WORLD CONFERENCE ON TIMBER ENGINEERING 2025
BRISBANE, AUSTRALIA
Advancing Timber for the Future Built Environment

How Office Workers Evaluate Computer-Generated (CG) Images of Wooden Office Spaces: Examining Gender and Age Differences

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ABSTRACT: This study investigated the willingness of office workers to use wooden structural offices in open-plan offices by examining user attributes, such as gender, age, personality traits, and work activities. Two surveys were conducted to gather comprehensive data: The first survey used the Evaluation Grid Method with 20 participants to identify their evaluation criteria related to office environments. The second survey involved 800 participants, allowing for a broader analysis of how various factors influence the willingness to use wooden materials in office designs. The findings revealed significant differences in the willingness to use wooden materials based on user attributes, particularly highlighting the influence of age and work activities. These results suggest that user characteristics significantly affect the spatial evaluation and emotional responses to wooden environments. This study underscores the necessity for tailored approaches in office design that consider these user attributes to enhance overall comfort and satisfaction in wooden office spaces. By providing insights into the preferences and evaluations of different user groups, this study provides valuable information for the integration of wood into modern office environments.

KEYWORDS: office, wooden structure, attributes, personality traits, work activities

1 – INTRODUCTION

Recent national surveys have reported that over 80% of office workers in Japan experience stress related to their work and workplace environments [1]. The issue of stress among Japanese office workers is serious, and reducing it has become an important challenge.

As a potential solution, the use of wood in interior designs in offices has attracted significant attention from the perspective of visual stimuli. Wood is a carbon-neutral material expected to contribute to carbon storage, and its incorporation into interiors can enhance the comfort of the working environment. Previous studies have reported that sensory stimuli from wood positively affect human psychological states [2]. Recently, efforts have been made to apply these findings to real-life settings, with evaluations conducted in both actual spaces [3] and virtual reality environments [4].

However, the psychological impressions regarding wood can differ based on factors, such as gender[5], age [6], and personality traits [7]. Additionally, in office settings, employment experience duration has been shown to influence psychological evaluations of spaces [8]. These findings suggest that, in wood-utilizing offices, the structure of space evaluations and aspects emphasized may vary depending on users' gender, age, personality traits, and work activities. However, research considering the influence of these attributes on the aforementioned evaluations of actual or virtual reality spaces is limited. Considering the user attributes, may help in gaining a more detailed understanding of spatial evaluations and emotional responses.

Therefore, this study aims to understand the willingness of office workers to use wooden structures in open-plan offices according to user attributes. This study focuses on the evaluation criteria established in previous research and differences in willingness to use wooden structures in office based on gender and age. Additionally, discusses a newly conducted large-scale web survey, which examined the differences in willingness to use wooden structures in office across various attributes,

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https://doi.org/10.52202/080513-0656

including gender, age, personality traits, and work activities.

2 – SURVEY 1 (PREVIOUS STUDY)

In the previous survey [9], a study was conducted using the Evaluation Grid Method (EGM), which is widely used to understand users' psychological needs, to collect evaluation criteria for users regarding their offices. The participants consisted of 20 Japanese individuals (10 men and 10 women, with 10 participants each from their 20s and 30s-40s). To examine differences in willingness to use based on gender and age, 16 CG images were created with office components as factors (Table 1), and the relationship between these factors and willingness to use was analyzed for each attribute.

In this experiment, categories were created based on the results of EGM using items with similar meanings in Japanese, which included categories containing items answered by more than ten respondents, or items that were mentioned during the initial comparison of images in the interview process (referred to as Original Evaluation Items in EGM). As a result, the evaluation criteria for offices consisted of 34 items . Analyzing the differences in the number of responses across attributes using Fisher's exact probability test revealed that in the categories of "strong presence of frames" and "highly functional furniture," the number of responses from women was significantly higher than that from men, while in the category of "suitable air quality," those in their 30s-40s had a significantly higher number of responses than those in their 20s. The only category related to wooden structures was "strong presence of frames," indicating that women tend to positively evaluate offices where the columns are large or close.

Regarding the relationship between office factors and willingness to use, significant differences by gender were found in "presence of columns (Fig.1)," "amount of greenery," "presence of beams," and "matrials of ceiling," while significant differences by age were noted in "amount of greenery." These results suggest that the influence of factors related to wood in offices on willingness to use varies by gender.

