Evaluation of Lighting Performance and Daylight Factor of student working space with case study in The University of Kitakyushu building

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sbcc 2024

International Symposium and Workshop on Sustainable Buildings, Cities, and Communities
"Building Low Carbon Future: Decarbonizing with Impact"

Introduction

- Productivity and well-being are affected by the condition of the computer room. In this case, lighting becomes a crucial factor in optimizing user room conditions.

- Illuminance, the amount of light in a specific area, is crucial for work environments. It directly influences visual tasks, safety, and well-being. It highlights the level of illumination, giving design impact along with the influence of operational and non-visual elements of the room. Effective lighting strategies contribute to improved comfort and health, influencing positive or negative moods in educational settings. Particularly in stimulating motivation and fostering creativity among students.

- The daylight factor represents the ratio of light inside and outside a structure and is crucial in workspace design. Architects and engineers consider it to determine natural light accessibility, influencing electricity usage and energy expenses.

LITERATURE REVIEW

- Students often use mood to perform their work or tasks. Moods in the workplace (positive or negative) are also associated with influencing creativity. Good mood stimulates motivation and improves focus, which fosters creativity[1]

- The University of Kitakyushu is located in a zone called Kitakyushu Science and Research Park (KSRP). With the goal of lowering its environmental impact, this building is actively creating a system to optimize its usage of waste-free water and energy use, as well as natural energy sources including light, wind, and heat[5].

- For Daylight factor (DF), is calculated as[2][3]:

$$DF = \frac{E_1}{E_0} \times 100\%$$

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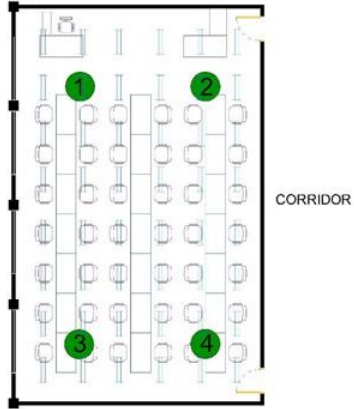
Method

Figure 1. CAD Room 1 Floorplan
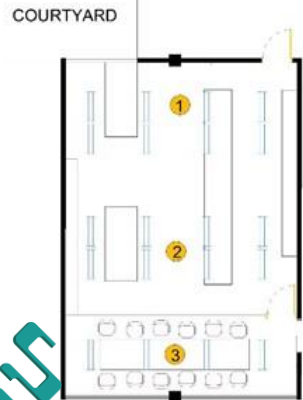

Figure 2. N-312-3 Floorplan

Figure 3. Illuminometer (left) and Direct Sunlight Block (right)

Table 1. CAD Room 1 experiment pattern

	Lights	Curtain Downer	Curtain Opener	Outside (Average)
A	Off	Down	Half open	Yes
B	Off	Up	Open	Yes
C	On	Down	Closed	Yes

Table 2. N-312-3 Room experiment pattern

	Lights	Curtain Deck	Curtain Courtyard	Outside (Average)
A	On	Close	Close	Yes
B	On	Close	Open	Yes
C	Off	Open	Open	Yes
D	Off	Close	Close	Yes
E	Off	Half open	Open	Yes
F	Off	Close	Open	Yes
G	Off	Open	Close	Yes

Methodology in research data processing is carried out with a quantitative approach with 2 activities,

- Measurement, by measuring natural and artificial light in CAD Room 1 and Room N-312-3 using tools such as Illuminometer and Direct Sunlight Blocking. These tools are strategically placed indoors to measure light in lux. This tool plays an important role in clear data acquisition, data collection, and engagement with emphasized experimental patterns.

- The questionnaire, by giving questions to users in both rooms, captured demographics, computer usage patterns, and subjective experiences with lighting conditions. This data aims at making decisions and recommendations in creating a more comfortable and conducive environment in the CAD room according to user needs and preferences.

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Result and Discussion

CAD Room 1, there are 3 patterns in the room. Pattern A gets natural light, then Pattern B which is far from light, and Pattern C with the help of lights. These three patterns will be compared with the Illumination Vector and Daylight Factor

- Illumination Vector, in measurements with illumination standards, Pattern A does not get a single point that meets the illumination standard. Then Pattern B only gets a few spots near the window, while the light on Pattern C is also not enough for this room.

- Daylight Factor, by comparing Patterns A and B as it uses natural light with a minimum average of 5% for daylight. Pattern B can meet the standards of points 1 and 3, while Pattern A is far below the standard which proves that some areas need additional light.

