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Author(s)	李, 知恒
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氏　　名	LI, Zhiheng		
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論文題目	Research on the mathematical model about the influence mechanism of indoor environment on researchers' comfort and productivity		
論文審査委員	KIM, Eunyoung (main examiner)	JAIST	Assoc. Prof.
	KOHDA, Youji	JAIST	Professor
	YUIZONO, Takaya	JAIST	Professor
	GOKON, Hideomi	JAIST	Assoc. Prof.
	GEORGIEV, Georgi	Oulu University	Assoc. Prof.

論文の内容の要旨

With the development of society, the core of modern work has gradually shifted from the manufacturing industry to the knowledge-based departments in indoor office environments. In line with the foregoing, indoor environment quality is an important indicator of the status of the indoor environment. It not only reflects the comfort level of the researchers in the building but also affects their performance, particularly in research institutions. However, due to the inherent correlation among various environmental comfort indexes, it is difficult to evaluate the influence of specific environment physical parameters on researchers' comfort and their research performances. Therefore, the main objective of this paper is to develop a mathematical model that would determine the relationship between environment physical parameters and research performance.

This study was based on an experiment carried out at a controlled research office in a pharmaceutical research company located in the northeast of China. The controlled research office was equipped with a radiant floor heating system that supplied heat in winter. A total of 32 researchers were recruited and divided into four experiment groups. Each experiment group was required to conduct daily research activities under 12 different environment conditions. Data were collected from physical environment measurements, subjective questionnaire surveys, and performance tests.

The results showed that changes in the thermal, visual, and acoustic environments had significant influences on the researchers' environmental perceptions and satisfactions. Moreover, the environment physical parameters exerted significant impacts on the researchers' response times in the performance tests and, consequently, had significant effects on their research performance. For the influence weight of the items under environmental comforts, thermal comfort had the highest weight, followed by visual comfort. Meanwhile, acoustic comfort had the least impact. In addition, there was a positive correlation among the thermal, visual, and acoustic environments.

This paper also developed a mathematical model for evaluating the researchers' performances based on the indoor environment physical parameters. In order to establish the mathematical model, the improved environmental comfort index was obtained by enhancing the three existing mathematical models. Based on a factor analysis of environment comfort, the weight of each comfort index was obtained. Finally, through a nonlinear regression analysis between the performance index and the indoor environment quality index, the relationship between research performance and

environment physical parameters was obtained.

Keywords: *Indoor environment quality, environmental comfort, environmental perception, environmental satisfaction research performance*

論文審査の結果の要旨

Recently, the importance of indoor environments has been increased tremendously and it needs to understand how the indoor environments such as temperature, light, noise level effect on our comfort and performances. This research developed a mathematical model to predict the researchers' performance based on the actual data collected in the winter season (13th Jan. – 1st Mar. 2021) from 32 participants who works in a research office in Northeast of China.

To develop a model, it reviewed and compared the widely used models in existing research with the collected data, and established the adjusted model with the improved environmental comfort index obtained by enhancing the three existing mathematical models. Based on a factor analysis of environment comfort, the weight of each comfort index was obtained. Through a nonlinear regression analysis between the performance index and the indoor environment quality index, the relationship between research performance and environment physical parameters was identified.

Finally this research suggest the value range and interval for different environmental variables: 1) Temperature: 20°C, 22°C, 24°C, 26°C, 28°C, 30°C ; 2) Illuminance level: 50lux, 200lux, 500lux, 1000lux ; 3) Background noise intensity: 45dB, 60dB, 70dB.

The model developed in this research can be applied and modified in further research in different environment. Thus it has both theoretical and practical contribution in the area of human and environment for enhancing our quality of life.

In summary, this is an excellent dissertation and we approve awarding a doctoral degree to Mr. LI Zhiheng in March 2022. All the committee members approved it on his final defense on Feb 2nd 2022.