

**A STUDY ON THERMAL COMFORT AND ILLUMINATION IN OFFICE
WORKSTATION**

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DISSERTATION

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CANDIDATE'S DECLARATION

*I, here by Declare that the dissertation
or part there of has not been submitted
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or diploma.*

Place : Parbhani

Date : 30/5/2009


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CERTIFICATE-I

Khogare Dadasaheb Trimbak has satisfactorily prosecuted his course of research for a period of not less than two semesters and that the dissertation entitled "**A study on Thermal comfort and Illumination in office work station**" submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any university.

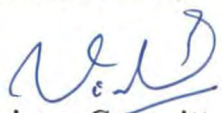
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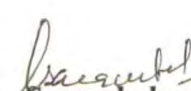

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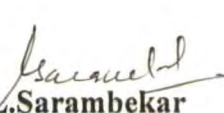
CERTIFICATE-II


This is to certify that the dissertation entitled "**A study on Thermal comfort and Illumination in office work station**" submitted by **Mr. KHOGARE DADASAHEB TRIMBAK** to the Marathwada Agricultural University, Parbhani in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (HOME SCIENCE)** in the subject of **Family Resource Management** has been approved by the students advisory committee after oral examination in collaboration with external examiner.


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Date : 30/5/2009


Khogare D.T.

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INTRODUCTION

Chapter I

INTRODUCTION

The office environment is a combination of lighting, temperature, humidity, air quality and decoration. The office can be a healthy and comfortable place to work in if the correct combination of these elements is maintained.

The thermal comfort and illumination is of utmost importance. The efficiency of the worker is affected by these factors which contribute to the mood of the worker. The discomfort levels of work place lead to many health problems which are normally not taken care off.

Work place is a place where work is done; A place, such as an office or factory, where people are employed, or the work setting in general.

A suitable physical climate is needed if one wants to feel comfortable and efficient at work. The environment feels comfortable when you are barely aware of the climatic conditions. It is only when the temperature decreases or increases beyond ones comfort limits that one become aware of discomfort (John Tofum, 2002).

A comfortable temperature must be maintained (Between 20 - 26 degree Celsius). Office temperature can be localized. The comfort zone is about 20-22°C for a clothed person in the winter, and 20-24 °C in the summer. An increase in temperature above the comfort level may make one tired and sleepy. A decrease in temperature may make one restless and less attentive. People vary in their feelings about what is a comfortable temperature, and this depends on what they are doing and what they are wearing (Peter Hoppe, 2003).

One of the many important factors is the humidity or water vapor content of the air. At all temperatures above freezing water tends to evaporate into the air and the rate of evaporation increases with temperature. Low humidity can cause dryness of the eyes, nose and throat and may also increase the frequency of static electricity shocks. High humidity, above 80% can be associated with fatigue and report of "stuffiness".

According to Engdahl (1998) proper ventilation in any structure plays very important role for supporting the physical environmental factor and making it comfortable for a person. In order to provide a safe, healthy and comfortable indoor environment, minimum ventilation standard needs to be provided depending on the pattern of occupancy and functionality of the accommodation.

A work surface is - a horizontal surface for supporting objects used in working or playing games. Surface - the outer boundary of an artifact or a material layer constituting or resembling such a boundary. Tabletop - the top horizontal work surface of a table writing board - work surface consisting of a wide lightweight board that can be placed across the lap and used for writing

As environment is a combination of temperature, humidity, and lighting it is observed that the worldwide interest in artificial illumination gathered momentum by the beginning of the twentieth century. The psychological and physiological aspects of higher levels of illumination come closely related to human welfare and well being.

Office work is visually demanding and has always required good lighting for maximum comfort and productivity. "Good" lighting means providing enough illumination so that people can see printed, handwritten or displayed documents clearly but are not blinded by excessively high light levels (a cause of glare).

The quality of lighting in a workplace can have a significant effect on productivity. With adequate lighting workers can produce more products with fewer mistakes, which can lead to a 10-50 % increase in productivity. Good lighting can decrease errors by 30-60 % as well as decrease eye-strain and the headaches, nausea, and neck pain which often accompany eye-strain. Adequate lighting allows workers to concentrate better on their work which increases productivity.

The level of lighting that workers need varies depending on the nature of the task, the sharpness of the workers eyesight, and the environment in which the work is done. For example, detailed work, such as inspection, assembling of small parts or technical drawing, needs a great deal of light. Coarse work, on the other hand, such as loading or unloading materials, handling of materials or packaging, requires less light.

A work surface has to be illuminated with a wide spread of light. Lighting has moved from being just utilitarian to psychological suggestive tool which influences peoples thinking.

Artificial lighting is needed to provide task luminance and adequate visual environments to carry on the tasks when natural light is inadequate or not available. Good artificial illumination, Prevent accidents, protects health by minimizing eyestrain. Inadequate light may lead to problems like lack of interest, failure to concentrate sleepiness and apparent laziness. Further, eyestrain, headache, indigestion and irritability are the other problems due to inadequate light.

Light is effective when it corresponds to the visual needs of the worker. Sustainable lighting helps to avoid accidents, supports emotional and physical well being and contributes to security. Ergonomics in simple terms means fitting the task to the user's requirements. Ergonomics of lighting at work place would mean determination of lighting needs of the user with minimal strain in given environment.

The aim of visual ergonomics is to optimize the perception of visual indurations, maintain an appropriate level of performance, ensure safety and provide visual comfort, lighting has the potential to change human performance and hence to enhance or diminish productivity. When artificial lighting is used it should be sufficient so as to avoid visual fatigue and prevent glare or refraction into the workers eyes.

Making the work environment healthy for everybody will help not only the well-being of the workers, but also the well-being of the organization as a whole. Considering these aspects it becomes essential to study the illumination and thermal comfort in the office work stations. Hence this study was carried out with the following objectives.

Objectives

1. To determine the illumination in office workstation
2. To determine the thermal comfort in office workstation
3. To correlate the illumination levels and thermal comfort with the satisfaction levels of work output.

REVIEW OF LITERATURE

Chapter II

REVIEW OF LITERATURE

Maintaining a healthy office environment requires attention to chemical hazards, equipment and work station design, physical environment (temperature, humidity, light, noise, ventilation, and space), task design, psychological factors (personal interactions, work pace, job control) and sometimes, chemical or other environmental exposures. The most common complaints resulting from poor lighting are: eyestrain, eye irritation, blurred vision, dry burning eyes, and headaches. Poor lighting affects not only the ocular system but can also contribute to stiff necks and aches in shoulder area. These problems can occur when people adopt poor or awkward postures when trying to read something under poor lighting conditions. When people are exposed to glare or have uncorrected vision problems, they tend to lean forward or backward in an attempt to compensate. An awkward body position leads to eye strain and accelerates postural fatigue that, in turn, contributes to musculoskeletal injuries (MSI). Satisfaction is an attitudinal reaction to the thermal comfort and illumination it represents the feeling of the office workers about how happy or unhappy he / she are with the thermal comfort and illumination. It has been observed that workers dissatisfaction with certain conditions of thermal comfort and illumination causes serious work problems and on the other hand workers satisfaction with thermal comfort and illumination leads to organizational goal of productivity. Determining adequacy of illumination and thermal comfort in the offices has not been carried out and hence relevant literature pertaining to illumination and thermal comfort have been reviewed and presented in this chapter.

Thermal Comfort

The adaptive approach to thermal comfort is based on the findings of surveys of thermal comfort conducted in the field. Field surveys concentrate on gathering data about the thermal environment and the simultaneous thermal response of subjects in real situations interventions by the researcher being kept to a minimum. The more recent tropical summer index of Sharma and Ali (1986) is example of this approach.

The theoretical foundation behind existing thermal comfort standards is a physiological and physics based description of a social science experiment. Individuals

expressed satisfaction or dissatisfaction with thermal environment that Fanger summarized in a set of equations establishes theoretical human body in thermal equilibrium with its environment. Metabolic based heat gain is affirmed with heat losses through conduction, convection, radiation and evaporation. The thermal comfort equations account for variations in activity level posture, clothing insulation air movement plus dry bulb wet bulb and radiant temperatures (Anderson, 1990).

Busch and John (1992) believe that occupants in buildings with natural ventilation accept a different set of thermal conditions compared to occupants in buildings with mechanical ventilation which is reflected in the modified standard.

Age and gender can also make a difference. Old people, people with disabilities, babies and young children typically feel more comfortable at higher temperatures. Women notice that they are feeling cool quicker than men, which may be related to their different body size, but is also related to a difference in the how quickly women respond to changes in temperature. Women reduce the blood flow to their arms, hands and feet faster than men if they cool down, resulting in colder fingers and toes. This reduction in blood flow is a way of regulating body temperature. (Bernstein et al 1995).

Kolokotroni et al. (1996) suggested that the naturally ventilated buildings typically use about half the energy of one's which are air conditioned. The temperatures in free running naturally ventilated buildings are constantly changing in line with outdoor conditions. A constant temperature standard therefore militates against the use of natural ventilation. A variable indoor temperature standard will help save energy by encourage the use of naturally ventilated buildings.

The fundamental assumption of the adaptive approach is expressed by the adaptive principle. If a change occurs such as to produce discomfort, people react in ways which tend to restore their comfort. This principle links field survey conducted in a wide range of environments and thus supports Meta analyses of comfort survey (Brager and Dedear, 1998).

The proportion of office workers who were comfortable at different indoor temperature. It was noticed that on many occasions the subjects recorded no discomfort, with continually changing indoor temperature and comfort temperature. Pakistani

buildings were found comfortable at temperatures ranging between 20^oc and 30^oc with no cooling apart from fans (Nicol *et al.* 1999).

McCarthy and Nicol (2001) implied that the use of variable temperature does not increase discomfort. Control regime discomfort among occupants but provides substantial savings in energy use by the air conditioning system.

Stoops (2001) illustrates that different cultures may have different thermal comfort responses. These different comfort responses appear to include the occupant's thermal expectations. The motivating factor or factors behind those thermal expectations remains unanswered. Invariably the top two complaints deal with thermal dissatisfaction that is building spaces are too hot or too cold. So even with the considerable effort and resources devoted to providing thermal comfort in modern buildings occupants are not satisfied. This is especially interesting when cultures with close thermal control in building (Scandinavia) are compared to be direct relationship between improved thermal control and improved thermal satisfaction.

Minigzhi *et al.* (2003) reported that the indoor relative humidity is relatively high, between 71 % and 81% and is 74 % on average. Because there are no air conditioners in the classroom, the indoor air temperature is quite high, the maximum reaches 34.4 ^oC and the minimum is 31.6 ^oC air temperature is 33.2 ^oC on average.

Seppanen *et al.* (2003) have developed a relation between performance and temperature. It showed a decrease in performance by 2 % per degree Celsius increase of the temperature in the range of 25-32 ^oC and no effect on performance in temperature range of 21-25 ^oC.

Melikov *et al.* (2005) made a division between buildings which are centrally air conditioned and those which are naturally ventilated. They argue that occupants of building which is air conditioned have different expectations than the occupants of naturally ventilated buildings.

Eicker *et al.* (2006) observed that occupants tend to prefer horizontal windows and that they would accept a minimum window area of 20-30% as satisfying, satisfaction is increasing with window area ranging to 100% depending on the situation.

Illumination

Collins *et al.* (1990) concluded that the low ratings given by office occupants to the combination of indirect furniture mounted fluorescent luminaries with under shelf task lamps was related to the high task luminance and low peripheral brightness of the workstation. When the same systems furniture was lit with a direct system vertical luminance were higher and so was satisfaction.

Rea *et al.* (1990) reported that varied task surround luminance ratios by varying the reflectance of the surround while keeping the task reflectance constant, a variety of background luminance and task contrast conditions using a horizontal paper – based numerical verification task. They found that the task surround luminance ratio had a very small effect on visual performance and no effect on ratings of the readability of the tasks. As expected background luminance and task contrast both affected visual performance and readability ratings.

Baron *et al.* (1992) tested the hypothesis that lighting conditions that produce positive affect will influence cognitive task performance and social behaviors. The results did not clearly demonstrate that the lighting conditions (combinations at luminance and lamp spectral power distribution) caused positive effect, but the pattern of results over the three experiments was consistent with other research concerning the effects as positive effect on behavior.

Satisfaction is the state of feeling that one's needs are fulfilled by implication, conditions that produce satisfaction or comfort are those that one prefers for some writers this judgment define lighting quality (Bean and Bell, 1992).

Lindner and Kropf (1993) found that increasing the operating frequency of the fluorescent lighting system decreases the incidence of eyestrain headache and other asthenopic symptoms.

Dollins *et al.* (1993) varied the illuminance at workstations in which male subjects worked overnight on computer tasks and obtained the expected dose dependent suppression of melatonin secretion, but it was not accompanied by changes in any behavior or mood measure.

Slater *et al.* (1993) found that illuminance ratio as low as 0.6 between desks in an open office were acceptable when room illuminance uniformity between desks for lower illuminance (350 LUX) were 0.7. This suggests that at low illuminance people want more uniformity.

Bernecker *et al.* (1993) obtained ratings of visual comfort for a variety of task lighting conditions. They obtained the same rankings of their five luminous conditions with several measures at visual comfort, but this ranking was not related to the illuminance uniformity across the desk surface. Rather the luminous conditions of all the work surfaces vertical and horizontal were important. Bright surfaces without excessive glare were most highly rated.

Kiernan (1994) reported that changing from direct to indirect lighting dramatically improved productivity in a postal station in Nevada. Unfortunately the systematic investigations of lighting system changes do not show such dramatic results.