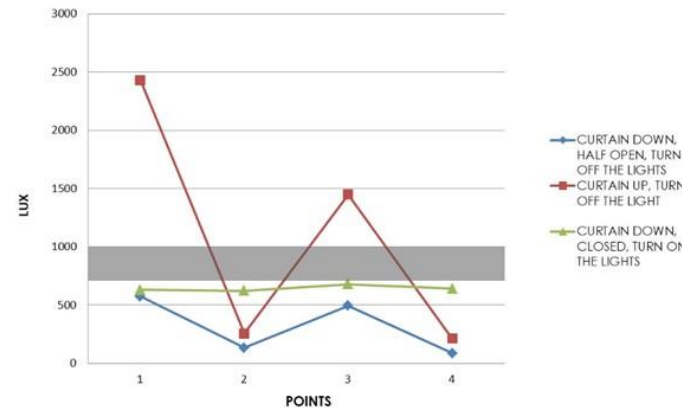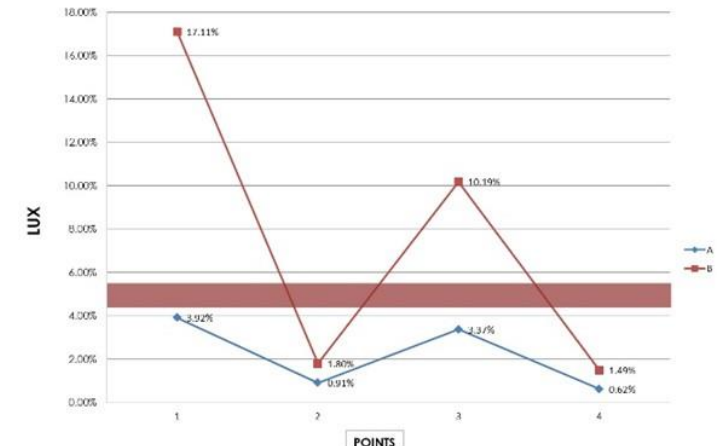| Table 3. Measurement result CAD Room 1				
	1	2	3	4	Outside (Average)
A	573	134	495	92	14650
B	2430	256	1448	212	14200
C	631	631	679	642	14350

Figure 4. Illumination Vector CAD Room 1

Figure 5. Daylight Factor CAD Room 1

Result and Discussion

Room N-312-3, there are several variants of the pattern. However, the pattern that gets the highest lux is Pattern B when using both additional light and natural light. Then the lowest pattern is in Pattern F, the condition when the lights are turned off, the curtain deck is closed, and the courtyard curtain is opened.

- Illumination Vector, with illumination standards there are 3 points that reach it. Both using natural and artificial light. But when the lights are turned off, none of the patterns reach the standard. As for Pattern C, it only reaches the standard when all curtains are opened.

- Daylight Factor, with a standard factor of about 1.5% - 2%, points 1 and 3 have met the standard, only 2 less and only get 1%. So that area is more suitable for simple visual tasks or short time medium visual tasks.

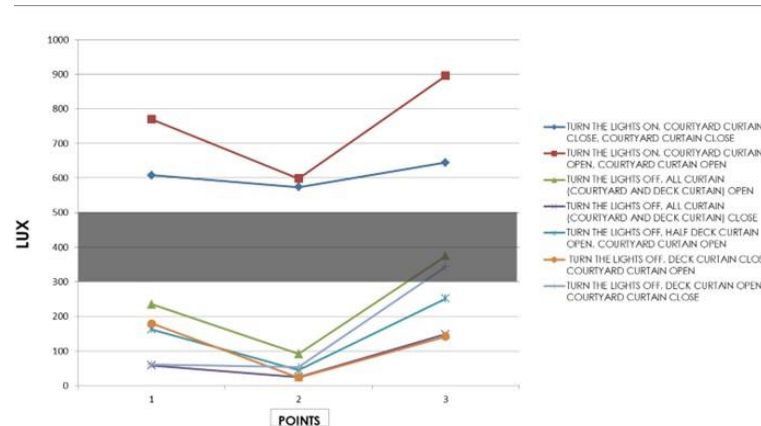| Table 4. Measurement result N-312-3 Room				
	1	2	3	Outside (Average)
A	608	574	645	9710
B	770	599	869	9800
C	235	92	375	9810
D	585	24	149	9780
E	163	45	252	9760
F	179	23	143	9820
G	610	54	344	9815

