

Effects of Wellness Conscious Buildings on the Well-being and Comfort of Workers

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Abstract. In recent years, Mental and physical health of office workers is regarded as a problem and the office buildings which improve workers' wellness. The WELL Building Standard was announced with the aim of improving the health condition of building users in 2014. The purpose of this study is to demonstrate the improvement of the health condition of the office workers who work at the office applying WELL Building Standard. To achieve this purpose, low-score office and high-score office for WELL Building Standard scores were created by changing the indoor environment and furniture in the office, and subject experiments in which we perform the work were conducted in each condition. From the experimental results, we propose environmental control and introduction furniture to verify changes in health condition of office workers, to improve the wellness of building users, and to bring synergy effects to health. It was confirmed that working at plural spaces which workers chose themselves.

1 Introduction

1.1 Background

In recent years, the mental and physical health of office workers has come to be recognized as a problem, and many researchers have begun focusing on changing office buildings to improve worker wellness¹⁾²⁾. Standards and indicators to evaluate buildings based on the influence of the building environment on workers' wellness are currently being developed in consideration of the principles for responsible investment in the real estate field. In 2014, the WELL Building Standard³⁾ was announced with the aim of improving the health of building users. This standard was classified into seven categories that integrate research ideas from various fields such as medical care and business administration, and it consists of 105 medium items. According to this standard, not only the indoor environment, but the office furniture, creativity of the layout, and the exercise environment available to the worker are also subject to evaluation. Although indicators to evaluate the effects of the conditions of indoor environment on health are constantly being enhanced⁴⁾, knowledge of the beneficial and synergistic effects of wellness-conscious offices on worker health and comfort remains insufficient.

1.2 Method

The purpose of this study was to demonstrate that an office designed according to the WELL Building Standard can improve the wellness and increase the

comfort of the employees. In this report, we conducted experiments that placed subjects in a simulated office with different indoor environments and furniture to investigate the effects of the working environment on employee wellness and comfort. Low-scoring and high-scoring offices, which were determined based on the WELL Building Standard scale, were created by changing the physical environment and office furniture, and experiments in which the subjects perform the task were conducted under each design condition. The experiment included 14 subjects and four conditions. From the experimental results, we propose environmental control and introduction fixtures to verify changes in the health conditions of office workers, to improve the wellness of workers who use buildings, and to provide synergistic effects on health. The results of this study provide insight into the comfort, the influence of the physical environment and furniture on the health and comfort of workers, and the importance of changing the physical environment and furniture to improve the health and comfort of workers.

2 Experiment

2.1 Experimental conditions

Table 1 shows the experimental conditions. We created a laboratory simulating an office assuming two adjacent rooms (Room A and Room B) as one office space and let the total of 16 men who routinely perform their duties. We applied to the laboratory about the indoor physical

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environment of WELL Building Standard and evaluation items concerning furniture that can be introduced to domestic existing office in operation stage. Experimental conditions are as follows: Condition 1 that does not apply WELL Building Standard items that can be introduced to existing offices, Condition 2 applied only to the physical environment, Condition 3 applied only in the fixture environment, Condition 4 applied to the physical / fixture environment, and four conditions for each condition were set.

Table1. summarizes the experimental conditions

	WELL Building Standard		physical environment		
	physical environment	office furniture	PMV	illuminance[lx]	CO ₂ [ppm]
condition1	×	×	0.8	200	1000
condition2	○	×	0.2	1000	800
condition3	×	○	0.8	200	1000
condition4	○	○	0.2	1000	800

2.1 WELL certification item on indoor physical environment

CO₂ concentration of 800 ppm or less, horizontal plane illuminance of 215 lx or more and less than PMV ± 0.5 shown in WELL certified "Feature.03 Ventilation Efficiency", "Feature.53 Visual Design of Light", "Feature.76 Thermal Comfort" Set values for conditions 1 and 3 and conditions 2 and 4 as shown in Table 1 as criteria for environment setting. The amount of ventilation was adjusted to keep indoor CO₂ concentration below 800 ppm. Regarding the horizontal surface illuminance, in the conditions 1 and 3 that do not satisfy the WELL certification, the window blind was closed and the influence of solar radiation was eliminated as much as possible. In calculation of PMV, the clothes amount is 0.65 clo and the activity amount is 1.1 met. In Conditions 1 and 3, air conditioning set temperature is set to room A: 26.0 °C, room B: 25.5 °C, for condition 2 and 4, Room: 23.5 °C, room B: 24.5 °C.