Begemann *et al.* (1994) found that Dutch office workers added an average of 800 lux of artificial light, regardless of daylight or weather conditions. The Dutch luminance standard for offices is 500 lux. British office workers were more satisfied with a horizontal luminance at 800 lux than with the then standard 400 lux.

Miller (1994) reported an informal experiment in which conference attendees rated their opinions of five scenes in simulated offices. The most preferred scene had approximately equal amounts of lighting energy directed at the walls and working plane. The test illuminance of that scene was 387 lux.

Knez (1995) conducted two experiments in which the lamp type were varied and test performance measured for both male and female participants, females rated the lighting as more intense and glaring than males regardless of the actual conditions however this finding did not replicate.

Begemann *et al.* (1995) have speculated that the changes they observed in illuminance preferences over the course of the working day relate to differences in alertness. That is, that individual prefers higher illuminances at the time of day when the circulation cycle dips, so that illuminance maintains the acceptable alertness level.

Tabuchi *et al.* (1995) found that the settings of participants preferred ambient illuminance and the lower limit of acceptable ambient illuminance for a range of task illuminance levels. The preferred levels were much higher than the lower limits. For task illuminances up to 500 lux participants preferred equal levels of task and ambient illumination. Above 500 lux, the optimal conditions consisted of ambient illuminance slightly lower than the task illuminance.

Gifford *et al.* (1996) found that contrast between low (average total) and medium (average 486 Lux) luminance levels did not produce significant effects on task performance, however, contrast between low & high luminance (average 1962 lux) produced a (Statistically significant) average correlation at 0.25 between luminance and task performance. Thus, it is likely that any relationship between these variables is transitory. People adapt to new luminous conditions and can perform well regardless of the luminance level.

An extensive study under office conditions has shown that people prefer high additional electric lighting in an office environment (average 800 lux) on top of the prevailing day light contribution (Begemann, 1997).

According to the results obtained the recommended (Commission International de l'Eclairage (CIE) indoor ceiling mounted lighting did alter positive and negative moods in participants (Knez and Enmarker, 1998).

Studies of stress levels and complaints in people working indoors have been made only in comparison with people working under a combination of electric light and day light. These studies show that the stress in the group with the combined lighting was substantially lower in summer than in winter (Kerkhof, 1999).

Despite the wide individual variability in preferred lighting conditions individuals show consistent preferences from one day to another (Carter *et al.*, 1999).

Several investigations have found that lighting installations with individual controls result in lower energy consumption because some people choose lower light level in the office and some people near windows will dim or turn off when daylight is available (Boyce *et al.* 2000, Moore *et al.* 2002, Veitch and Newsham, 2000).

Successful day lighting also requires attention to controlling thermal effects cooling in winter and overheating in summer by using insulating windows and shades or blinds to control direct sunlight (Roche *et al*, 2000).

Webb (2006) states daylight has a range of influences on the human. In addition to vision it has implications for sleep / wake states, alertness, mood and behavior.

Desert control of blinds is based on the adaptive principle “If a change occurs such as to produce discomfort, people react in ways which tend to restore their comfort” (Galsiu and Veitch, 2006).

Muzammil *et al*. (2008) showed that levels of illumination were having a statistically significant effect on task performance of the operator. These results are in the line (as far as illumination was concerned) with the recommendation of the Illuminating Engineering society who has recommended 500-600 lux of illumination for better performance in an assembling task.

MATERIALS

AND

METHODS

Chapter III

MATERIALS AND METHODS

The present study was conducted in order to evaluate the thermal comfort and illumination levels at the workstation used by the employees. To meet the objectives of the present study the procedure followed was as below

- 3.1 Locale of study
- 3.2 Selection of sample
- 3.3 Development of recording tools
- 3.4 Collection of data
- 3.5 Classification & Tabulation of data
- 3.6 Statistical analysis

3.1 Locale of study

The present study was conducted in Parbhani city of Marathwada region in Maharashtra state

3.2 Selection of samples

For the study a sample of twenty five subjects each from the administrative office of Marathwada Agricultural University, Collectors office. Zilla Parishad Office, District Welfare office and Municipal Council office were randomly selected, thus the total number of subjects were one hundred and twenty five.

3.3 Development of recording tools

The experiment was carried out in three stages.

3.3.1. Development of questionnaire cum interview schedule

3.3.2. Recording of temperature and illumination levels.

3.3.3. Development of satisfaction scale for thermal comfort, illumination levels and work output.

3.3.1 Development of questionnaire cum interview schedule.

In general the word questionnaire refers to a device for procuring answers to questions by using a form which the respondent fills in himself. A schedule is the form containing some questions or blank tables which are to be filled by the respondent. Rating schedules are used for sociological or psychological research. They are used in cases where attitude or opinion is to be measured (Bajpai, 1960).

Looking into the advantages of questionnaire and interview schedule, both methods were implemented for the collection of data. The questionnaire cum interview schedule was prepared to elicit the general information and specific information.

General information included the independent variable i.e. Age, Education, Sex, Income, BMI, Eye sight, Area of workplace and Type of work.

Dependent variable i.e. Present feeling, Expected change, General feeling, Expectation, Temperature in office, Humidity in office, Ventilation in office, Location of fan, Provision of coolers, Provision of AC, Drought control in office, Provision of curtains, Plants near the windows, Exhausts fan.

The aspects covered under specific information were schedule of openings, number of light fixtures fans and coolers, satisfaction regarding thermal comfort and illumination was known by application of developed scale. Questionnaire was pretested for its clarity ambiguity, additions and deletions of question and the finalized questionnaire cum interview schedule was used for recording the data (Appendix I).

3.3.2 Recording data for thermal comfort and illumination levels.

A record of humidity temperature and illumination levels was maintained for knowing the effects of work places on the worker.

Thermal Comfort

The temperature was recorded by using sling Psychomotor (Dry and Wet bulb thermometer). Humidity was recorded with the help of Hygrometer.

Temperature and humidity were recorded i.e. thrice in a day during working hours during morning 9-10 am after noon 12-1 pm and evening 4-5 pm. Bedford

scale was employed for studying the thermal comfort. The temperature and humidity in the room was recorded.

Record charts for temperature and humidity for the study period were obtained from the metrology department which were the standards for the said period. Recorded data of temperature humidity and weekly normal of weather parameter (database 1975-2004) are given in Appendix II-A and II- B

Illumination

The quality of general and artificial light was measured using a Digital Lux meter (Lx-101 meter). The illumination levels were recorded three times during the office working hours.

The procedure followed for taking down the reading was by keeping the digital lux meter horizontally on the surface of the work station illumination level at four corners and center of the work table and the mean intensity of light was obtained. Illumination levels with and without artificial light were also recorded.

Adequacy of light was determined by comparing the values of available light at work station and office area with the recommended illumination level reported in IS-3646 standards. Recorded data of illumination and IS-3646 standards are seen in Appendix III-A and III-B.

3.3.3 Development of scale

The first step followed in the development of scale was obtaining statements. A statement is anything that a given psychological object reflects highest or lowest amount of satisfaction regarding thermal comfort and illumination.

In the very beginning a list of statements regarding satisfaction about thermal comfort and illumination was prepared, this list of statement was then given to 20 panel members - 10 experts and 10 subjects (Appendix IV-A). They were asked to rate the appropriate statements and to add or delete them if they felt so on the basis of the suggestions given and ratings of the panel members a modified list of statement was prepared (Appendix IV-B).

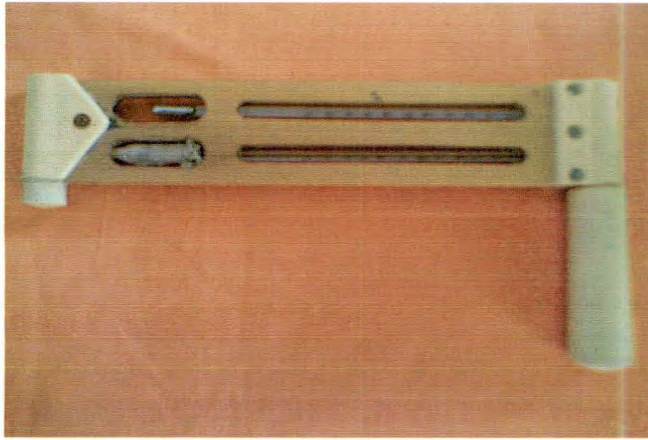


Plate 1. Sling Psychrometer (Dry and Wet bulb thermometer)



Plate 2. Lux Meter (LX-101 Meter)



Plate 3. Hygrometer

The statements thus prepared were given to the same panel members for the relevance and face validity. The statements were rated for the response on a five point continuum viz., highly satisfied (5), satisfied (4), neutral (3), dissatisfied (2) and highly dissatisfied (1)

The statements after being tested for the relevance and face validity and language were then given to 70 office workers. Exclusive of the final sample the office workers were randomly selected from five offices Administrative office of Marathwada Agricultural University, Zilha parishad office, Collector office, Municipal council office, District welfare office of Parbhani city of Marathwada region. The office workers were instructed to express their feelings of satisfaction with each statement on the five point continuum

The final number of statements after calculation of 't' values were thus selected for the final scale (Appendix- V).

Sr. No.	Activities	No. of statement prepared	No. of statements selected
1	Thermal comfort	36	10
2	Illumination	21	10
3	Initial no. of statements	(36+21)	57
4	No. of statements finally selected for scale	(10+10)	20

3.3.3.1 Item Analysis

The subjects were arranged in an ascending order based on the scores obtained by them. The top 25 per cent of the subject with higher scores (High Group) & 25 per cent subjects with low scores (Low Group) were used as criteria group. The middle 50 per cent respondents were deleted. The responses were analyzed to determine which of the items discriminate most clearly between the high and low group.

For evaluating the response of the high and low group to the individual statements. The 't' value was calculated by applying the following formula suggested by Edward (1969).

$$t = \frac{\bar{X}_H - \bar{X}_L}{\frac{\sqrt{\sum (X_H - \bar{X}_H)^2 + \sum (X_L - \bar{X}_L)^2 \times (1/n_1 + 1/n_2)}}{(n_1 + n_2 - 2)}}$$

$$(X_H - \bar{X}_H)^2 = \frac{X_H^2 - (X_H)^2}{n}$$

$$\& (X_L - \bar{X}_L)^2 = \frac{X_L^2 - (X_L)^2}{n}$$

\bar{X}_H = the mean score on a given statement for the high group.

\bar{X}_L = the mean score on the same statement for the low group.

The value of 't' was used as a measure of the extent to which a given statement differentiates between the high and low group Based on the 't' values, the statements with largest 't' values were selected for the scale (Appendix-V).

3.3.3.2 Testing the validity and reliability of the scale

The validity of test or of any measuring instrument depends upon the fidelity with which it measures what it purports to measure A test is valid when the performances which measures correspond to the same performance as otherwise independently measured or objectively defined Validity is a relative term (Garrett, 1981).

Validity of a scale is the property which ensures that the obtained scale measures the variables they are supposed to measure A scale is said to be valid when it measures what it intends to measure (Goode and Hatt, 1983).

Correlation was worked out to know the validity of the scale Independent variables like age, education, income etc and a positive correlation was hoped, indicating that the scale is valid in construct.

Kerlinger (1978) defined reliability as accuracy or precision of a measuring instrument. A scale can be said to be reliable only when it will consistently produce the same result when applied to the sample any number of times Reliability of the scale was assessed by split half method.

The split half method is employed when it is not feasible to construct parallel forms of the test nor advisable to repeat, the test itself One of its main advantages is the fact that all data for computing reliability are obtained upon one occasion; so that variations brought about by differences between the two testing situations are eliminated (Garrett, 1981).

For calculating the reliability, the scores for the 20 statements finally selected for the scale were given to 70 office workers, who were randomly selected The scores thus obtained were split up as statements with even numbers and statements with odd numbers. Spearman Brown prophecy formula for estimating reliability from two comparable halves of a test (Garrett, 1981).

$$r_{11} = \frac{2 r_{\frac{1}{2}} \cdot \frac{1}{11}}{1 + r_{\frac{1}{2}} \cdot \frac{1}{11}}$$

Where r_{11} = reliability coefficient of the whole test.

$r_{\frac{1}{2}} \cdot \frac{1}{11}$ = reliability coefficient of the half test found experimentally

Hence, the reliability coefficient of half test for part A (Thermal comfort) of the scale was **0.80** and the reliability coefficient of the whole test for this part was **0.88**. Thus it was found to be positively significant and the reliability coefficient of half test of part-B (Illumination) of the scale was **0.76** and the reliability coefficient of the whole test for this part was **0.86** which also found to be positively significant also the reliability coefficient for part-c (Work output) of the scale was **0.68** and the reliability coefficient of

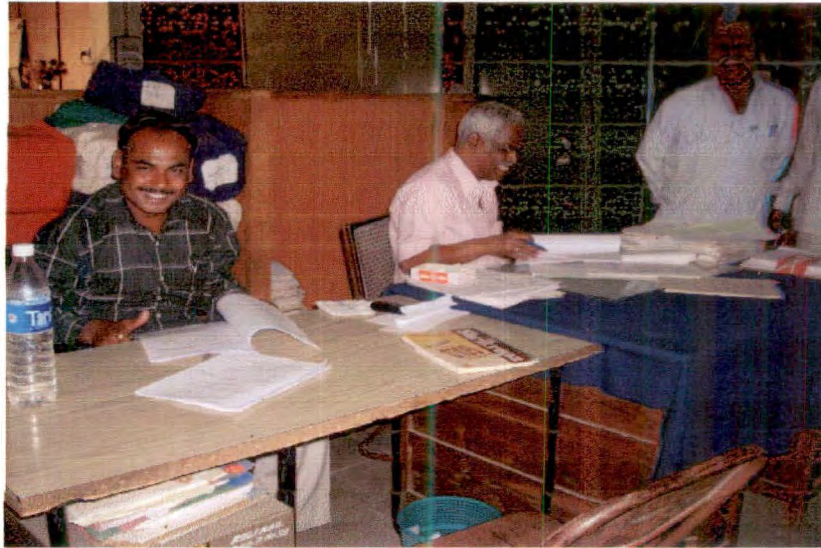


Plate 4 . Sitting position of office workers at work station

the whole test for this part was **0.80** which was also found to be positively significant. The scale thus developed was used for the final survey and data collection.

