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Development of Wellness Architecture

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Abstract. By using index of wellness architecture such as WELL Building Standard, Takenaka Corporation had renovated and rebuild some projects to improve comfort and intelligent productivity from 2016. The purpose of this report is to give an overview of efforts and achievement in project we've done. In the case of large-scale office building renovation, we aim to obtain Well Building Standard certification. We introduce the efforts in the following evaluation items, consideration for the air environment such as whole building smoking cessation and consideration for the mind such as office layout that green is in sight. In the case of rebuilding dormitory for singles, we aim to create an educational dormitory that considers physical and mental health, safety and security, and the environment. We introduce approaches such as plan to promote communication, setting of sleep specialization room as place for creating the opportunity to know one's own health condition and sleep rhythm. In the case of medium-sized office buildings, We introduce the office layout for a smart working, such as "Workplace to choose the place according to the activity", the introduction of the wellness air conditioning system corresponding to the thermal individual comfort and the effect verification about the worker satisfaction

1. Introduction.

Wellness so called health-conscious architecture for catch people's attention as a next building of sustainable building or energy-saving building in large office buildings, single dormitories and small-medium office buildings. We have been carrying out renovation or rebuild works for the purpose of improving comfort and intellectual productivity from 2016 to 2019 with evaluation tool like a WELL Building Standard which is evaluation methods of Wellness architecture. We will introduce the contents of those plans in this time.



Figure 1. Building outline

Construction area: 5,937 m ^{2}
Total floor area: 29,781 m ^{2}
Structure: Steel frame and CFT column
Number of floors: 7th floor
Completion Date: September 2004
Renovation work:April2018-October2018

Figure 2.
TAKENAKA CORPORATION
Tokyo Main Office

2. Renovation example of large scale office.

2.1. Building outline.

This is existing low-rise building of seven stories in Tokyo. As of 2019, 15 years have already passed since the construction of the new building in 2004. In those days social "environmental consideration" and "sustainability" began to be demanded for architecture, and also this plan was designed with the following

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points as the main concept.

- Construction of high-sensitivity, high-quality workplace
- Reduction of environmental load
- High level integration of building, structure and facilities.

It is a building that acquired S rank as a permanent large-scale office building of CASBEE which is an evaluation index of environmental performance. This is the first case in Japan.This time, we carried out renovation work to create new values and productivity improvement". Furthermore, it is aimed to acquire the certification of WELL Building Standard, and we introduce what kind of efforts are done for each main evaluation item in this renovation.

2.2. Improvement of air quality,

2.2.1. Introduction of total smoking ban.

In order to improve the air quality environment in the building, we decided to abstain from smoking in the whole building. We abandoned the smoking room which had been located on each floor, and established a smoking area on the outside of the building instead. The smoking room up to now has been ventilating with machinery, but natural ventilation is done by installing it outside.



Figure 3. Smoking area



Figure 4. Bamboo grove in front of smoking area

2.2.2.Introduction of CO2 control.

In conventional air conditioning equipment, CO2 control was not introduced. And we only confirmed the CO2 concentration by measuring the indoor environment once every two months. In this time we introduced CO2 control and made it possible to set indoor CO2 concentration from central monitoring. Currently it is operating at 800 ppm setting. In addition, the current internal CO2 concentration is displayed in real time on the in-house website, and employees can confirm it at their own seats.

2.2.3.Introduction of high-performance filters.

In order to reduce VOC in the room, activated carbon filters were installed in the air conditioner. And medium performance filters corresponding to MERV 14 were installed in the Outdoor-Air Processing Unit to remove PM 2.5. In order to install these on the pre-filters or medium performance filters which had been installed so far, it was necessary to remodel the filter installation space of air conditioner. In order to install the activated carbon filter without modifying the existing air conditioner and outside air treatment air conditioner this time, we have created and introduced medium performance filters (equivalent to MERV 14) and activated carbon filters those size are same as the existing medium performance filters with the cooperation of the manufacturer. Regarding the increasing filter pressure loss, we created as low pressure loss as possible and introduced it within the adjustment range of existing fans.