This survey clarified the evaluation criteria and gender differences in evaluations for each participant. However, since this survey was conducted with only 20 participants, it is necessary to examine whether this classification of attributes purely reflects gender differences. Therefore, an online survey was conducted to recruit a larger and more diverse group of participants for further examination of the attributes.

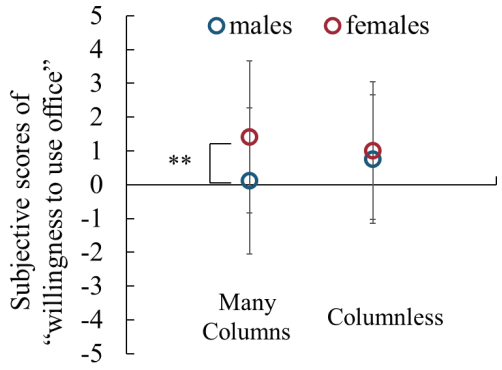

Fig.1 Interaction between column presence and gender on the scores for "Willingness to use office." (n = 10, Mean ± S.D. **: p<0.01, Mann-Whitney U test, Bonferroni correction)

Table 1 Factors of the CG space used in this survey

A: column less B: many columns	Materials of columns and beams	Amount of greenery	Presence of beams	Distance to columns	Seat density (/seat)	Material of ceiling	Wall pattern
A1, B1	Wood	Less	Yes	Near	15m²	Wood	White
A2,B2	Wood	Less	Yes	Far	10m²	Non-wood	Picture
A3,B3	Wood	More	No	Near	15m²	Non-wood	Picture
A4,B4	Wood	More	No	Far	10m²	Wood	White
A5,B5	Non-wood	Less	No	Near	10m²	Wood	Picture
A6,B6	Non-wood	Less	No	Far	15m²	Non-wood	White
A7,B7	Non-wood	More	Yes	Near	10m²	Non-wood	White
A8,B8	Non-wood	More	Yes	Far	15m²	Wood	Picture

https://doi.org/10.52202/080513-0656

3 – SURVEY 2

3.1 OBJECTIVE

In Survey 1, subjective evaluation scores regarding willingness to use offices were collected, but quantitative data for other evaluation items were not obtained. Furthermore, the examination of attributes was limited to gender and age, leaving other factors unexamined. Therefore, in Survey 2, the aim was to collect diverse attributes and evaluation items for each CG space through a web survey and to quantitatively understand the evaluation of spatial composition factors and attributes.

3.2 PARTICIPANTS

The participants in this survey consisted of 800 Japanese individuals with more than one year of work experience in offices with ten or more employees. Each age group of 25-34, 35-44, 45-54, and 55-64 included 200 participants (100 men and 100 women). After excluding participants who answered incorrectly to dummy questions (e.g., "Please select -3 for this item"), a total of 800 participants were collected. The study was conducted with the approval of the ethics committee of the Kajima Technical Research Institute, and informed consent was obtained from the participants prior to the experiment.

3.3 SURVEY PROCEDURE

Participants answered a questionnaire regarding their attributes (Fig.2). Phase 1 involved questions about gender, age, residential area, work industry experience, and number of family members living together. Subsequently, they answered questions about their personality traits and the time allocation for their work activities. Phase 2 included subjective evaluation items for 16 CG spaces, each with 38 items. Initially, participants reviewed all 16 images at once, followed by individual presentations of each image, for which they provided ratings on a seven-point scale ranging from -3 to +3. The presented images were from the seating perspective used in Survey 1 (Fig.3). The order of presentation was alternated based on the presence of columns; whereas, the other conditions were randomized for each participant. All question items were presented in the same order for each participant, arranged from higher to lower-level items, based on the evaluation structure indicated in Survey 1. Finally, Phase 3 comprised questions about participants' values regarding nature.