3.4 Collection of Data:

The data were collected by implementing survey method with the help of prepared questionnaire cum interview schedule by the investigator.

For conducting the interview the respondents were personally contacted. The investigator introduced self, and gave a brief idea about the study and the purpose of study. The respondents were taken, into confidence and explained that the information received from them will be confidential and the secrecy will be maintained. The office workers were contacted in their respective offices personally and were appraised about the study. They were handed over copies of the questionnaire as they did not have time for the single sitting to complete the required information. The questionnaires were collected back after 2 days.

A total number of 150 forms were distributed in all the places but due to certain reasons all the forms were not returned back. Some office workers who were handed over the forms had gone on a long leave. Some forms were returned incomplete on the pretext of lack of time. In some forms the general information required from the office workers were not filled up properly therefore the forms with inadequate information were deleted. Out of 150 forms 135 forms were received back but out of these 10 forms had to be deleted due to inadequate information. Thus the target group of 125 forms was fulfilled.

3.5 Classification and tabulation of data:

The data has been classified for simplification and presenting results.

Age Groups	Groups
(35 -45 years)	I
(45 years & above)	II

Type of Work

Clerical	Clrk
Administration	Admn

Eye sight

Short sighted	SS
Long sighted	LS
Bifocal	BF
Normal	N

Area of Work Place

Side of the room	SR
Center of the room	CR
Near the door	ND
Near the windows	NW

Orientation of the openings

East	E
West	W
North	N
South	S

BMI

19-21	I
21 & above	II

The data thus obtained were then classified and tabulated for analysis. Tabulation was done by summing the scores for each individual item to get the satisfaction.

3.6 Statistical analysis

Apart from calculating the percentage and frequencies co-efficiency of correlation was applied to test the reliability of the scale and also to relate the dependent variables with the independent variables.

Correlation was worked out with the help of the following formula given by Elhance 1969.

Co-efficient of correlation-direct method

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \times \sum y^2}}$$

Where $X \times Y$ are deviations from their Arithmetic Mean i.e. $X = \bar{x} - x$, $Y = \bar{y} - y$

T- Value was worked out with the help of the following formula

$$t = \frac{\bar{X} - N}{SE(\bar{X})}$$

Where, N= Assumed mean = standard value

\bar{X} = Sample mean.

RESULTS AND DISCUSSION

CHAPTER-IV

RESULTS AND DISCUSSION

A study on thermal comfort and illumination in office workstation was carried out, and the collected data and statistical analysis have yielded the following results.

Table 1: General information of the office workers

Sr. No.	Particulars	(N=125)
1.	Age (years)	
	Age Group-I (35-45 year)	43 (34.4%)
	Age Group-II (45-above)	82 (65.6%)
2.	Education	
	H.Sc.	20 (16%)
	U.G.	90 (72%)
	P.G.	15 (12%)
3.	Type of work	
	Clerical	111 (88.8%)
	Administration	14 (11.2%)
4.	Sex	
	Male	113 (90.4%)
	Female	12 (9.6%)
5.	BMI	
	Group-I (19-21)	85 (68%)
	Group-II (21 & above)	40 (32%)
6.	Eye sight	
	Short sighted	40 (32%)
	Long sighted	43 (34.4%)
	Bifocal	28 (22.4%)
	Normal	14 (11.2%)
7.	Income (Rs)	
	9500-10500	23 (18.4%)
	10500-11500	39 (27.2%)
	11500 - above	68 (54.4%)

Note: Figures in parenthesis indicate percentages

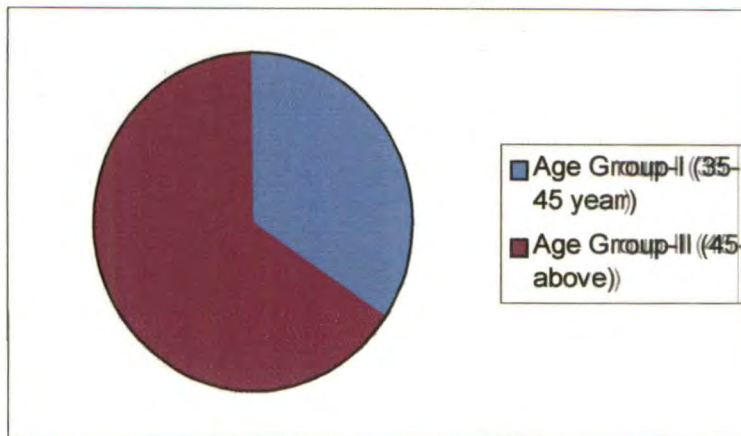


Fig. 1 : Age group of office workers

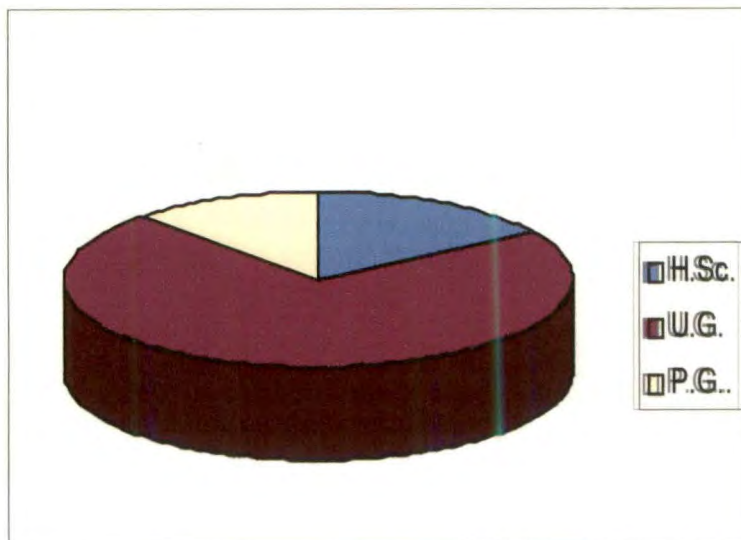


Fig. 2 Education of office workers

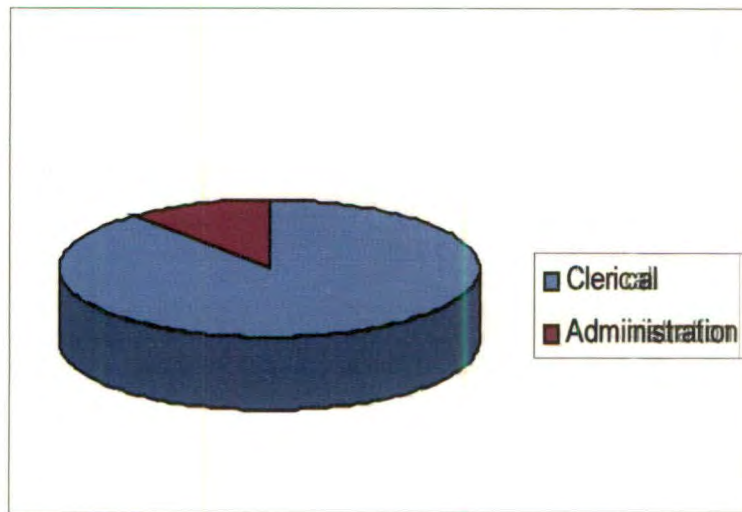


Fig. 3 : Type of work of office workers

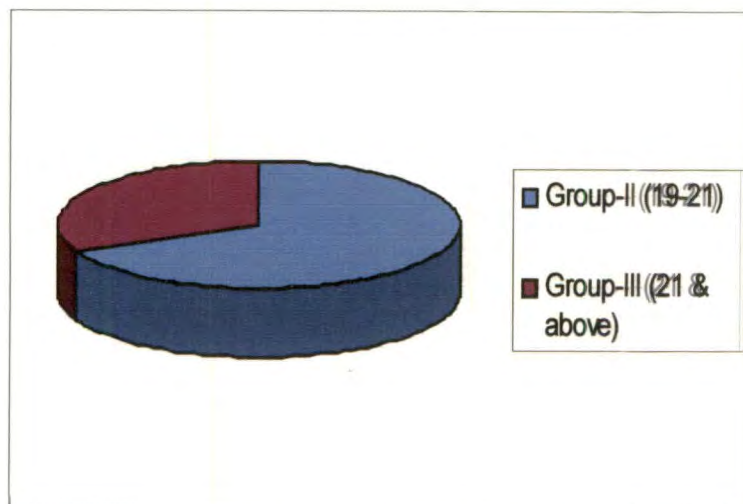


Fig.4 : Body Mass Index of Office Workers

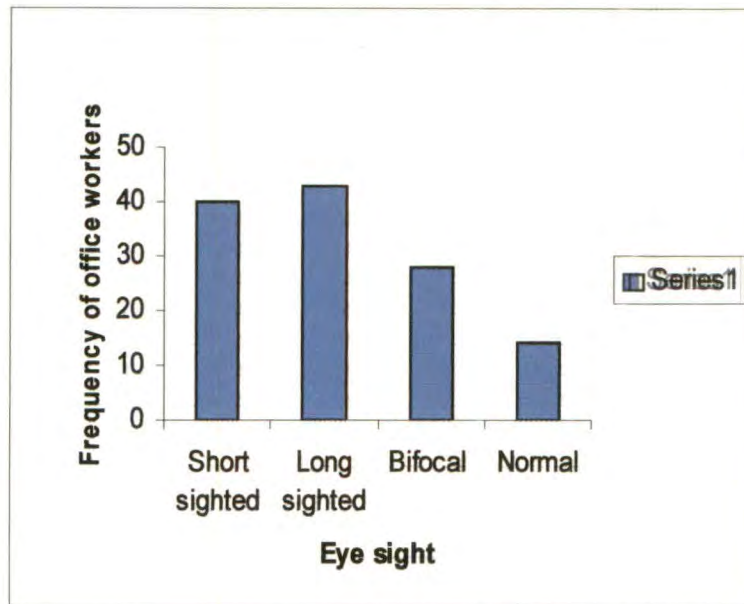


Fig. 5 : Eye sight of office workers

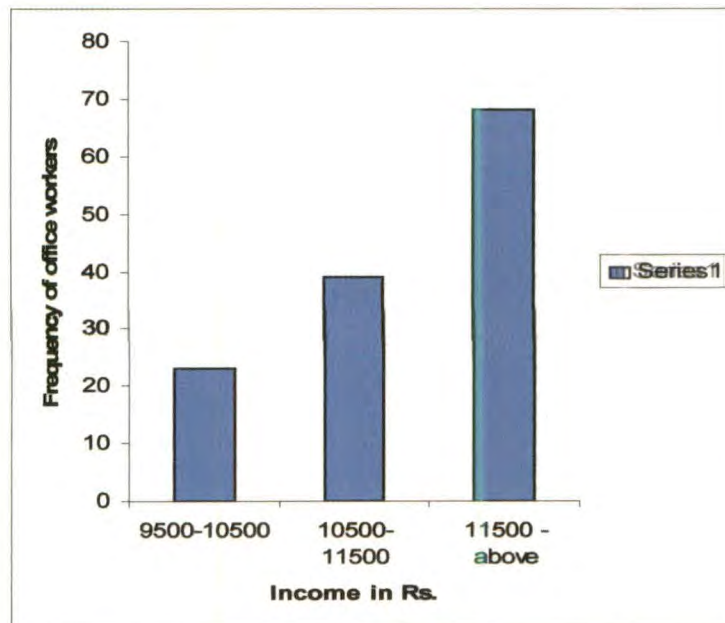


Fig. 6 : Income of office workers

Table: 1 General information of the office workers

Table 1 describes the general information of the office workers. It is clear from the table that 65.6 percent office workers belonged to the age group of 45 years and above. The remaining 34.4 percent belonged to the first age group. The results have also been depicted in fig no.1.

With respect to the education level of the respondents it is seen that majority percent of them were undergraduates sixteen per cent were educated up-to higher secondary level, while twelve per cent respondents were post graduate. Fig. 2. Indicate the education of office workers.

Classification of type of work yielded resultant to two major groups as clerical (88.8 %) and administrative jobs (11.2 %). With a random sample, the classification of respondents under gender depicts ninety point four per cent males and only nine point six per cent females. The results have been illustrated in fig no.3.

The Body Mass Index of respondents shows that 68 per cent belonged to 19-21 Body Mass Index and 32 per cent respondents had a Body Mass Index of 21 and above. Body Mass Index of office workers is disclosed in Fig.No.4.

Concerning the workplace and visibility, the eye sight of the respondents was studied and the results show that thirty four point four per cent employees wore glasses for long sight followed by thirty two per cent employees with short sight, while twenty two point four per cent respondents wore bifocal lenses and only eleven point two per cent had normal eye sight. The results have been depicted in fig no.5.