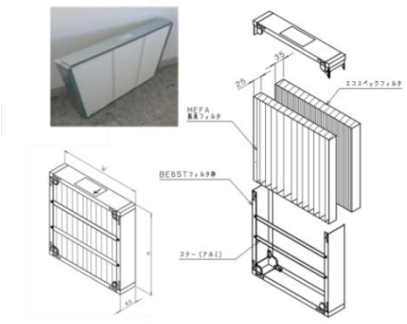


Figure 5. Improved filter

2.2.4.Control of the invasion of pollutants.
In order to prevent invasion of pollutants from the outside, functional entrance mat is installed in the wind shield room. This will drop any dirt such as mud, sand, dust, snow, rain that adheres to the shoe sole at the entrance to clean the environment inside the building.



Figure 6. Entrance mat

2.3.About foods

2.3.1. Reliable intake of fruits and vegetables.
To promote the intake of fruits and vegetables at the company cafeteria, fruit and vegetable corners were placed at the beginning of the food supply line. Also, in order to enrich the menu of fruits and vegetables, salad bar has also begun offering. Even at convenience stores in the building, we are trying to promote the intake of vegetables and dietary fiber by arranging a banner on the ceiling, placing salads and fruit packs at the height of the line of sight.



Figure 7. Salad bar in cafeteria

2.3.2. Transparency of nutrition.
At the company cafeteria, nutrition information, ingredients, etc. are displayed on the menu board. The total calories and weight indication of protein, fat, carbohydrates necessary for the day are also started to be provided. Also at the convenience store in the hall, we have started countermeasures such as provide knowledge of trans fatty acids on the walls, display of attention (poster) on taking too much sugar, detailed information can be obtained by QR code for part of selling items such as over-the-counter cooked goods.

2.3.3 Allergy substances - Implementation of component labeling –
The ingredient list is displayed in the menu table or packing so that the food purchaser can know whether allergic substances are contained at the time of purchase.

2.*4. Active building*

2.4.1. Environment where seats can be chosen (ABW).
We introduced ABW to select own working environment according to mood and work of the day. The furniture were installed in a layout that considered walkability, accessibility and creating worker's hangouts. On the operational side, we are also making rules such as thoroughly clearing desk at the time of returning home and not sitting on the same seat continuously.

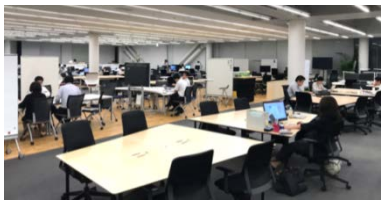


Figure 8. Layout for ABW

2.4.2. Promotion of health education.
We recommend employees to use health management tool "KenCoM" for the purpose of enhancing knowledge and information utilization on health. This application has a function to distribute recommendable health news according to personal health condition and display change graph such as weight and blood pressure, and so on.



Figure 9. Health management tool "KenCoM"

2.4.3. Height adjustable furniture.
Monitors were introduced that allows the user to adjust height and horizontal distance. And desks of 25% of the total are adjustable in height.



Figure 10. Height adjustable furniture

2.4.4. Promotion of employee activities.
We put a table tennis table in the space of 7F. And the central stairway of the building was designed with a sense of openness from the initial plan, but in this time, we are encouraging proactive use of this stairway with bulletin boards

2.5. *Indoor environment (light, noise, thermal comfort, material)*

2.5.1. Thermal environment monitoring.
To make it possible for employees to grasp the real-time information of the temperature / humidity sensor installed in the room, a temperature and humidity display monitor screen was created on the in-house WEB. By doing this, each employee can grasp how the environment of the building is.

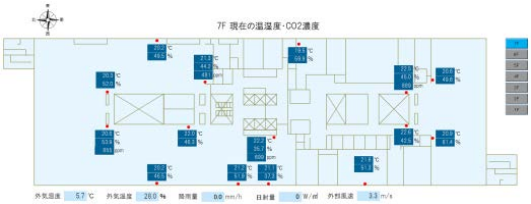


Figure 11 . Map of temperature and humidity

2.6. *Consideration for mental*

2.6.1. Promotion of mental health literacy.
The counseling room was set up in the clinic in the building and employees are able to receive counseling by specialized counselors. And we have introduced a system that allows employees to check the degree of fatigue accumulation using websites. In addition, the system has partnered with the Depression Center of Japan and makes it possible for employees to receive "mental health consultation".