Fig.3 Example of CG office (B2)

3.4 EVALUATION ITEMS

In Phase 1, personality traits were measured using the Japanese version of the Ten-Item Personality Inventory (TIPI-J) [10], a questionnaire measuring the Big Five personality traits: "Extroversion," "Agreeableness," "Conscientiousness," "Neuroticism," and "Openness," using a total of 10 items rated on a 1–7 scale. Additionally, the work activities experienced in Phase 1 were answered based on 11 work categories ("Focus," "Process," "Call," "Duo," "Dialogue," "Create," "Coordinate," "Inform," "Relax," "Technical," "Others") as defined in previous studies [11], ensuring that the total added up to 100%. The basis for the responses was the subjective time allocation for each task. The subjective evaluation items collected during Phase 2 are listed in Table 2. These items were created based on the evaluation criteria obtained from Survey 1. For each question, the participants evaluated the spaces using a seven-point scale ranging from -3 (not at all agree) to +3 (strongly agree). The questionnaire used to assess values regarding nature in Phase 3 was based on a previous study [12]. It consisted of six items rated on a 1–5 scale,

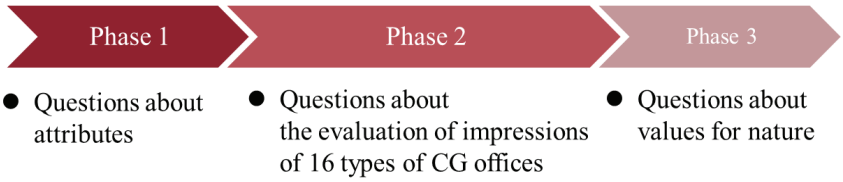

Fig.2 Survey procedure

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and the average score for these items was calculated as the naturalistic value score.

Table 2 Questionnaire items for office impression evaluation

No.	Question Content
Q1	An office where I want to work
Q2	An office that motivates me
Q3	An office where I can work more efficiently
Q4	A relaxing office
Q5	A refreshing office
Q6	An office where I don't feel tired
Q7	An office where I can communicate easily
Q8	An office where I can concentrate
Q9	An office where I can hide from people
Q10	An office with a clear view of its surroundings
Q11	A quiet office
Q12	An open office
Q13	A formal office
Q14	A cold office
Q15	A casual office
Q16	A closed office.

3.5 ANALYSIS

The subjective evaluation scores of the willingness to use offices were analyzed for differences between CG image parameters and participant attributes. The attributes examined were gender, age, personality traits, and time allocation for work activities (AT). For personality traits, cluster analysis was performed using the five trait scores obtained from the TIPI-J; whereas, AT was classified based on the proportions of the 11 task types using k-means clustering. Based on the elbow method, the number of clusters was determined to be four for personality traits and five for AT. The normality of the score distributions for each question item was confirmed using the Shapiro-Wilk test, resulting in $p<0.01$, indicating a non-normal distribution. Therefore, all impression evaluation scores collected from participants were standardized using robust z-scores. For the score differences among attributes for each parameter, the Kruskal-Wallis test was conducted, and for parameters showing significant differences with three or more attribute classifications, the Mann-Whitney U test was performed with Bonferroni correction. For score differences within the parameters of each attribute, a Wilcoxon signed-rank test was conducted. Statistical analyses were performed using Python 3.12, with the significance level set at 0.05.

3.6 RESULTS

3.6.1 CLUSTERS OF ATTRIBUTES

The scores for each cluster dimension when the participants were classified based on personality traits are shown in Fig.4. The maximum score for all dimensions was 14, and minimum was 2. Cluster 1 (P1) showed moderate scores across all dimensions; P2 consisted of participants with a tendency toward high scores in "Agreeableness" and "Conscientiousness," P3 included those with high scores in "Neuroticism" and low scores in "Extroversion," "Conscientiousness," and "Openness," while P4 included those with low scores in "Neuroticism" and high scores in other dimensions. The number of participants in Clusters 1, 2, 3, and 4 was 254, 210, 130, and 206, respectively. The work allocations for the AT by cluster are shown in Fig.5. AT1 consisted of participants performing a wide range of tasks with relatively uniform time allocation; AT2 included those whose co-working tasks accounted for over 70%; AT3 comprised participants with a high concentration of tasks (over 65 %); AT4 involved those whose tasks accounted for over 80% in other categories; and AT5 included participants with specialized tasks comprising about 65% or more. The largest cluster was AT1, followed by AT3, AT5, and AT2; AT4 was the smallest, comprising approximately 30 participants each.