It is evident from the table that the income of 68 respondents was Rs.11500. and above followed by thirty four employees with an income range of Rs. 10500-11500 while twenty three respondents had income ranging between 9500-10500 rupees per month. Fig.6. Indicate the income of office workers.

It can be concluded that majority of the respondents belonged to age group of 45 years and above. 12 per cent respondents were post graduates. Monthly income of 54.4 per cent subjects was Rs.11500. and above majority of the respondents belonged to the clerical community 11.2 per cent were having normal eye sight. 68 per cent respondent were having 19-21 Body Mass Index and majority i.e. 90.4 per cent respondent were male members.

Table 2: Details of openings

Sr. No.	Particulars	(N=125)	Size
1.	Door-1	113 (90.4%)	7'x4'
	Door-2	12 (9.6%)	6'x3'
2.	Window-2	63 (50.4%)	3.5'x4'
	Window-3	50 (40%)	3'x3.5
	Window-4	12 (9.6%)	3'x4'

Note: Figures in parenthesis indicate percentages

Table 2: Details of openings

Table 2: It Discloses information regarding a details of openings, and Fig.8. It discloses the details of openings.

It is cognizant from the table that maximum number of the rooms (113) had one door of 7'x4' whereas only 12 rooms had two doors of 6'x3'. In case of windows 50.4 per cent rooms had two windows of 3.5'x4', 40 per cent rooms had three windows of 3'x3.5' while 9.6 per cent rooms were having four windows of 3'x4'.

Table 3: Details of work station

Sr. No.	Particulars	(N=125)
Area of workstation		
	Side of the room	18 (14.4%)
	Centre of the room	48 (38.4%)
	Near the door	34 (27.2%)
	Near the windows	25 (20.0%)
Orientation of the openings		
	East	47 (37.6%)
	West	3 (2.4%)
	North	31 (24.8%)
	South	44 (35.2%)
Size of workstation		
	4'x3'	68 (54.4%)
	5'x4'	57 (45.6%)
Size of room in Sq.ft.		
	15' x 10'	74 (59.2%)
	18' x 20'	7 (5.6%)
	20' x 22'	5 (4%)
	8' x 12'	39 (31.2%)

Note: Figures in parenthesis indicate percentages

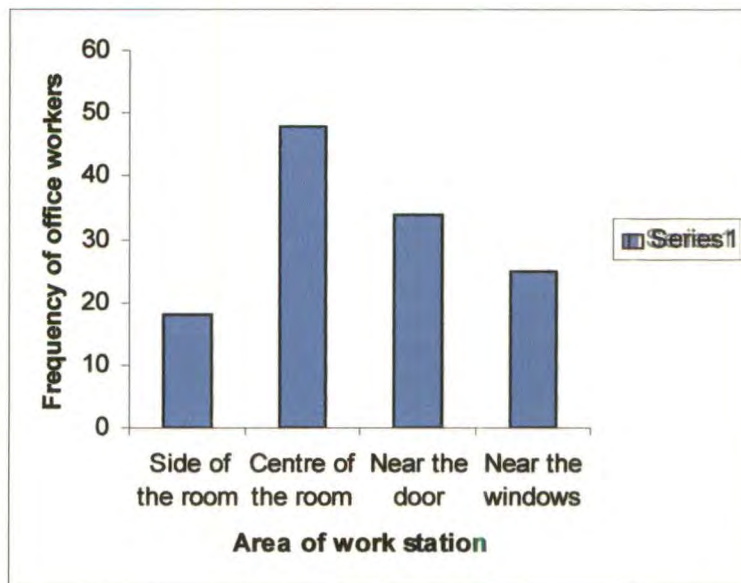


Fig. 7 : Area of work station

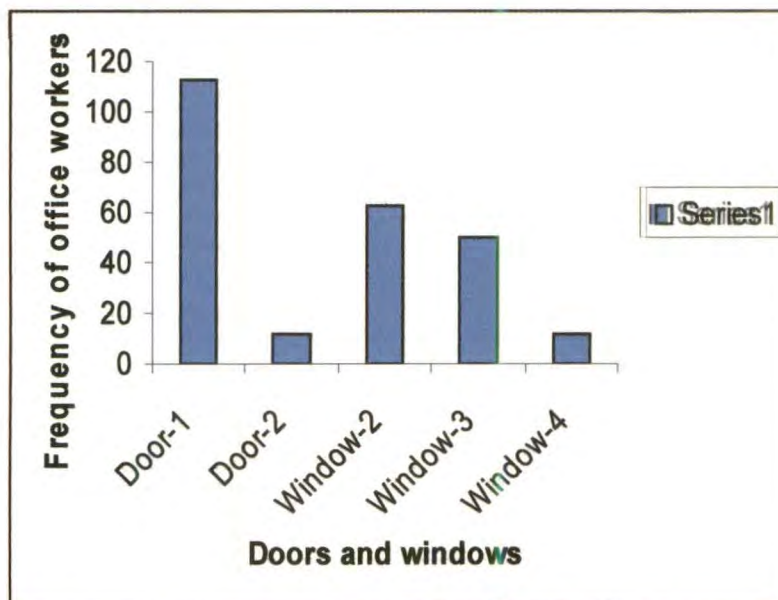


Fig. 8 : Schedule of openings

Table 3: Details of workstation

Table 3.and fig.no.7. It gives the details of workstation. It is observed from the table that 14.4 per cent office workers were having work stations at a side of the room, followed by 38.4 per cent office workers having work stations at center of the room, 27.2 per cent office workers were having work stations near the door and 20 per cent office workers were having workstation near the windows. A general observation and discussions with the office workers revealed that they preferred workstation near the window these findings are almost similar to Eicker *et al.* (2006) mentioning that occupants tend to prefer horizontal windows and that they would accept a minimum window area of 20-30% as satisfying, satisfaction is increasing with window area ranging to 100% depending on the situation.

Concerning orientation of the openings, it is observed that 37.6 per cent rooms were having an opening at an east side, 2.4 per cent, rooms were having an opening at a west side, 24.8 per cent, rooms were having an opening at a north side and 35.2 per cent were having an opening at a south side. Fig.10. It indicates the orientation of the opening. It is cognizant from size of workstation that 54.4 per cent, respondents were having 4'x3' workstation size, while 45.6 per cent; respondents were having 5'x4' workstation size.

It is seen from the table that the size of room that 59.2 per cent respondents were having the workstation in the room size 15'x10' followed by 5.6 per cent with a room size of 18'x20' and 4 per cent respondents were sitting in a room size 20'x22', whereas 31.2 per cent respondents were having the workstation in the room size 8'x12'. It was noted that bigger room sizes were shared by two (15'x10'), four (18'x20') and 6 to 7 (20'x22') members respectively, while the room of 8'x12' were occupied by single persons.

Therefore, it can be summed that 38.4 per cent respondent had workstation in the center of the room, 37.6 per cent rooms had an opening towards east, 54.4 per cent respondents had workstation size of 4'x3' and 59.2 per cent respondents were having the workplace in a room size of 15'x10'.

Table 4: Information regarding light fixtures at work place

Sr. No.	Particulars	(N=125)
1.	Frequency of use of artificial light (hr)	
	4 hr	19 (15.2%)
	5 hr	60 (48%)
	6 hr	46 (36.8%)
2.	Placement of light	
	Convenient	62 (49.6%)
	Inconvenient	63 (50.4%)
3.	Placement of light fixture	
	Wall	48 (38.4%)
	Ceiling	77 (61.6%)
4.	Wattage at light fixture	
	40 watt	57 (45.6%)
	60 watt	68 (54.4 %)
5.	No. of light fixture	
	1	55 (44%)
	2	60 (48%)
	3	6 (4.8%)
	4	4 (3.2%)

Note: Figures in parenthesis indicate percentages.

Table 4: Information regarding light fixture at workplace

Table 4 discloses the information regarding light fixture at workplace. It is evident from the table that artificial light is required by forty eight per cent respondent for five hours during the day followed by thirty six point eight per cent requiring artificial light for six hours while fifteen point two per cent respondents used artificial light for about four hours a day.

Concerning placement of light fixture, it is observed that fifty point four per cent felt them inconvenient while the remaining opined that the placement of light fixtures is convenient.

The light fixtures were placed on the ceilings at work places for seventy seven respondents while the fixtures were placed on walls for thirty eight point four per cent respondent work places.

With regards to the wattage of the light fixtures the work places had 40 watt (45.6 %) and 60 watt (54.4 %) fluorescent tubes.

The results for number of light fixtures at workplace show that most of the rooms (48 %) had two tubes followed by rooms with one tube (44 %) while the work places with three (4.8 %) and four (3.2 %) tubes were very few.

Table 5: Final format of satisfaction levels of employees regarding thermal comfort and illumination.

Table 5.1: Summarized structure showing 't' values of satisfaction regarding thermal comfort.

Sr. No.	Statement	't' Values
1	How much satisfied are you about the provision of curtains to control the air flow?	2.92
2	How much satisfied are you about the provision of AC?	2.87
3	How much satisfied are you about the ventilation of office?	2.82
4	How much satisfied are you about the exhaust fan for air circulation?	2.73
5	How much satisfied are you about the plants near the windows?	2.62
6	How much satisfied are you about the provision of cooler?	2.57
7	How much satisfied are you about the humidity in office?	2.56
8	How much satisfied are you about the location of fan?	2.32
9	How much satisfied are you about drought control in office?	2.15
10	How much satisfied are you about the temperature in office?	2.12

Table 5.2: Final format showing 't' values of satisfaction levels regarding illumination

Sr. No.	Statement	't' Values
1	How much satisfied are you about placement of light fixtures?	2.98
2	How much satisfied are you about wattage of lamp?	2.72
3	How much satisfied are you about placement of light?	2.65
4	How much satisfied are you regarding the color contributing to reflectance of light in your room?	2.58
5	How much satisfied are you about intensity of light?	2.52
6	How much satisfied are you about type of light?	2.42
7	How much satisfied are you about better visibility for work station?	2.36
8	How much satisfied are you about curtains for avoiding glare?	2.21
9	How much satisfied are you're about reflectance of light on the work space?	2.17
10	How much satisfied are you regarding control safety?	2.17

Table 5.3: Final format showing 't' values of satisfaction levels regarding work output

Sr. No.	Statement	't' Values
1	How much satisfied are you about afternoon work output?	2.92
2	How much satisfied are you about the work output during summer period?	2.87
3	How much satisfied are you about the work output at the time of provision of fan?	2.62
4	How much satisfied are you about the work output at the time of provision of coolers?	2.54
5	How much satisfied are you about the work output during winter period?	2.52
6	How much satisfied are you about the output of work in direct light?	2.44
7	How much satisfied are with the work output while working with natural light?	2.39
8	How much satisfied are you about the work output while working with artificial light?	2.33
9	How much satisfied are you about morning work output	2.31
10	How much satisfied are you about the work output during the rainy period	2.18

Table 5: A Final format of satisfaction levels of employees regarding thermal comfort and illumination.

The scale was developed by Likert summated rating method, containing 10 statements with highest 't' values in sub class of temperature and illumination. The statements found in the final format of the scale were open ended and self explanatory table depicts the statements along with the 't' values.

Table 6: Perception of thermal comfort

Sr. No.	Scale	How you feel now (N=125)	General feeling at work (N=125)
1.	Much too cool	1 (0.8 %)	6 (4.8%)
2.	Too cool	2 (1.6%)	12 (9.6%)
3.	Cool	5 (4%)	16 (12.8%)
4.	Neutral	30 (24%)	40 (32%)
5.	Comfortably warm	52 (41.6 %)	42 (33.6 %)
6.	Too warm	25 (20 %)	5 (4 %)
7.	Much too warm	10 (8 %)	4 (3.2 %)
8.	Warmer	81 (64.8%)	35 (28%)
9.	No change	40 (32%)	79 (63.2%)
10.	Cooler	4 (3.2%)	11 (8.8%)

Note: Figures in parenthesis indicate percentages

Table 6: Perception of thermal comfort

Table 6: It Describes perception of thermal comfort. The results regarding responses towards the present feelings, depict that 41.6 per cent respondents felt comfortably warm, followed by (24 per cent) being neutral, while 0.8 per cent felt much too cool. 33.6 per cent mentioned that they generally are comfortably warm followed by 12.8 per cent expressing that they generally felt cool and only 3.2 per cent opined that they generally felt much too warm at workplace. The feeling regarding how you would like to be now show that 64.8 per cent said warmer, followed by 32 per cent who did not want any change and only 3.2 per cent wanted to be cooler. Whereas their feelings about how would you like to be generally at work represent that 28 per cent wanted to be warmer,

63.2 per cent respondents opted for no change and 8.8 per cent said they would like to be cooler.

Findings of Stoops (2001) illustrates that different cultures may have different thermal comfort responses. These different comfort responses appear to include the occupant's thermal expectations. The motivating factor or factors behind those thermal expectations remained unanswered. Invariably, the top two complaints deal with thermal dissatisfaction that is building spaces are too hot or too cold. So even with the considerable effort and resources devoted to provide thermal comfort in modern building occupants are not satisfied. This is especially interesting when cultures with close thermal control in building (Scandinavia) are compared to be direct relationship between improved thermal control and improved thermal satisfaction are supportive to the obtained results.