2.2 WELL certification item on furniture environment

Figure 1 shows the office layout. Regarding the furniture environment, 9 items of WELL certification were targeted. In Conditions 1 and 2, subjects performed duties at fixed seats. The room layout in Conditions 1 and 2 is the same for both Room A and Room B. In Conditions 3 and 4, we switched office desks and chairs in the office to upper and lower ascending desks and chairs whose height and depth can be adjusted and changed the arrangement. In addition, we introduce furniture and space described in WELL certification items such as refrigerator, exercise equipment, manual on which information on health is posted, intensive booth, refresh space that can also be used as a nap space, planting etc, subjects prefer We adopted the free address system which selects the space of the office and performs the office. The office layout was decided so that each evaluation item was not hindered by each other.

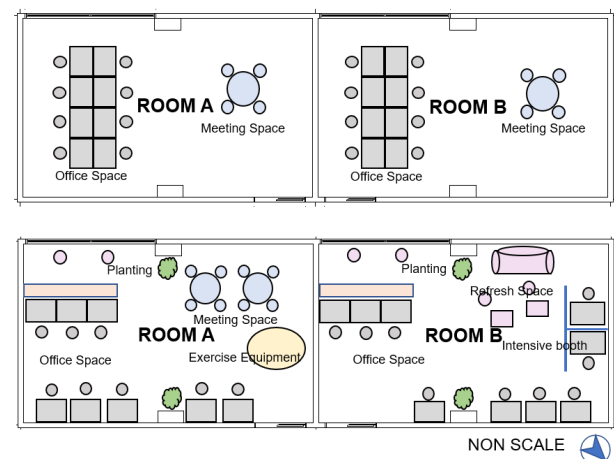


Fig1. Office layout.

3 Survey matter

As a physical environment measurement, Temperature, humidity, illuminance, CO₂ concentration, PMV were measured. The subjects performed questionnaires at the time of starting and returning for each experimental period, declaring the staying place of the day at the time of leave of the experimental period, and conducting a questionnaire survey on the last day of each condition. Questionnaires were prepared based on SAP2013⁵⁾ and surveys were conducted on the satisfaction level of the indoor environment, subjective work capacity, and subjective health view, and the indoor environment of each condition is related to the health and comfort of the worker We evaluated the impacts. In "Jikaku-sho Shirabe"⁶⁾, we investigated the feeling of sleepiness, instability, discomfort, feeling of sagging, and the feeling of blur, with the aim of grasping the temporal change of the subject's fatigue situation with work.

4 Physical environment measurement result

Table 2 shows the measured physical environment physical values. Both air temperature and glove temperature were around 26°C for conditions 1 and 3, and around 25°C for conditions 2 and 4 where the physical environment was improved. Relative humidity decreased to about 60% in conditions 1, 2, and 4, and about 50% in condition 3. It is conceivable that the absolute humidity of the outside air was low as a factor. PMV was 0.4 lower than the set value of 0.8 in the condition 3 where the relative humidity was low. Horizontal surface illuminance exceeded the set values 200 lx (condition 1, 3) and 1000 lx (condition 2) in the condition and measurement position other than B on condition 2 and 4. As a factor, both chambers were affected by natural light from the southwest side window. The average CO₂ concentration was lower than the set value of 1000 ppm (Condition 3)

and 800 ppm (Conditions 2, 4) in all but the measurement point of B.