2.6.2. Provide access to nature.
As a place where employees meet "green" and emerge, we renovated the area used as the office space to a work lounge space called "KOMOREBI". It is set as a place for anyone to use, such as the office space of the department that adopts ABW, the meeting of small number of people, the touchdown space for outside workers. In addition to the work lounge, plants are put on various places so that green continues to be in sight.



Figure 12.KOMOREBI

2.7. *Others.*

2.7.1. Response to diversity.
Although it does not correspond to the evaluation item of the Well Building Standard, we are planning the following as a diversity response in recent years.

- Individual toilet that can be used regardless of gender
- Multipurpose toilet for wheelchair installed on each floor.
- "Komachi Room" is planned as a exclusive space to support working women. That can be used for many purposes, such as resting with poor physical condition, milking during childcare, changing clothes for a short time.
- A prayer room that has prepared necessary arrangements for prayer, such as a water field and a shoes removal place as Muslim correspondence.

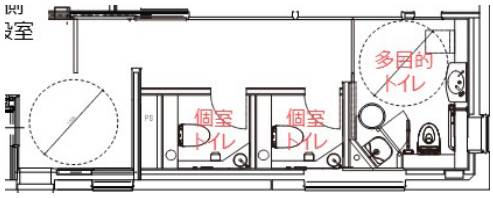


Figure 13. Toilet that anyone can use



Figure 14.
Komachi Room

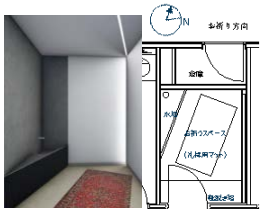


Figure 15.
Prayer room

3.Rebuild example of dormitory for singles.

3.1. Building outline.



Figure 16. TAKENAKA CORPORATION dormitory for singles

Construction area: 2,461 m ^{2}
Total floor area: 6,174 m ^{2}
Structure: RC ,Steel flame
and base isolated structure
Number of floors: 3rd floor
Completion Date: July, 2019

Figure 17. Building outline

As part of client company's 120th anniversary project, we are currently undertaking rebuild project of single dormitory In Kobe City, Hyogo Prefecture for new recruits, which is the spiritual origin of employees. The former single dormitory was completed in June 1960 as a training dorm accommodating all new recruits. The purpose of this building was "to train mind and technology" and "to cultivate rich empathy" as "a place for mutual study". The event noteworthy in this dormitory history is the Great Hanshin-Awaji Earthquake that occurred on January 17, 1995. At that time, 180 new recruits rescued 80 people based on this dormitory, and also conducted nursing care and fire fighting activities for injured people. In addition, the dormitory was opened as a shelter of the local residents for half a year, and contributed greatly to restoration of the area. The new dormitory aims to become "a education dormitory for people who create a new future," following the history and traditional spirit. In addition, it is planned with consideration for physical and mental health, safety, and environment.

3.2. Planning.

3.2.1 .Change of shared room system

This dormitory is a site for the growth of residents through a one-year communal life and communication with friends. And this is a place of departure to the each future that they envisioned. Depending on the number of female employees and the needs of the times, we changed the dormitory system, which is the tradition of this dormitory, and changed all dormitory rooms to private rooms. However, we aimed for a plan to promote interactions while ensuring the privacy of residents

3.2.2 . Promoting communication.

We settled 10 dorm rooms as a group of "clusters" and planned a shared "cluster living" in the center. And by sharing the utilities such as the toilet and the washbasin located in the shared section, we try to increase the opportunities for residents to meet each other naturally. Furthermore, a shared space which we named "concept living" such as a stairway and a shared kitchen and a library is arranged for each of the four clusters, to promote communication between the upper and lower floors.