Table 7: Thermal comfort scores

Scale rating	N=125
Hot	3 (2.4%)
Warm	20 (16%)
Slightly warm	30 (24%)
Neutral	50 (40%)
Slightly cool	16 (12.8%)
Cool	5 (4%)
Cold	1 (0.8%)

Note: Figures in parenthesis indicate percentages

Table 7: Thermal comfort scores

Thermal comfort scores have been illustrated in table 7. It is evident from the table that 40 per cent of the office workers were neutral towards the temperature in the office. While 24 per cent felt slightly followed by 16 per cent scores for warm and Two point four per cent scores for hot, where as for slightly cool scores of 12.8 per cent responses were noted followed by 4 percent scores for cool and 0.8 percent scores for cold. The results have been depicted in fig. No7.

The higher scores for feelings of slightly warm to hot may be due to rise in environment temperature during the study period, where as the lower scores for thermal comfort towards the cooler side may be due to personal adoptability towards temperature.

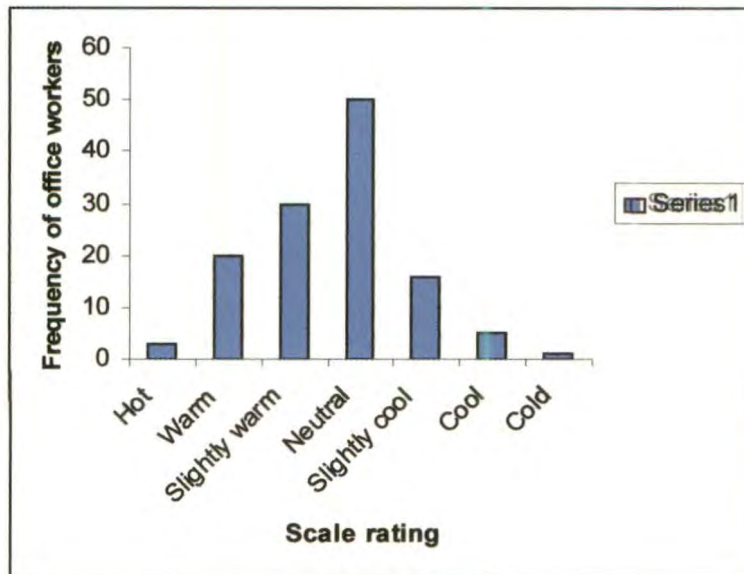


Fig. 9 : Thermal comfort scores

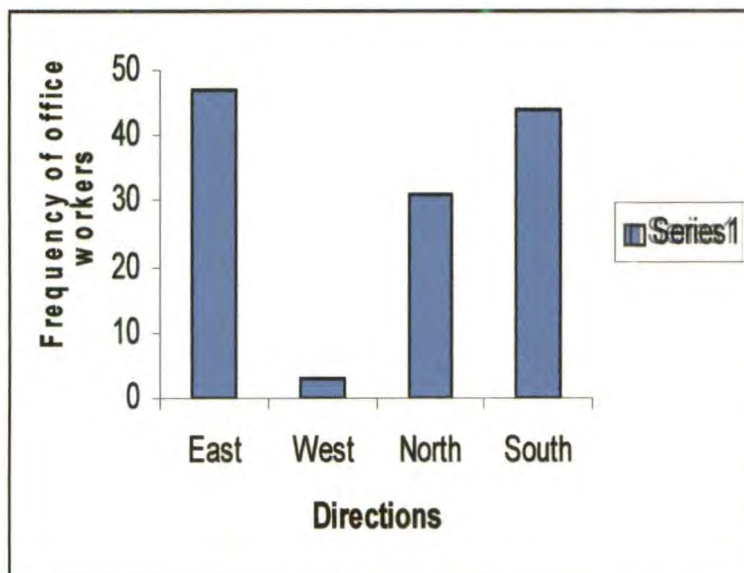


Fig. 10 : Orientation of the opening

It could be said that the workers have adapted the office temperature cooling because the facilities for cooling down or measures to reduce temperature are not being provided to him. These findings are in line with results of (Nicol *et al.* 1999).The proportion of office workers who were comfortable at different indoor temperature. It was noticed that on many occasions the subjects recorded no discomfort, with continually changing indoor temperature and comfort temperature.

Table 8: Comparison of temperature and humidity with standards

Particulars (monthly) temperature (⁰ C)	Mean \pm SD	Standard mean	t=value
January			
Inside room	29.42 \pm 0.97	29.77	-0.03 ^{NS}
Outside room	31.28 \pm 1.11		0.11 ^{NS}
February			
Inside room	31.42 \pm 1.27	32.37	-0.06 ^{NS}
Outside room	33.71 \pm 1.25		0.08 ^{NS}
March			
Inside room	35.14 \pm 1.57	36.38	-0.05 ^{NS}
Outside room	37.14 \pm 1.34		0.04 ^{NS}
Humidity (%)			
January			
Inside room	77.42 \pm 3.2	73.5	0.04 ^{NS}
Outside room	74.42 \pm 3.2		0.01 ^{NS}
February			
Inside room	69 \pm 3	62.75	0.08 ^{NS}
Outside room	64.85 \pm 2.91		0.02 ^{NS}
March			
Inside room	47.85 \pm 2.54	46.6	0.02 ^{NS}
Outside room	51.28 \pm 2.98		0.08 ^{NS}

N.S. = Non significant value

Table 8: Comparison of temperature and humidity with standards

Comparison of temperature and humidity with standard is given in a table no.8. The table discloses the recording of temperature and humidity for three months along with Mean, S.D., Standard Mean and 't' value.

It is clear from the table that the standard mean for temperature in Jan., Feb., Mar. Was 29.7⁰C ,32.03⁰C and 36.3⁰C respectively and the Mean and S. D. for inside

room temperature and outside were almost at part with the standard mean (32.3), however, statistically no significant variation in inside room temperature , outside room temperature and standard was noted. Similarly the reading for humidity indicated that the humidity inside the room was higher than standard (62.75) during Jan. (77.42 ± 3), Feb. (69 ± 3), Mar. (47.85 ± 2.54). While the percent humidity outside the room (51.28 ± 2.98) was greater than the standard (46.6). Though this variation is noted in mean values yet the statistical computation has shown no significant results but are suggestive that measures to comfort the temperature and humidity need to be provided to the workers for comfortable work environment. Minigzhi *et al.* (2003) have also reported that the indoor relative humidity is relatively high, between 71 % and 81% and is 74 % on average.

Hence it can be concluded that the temperature and humidity levels inside and outside the room were almost similar to the prevailing data standards.

Table 9: Correlation of independent variables with thermal comfort

Variables	Present feeling	Expected change	General feeling	Expectation
Type of work	-0.21*	0.01 ^{NS}	-0.09 ^{NS}	0.40**
Work place	-0.01 ^{NS}	0.01 ^{NS}	-0.01	-0.28*
Age group				
Group-I	-0.23*	-0.28**	-0.26**	-0.21*
Group-II	0.23*	-0.23*	0.28**	0.20*

*Denotes significance at 5% level

** Significance 1% level

N.S. = Non significant value

Table 9: Correlation of independent variables with thermal comfort

Table 9 gives correlation of independent variables with thermal comfort, the findings reveal that the type of work is ($r = -0.21^*$) negatively significantly correlated with the present feeling implying that the thermal comfort decreased with variation in the type of work. While it was found to be highly significantly correlated ($r = 0.40^{**}$). For the

expectations about thermal comfort and type of work indicated that as type of work changes the expectations regarding comfort are higher.

Whereas for workplace it was noted that a change in workplace reflected negative significance ($r = -0.28^{**}$) on expectations regarding thermal comfort. Correlation of age group show that as the age increased the feelings regarding thermal comfort decrease significantly, where as in the second age group only the expected change in the thermal environment is negatively significant ($r = -0.23^{*}$). Suggesting that with expectations the facilities provided for temperature control do not change. Therefore, the negativity towards work and workplace remain reflecting on the output.

Hence it can be concluded that with the change in type of work, workplace and aging the feelings of thermal comfort vary from negative significance to highly positive significance.

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Table 10: Correlation of independent variable with satisfaction regarding thermal comfort

Satisfaction Independent variable	Temperature in office	Humidity in office	Ventilation in office	Location of fan	Provision of cooler	Provision of AC	Drought Control in office	Provision of curtains	Plants near the windows	Exhaust fan for air circulation
Age group										
Group-I (35-45 Yr)	0.22*	0.28**	0.17 ^{NS}	0.19*	0.11 ^{NS}	0.18 ^{NS}	-0.05 ^{NS}	-0.21 ^{NS}	0.19*	0.19*
Group-II (45 & above)	0.23*	0.21*	0.07 ^{NS}	0.20*	-0.00 ^{NS}	-0.03 ^{NS}	-0.08 ^{NS}	0.05 ^{NS}	0.22*	0.23*
Type of work										
Group-I (Clerk)	0.21*	0.19*	-0.02 ^{NS}	0.22*	-0.08 ^{NS}	0.01 ^{NS}	0.19*	0.25**	-0.07 ^{NS}	0.01 ^{NS}
Group-II (Admn)	0.19*	0.23*	0.04 ^{NS}	0.21*	-0.05 ^{NS}	0.11 ^{NS}	-0.21*	0.25**	0.01 ^{NS}	0.12 ^{NS}
Area of workplace										
Centre of the room	0.25**	0.00 ^{NS}	-0.24*	-0.01 ^{NS}	-0.05 ^{NS}	0.12 ^{NS}	-0.12 ^{NS}	0.01 ^{NS}	-0.20*	-0.22*
Side of the room	0.28**	-0.12 ^{NS}	0.27**	0.08 ^{NS}	0.29**	0.06 ^{NS}	-0.04 ^{NS}	0.19*	-0.01 ^{NS}	0.27**
Near the door	0.10 ^{NS}	-0.01 ^{NS}	0.12 ^{NS}	0.13 ^{NS}	0.12 ^{NS}	0.00 ^{NS}	0.01 ^{NS}	-0.10 ^{NS}	0.01 ^{NS}	0.02 ^{NS}
Near the window	0.00 ^{NS}	0.05 ^{NS}	0.17 ^{NS}	0.15 ^{NS}	0.12 ^{NS}	0.01 ^{NS}	0.13 ^{NS}	0.21*	0.23*	0.00 ^{NS}
BMI Group-I (Normal)	-0.20*	0.19*	-0.04 ^{NS}	0.24*	0.16 ^{NS}	0.13 ^{NS}	-0.05 ^{NS}	0.14 ^{NS}	-0.21*	0.19*
Group-II (Above normal)	0.29**	0.33**	0.24*	-0.14 ^{NS}	0.12 ^{NS}	0.17 ^{NS}	-0.11 ^{NS}	0.09 ^{NS}	0.26**	0.29**

*Denotes significance at 5% level

** Significance 1% level

N.S. =Non significant value

Table 10: Correlation of independent variable with satisfaction regarding thermal comfort

Table 10. It shows correlation of independent variables with satisfaction regarding thermal comfort. It is evident from the table that, the age Group, (I & II) groups positive significant correlation regarding temperature in an office ($r=0.22^*$, 0.23^*), location of the fan ($r=0.19^*$ and 0.20^*), plants near the window ($r=0.19^*$ & 0.22^*), and exhaust fan to aid air circulation ($r=0.19^*$ and 0.23^*) respectively.

While correlation for satisfaction regarding humidity in the office ($r=0.28^*$) with high positive significance for the group-I, whereas it was noted to be positively significant for group-II ($r=0.21^*$). No significant Correlation for age and other aspects of satisfaction regarding thermal comfort was seen.

The findings imply that the office workers from both the age groups were satisfied regarding Temperature in the office, Humidity in the office, Location of the fan, Ventilation in the office, Provision of curtains, Drought control in the office, Plants near the window and Exhaust fan for air circulation aspects. With reference to type of work and satisfaction regarding thermal comfort it is evident from the table that there is positive significant correlation among clerks, administrative workers with satisfaction regarding temperature in the office ($r=0.21^*$ and $r=0.19^*$), humidity in office ($r=0.19^*$ and $r=0.23^*$), location of fan ($r=0.22^*$ and $r=0.21^*$) and drought control in office ($r=0.19^*$). Negative significant correlation was seen for administrative workers for drought control in office ($r= -0.21^*$), satisfaction regarding provision of curtains ($r=0.25^{**}$) was positively highly significantly correlated with the office workers. The correlation for other factors are found to be non significant. The result implies that as the type of work change satisfaction regarding drought control in the office reduces.

Correlation for area of workplace and satisfaction regarding thermal comfort yielded that office worker with workplace at the center of the room were positively highly significantly satisfied regarding temperature in the office ($r=0.25^{**}$). while negative significant correlation was noted for ventilation in the office, plants near. The windows and exhaust fan for air circulation with values ($r= -0.24^*$), ($r= -0.20^*$) and ($r= -0.22^*$) respectively. Satisfaction regarding other aspects was non significant. Worker with workplace at the side of the room showed positively highly significant correlation for temperature in the office, ventilation in the office, provision of coolers and exhaust

fan for air circulation their values being $r=0.28^{**}$, $r=0.27^{**}$, $r=0.29^{**}$, $r=0.27^{**}$ while positive significant correlation for satisfaction regarding provision of curtains ($r=0.19^{*}$), and Satisfaction regarding other aspects was not significant.

Worker with workplace near the window showed positively highly significant correlation for provision of curtains, plants near the windows their values being ($r=0.21^{*}$), ($r=0.23^{*}$) respectively. While satisfaction regarding other aspects was non significant. Workers with workplace near the door showed no significant correlation for all aspects. These findings are similar to Bean and Bell (1992) mentioning that satisfaction is the state of feeling that once needs is fulfilled by implication conditions that produce satisfaction is those that one prefers.