Table2. measured physical environment physical values

Condition	item	Temperature	Humidity	PMV	illuminance[lx]	CO ₂ [ppm]
1	A-1	26.5	58	0.7	344	475
	A-2	26.2	58		315	499
	B-1	26.5	60	0.7	366	1220
	B-2	26.2	63		289	490
	Average	26.3	60	0.7	329	671
2	A-1	25.1	57	0.1	1025	543
	A-2	24.2	59		1111	567
	B-1	25.6	54	0.1	1019	713
	B-2	24.6	58		1001	515
	Average	24.9	57	0.1	1039	585
3	A-1	26.2	47	0.5	373	-
	A-2	26.0	46		289	637
	B-1	25.8	50	0.4	339	820
	B-2	25.6	52		257	688
	Average	25.9	49	0.4	314	715
4	A-1	24.8	57	0.1	1321	603
	A-2	24.3	58		1097	639
	B-1	25.5	54	0.1	1216	690
	B-2	24.7	58		973	519
	Average	24.8	57	0.1	1152	613

5 Satisfaction survey result

Fig. 2 shows the average value of the overall physical / Furniture environmental satisfaction level. I declared the satisfaction level at 7th level. An average value weighting the number of responses was calculated, and a significant difference was judged by *t* test. In Conditions 2 and 4 in which the physical environment was improved from Condition 1, a significant improvement in overall physical environment satisfaction was observed ($p < 0.01$). Condition 1 also showed a significant improvement in comprehensive furniture environment satisfaction with Conditions 3 and 4, which improved the furniture environment ($p < 0.01$). It was shown that each satisfaction degree improved significantly by improving physical and furniture environment.

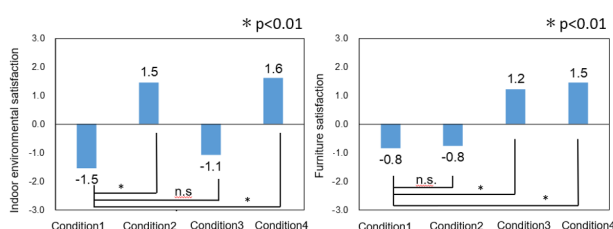


Fig2. The average value of the overall physical / Furniture environmental satisfaction level

6 Impact of physical environment and furniture environment on wellness and comfort

Figure 3 shows the subjective health view. We declared health status during each condition period from 0 to 100% for health condition that each subject considered to be in the best condition. The average value and the standard

deviation were as follows: Condition 1: 51% (± 23), Condition 2: 49% (± 21), Condition 3: 48% (± 20) Condition 4: 60% (± 20) As a result of the significant difference judgment by the *t* test, the declaration of the condition 4 was improved significantly ($p < 0.01$) as compared with the conditions 1, 2, and 3. To grasp the interaction between physical environment satisfaction degree and furniture environment satisfaction degree, two-way analysis of variance was carried out. Interaction was confirmed with regard to the influence of the indoor environment and the furniture environment under Condition 4 on the subjective view of health. ($p < 0.05$) Furthermore, since there was no significant difference in the subjective health view from Condition 1 to Condition 2 and from Condition 1 to Condition 3, there is a possibility that the subjective health view can be improved by the synergistic effect of the improvement of physical environment and furniture environment. It was shown.

Figure 4 shows the work capacity. We declared subjective work capacity under each condition when deciding the working capacity in the office, which considered to be optimal physical environment and furniture environment at 0 to 100%. The mean value and standard deviation were Condition 1: 61% (± 19), Condition 2: 71% (± 13), Condition 3: 77% (± 10) Condition 4: 85% (± 6). Significant improvement was observed from condition 1 to each condition. ($p < 0.01$) Compared to condition 2, PMV in condition 3 became more neutral than the set value as a factor that the average value of condition 3 got higher. From the condition 1 to the physical environment and the condition 4 in which the furniture environment was improved, an increase in the average value and a decrease in the standard deviation were observed, and it was considered that there was a tendency to be different between the upper level and the lower level respectively, so that the subjective work capacity under Condition 1 For the top 3 and bottom 3 people, the rate of change between the conditions was compared. The rate of change of the top three from condition 1 to condition 4 stayed at an average of (+ 8%), while the lowest 3 persons were (+ 52%) on average, and the subjective work capacity improved significantly due to the improvement of the physical environment and furniture environment.