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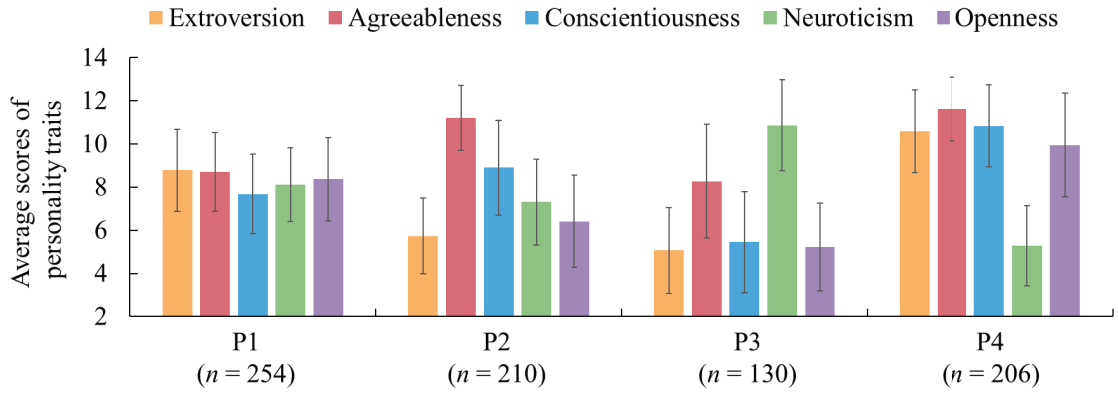

Fig.4 Scores of personality traits by cluster

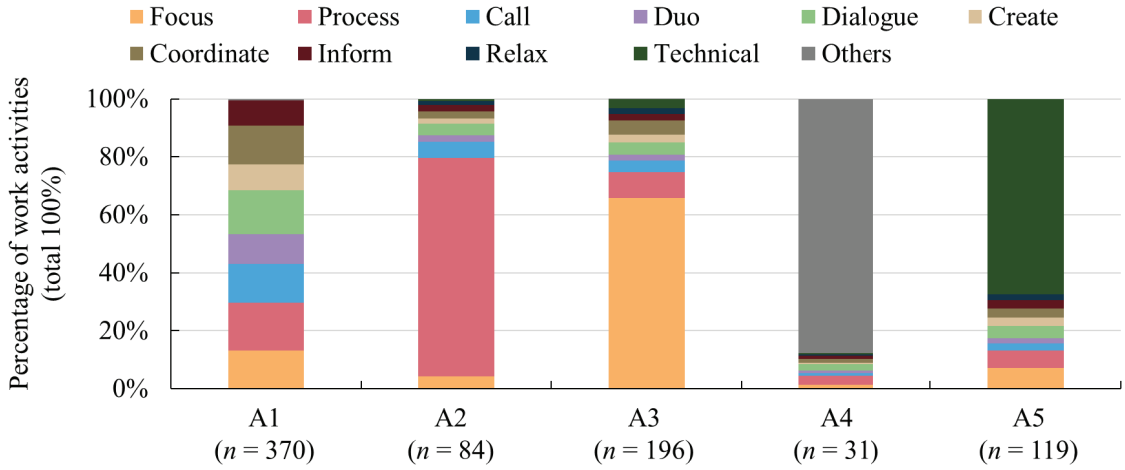

Fig.5 Percentage of work activities by cluster

3.6.2 DIFFERENCES IN SCORES OF WILLINGNESS TO USE

Table 3 presents the differences in willingness to use among the four attributes (gender, age, personality traits, and work activity) across the 16 conditions of the eight factors and two levels. Differences were observed among attributes, particularly in terms of age and work activities. Regarding age, significant differences were noted in 10 of the 16 conditions. The parameters related to wood and the introduction of wood included five items (Wood columns/beams, Non-wood ceiling, Columnless, With beams, and Without beams). Among these, six items showed significant differences in scores between age groups, all of which were significant compared with the 55–64 age group. Additionally, clusters based on the time allocation of work activities (AT) showed significant differences among the four conditions. Among these, all four parameters related to wood and the introduction of wood were included (Non-wood ceiling, Many Columns, Close to columns, and Far from columns). For the two conditions of "Many Columns" and "Close to columns," significant differences between clusters were noted, indicating that the willingness to use for both conditions was higher for AT3 compared with AT1.