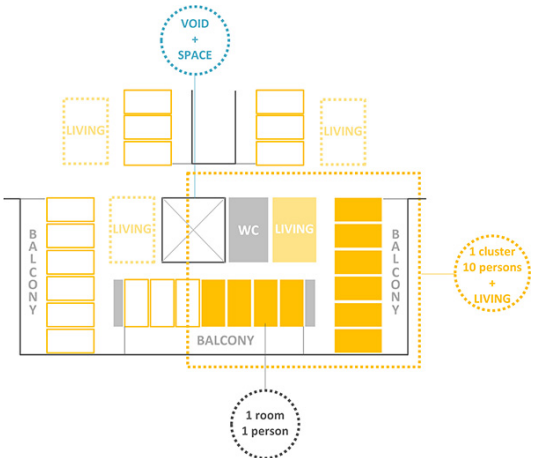


Figure 18. Concept diagram

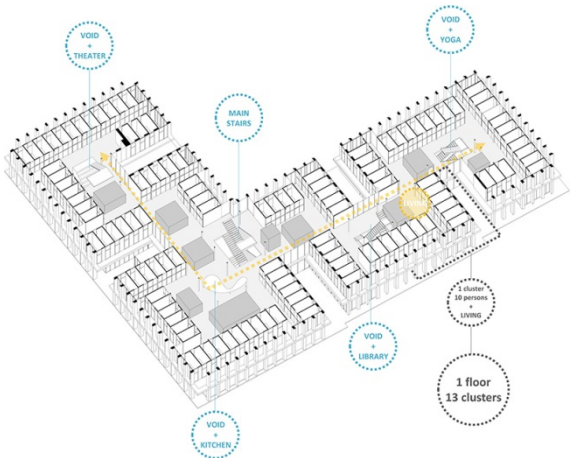


Figure 19. Reference floor axonometry drawing

3.2.3 . Relationship with the surrounding area.
In the outside structure, we eliminate the fence so that it gradually connect with neighborhood through planting. And we promote wide-ranging communication including neighboring residents.

3.2.4 . Learning to create an optimum environment - Education dormitory as a teaching material –
We designed this building with the following concept , living in the dorm itself gives a chance to think about creating the optimum environment for residents, and it becomes a teaching material of the latest technology. Regarding the living environment, we arranged various locations such as cluster living and concept living so that residents can spend a rich time. And the dormitory room and the balcony with the eaves arranged on the outer side play the role of the middle area, so the common area inside the building becomes a comfortable and stable environment. Furthermore, we will create a comfortable space from a wide range of perspectives such as air, water, nutrition, light, exercise and mind, and realize the mentally and physically health and rich life of the residents. Finally we are aiming for Japan's first acquisition of "WELL Building Standard" in residential construction.

3.2.5 . Introducing technology.
Regarding equipment control, we use the latest sensing technology such as microwave Doppler sensor and infrared array sensor, and perform automatic control of lighting and air conditioning corresponding to the activities of the residents. At the same time information on personnel density obtained from the sensor will be displayed on the signage as "bustle degree map", thereby inducing communication. In addition, "energy saving support system" which urges the natural ventilation of the common area by sign, leads the dormitory student himself to open the window and leads to create a comfortable environment. On the construction side, we planned the living space itself to be a learning place for new employees of construction companies by not setting the ceiling and making the equipment visible.

