

# To study the Relationship of Thermal environment on Productivity of employes in Ludhiana

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## Abstract

Indoor temperature is one of the fundamental characteristics of the indoor environment. The indoor temperature affects several human responses, including thermal comfort, perceived air quality, sick building syndrome symptoms and performance at work. India has extraordinary climatic regions that range from tropical to the south region and the Himalayas experience alpine climate. Ludhiana experiences minimum temperatures above 27 °C (81 °F) for more than two months. The annual average temperature in the entire state is approximately 21 °C (70 °F). Further, the mean monthly temperature range varies between 9 °C (48 °F) in July to approximately 18 °C (64 °F) in November. The present study is an attempt to probe into the effect of indoor temperature on productivity of employees working in Ludhiana. total of 250 employees from various offices of Ludhiana were recruited as sample. The age range of the sample was between 25 to 50 years. The questionnaire for the study contained 44 total items pertaining to employees' general demographics and satisfaction with thermal, acoustic, and lighting conditions. Results support that employees productivity is positively correlated with satisfaction with temperature level in the office. The finding suggest that more attention could be focused on the thermal environment in commercial buildings to improve occupant satisfaction with their working environment.

**Key Words:** environment, temperature, perceived satisfaction, correlate, Design, Built environment

## Introduction

Air temperature is the commonly used indicator of thermal environment in IEQ and productivity research. One of the very first attempts to create the relationship between temperature and performance was made by Wyon (1986), and was based mainly on his experimental studies; the relationship differentiated between effects in summer and in winter (depending on clothing), as well as between effects for different type of work. The relationship showed that both elevated and too low temperatures have negative effects on performance of office work.

Increased evidence shows that indoor environmental conditions substantially influence health and productivity. Comfort and productivity loss of 15% was reported due to thermal conditions (Kosonen et al., 2004). There is some evidence that high temperature (> 25.4 C) is associated with lower work performance.

In general, warmer temperatures above 24.5-25.4 °C induced a decrement in performance. Over the years several studies have investigated the effects of temperature on performance and productivity of the employees (Loftness et al., 2003; . Wyon et al., 2004; Tham , 2004; Nezar, 2006; Wargocki et al., 2007; . Zalejska-Jonsson and Wilhelmsson , 2013) Raised temperature increased eye, nose and throat irritation, headache intensity, difficulty in thinking clearly and concentrating, and decreased self-estimated performance (Wyon et al., 2004).

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## Methodology

### Sample

A total of 250 employees from various offices of Ludhiana were recruited as sample. The age range of the sample was between 25 to 50 years. The employees who were working for the last three years in a particular organization were considered for inclusion in this study. The minimum educational qualification of the selected subjects was graduation. The research took place approximately three year post-occupancy to eliminate effects related to occupants being satisfied with the building because it was new and different (Franke & Kaul, 1978). The minimum educational qualification of the selected subjects was graduation.

### Questionnaire

The data collection instrument for this study was a structured questionnaire developed by the researcher with the help of experts. The questionnaire is adapted and modified version of already existing scales of occupants' satisfaction with indoor environment quality (IEQ) components of other buildings by different researchers. The questionnaire items were developed to reflect the satisfaction/comfort/productivity components of the office environment. The questionnaire for the study contained 44 total items pertaining to employees' general demographics and satisfaction with thermal, acoustic, and lighting conditions. Thirty-two items of the questionnaire were related to the occupants' satisfaction of the IEQ components of thermal, acoustic, and lighting conditions. They were rated by the occupants based on a five-point Likert-type scale (1= "very dissatisfied" to 5 = "very satisfied").

## Data Analysis

For result findings and in-depth analysis of the different components of office environment on the productivity of the office employees, statistical techniques of correlation has been used. SPSS 16 software as research tool for data analysis was used for this research.

## RESULTS AND DISCUSSION

**Table 1: Descriptive Statistics**

Variables	Mean	Std. Deviation	Respondents (N)
Productivity	3.62	.75	250
Temperature	3.02	.44	250

**Table 2: Coefficients of Correlations between Productivity and Element of Office Design**

Sr. No.	Variable	(r)
1	Temperature	.105**

\*\* Significant at .01 levels

Present study supports that employees productivity is positively correlated with satisfaction with temperature level in the office. The obtained findings are consistent with earlier research (Becker et al., 1983; Wyon, 1996; Niemelä et al., 2002; Federspiel et al., 2002; Seppänen et al., 2003; Tham, 2004; Witterseh et al., 2004; Federspiel, 2004; Seppänen et al., 2005; Danielsson, 2005; Jensen et al., 2005; Pejtersen et al., 2006; Tanabe, 2006). In many commercial buildings, thermal conditions are not controlled well, due to insufficient cooling or heating capacity, high internal or external loads, large thermal zones, improper control-system design or operation, and other factors. Thermal conditions inside buildings vary considerably, both with time, e.g., as outdoor conditions change, and spatially. While the effects of temperature on comfort are broadly recognized, the effects on worker productivity have received much less attention. Previous researches of Lan et al. (2010) and Niemela et al. (2002) which revealed that temperature has an effect as long as the task concerned lasts at least 60 minutes. In one experiment, Lan et al. (2010) found that employees felt slightly uncomfortable in both the coolest and warmest of these climates, that they were less motivated and that they experienced their workload as more onerous, with a consequent decline in productivity. To estimate cost effectiveness based on improved indoor environment, a researcher at Finland's Helsinki University of Technology developed a conceptual model that demonstrates

a decrease in performance by 2% for each degree increase of space temperature ranging between 77°F and 89.4°F. Optimal productivity performance was found to occur at a space temperature of 72°F (as quoted by Salah Nezar, 2009)

### Conclusions

These results suggest that more attention could be focused on the thermal environment in commercial buildings to improve occupant satisfaction with their working environment. So that employees are comfortable in their work environment. Since comfortable employees will be productive work force for the organization thus generating better revenue.

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