Table 11: Independent variables and overall satisfaction levels of office workers regarding Thermal comfort

Independent variables	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly Dissatisfied
Age					
Group-I	28 (22.4%)	26(20.8%)	25 (20%)	24 (19.2%)	22(17.6%)
Group-II	27 (21.6%)	23(18.4%)	29(32.2%)	24 (19.2%)	25 (20%)
BMI					
Group-I	25 (20%)	35 (28%)	25 (20%)	30(24%)	10(8%)
Group-II	25 (20%)	22(17.6%)	24(19.2%)	24(19.2%)	30(24%)

Note: Figures in parenthesis indicate percentages

Table 11: Independent variables and overall Satisfaction levels of office worker regarding thermal comfort.

Table No. 11. Reveals the Independent variables and overall Satisfaction levels of office worker regarding thermal comfort. It is evident from the table that 22.4 per cent office workers were overall highly satisfied, where as 17.6 per cent were highly dissatisfied from an age group-I. Age group II shows that 32.2 per cent were neutral and only 18.4 per cent were satisfied.

BMI group I indicates that 28 per cent were satisfied, while 8 per cent were highly dissatisfied. BMI group II shows that 24 per cent were highly dissatisfied and 19.2 per cent respondents were remained neutral.

Satisfaction being a relative term may include many other factors and hence the results are just representative on the basis of frequency / percentage it can be said that with increasing BMI, there is a decrease in thermal comfort.

Table 12: Correlation of independent variable with satisfaction regarding illumination.

Satisfaction Independent variable	Better Visibility of work station	Placem ent of Light fixture	Reflectance of light	Curtains for Avoiding glare	Wattage of tube	Control safety	Light on the work place	Intensity of light	Placement of light	Type of light
Age group										
Group-I (35-45Yr)	0.06 ^{NS}	0.19*	-0.00 ^{NS}	0.19*	-0.03 ^{NS}	0.08 ^{NS}	0.25**	-0.03 ^{NS}	0.27**	0.08 ^{NS}
Group-II (45 & above)	0.13 ^{NS}	0.03 ^{NS}	-0.01 ^{NS}	0.19*	-0.06 ^{NS}	0.06 ^{NS}	0.15 ^{NS}	0.21*	0.01 ^{NS}	0.00 ^{NS}
Type of work										
Group-I (Clerk)	0.01 ^{NS}	-0.08 ^{NS}	-0.01 ^{NS}	0.21*	-0.04 ^{NS}	0.06 ^{NS}	0.00 ^{NS}	-0.04 ^{NS}	-0.01 ^{NS}	-0.02 ^{NS}
Group-II (Adm)	-0.04 ^{NS}	0.00 ^{NS}	0.11 ^{NS}	-0.10 ^{NS}	-0.12 ^{NS}	-0.07 ^{NS}	0.12 ^{NS}	0.10 ^{NS}	0.19*	0.12 ^{NS}
Eye Sight										
Group-I (SS)	0.09 ^{NS}	-0.10 ^{NS}	0.26**	-0.05 ^{NS}	-0.16 ^{NS}	-0.00 ^{NS}	-0.15 ^{NS}	0.00 ^{NS}	-0.14 ^{NS}	0.28**
Group-II (N)	0.19*	-0.05 ^{NS}	0.06 ^{NS}	-0.05 ^{NS}	0.15 ^{NS}	0.10 ^{NS}	-0.08 ^{NS}	-0.04 ^{NS}	-0.00 ^{NS}	0.17 ^{NS}
Group-III (LS)	-0.09 ^{NS}	0.06 ^{NS}	-0.22*	0.19*	0.20*	-0.03 ^{NS}	0.17 ^{NS}	0.16 ^{NS}	0.03 ^{NS}	-0.02 ^{NS}
Group-IV (BF)	0.21*	-0.14 ^{NS}	0.09 ^{NS}	-0.16 ^{NS}	0.07 ^{NS}	0.11 ^{NS}	0.02 ^{NS}	0.06 ^{NS}	-0.18 ^{NS}	0.15 ^{NS}

*Denotes significance at 5% level

** Significance 1% level N.S. = Non significant value

Table 12: Correlation of independent variables with satisfaction regarding illumination

Correlation of independent variable with satisfaction regarding illumination is revealed in table 12. It is clear from the findings that age group-I is significantly correlated with satisfaction towards placement of light fixtures ($r=0.19^*$), curtains for avoiding glare ($r=0.19^*$) and positively highly significantly correlated with satisfaction regarding light at workplace ($r=0.25^{**}$) and placement of light ($r=0.27^{**}$) while the other aspects were found to be non significant.

Whereas in the second age group satisfaction regarding curtains for avoiding glare ($r=0.19^*$) and intensity of light ($r=0.21^*$) were significantly correlated and the other factors were found to be non significant.

The type of work shows that for satisfaction regarding curtains to avoid glare ($r=0.21^*$) was positively significantly correlated for clerical workers while it was found to be non significant for all other aspects of satisfaction regarding illumination.

Where as in the administrative office worker's satisfaction regarding placement of light ($r=0.19^*$) was found to be positively significantly correlated while for other factors non significant correlation was observed.

Positive significant correlations of a clerk with satisfaction regarding curtains for avoiding glare imply the office should provide curtains for comfortable working similarly placement of light is also an important aspect for administrative workers.

Considering that illumination has a major impact on visibility and satisfaction of work can be gained only with proper illumination hence the correlation results imply that workers with short sight showed highly positively significant correlation for satisfaction regarding reflectance of light ($r=0.26^{**}$) and type of light ($r=0.28^{**}$) where as the satisfaction regarding other aspects of illumination were non significant.

For office workers with normal eye sight positive significant correlation ($r=0.19^*$) for better visibility at workstation was noted with other aspects being non significant.

Satisfaction regarding reflectance of light at workplace ($r= -0.22^*$) was negatively significantly correlated for people with long sight, whereas positive

significant correlation was seen regarding curtains for avoiding glare ($r=0.19^*$) and wattage of tube ($r=0.20^*$). The other aspect was found to be non significant.

Correlation of satisfaction regarding illumination and bifocal lens user workers revealed positive significant correlation for better visibility at workstation ($r=0.21^*$). While the satisfaction regarding other aspects of illumination was not significant. Despite the wide individual variability in preferred lighting conditions individuals show consistent preferences from one day to another (Carter *et al*, 1999).

Lighting control in the office is similar to the findings of Moore et al., (2002). Several investigations have found that lighting installations with individual controls result in lower energy consumption because some people chose lower light levels, some people switch off when they leave the office and some people near windows will dim or turn off when daylight is available.

Table 13: Satisfaction of office workers regarding illumination

Independent variables	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly Dissatisfied
Age					
Group-I	23 (18.4%)	35 (28%)	33 (26.4%)	12 (9.6%)	22 (17.6%)
Group-II	18 (14.4%)	212 (16.8%)	19 (23.2%)	30 (24%)	27 (21.6%)
Eye sight					
Short sighted	26 (20.8%)	28 (22.4%)	25 (20%)	24 (19.23%)	22 (17.6%)
Normal	24 (19.2%)	30 (24%)	25 (20%)	24 (19.2%)	22 (17.6%)
Long sighted	25 (20%)	25 (20%)	30 (24%)	35 (28%)	10 (8%)
Bifocal	27 (21.6%)	23 (18.4%)	25 (20%)	24 (19.2%)	29 (32.2%)

Note: Figures in parenthesis indicate percentages

Table 13: Satisfaction of office workers regarding illumination

It is evident from the table that 28 per cent office workers were satisfied about illumination and 9.6 per cent felt dissatisfied from age group I. In age group II 24 per cent office workers expressed dissatisfaction and 14.4 per cent were satisfied about

illumination. It can be concluded that when age increases satisfaction of office workers about illumination decreases.

Result of eye sight show that short 24 per cent sighted office workers are satisfied. Twenty four per cent normal eye sight office workers expressed satisfaction where as 28 per cent long sighted office workers were dissatisfied and thirty two per cent bifocal lance users were highly dissatisfied about illumination.

It can be concluded that with the degree of complexity of a lens is an increase in dissatisfaction towards office illumination.

Table 14: Comparison of illumination levels in the office with standard

Offices	Standard	Work station mean \pm SD	t-value	General light mean \pm SD	t=	Artificial light mean \pm SD	t=
Collector office	300- 750	402.79 \pm 52.60	-0.064	544.11 \pm 18.84	0.020	689.33 \pm 44.03	0.60
ZP office	300- 750	410.73 \pm 48.41	-0.064	548.46 \pm 19.78	0.024	688.24 \pm 44.65	0.059
District welfare office	300- 750	405.14 \pm 52.35	-0.063	542.68 \pm 19.84	0.018	683.94 \pm 45.33	0.057
Municipal council office	300- 750	401.91 \pm 61.90	-0.055	541.05 \pm 19.80	0.016	690.23 \pm 44.19	0.060
Marathwada Agricultural University Administrative office	300- 750	406.00 \pm 50.63	-0.064	547.60 \pm 19.99	0.023	697.85 \pm 45.25	0.061

Ref: IS – 3646 (Part I) : 1992 code of practice for interior illumination.

Table 14: Comparison of illumination levels in the office with standard

The comparative evaluation of illumination levels in the selected office with standard revealed that illumination at workstation was low in all the offices viz. collector office (402.7 ± 52.68), Z.P. office (410.7 ± 48.4), A District welfare office (405.1 ± 52.3), Municipal council office (401.9 ± 61.9) and MAU Administrative office (406 ± 50.6) while the standard illumination mean was 525 Lux the mean values differ yet they were statistically not significant.

While in case of general light the Mean \pm SD reading for offices all offices were higher than the standard mean 525 Lux but statistics shows no significant variation in illumination levels were as the findings for artificial light in a similar trend with general light. The values for artificial light being higher than standard mean disclose that the office workers feel more comfortable with higher illumination levels while the statistical implication is not significant.

The illumination levels in the office are similar findings are Begemann *et al.*(1994) Found that Dutch office worker added an average of 800 Lux of artificial light, regardless of day light or weather conditions. The Dutch luminance standard for offices is 500 Lux. British office workers were more satisfied with a horizontal luminance at 800 Lux.

Table 15 Comparison of illumination with standard for age groups

Age groups	Standard	Work station light (Lux) Mean \pm SD	t-value	General light (Lux) mean \pm SD	t=value	Artificial light(Lux) mean \pm SD	t=value
35-45 years	400-800	415.2 \pm 50.1	-0.06	534.1 \pm 18.8	0.00	680.2 \pm 42.9	0.05
45 and above	400-800	460.1 \pm 36.1	-0.04	547.6 \pm 19.9	0.02	693.8 \pm 46.4	0.06

Table 15: Comparison of illumination with standard for age groups

The comparative evaluation of illumination levels in the selected offices with standard IS – 3646 reveals that illumination at workstation was low for both the age groups Viz. 35-45-year age group (415.2 \pm 50.1) 45 year and above age group (460.8 \pm 36.1) while the standard illumination was 300 – 750 lux therefore though the mean values differ yet they were statistically non significant.

While in case of general light the mean \pm SD reading for both the age groups was higher than the standard mean 525 Lux but statistics showed no significant variation in illumination levels. Whereas the findings for artificial light are in a similar trend with general light. The values for artificial light being higher than standard disclose

that the office worker feel more comfortable with higher illumination levels. While the statistical implication is not significant.

Indoor levels without daylight contributions are between 100 and 500Lux only and are usually determined by the requirement in the standard or recommendations.

Findings are supported by Begemann (1997) study that people prefer high additional electric lighting in an office environment (average 800 Lux on top of the prevailing daylight contribution.)

Table 16: Correlation of independent variables with satisfaction regarding Work output

Satisfaction Regarding Independent variable	Workout put in a day.	Artificial light	Natural light	Provision of cooler	Provision of fan	Provision of curtains
Age group						
Group-I (35-45 Yr)	0.19*	0.21*	0.19*	0.12 ^{NS}	0.21*	0.15 ^{NS}
Group-II (45 & above)	0.21*	0.20*	0.18 ^{NS}	0.09 ^{NS}	0.23*	0.17 ^{NS}
Area of work place						
Center of room	0.19*	0.22*	0.12 ^{NS}	0.13 ^{NS}	0.22*	0.17 ^{NS}
Side of room	0.18 ^{NS}	0.19*	0.17 ^{NS}	0.15 ^{NS}	0.18 ^{NS}	0.13 ^{NS}
Near the door	0.17 ^{NS}	0.18 ^{NS}	0.19*	0.12 ^{NS}	0.17 ^{NS}	0.15 ^{NS}
Near the window	0.20*	0.17 ^{NS}	0.21*	0.09 ^{NS}	0.18 ^{NS}	0.19*
BMI						
Group-I (Normal)	0.19*	0.21*	0.18 ^{NS}	0.12 ^{NS}	0.21*	0.18 ^{NS}
Group-II (above normal)	0.18 ^{NS}	0.19*	0.17 ^{NS}	0.15 ^{NS}	0.20*	0.16 ^{NS}

*Denotes significance at 5% level

** Significance 1% level

N.S. = Non significant value

Table 16: Correlation of independent variables with satisfaction regarding Workout put.

Correlation of independent variables with satisfaction regarding work output is revealed in table 16 it is clear from the findings that Age group-I is significantly correlated with satisfaction towards work output in a day ($r=0.19^*$), artificial light ($r=0.21^*$) while other aspects are found to be non significant.