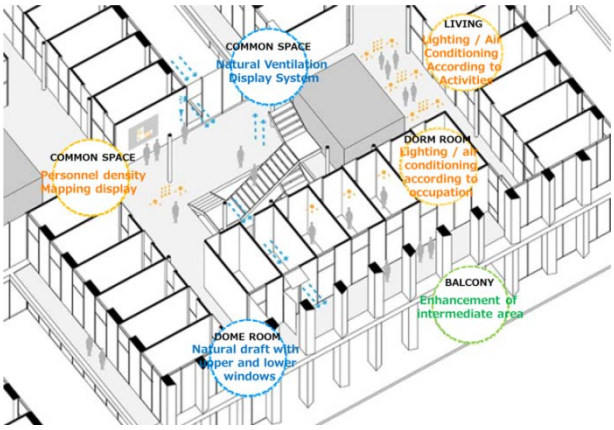


Figure 20.
Support technology for energy conservation awareness improvement

3.2.6. Establishment of special room for sleeping.

Collaborative research [1,2,3] with universities and air conditioning equipment makers is underway with the aim of establishing a sleep specialized room "wellness room" as a place for residents to learn their own health condition and sleep rhythm and learn optimal lifestyle . A sleeping space wrapped in a "canopy membrane" that separates bedding is a basic policy, suppressing the airflow feeling and making it a pseudo radiation low air conditioning. In addition, sleep depth is estimated from body motion information obtained from a non-contact sensor such as an image sensor, and the information is utilized for equipment control such as air conditioning and lighting. At the same time, we are considering establishing a system that judges sleep quality by comparing with the normal sleep database accumulated by the university and feeds back to the user. We can not implement this wellness room at the completion, but we are planning to introduce and operate it within the two years. We will develop a health education program including plan to utilize the wellness room. And we would like to encourage the active behavior change of the dormitory students who will take on the new future.

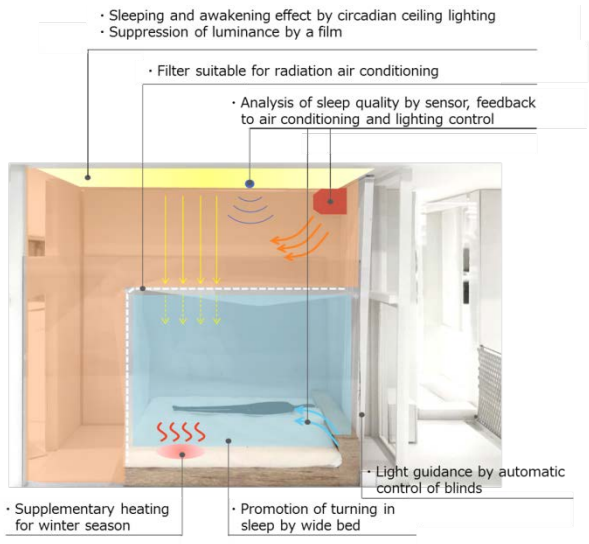


Figure 21. Wellness room image diagram

3.2.7. Superlative safety technology supporting the dormitory life and region.

From experience of the Great Hanshin-Awaji Earthquake, we will introduce new seismic isolation system in order to protect the life of the residents, and to act as a disaster prevention center in the region at the time of a disaster. This system is a structure that exerts the seismic isolation effect in a wide range from a small scale to a huge earthquake which was difficult in the past. At the time of a medium-scale earthquake, friction elastic sliding bearings function reduces seismic forces, At the time of a huge earthquake, the multilayer rubber bearing with sliding mechanism "QTB" functions, thereby preventing the increase of the seismic force. By doing this, we will protect the lives of the residents and realize the highest level of safety as a disaster prevention center in the area. Through these efforts, we will contribute to the realization of a safe and plentiful future including the surrounding regions.

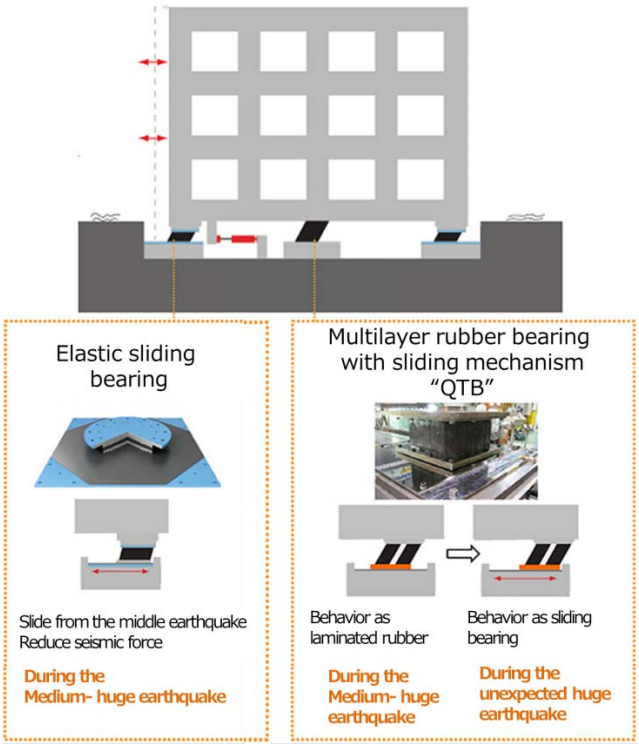


Figure 22. Conceptual diagram of seismic isolation system

4.Renovation example of small-medium scale office.