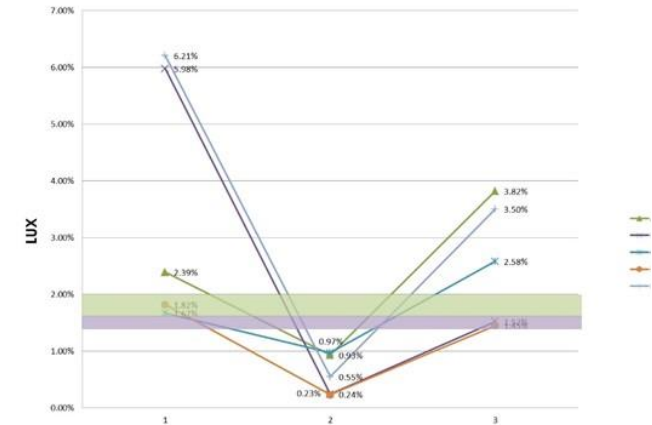Figure 6. Illumination Vector N-312-3 Room

Figure 7. Daylight Factor N-312-3 Room
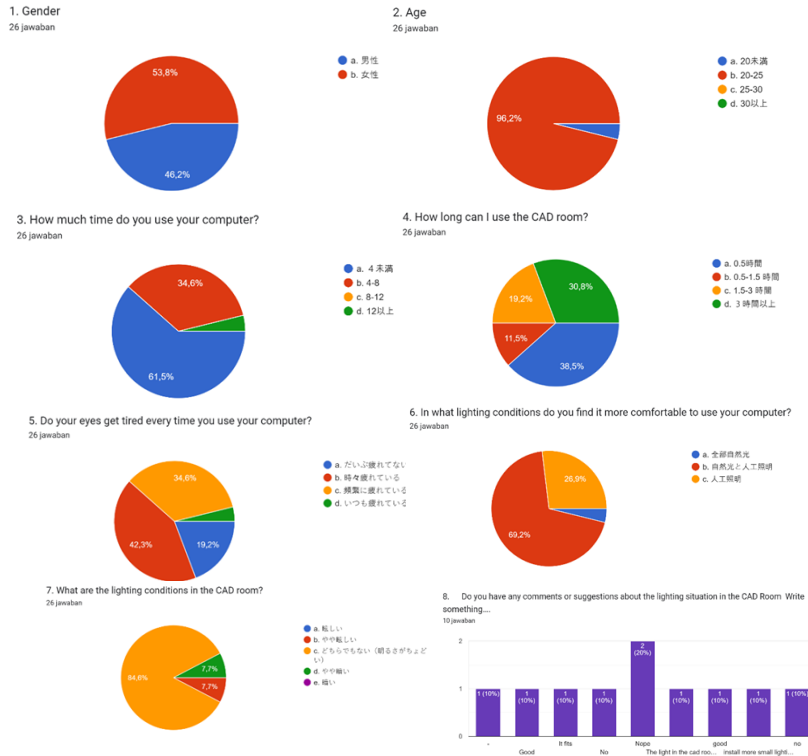
Result and Discussion

Figure 8. Questionnaire Result

Questionnaire Results

- Respondents according to gender, namely Women amounted to around 53.8% and Men around 46.2%. With an average age of about 20-25 years.

- The average respondent's computer usage was more than 4 hours by number, and the duration of using CAD 1 room was at most 0.5 hours.

- Most respondents said they were sometimes tired of using computers, and the rest often felt tired. Then the majority of respondents are more comfortable using lamps and natural light than lamps alone.

- Respondents' answers to the lighting in CAD Room 1 tended to be normal and only slightly bright. Then they also ask that they raise the light and adjust it to the use of space, besides that some of them have no problem and feel enough. The advice given by respondents for CAD Room 1 is to provide several types of lighting, including warm task lighting and indirect lighting.

Conclusion

- CAD Room 1 has one side equipped with windows and curtains, so the strategic location is only in a few places. Although this room still requires additional light even though there is natural light, this room is a room suitable for doing long-term precision tasks.

- N-312-3 Room has two sides of natural light sources so it has a strategic and also least strategic point of place. This room is suitable for conducting meetings, writing on blackboards and reading and health consultations.

- These two rooms need more attention in terms of the distribution of lights on and off by row, so that rows that already get natural light during the day can be turned off and turned on as needed to optimize energy use.

- The University of Kitakyushu students mostly use CAD Room 1 with a duration of more than 4 hours. With the majority stating they are sometimes tired of using computers, they are comfortable with the use of natural and additional light simultaneously. Then they suggest giving additional light to CAD Room 1.

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