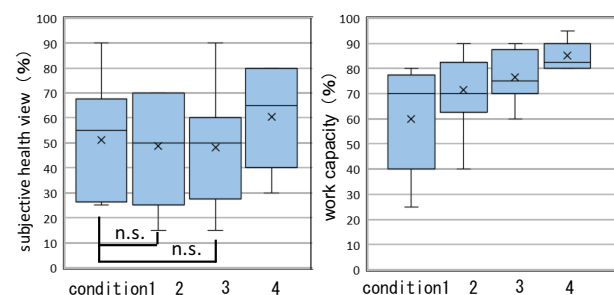


Fig3. The subjective health view **Fig4.** work capacity

7 Impact of physical environment and furniture environment on productivity

Figure 5 shows the relationship between office environmental satisfaction and subjective work capacity. The average value for each subject in physical environment satisfaction level and furniture environmental satisfaction level was taken as office environmental satisfaction level. Using the questionnaire answers of all the subjects, furniture and physical environment satisfaction were classified into 0.5, the subjective work capacity was classified as approximate every 5%, then a bubble diagram was created and the correlation was confirmed. There was a weak positive correlation trend between physical environment satisfaction and subjective work capacity ($R^2 = 0.20$), furniture environment and subjective work capacity ($R^2 = 0.25$). With regard to the subjective work capacity at the time of declaration on the satisfaction side, the subjective work ability declared when the declaration of the physical environment satisfaction degree was satisfied was 60% or more except for one subject, and declaration of furniture environmental satisfaction was 65% or more in all subjects when the subject was satisfied. On the other hand, when the physical environment and the declaration of the degree of satisfaction of the furniture environment were unsatisfactory, the subjective work capacity fluctuated largely as 90% at the maximum and 25% at the lowest. It is suggested that both subjects who do not decrease their work ability and subjects that drops extremely in the physical environment and furniture environment are bad. In addition, a weak positive correlation ($R^2 = 0.39$) was confirmed in the indoor environmental satisfaction level and the subjective working ability. Relationship between the physical environmental satisfaction level and the subjective work ability strongly correlated with the relationship between physical environment and furniture environment satisfaction level and subjective work capacity. It is thought that improving both the physical environment satisfaction level and the furniture environmental satisfaction level can improve the subjective work capacity of the entire office worker.

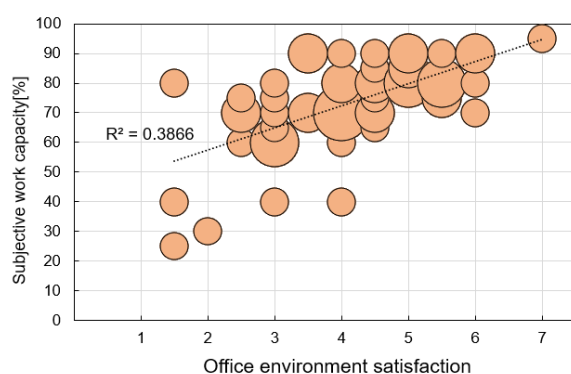


Fig5. The relationship between office environmental satisfaction and subjective work capacity

8 Conclusion

In this report, we report on the results of the analysis on the degree of satisfaction of the physical and the furniture in the experiment, and the influence of physical

environment and furniture environment on the health and comfort of office workers.

1) By improving the physical environment and furniture environment, a significant improvement ($p < 0.01$) was confirmed for each satisfaction level.

2) Subjective health view was improved only for condition 4 which improved both physical environment and furniture environment, and interaction ($p < 0.05$) was confirmed in the physical environment and furniture environment influence on subjective view of health.

3) Subjective work capacity was significantly improved ($p < 0.01$) by improvement of either physical environment or furniture environment. In addition, subjects with low subjective task capacities in poor indoor environments tended to improve significantly in subjective task capacity due to improved physical environment and furniture environment.

4) It was suggested that both subjects who do not decrease their working ability and subjects who drop extremely in the physical environment and furniture environment are bad. Positive correlation was confirmed in the indoor environmental satisfaction level and the subjective work capacity, and the correlation tendency was stronger than the relation between each environmental satisfaction degree and subjective work ability.

From the above, it was confirmed that improving comfort of office workers was improved by improving the physical / furniture environment, and the ease of action in the office was changed. To improve the wellness of the office worker, it was suggested that the space where the office worker can select many spaces and can perform work and refresh is important. There is a possibility that a synergistic effect by physical / furniture environment is necessary to improve subjective health view, and in order to improve office space for the purpose of improving health and comfort, there is a possibility that physical environment and It is suggested that it is necessary to improve both the physical environment and the furniture environment.

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