4.1. Building outline.



Figure 23. TAKENAKA CORPORATION Higashikanto Branch Office

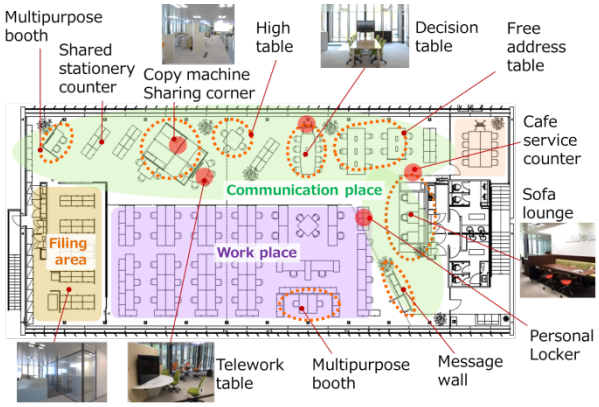


Figure 24. Office planning

This building is a two-story existing medium-sized office building in Chiba Prefecture. This renovation work was designed aiming for "office that arrows workers to pick a place according to their own activities" instead of "office fixed to own seat". And we reconsidered comfort and intellectual productivity according to human work mode. We are introducing the following technologies to improve comfort.

Construction area: 680 m ^{2}
Total floor area: 1,318 m ^{2}
Structure: Steel flame
Number of floors: 2nd floor
Completion Date: November 2003
Renovation work: October2015 – March

Figure 25. Building outline

4.2. Smart working.

To create a place for various tasks and meetings, we set up various work spots in the communication area of office. We planned office choosing a workplace according to own activity and avoid "traditional fixed office". In addition, we moved away from "paper principal" and moved to "collaborative work using large monitors". The paper stock was compiled and compressed, and separated from the work area. By doing this we have made a change to the 'walking office'. By setting various environmental differences in the office, the work mode changes. For example, the desk work area is set to make lighting and air conditioning suitable for office work, and the communication area plans to positively utilize natural ventilation and natural lighting. By changing the environment according to the work mode, we intend to create new ideas and improve intellectual productivity.

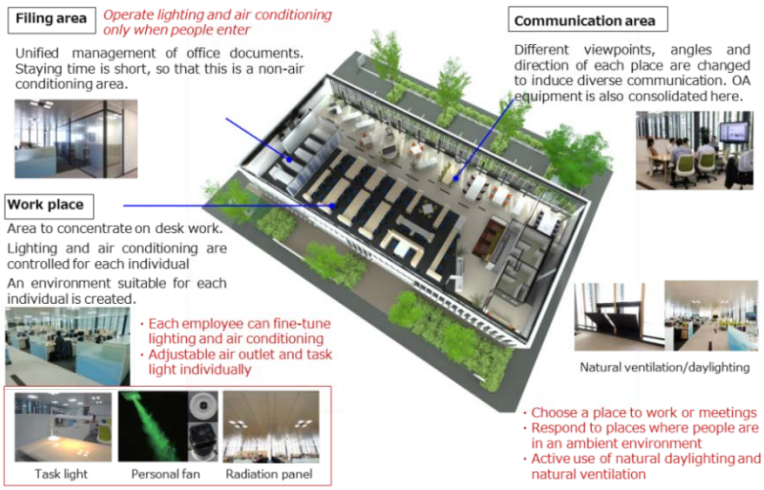


Figure 26. Concept diagram

4.3. Wellness air conditioning system.

In order to respond to comfort with individual differences, comfort indicators of each individual are corrected and learned from various information such as the position of the worker, each thermal environment obtained from each sensor and physical sensation declaration of the worker. Then, based on the indicators, we constructed an air conditioning system [4] that controls the personal airflow unit and the setting value of the room temperature. Wellness control has three air conditioning functions reflecting the following.

