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RESEARCH BRIEF 2007

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PRODUCTIVITY AND INDOOR ENVIRONMENTAL QUALITY (IEQ)

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BACKGROUND

Office work is one of the greatest contributors to the new economy, thus, it is important to understand the impact of indoor environmental quality on office productivity. This research examines the effects of two main indoor environmental determinants, i.e. the room air temperature and the fresh air provision, on workers' perception, health-related matters and performance within the tropical region.

RESEARCH OBJECTIVES

The objectives are:

1. To determine the impacts of thermal environment and fresh air provision on the actual work performance in the offices in the tropics.
2. To identify the plausible mechanisms linking the indoor environmental factors and the performance outputs through the perceptual responses and the reported Sick Building Syndrome (SBS) symptoms of the tropically-acclimatized people.

RESEARCH METHOD AND DATA ANALYSIS

Controlled blind intervention studies were conducted in three call centers in Singapore. In order to study the main effects of room air temperature or fresh air provision, a 2x2 balanced experimental design was applied in each call center for nine consecutive weeks. Interventions to either room air temperature or fresh air provision rate were carried out on a weekly basis.

Data on call handling performance (talk time as the performance metric) of the office workers, whose primary task was to answer customer inquiries through the phone, was recorded daily. Questionnaires on the indoor environmental perceptions and the intensity of SBS symptoms were distributed on Thursdays – once in the morning and again in the afternoon. Principal component analysis and non-parametric procedures were used to analyze the subjective data obtained from these surveys. Statistical analysis for repeated-measures were applied for testing whether, and to what extent are the differences in call handling time under the various exposure conditions. Arising from the percentage of performance increments, cost-benefit analysis was performed to determine the productivity gain of improving the indoor environmental quality.

MAIN RESULTS

Effects of room air temperature

Lowering room air temperature from 24.5°C to 22.5°C was perceived as slightly cool and more comfortable by office workers in their normal office attires with jacket (>0.6clo). Acceptability of the air quality was higher, dryness symptoms intensity was reduced and the neurobehavioral-related (central nervous system) symptoms intensity was lower at 22.5°C. These positive effects were accompanied with improved call handling performance by the office workers.

The mixed model analysis of talk time revealed that the office workers reduced their talk time by 5.7% during each call when exposed to the cooler environment. The estimated benefit to achieve this optimum condition exceeded the costs by a factor of 17.0 based on nominal estimates of average wage rate, capital costs of equipment and energy. This translates to an annual savings of approximately 0.7 billion USD for the Singapore service sector.

Effects of fresh air provision

Doubling fresh air provision led to the following positive effects: lower intensity of neurobehavioral-related symptoms, better acceptability of air quality and air freshness, lower intensity of odor, and reduced irritation to the nose and throat. The advantage of increasing (doubling) the fresh air provision diminishes at higher outdoor air supply rate (Figure 1).

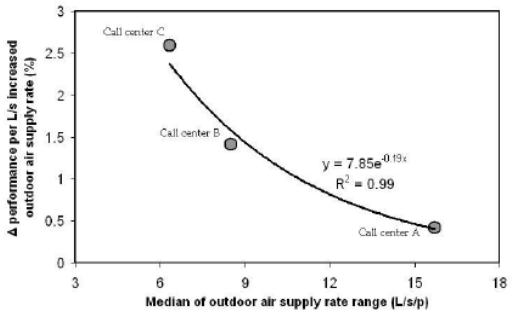

Figure 1 Performance changes as the function of outdoor air supply rate ranges

Doubling fresh air provision could improve talk time between 5.1 to 10.9% during each call. Based on data taken from an office, the estimated benefit could potentially exceed the costs by a factor of 36.0, which is equivalent to an annual saving of approximately 1.1 billion USD for the Singapore service sector.

PLAUSIBLE MECHANISMS

In the call centers, simultaneous tasks handling such as information search, data processing and responding to customer query could be impaired without sustained attention and mental alertness. Our results indicated that a more comfortable thermal environment, achievable through a slight reduction of room air temperature, may promote better perception and lowered the intensity of some SBS symptoms, and thus, optimize the abilities to work. Similarly, we also observed that higher fresh air provision, as a proxy indicator of reduced indoor air contaminants level, lowered the intensity of neurobehavioral-related symptoms and improved perceptual responses. Detailed evaluation of relevant physiological indicators, such as skin and lung/ respiratory responses, towards the indoor environmental parameters should be conducted in the future studies.

CONCLUSION

Work performance of tropically acclimatized office worker in the real office settings is improved by reducing room air temperature from 24.5°C to 22.5°C and/or doubling of the outdoor air supply rate. The projected economical gain is very substantial if these conditions are achieved and maintained. Mechanisms of the occupants-indoor environment interactions have been postulated and proposed for further research.

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