cases where the NVF is small, additional experiments on different view contents are needed.

Second, no data were obtained in this study for conditions with the SVF of 0,6 or more. Past VR experimental results have shown that the view satisfaction decreases when the SVF approaches 1,0. Hence, additional experiments in actual offices are needed to confirm the view satisfaction when the SVF is 0,6 or more.

Further studies will be planned to accumulate experimental data and to improve the reliability of the proposed method. In addition, the authors of this paper will develop an applied method to easily calculate view performance using a BIM and a 3D city model. This will allow more effective window design.

References

KOGA, Y., KOJIMA, Y., OHKI, C. and KAWANO, A. 2023. A review of various standards for view quality of windows of office buildings. *Journal of Environmental Engineering*, 88(806), 255-264. (DOI: https://doi.org/10.3130/aije.88.255)

EN 17037:2018. *Daylight in buildings,* European Committee for Standardization.

USGBC 2019. *LEED v4 for building design and construction*, U.S. Green Building Council.

CIBSE LG10:2014. Daylighting – A guide for designers

MURACHI, T., HORI, Y., MATHUNAGA, S., and YOSHIZAWA, N. 2019. Derivation of the evaluation structure of views from windows in commercial buildings Development of quantitative evaluation method of view effects as a window performance of buildings. *J. Environmental Engineering,* 84 (762), 729-737. (DOI: http://doi.org/10.3130/aije.84.729)

KO, W. H., KENT, M. G., SCHIAVON, S., LEVITT, B., and BETTI, G. 2021. A Window View Quality Assessment Framework. *LEUKOS*, *18*(3), 268–293. (DOI: https://doi.org/10.1177/096032718902100404)

KOGA, Y., KIYOHARA, H., INOUE, M., KOJIMA, Y., OHKI, C. and KAWANO, A. 2022. Quality of the view through windows in offices – Visual information and viewers' perspectives. *Summaries of Technical Papers of Annual Meeting, AIJ, Environmental Engineering*, 521–522

OHKI, C., KOJIMA, Y., KAWANO, A., INOUE, M., KIYOHARA, H. and KOGA, Y. 2022. VR-Aided Evaluation of the View Quality for Windows. *Summaries of Technical Papers of Annual Meeting, AIJ, Environmental Engineering*, 585–588

KOGA, Y., OKAMOTO, T., MAJIMA, R., F JARRIN., KOJIMA, Y., OHKI, C., KAWANO, A. and TAKAGI, N. 2023. Green view factor and satisfaction with window views in urban offices. *CISBAT Journal of Physics: Conference Series*, 2600 (2023) 112016. (DOI:10.1088/1742-6596/2600/11/112016)

KOJIMA, Y., OHKI, C., KAWANO, A., TAKAGI, N., KOGA, Y., OKAMOTO, T., MAJIMA, R. and F JARRIN. 2023. Assessing views from office buildings in virtual reality. *CISBAT Journal of Physics: Conference Series*, 2600 (2023) 112014.

(DOI:10.1088/1742-6596/2600/11/112014)

OKAMOTO, T., MAJIMA, R., KOGA, Y., KOJIMA, Y., OHKI, C., KAWANO, A. and TAKAGI, N. 2023. Quality of the view through windows in offices – Depth effect of the view content. *Summaries of Technical Papers of Annual Meeting, AIJ, Environmental Engineering*, 491–492

OHKI, C., KOJIMA, Y., KAWANO, A., TAKAGI, N., OKAMOTO, T. and KOGA, Y. 2023. View quality evaluation experiments in real space and VR space in an office building. *Summaries of Technical Papers of Annual Meeting, AIJ, Environmental Engineering*, 493–494

Hellinga, H., Hordijk, T. 2014. The D&V analysis method: A method for the analysis of daylight access and view quality. *Building and Environment*, 79, 101-114

MAJIMA, R., KOGA, Y., OKAMOTO, T., F JARRIN., KOJIMA, Y., OHKI, C., KAWANO, A. and TAKAGI, N. 2023. Use of digital 3D urban models for view evaluation in building envelope design. *CISBAT Journal of Physics: Conference Series*, 2600 (2023) 112017. (DOI:10.1088/1742-6596/2600/11/112017)

KOGA, Y., KOJIMA, Y. and OHKI, C. 2024. Quantifying view performance for window design in office buildings. *Summaries of Technical Papers of Annual Meeting, AIJ, Environmental Engineering*, 433–436

OHKI, C., KOJIMA, Y., KOGA, Y. and LI S. 2024. Verification of view quality evaluation functions through view evaluation experiments in an office building. *Summaries of Technical Papers of Annual Meeting, AIJ, Environmental Engineering*, 437–440