- Acquisition of environmental information
- User's declaration of physical sensation
- Air conditioning control reflecting the declaration of individual

First, a beacon signal set at each individual seat and each part of the shared area are acquired by a smartphone through Bluetooth to specify the user's position information. At the same time, it acquires the thermal environment to which the user is exposed from information of the sensor related to the place. Also, grasp the metabolic rate with smart watch and smartphone, calculate PMV and use it for air conditioning control. We investigated the influence of this wellness air conditioning on the thermal sensation and satisfaction of office workers.

In order to investigate the influence of this wellness air conditioning on the thermal sensation and the degree of satisfaction of the officer, a subjective evaluation questionnaire was conducted[5]. It was confirmed that the satisfaction level improved in case of performing the wellness control, and when the degree of thermal satisfaction was high, the productivity also tended to be high. It is suggested that the wellness control indirectly contributes to productivity improvement.

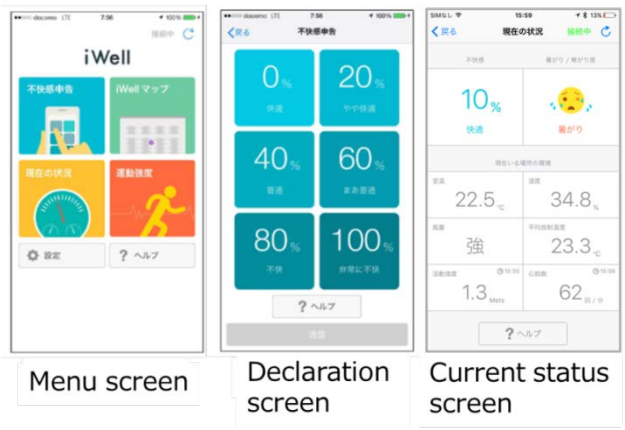


Figure 27. Application screen

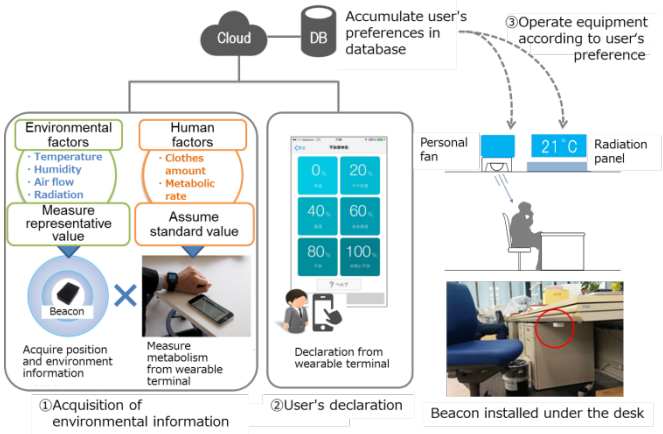


Figure 28. Concept diagram of wellness control

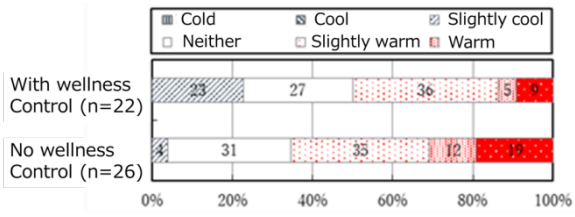


Figure 29. Comparison of thermal sensation

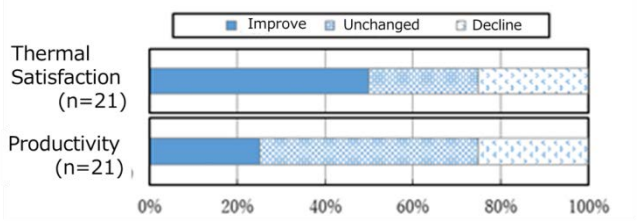


Figure 30. Difference in thermal satisfaction and productivity by subjective evaluation

5.Summary

In the case of a large-scale office building we introduced case examples of each evaluation item targeting certification of WELL Building Standard.

In the case of a new dormitory, we introduced the outline of the plan aiming to be "educational dormitory for people who create a new future", and each technologies aimed at acquiring WELL Building Standard.
In the case of a small-medium scale office, we reported cases of renovation with the aim of improving comfort and intellectual productivity. We showed office layout aiming for smart working and outlines of wellness air conditioning system aiming at improvement of satisfaction and productivity.

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