Whereas in the second age group satisfaction regarding work output in a day ($r=0.21^*$), artificial light ($r=0.20^*$) and provision of the fan ($r=0.23^*$) was significantly correlated and the other factors were found to be non significant. With increase in age artificial light and provision of the fan need to be improved. Similar thoughts have been expressed by Bommel *et al.* (2002) in 'Industrial Lighting and Productivity', that age is important criterion since lighting requirements increase with age. Older clerical workers however, did show stronger preferences for higher luminance than younger ones (Barnaby, 1980)

It is seen from the findings that area of workplace at center of room is significantly correlated with satisfaction towards work output in a day ($r=0.19^*$), artificial light ($r=0.22^*$) and provision of the fan ($r=0.22^*$) while other aspects are found to be non significant.

Whereas the area of workplace at the side of room is significantly correlated ($r=0.19^*$) and the other factors were found to be non significant. While the area of workplace near the door is significantly correlated with satisfaction towards natural light ($r=0.19^*$) and the other factors were found to be non significant. Whereas the area of workplace near the window is significantly correlated with satisfaction towards work output in a day ($r=0.20^*$), natural light ($r=0.21^*$), provision of curtains ($r=0.19^*$) and the other factors were found to be non significant.

Table 17: Perception regarding work output

Sr. No.	Statements	Agree	Disagree
		(N=125)	(N=125)
1.	Do you feel your work output is affected by humidity?	85 (68%)	40 (32%)
2.	Do you feel your work output is affected by temperature?	92 (73.6%)	33 (26.4%)
3.	Do you feel your work output is affected by illumination?	112 (89.6%)	13 (10.4%)
4.	Do you feel your work output is affected by room comfort	79 (63.2%)	46 (36.8%)
5.	Do you feel your work output is affected by work station?	105 (84%)	20 (16%)
6.	Do you feel your work output affected by air flow in room?	71 (56.8%)	54 (43.2%)
7.	Do you feel your work output is affected by provision of ventilation?	97 (77.6%)	28 (22.4%)
8.	Do you feel your work output is affected by provision of cooler?	94 (75.2%)	31 (24.8%)
9.	Do you feel your work output is affected by color of office?	87 (69.6%)	38 (30.4%)
10.	Do you feel your work output is affected by provision of fan?	68 (54.4%)	57 (45.6%)

Note: Figures in parenthesis indicate percentages

Table 17: Perception regarding work output

Perception regarding workout is disclosed in table 17, work output is a very vague term, the results of perception regarding over all work output in the day concerning their environment and decided work for the day was enquired hence the factors which may affect the work output were studied.

It is clear from the table that 89.6 per cent office workers agreed that work output is affected by illumination, followed by 84 per cent who approved that workstation effect output, 77.6 per cent admitted that ventilation has an effect on work output and 72.5 per cent respondents accepted that provision of coolers at office workstation affects the work output. While lower percentage but not below 50 per cent admitted that provision of fans affect the work output.

The percentage for disagreement regarding perception of work output were lower than fifty per cent, the comparatively higher values' for disagreement about provision of the fan (45.6 %) effect of air flow on work output (43.2%) and effect of the room comfort on work output (36.8 %) were seen, while least percentage of disagreement was observed for illumination at workstation (10.4%).

Therefore, it can be concluded that the work output as agreed by higher percentage of respondents is affected by illumination, workstation, ventilation and provision of coolers.

SUMMARY

AND

CONCLUSION

SUMMARY AND CONCLUSION

The thermal comfort and illumination are of utmost importance be it home or office. The efficiency of the worker is affected by these factors which contribute to the mood of the worker. The discomfort levels of workplace lead to many health problems which are normally not taken care off.

A suitable physical climate is needed if one wants to feel comfortable and efficient at work. The environment feels comfortable when you are barely aware of the climatic conditions. It is only when the temperature decreases or increases beyond one's comfort limit that one become aware of discomfort.

Light is effective when it corresponds to the visual needs of the worker. Sustainable lighting helps to avoid accidents, supports emotional and physical well being and contributes to security. Ergonomics in simple terms means fitting the task to the user's requirements. Ergonomics of lighting at workplace place would mean determination of lighting needs of the user with minimal strain in given environment.

Considering these aspects it becomes essential to study the illumination and thermal comfort in the office work stations with the following objectives.

1. To determine the illumination in office workstation
2. To determine the thermal comfort in office workstation
3. To correlate the illumination levels and thermal comfort with the satisfaction levels of work output.

The study was conducted with the 5 offices (Administrative Office, Municipal Council Office, Zillah Parishad Office, Collector Office, District Welfare Office) situated in Parbhani town during 2008-2009. Twenty five workstations each were selected randomly from these offices totaling up to 100. A purposive random sample of office workers using the workstations for 6-8 hrs were choosen for the study. The respondents using the workstations were interviewed with the help of a prestructured &

pretested questionnaire. Parameters such as illumination, temperature & humidity will be recorded.

The illumination level at the workstation was measured as general light present in lux & illumination level at five points of the workstation were recorded with the help of Digital Lux meter & an average was worked out. The illumination level was recorded three times a day i.e. Morning, Afternoon, Evening. Illumination level with natural & artificial light was also recorded.

Room temperature was recorded with the help of dry & wet bulb thermometer. Also the temperature outside the building was recorded. Humidity was recorded with the help of Hygrometer. Bedford scale was used for recording the thermal comfort level.

A scale was developed for the satisfaction of workers regarding illumination, thermal comfort and work output. The collected data was tabulated & analyzed by calculating averages, percentiles, correlation & other suitable statistical techniques.

It can be concluded that majority of the respondents belonged to age group of 45 years and above. 12 per cent respondents were post graduates. Monthly income of 54.4 per cent subjects was Rs.11500. and above majority of the respondents belonged to the clerical community 11.2 per cent were having normal eye sight. 68 per cent respondent were having 19-21 Body Mass Index and majority i.e. 90.4 per cent respondent were male members.

Maximum number of the rooms (113) had one door of 7'x4' whereas only 12 rooms had two doors of 6'x3'. In case of windows 50.4 per cent rooms had two windows of 3.5'x4', 40 per cent rooms had three windows of 3'x3.5' while 9.6 per cent rooms were having four windows of 3'x4'. 38.4 per cent respondent had workstation in the center of the room, 37.6 per cent rooms had been opening towards east, 54.4 per cent respondents had workstation size of 4'x3' and 59.2 per cent respondents were having the workplace in a room size of 15'x10'.

Artificial light is required by forty eight per cent respondent for five hours during the day, placement of light fixture, fifty point four per cent felt that placement of light fixture inconvenient. Number of light fixtures at workplace show that most of the rooms (48 %) had two tubes

It can be concluded that 41.6 per cent respondents felt comfortably warm and only 3.2 per cent opined that they generally felt much too warm at workplace, as perception of thermal comfort.

Thermal comfort scores indicated that 40 per cent of the office workers were neutral towards the temperature in the office. Temperature in Jan., Feb., Mar. Was 29.7°C , 32.03°C and 36.3°C respectively, Similarly the reading for humidity indicated that the humidity inside the room was higher than standard (62.75) during Jan. (77.42 ± 3), Feb. (69 ± 3), Mar. (47.85 ± 2.54).

The type of work is ($r = -0.21^*$) negatively significantly correlated with the present feeling implying that the thermal comfort decreased with variation in the type of work. With a change in type of work changes the expectations regarding comfort are higher. As the age increased the feelings regarding thermal comfort decrease significantly.

Correlation for area of workplace and satisfaction regarding thermal comfort concluded that office worker with workplace at the center of the room were positively highly significantly satisfied regarding temperature in the office ($r = 0.25^{**}$). Worker with workplace at the side of the room showed positively highly significant correlation for temperature in the office, ventilation in the office, provision of coolers and exhaust fan for air circulation their values being $r = 0.28^{**}$, $r = 0.27^{**}$, $r = 0.29^{**}$, $r = 0.27^{**}$.

Overall Satisfaction levels of office worker regarding thermal comfort showed that 22.4 per cent office workers were overall highly satisfied. BMI group I indicates that 28 per cent were satisfied. BMI group II shows that 24 per cent were highly dissatisfied. Satisfaction being a relative term may include many other factors and hence the results are just representative on the basis of frequency / percentage it can be said that with increasing BMI, there is a decrease in thermal comfort.

Considering that illumination has a major impact on eye sight the correlation results imply that workers with short sight showed highly positively significant correlation for reflectance of light ($r = 0.26^{**}$) and type of light ($r = 0.28^{**}$) where as the satisfaction regarding other aspects of illumination were non significant. Satisfaction regarding reflectance of light at workplace ($r = -0.22^*$) was negatively significantly correlated for people with long sight. Correlation of satisfaction regarding illumination and bifocal lens user workers revealed positive significant correlation for better visibility at workstation ($r = 0.21^*$).

On the whole it can be concluded that values for indoor relative humidity and temperature compared with standard did not vary much implying that the humidity and temperature levels were within tolerable limit and work station light is not sufficient as compare to standard.

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LITERATURE CITED

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APPENDICES

APPENDIX -I

QUESTIONNAIRE CUM INTERVIEW SCHEDULE GENERAL INFORMATION

1. **Name** :
2. **Age** :
3. **Height** :
4. **Weight** :
5. **BMI** :
6. **Education** :
7. **Cadre** :
8. **Sex** :
9. **Income** :
10. **Type of work: 1.Clerical 2.Teaching 3. Research 4. Administrative**
11. **Duty hours** :
12. **Break period** : 15 min/ 30min/ 1 hr
13. **Eye sight** : 1.Short sighted 2.Normal 3.Long sighted 4.Bifocal
14. **Area of workstation(sq . foot)** :

15. No. of Tubes :
16. Placement of light fixtures : 1.Wall 2.Ceiling
17. Wattage of Tubes :
18. Area of workplace : 1.Center of the room 2.Side of the room 3.near the door 4.near the window
19. No. of doors :
20. No. of windows :
21. Size of doors :
22. Size of windows :
23. Orientation of the room : 1.East 2.west 3.North 4.South
24. Type of light fixture :1.Direct 2.Indirect 3.Semi direct 4. Semi indirect 5. diffused
25. Placement of light fixture control : 1.Convenient 2.Inconvenient
26. Indicate the frequency of artificial light during the day:
27. Indicate on the scale below how you feel now:1.Warm 2.Hot 3.Cool
28. Indicate on the scale below how you feel now:1.Hot 2. Warm
3. Slightly warm 4.Neutral 5. Slightly cool 6.Cool 7. Cold
29. Please indicate how you would like to be now: 1warmer 2.no change 3.cooler
30. Please indicate how you generally feel at work:1.hot 2.warm 3.cool

31. Please indicate how you would generally like to be at work:

1.warmer 2.no change 3.cooler

PERCEPTION REGARDING TO THERMAL COMFORT & ILLUMINATION:

1. Do you feel curtains help in regulating temperature?
a. Agree b. Disagree
2. Do you feel colors help in regulating temperature?
a. Agree b. Disagree
3. Do you feel types of light fixtures help in regulating temperature?
a. Agree b. Disagree
4. Do you feel indirect light is good for workplace?
a. Agree b. Disagree
5. Do you feel direct light is good for workplace?
a. Agree b. Disagree
6. Do you feel diffused light is helpful for better vision?
a. Agree b. Disagree
7. Do you feel wall washers should be provided for lobbies?
a. Agree b. Disagree
8. Do you feel color of wall help in intensity of light?
a. Agree b. Disagree
9. Do you feel windows are used for better air flow?
a. Agree b. Disagree

10. Do you feel exhaust fans are helpful in office?
a. Agree b. Disagree
11. Do you feel water loving pot plants are good for maintaining temperature in office?
a. Agree b. Disagree
12. Do you feel air coolers are provided for maintaining temperature & humidity in office?
a. Agree b. Disagree

**PERCEPTION REGARDING TO ENVIRONMENTAL FACTORS &
WORKOUTPUT**

1. Do you feel your work output is affected by humidity?
a. Agree b. Disagree
2. Do you feel your work output is affected by temperature?
a. Agree b. Disagree
3. Do you feel your work output is affected by illumination?
a. Agree b. Disagree
4. Do you feel your work output is affected by room comfort?
a. Agree b. Disagree
5. Do you feel your work output is affected by work station?
a. Agree b. Disagree
6. Do you feel your work output is affected by air flow in room?
a. Agree b. Disagree
7. Do you feel your work output is affected by provision of ventilation?
a. Agree b. Disagree

8. Do you feel your work output is affected by provision of cooler?
a. Agree b. Disagree
9. Do you feel your work output is affected by color of office?
a. Agree b. Disagree
10. Do you feel your work output is affected by provision of fan?
a. Agree b. Disagree

STATEMENTS RELATED TO ILLUMINATION

1. How much satisfied are you about better visibility for workstation?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
2. How much satisfied are you about placement of light fixtures?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
3. How much satisfied are you regarding the color contributing to reflectance of light in your room?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
4. How much satisfied are you about curtains for avoiding glare?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
5. How much satisfied are you about wattage of lamp/Tub?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
6. How much satisfied are you about regarding to the control safety?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
7. How much satisfied are you about reflectance of light on the work space?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
8. How much satisfied are you about intensity of light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
9. How much satisfied are you about placement of light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
10. How much satisfied are you about type of light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