3.7 DISCUSSION

Cluster analysis was used to classify the participants based on their personality traits and work activity attributes. Personality traits and work activities were categorized into four and five clusters, respectively. This

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Table 3 Significant differences within attributes by office factor
(Red: Kruskal-Wallis test, **p<0.01, *p<0.05
Black: Mann-Whitney U test, Bonferroni correction, **p<0.01, *p<0.05)

	Presence of columns		Materials of columns and beams		Amount of greenery		Presence of beams	
	Less	Many	Wood	Non wood	Less	More	Yes	No
Gender								
Age	** **55-64 > 35-44		** **55-64 > 35-44, *55-64 >45-54		* *55-64 > 35-44		** *55-64 > 35-44, *55-64 >45-54	* *55-64 > 35-44
Personality traits								
Work activities		** *A3 > A1						

	Distance to columns		Seat density (/seat)		Material of ceiling		Wall pattern	
	Near	Far	15m²	10m²	Wood	Non wood	White	Art
Gender								
Age			* *55-64 > 45-54	*		**	**	**
Personality traits								
Work activities	* *A3 > A1	**				**		

study ensured an equal distribution of gender and age among participants with no specific restrictions on work type. However, regarding the participants' location, 191 were from Tokyo and 228 from the surrounding areas (Kanagawa, Chiba, Saitama, Gunma, Tochigi, and Ibaraki), indicating that majority of participants resided in the Tokyo metropolitan area. Therefore, the attribute classification used was considered appropriate to represent individuals living in urban areas.

Regarding Survey 2, the attributes that showed differences in office workers' willingness to use wooden office were age and work activities. Conversely, Survey 1 did not recognize significant differences in the willingness to use among the different age groups. This discrepancy is likely due to the broader range of ages collected in Survey 2. While Survey 1 limited participants to those in their 20s to 40s, Survey 2 expanded the range to include individuals in their 20s to 60s, resulting in significant differences between participants aged 55–64, and those aged 25–34 and 35–44. The nature-oriented scores for each age group are shown in Fig. 6. The Mann-Whitney U test (with Bonferroni correction) indicated that participants aged 55–64 scored significantly higher than those aged 25–34 and 35–44. This suggests that older population in Japan may have a stronger inclination toward nature, which could be a reason for the differences in their willingness to use the presented CG spaces.

Moreover, while Survey 2 found no differences in the willingness to use based on gender, Survey 1 revealed differences among age groups. The reasons for this are unclear; however, they may be due to the ambiguous attribute classifications in Survey 1, leading to differing trends in other attributes (such as work activities) between genders, which manifested as differences. Furthermore, although no differences were noted based on personality traits in Survey 2, previous research [7] found differences in the willingness to use wooden

https://doi.org/10.52202/080513-0656

products. This could be attributed to the differences in the evaluation targets between the offices and wooden products. Additionally, prior studies have indicated that participants high in "Neuroticism" tend to show lower willingness to use wooden structures, likely related to the perception that wooden products are difficult to maintain due to issues like dirt, which may not have been reflected in the CG images presented. Future studies should confirm the trends in personality traits through comparative experiments in real space.

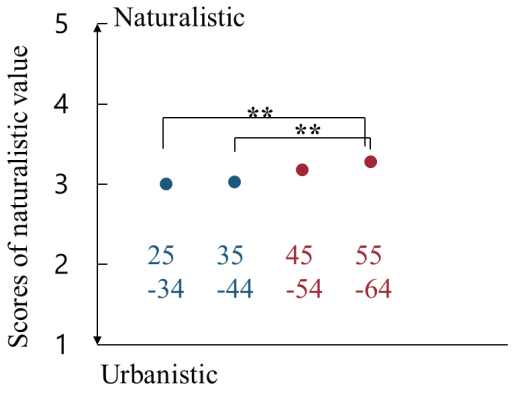

Fig.1 Scores of naturalistic value by age group (n = 200, Mean ± S.E. **: p<0.01, Mann-Whitney U test, Bonferroni correction)

4 – CONCLUSION

This study analyzed the willingness to use wooden-structural offices in open-plan offices based on attributes, such as gender, age, personality traits, and work activities. A diverse evaluation was conducted with 800 participants, highlighting the differences in their willingness to use based on age and work activities.

The results indicated that participants aged 55–64 demonstrated a stronger inclination toward nature than other age groups, showing significant differences in their willingness to use wood. Additionally, differences in evaluations based on work activities were confirmed, suggesting that specific task proportions influence the willingness to use wooden structures in office environments. This underscores the need for approaches tailored to user attributes when considering office design and the introduction of wood.

Future research should aim to clarify the causal relationships among the collected evaluation criteria and attempt to quantify the relationship between using wooden of offices and users' psychological evaluations. Furthermore, through experiments in real spaces and investigations of interactions with other environmental factors, deeper insights are anticipated.

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