STATEMENTS RELATED TO THERMAL COMFORT

1. How much satisfied are you about the temperature in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
2. How much satisfied are you about the humidity in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
3. How much satisfied are you about the ventilation of office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
4. How much satisfied are you about the location of fan?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
5. How much satisfied are you about the provision of cooler?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
6. How much satisfied are you about the provision of AC?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
7. How much satisfied are you about the provision of curtains to control the air flow?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
8. How much satisfied are you about plants near the windows?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
9. How much satisfied are you about drought control in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
10. How much satisfied are you about exhaust fan for air circulation?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

STATEMENTS RELATED TO WORKOUTPUT

1. How much satisfied are you about morning work output?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
2. How much satisfied are you about afternoon work output?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
3. How much satisfied are you about the work output during summer period?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
4. How much satisfied are you about the work output during winter period ?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
5. How much satisfied are you about the work output during rainy period?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
6. How much satisfied are you with the work output while working with artificial light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
7. How much satisfied are you with the work output while working with direct light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
8. How much satisfied are you about the output of work in natural light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
9. How much satisfied are you about the work output at the time of provision of cooler?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
10. How much satisfied are you about the work output at the time of provision of fan?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

APPENDIX II -A
WEEKLY TEMPERATURE AND HUMIDITY DATA STANDARD
[data base 1975-2004] ✓

meteorological readings

Week No.	Dates	Temperature ($^{\circ}\text{C}$)	Humidity (%)
1	01-07 Jan	28.8	75
2	08-14 Jan	29.2	74
3	15-21 Jan	30.1	73
4	22-28 Jan	31.0	72
5	29-04 Feb	31.4	66
6	05-11 Feb	31.8	65
7	12-18 Feb	32.9	61
8	19-25 Feb	33.4	59
9	26-04 Mar	34.8	53
10	05-11 Mar	35.7	49
11	12-18 Mar	36.7	47
12	19-25 Mar	38.0	42
13	26-01 Apr	38.2	42

*all data from 1975 to 2004
has been checked and
found to be correct.*

APPENDIX II-B

RECORDING SHEET FOR TEMPERATURE AND HUMDIITY

[illegible]

APPENDIX III- A
Illumination standard

Area	Illumination range in Lux	Remarks
General offices	300-500-750	--
Computer workstation	300-500-750	--
Assembly shops rough work for example frame and heavy machine assembly	200-300-500	Lighting and vertical surface may be important
Medium work for example assembly vehicle body assembly	300-500-750	--
fine work, for example office machinery assembly	500-750-1000	Localized lighting may be useful
Very fine work for example Instrument assembly	750-1000-1500	Local lighting and optical aids are desirable
Minute work for example watch making	1000-1500-2000	Local lighting and optical aids are desirable.

Ref : IS-3646 (Part I) : 1992 code of practice for interior illumination.

This reference is not quoted in Litendine's book. Where did you use this information? 12/11/2015

APPENDIX III - B

RECORDING SHEET FOR ILLUMINATION LEVELS

[illegible]

APPENDIX: IV-A

LIST OF STATEMENTS

STATEMENTS RELATED TO ILLUMINATION

1. How much satisfied are you about light fixtures, number of light fixtures?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
2. How much satisfied are you about type of light provided ?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
3. How much satisfied are you about direction of light?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
4. How much satisfied are you about the wattage of light fixtures?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
5. How much satisfied are you about natural light?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
6. How much satisfied are you about artificial light ?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
7. How much satisfied are you about control safety?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
8. How much satisfied are you about the type of wiring?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied

9. How much satisfied are you about placement of light?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
10. How much satisfied are you about the shielding provided for light?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
11. How much satisfied are you about the workplace light?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
12. How much satisfied are you about the intensity of light?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
13. How much satisfied are you about the table cloths?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
14. How much satisfied are you about the color of walls?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
15. How much satisfied are you about the carpet color?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
16. How much satisfied are you about illumination in office for reducing risk of the occupational accidents?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
17. How much satisfied are you about illumination in office for reducing risk of the Health problems?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
18. How much satisfied are you about better concentration & accuracy of work?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

19. How much satisfied are you about improved work performance?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
20. How much satisfied are you about better visibility?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
21. How much satisfied are you about increased work speed due to available light in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
22. How much satisfied are you about position of light sources?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
23. How much satisfied are you about the height, width & position of windows?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
24. How much satisfied are you about switches of light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
25. How much satisfied are you about placement of light fixtures?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
26. How much satisfied are you about location of workplace?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
27. How much satisfied are you about ceiling & wall colors?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
28. How much satisfied are you about trees around the office due to prevent or diminish direct glare from the sun?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

29. How much satisfied are you about general light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
30. How much satisfied are you about artificial light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
31. How much satisfied are you about work station light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
32. How much satisfied are you about curtains for avoiding glare?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
33. How much satisfied are you about appropriate colors are used for work background?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
34. How much satisfied are you about wattage of lamp/Tub?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
35. How much satisfied are you about regarding to the safety of light fixtures?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
36. How much satisfied are you about reflector for light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

STATEMENTS RELATED TO THERMAL COMFORT

1. How much satisfied are you about temperature in office?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
2. How much satisfied are you about humidity in office?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
3. How much satisfied are you about provision of fan?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
4. How much satisfied are you about the ventilation?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
5. How much satisfied are you about the placement of workstation?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
6. How much satisfied are you about the temperature during morning?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
7. How much satisfied are you about the temperature during afternoon?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
8. How much satisfied are you about the temperature during evening?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
9. How much satisfied are you about the location of fan?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
10. How much satisfied are you about the provision of curtains?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied

11. How much satisfied are you about the provision of cooler / AC?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
12. How much satisfied are you about the windows?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
13. How much satisfied are you about the size of office?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
14. How much satisfied are you about the air flow at workstation?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
15. How much satisfied are you about the location of workspace?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
16. How much satisfied are you about the cushion of chair?
a. highly satisfied b. satisfied c. neutral d. dissatisfied f. highly dissatisfied
17. How much satisfied are you about weared clothing?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
18. How much satisfied are you about plants near the windows?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
19. How much satisfied are you about drought in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
20. How much satisfied are you about placement of workstation?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
21. How much satisfied are you about exhaust fan?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

STATEMENTS RELATED TO WORKOUTPUT

1. How much satisfied are you about morning work output?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
2. How much satisfied are you about afternoon work output?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
3. How much satisfied are you about the work output during summer period?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
4. How much satisfied are you about the work output during winter period ?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
5. How much satisfied are you about the work output during rainy period?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
6. How much satisfied are you with the work output while working with artificial light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
7. How much satisfied are you with the work output while working with direct light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
8. How much satisfied are you about the output of work in natural light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
9. How much satisfied are you about the work output at the time of provision of cooler?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
10. How much satisfied are you about the work output at the time of provision of fan?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

11. How much satisfied are you about the work output at the time of water loving pot plant on table?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
12. How much satisfied are you about the work output at the time of plant near the windows?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
13. How much satisfied are you about the work output at the time of curtains provided for windows?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
14. How much satisfied are you about the work output at the time of provision of exhaust fans?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
15. How much satisfied are you about the work output at the time of better air flow in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

APPENDIX IV B

LIST OF MODIFIED STATEMENTS

STATEMENTS RELATED TO ILLUMINATION:

1. How much satisfied are you about better visibility for workstation?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
2. How much satisfied are you about placement of light fixtures?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
3. How much satisfied are you regarding the color contributing to reflectance of light in your room?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
4. How much satisfied are you about curtains for avoiding glare?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
5. How much satisfied are you about wattage of lamp/Tub?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
6. How much satisfied are you about regarding to the control safety?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
7. How much satisfied are you about reflectance of light on the work space?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
8. How much satisfied are you about intensity of light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
9. How much satisfied are you about placement of light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
10. How much satisfied are you about type of light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

STATEMENTS RELATED TO THERMAL COMFORT:

1. How much satisfied are you about the temperature in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
2. How much satisfied are you about the humidity in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
3. How much satisfied are you about the ventilation of office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
4. How much satisfied are you about the location of fan?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
5. How much satisfied are you about the provision of cooler?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
6. How much satisfied are you about the provision of AC?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
7. How much satisfied are you about the provision of curtains to control the air flow?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
8. How much satisfied are you about plants near the windows?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
9. How much satisfied are you about drought control in office?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
10. How much satisfied are you about exhaust fan for air circulation?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

STATEMENTS RELATED TO WORKOUTPUT

1. How much satisfied are you about morning work output?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
2. How much satisfied are you about afternoon work output?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
3. How much satisfied are you about the work output during summer period?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
4. How much satisfied are you about the work output during winter period ?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
5. How much satisfied are you about the work output during rainy period?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
6. How much satisfied are you with the work output while working with artificial light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
7. How much satisfied are you with the work output while working with natural light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
8. How much satisfied are you about the output of work in natural light?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
9. How much satisfied are you about the work output at the time of provision of cooler?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied
10. How much satisfied are you about the work output at the time of provision of fan?
a. Highly satisfied b. Satisfied c. Neutral d. Dissatisfied e. Highly dissatisfied

APPENDIX V

't' values of satisfaction regarding illumination

Sr. No.	Statement	't' Values
1	How much satisfied are you about placement of light fixtures?	2.98
2	How much satisfied are you about wattage of lamp ?	2.72
3	How much satisfied are you about placement of light?	2.65
4	How much satisfied are you regarding the color contributing to reflectance of light in your room?	2.58
5	How much satisfied are you about intensity of light?	2.52
6	How much satisfied are you about type of light?	2.42
7	How much satisfied are you about better visibility for work station ?	2.36
8	How much satisfied are you about curtains for avoiding glare?	2.21
9	How much satisfied are you about reflectance of light on the work space ?	2.17
10	How much satisfied are you regarding control safety ?	2.17
11	How much satisfied are you about the workplace light?	2.10
12	How much satisfied are you about improved work performance?	2.00
13	How much satisfied are you about artificial light?	1.99
14	How much satisfied are you about regarding to the safety of light fixtures?	1.97
15	How much satisfied are you about the carpet color?	1.96
16	How much satisfied are you about general light?	1.95
17	How much satisfied are you about better visibility?	1.91
18	How much satisfied are you about the height, width & position of windows?	1.90
19	How much satisfied are you about better concentration & accuracy of work?	1.88

20	How much satisfied are you about position of light sources?	1.87
21	How much satisfied are you about work station light?	1.85
22	How much satisfied are you about appropriate colors are used for work background?	1.82
23	How much satisfied are you about the table cloths?	1.80
24	How much satisfied are you about reflector for light?	1.80
25	How much satisfied are you about improved work performance?	1.79
26	How much satisfied are you about the type of wiring?	1.78
27	How much satisfied are you about illumination in office for reducing risk of the occupational accidents?	1.75
28	How much satisfied are you about increased work speed due to available light in office?	1.76
29	How much satisfied are you about artificial light ?	1.74
30	How much satisfied are you about illumination in office for reducing risk of the Health problems?	1.73
31	How much satisfied are you about trees around the office due to prevent or diminish direct glare from the sun?	1.72
32	How much satisfied are you about position of light sources?	1.71
33	How much satisfied are you about switches of light?	1.70
34	How much satisfied are you about increased work speed due to available light in office?	1.69
35	How much satisfied are you about wattage of lamp/Tub?	1.68
36	How much satisfied are you about the color of walls?	1.65

't' values of satisfaction levels regarding thermal comfort

Sr. No.	Statement	't' Values
1	How much satisfied are you about the provision of curtains to control the air flow?	2.92
2	How much satisfied are you about the provision of AC?	2.87
3	How much satisfied are you about the ventilation office?	2.82
4	How much satisfied are you about the exhaust fan for air circulation ?	2.73
5	How much satisfied are you about the plants near the windows?	2.62
6	How much satisfied are you about the provision of cooler?	2.57
7	How much satisfied are you about the humidity in office?	2.56
8	How much satisfied are you about the location of fan?	2.32
9	How much satisfied are you about drought control in office?	2.15
10	How much satisfied are you about the temperature in office?	2.12
11	How much satisfied are you about placement of workstation?	2.10
12	How much satisfied are you about the temperature during morning?	2.00
13	How much satisfied are you about wearied clothing?	1.98
14	How much satisfied are you about the cushion of chair?	1.95
15	How much satisfied are you about the location of workspace?	1.92
16	How much satisfied are you about the size of office?	1.89
17	How much satisfied are you about the windows?	1.87
18	How much satisfied are you about the temperature during afternoon?	1.84
19	How much satisfied are you about the temperature during evening?	1.80
20	How much satisfied are you about the placement of workstation?	1.79
21	How much satisfied are you about the provision of cooler?	1.76

't' values of satisfaction levels regarding work output

Sr. No.	Statement	't' Values
1	How much satisfied are you about afternoon work output ?	2.92
2	How much satisfied are you about the work output during summer period ?	2.87
3	How much satisfied are you about the work output at the time of provision of fan ?	2.62
4	How much satisfied are you about the work output at the time of provision of coolers ?	2.54
5	How much satisfied are you about the work output during winter period ?	2.52
6	How much satisfied are you about the output of work in natural light ?	2.44
7	How much satisfied are with the work output while working with direct light ?	2.39
8	How much satisfied are you about the work output while working with artificial light ?	2.33
9	How much satisfied are you about morning work output	2.31
10	How much satisfied are you about the work output during the rainy period	2.18
11	How much satisfied are you about the work output at the time of better air flow in office?	2.11
12	How much satisfied are you about the work output at the time of provision of exhaust fans?	2.09
13	How much satisfied are you about the work output at the time of curtains provided for windows?	2.00
14	How much satisfied are you about the work output at the time of plant near the windows?	1.95
15	How much satisfied are you about the work output at the time of water loving pot plant on table?	1.90