Bank Employees' Fatigue Level in Relation to Office Lighting

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Abstract

This research is focused to study light's visual and non visual impact. The objectives of research are to study lighting systems of banks' buildings in selected areas of Lahore, Pakistan. Lighting system is studied in term of light level, light color, shadows reflections and direction etc. In second phase employees' fatigue level is calculated on a scale and studied its association with their office lighting Light impact on male and female employees were also studied. Forty five branches of nine commercial banks were selected as study sampling. Lighting conditions were assessed through check list and employees' opinion was also recorder through questionnaire. FACES (Fatigue Adjective Scale; reliability .8) was used to asses employees' fatigue level. Data Analysis showed significant association between fatigue level and light level (lux level). Fatigue level is also associated with employees age.

Key words Fatigue, Lux level, Lights

Introduction

An interior is composed of different elements like, windows, doors, walls, furniture, furnishings and lighting etc. Experts in this field confirm that office design directly affects employees' health, well-being and productivity within the workforce(Hathaway, 1995). The American Society of Interior Designers described lighting both natural and artificial, temperature, furniture and space as important element in office. A well planned office increases employees productivity (performance), many published studies that measure human response to varying environmental conditions advance the argument that happier and more contented workers are likely to be more productive (work harder) than unhappy or dis-satisfied workers(Vicher 2003). The office employees spent most of their time inside so artificial light affects their health and well-being(Appleman, Figueiro & Rea 2013).

In designing banks' lighting system, placement, direction and intensity of luminaries are important factors to consider. Light has visual and non visual effects on human body(Lin etal 2008). Light through eyes controls the endocrine system; it is as important for body as food. The Combination of natural and artificial light is ideal for improving mood and mind alertness in office. Employees will suffer less visual fatigue, exhaustion, stress and headaches, so it means there will be more productivity and fewer work absentees(Ajala 2012). Light of high luminance level and white colour increases mind alertness, vitality and positive mood trait (Smolder etal 2012). Type of lamp, lux levels and light colour should be considered before designing bank's lighting. Red and blue lights increased electroencephalographic beta power (12-30 Hz), reduce sleepiness and increase positive mood traits (Figueiro etal 2009) Parabolic- louvered luminaries provide better verbal intellectual and clerical task performance than recessed lenses. Fluorescent and Led lamps are user accepted as compared to other sources of light (Islam etal 2013).

Light in an interior environment serves different purposes like, task performance, ambiance creation and to highlight some feature. A luminary installed in a bank serves the purpose of improving task performance. Employees perform some sensitive tasks like writing cheques and counting cash under these lighting conditions. So lux level, direction, reflection and shadows of lit environment should be planned to increase visual and non visual performance. Employees' mind alertness and vitality can be increased or decreased by choosing right type of light source, color and luminary. This research is focused to investigate type of lighting system in selected banks and its impact on employees fatigue level. This article will help interior designers and architects to design functional lighting for Banks' interior.

Pakistan is situated in a region where summers are long (approximately nine month) and harsh. Bank employees have to stay inside because of their long working hours under artificial light. They have very less amount of natural light

available. Lighting in most of the banks is neglected because architects, designers and management focused on heating & cooling, furniture, space etc. This study is design to find an association, if any between office lighting and employees' fatigue level.

This study is conducted to:

Explore lighting designs of selected banks in term of lux levels, lamp type and luminary placement.

Assess bank employees' fatigue level under different types of lighting.

Study variation in male and female fatigue level.

Determine relationship between fatigue and light variables.

This study is designed to answer the following questions.

What type of lighting is installed in bank buildings in term of lamp type, light levels and luminary placement?

Whether male and female employees' fatigue level varies significantly?

Is there any correlation between fatigue and light variables like luminary type, lux level etc.?

All available researches were studied thoroughly to explore impact of light on fatigue. Fatigue can be visual and non visual. Visual fatigue is caused by low lux level in performing daily activities especially at work place. Ten college students were exposed to four different light colour (white, blue, red & green) and two different light levels (20lx and 340 lx). These respondents reported that they are less fatigued while working under blue & white light than green and red. This research proposed different ways of using suitable light colours and illumination level(Lin etal 2008).

A researcher claimed that productivity of employees in offices can be increased at least 5% with suitable lighting system. The suitable lighting system is that which includes high lux level. Respondents perform better in high lux level(Higgins 2012). A study of on indirect and compound lighting system proved that direct lighting system was preferred by employees over indirect system except age & gender differences(Wolska 2003).

American Medical Association in a series of researches explains relationship of light with eyes. Fifty two different lighting systems were tested for visual comfort, efficiency of fresh eyes and loss of efficiency & discomfort after some work. The children visual acuity was tested while working under fluorescent lamp 3600k & 5500K (two conditions) and in third condition 50% less luminance. Results showed that visual acuity was directly related with luminance.

The studies on relationship of light with circadian clock explained impact of light on non visual fatigue. In another research it was proved that blue and red light exposure at night affects Cartisol, Alpha Amylase & Melatonin levels in blood(Figuerio etal 2009). The change in levels of these substances in relation to blue and red light proves photic pathway to the endocrine and autonomic nervous system.

A study of circadian phase of two groups of respondents with different circadian pattern showed significant impact of blue light on circadian phase change of selected groups(Figueiro & White 2013). In another research used a light mask to deliver light through eyelid and checked nocturnal melatonin level in blood (Figueiro etal 2009). This light dose was induced in respondents before sleep and during sleep. Results showed that light dose causes melatonin suppression. There are different types of light sources like LED & Fluorescent lamps. Circadian stimulus varies while exposed to these sources. (14) It was proved that color temperature of 2900K & 4200K have significant effect on circadian system(Bellia etal 2014).

Light interventions were introduced to improve sleep quality. Respondents were exposed to short-wavelength light in morning and short wave length orange light in evening. Delayed exposure to light delayed sleep and vice versa(Figueiro etal 2014). In another research researcher gave light treatment to older adults to improve their sleep(Figueiro etal 2008). The respondent's nocturnal melatonin levels were measured in blood and saliva. Melatonin level increases 35% for lower light level and 60% for higher light level.

A longitudinal study investigated effect of dynamic versus static lighting condition on vitality, mind alertness and sleep quality(De Kort etal 2009). They evaluated in two studies that lighting system has significant effects;

dynamic lighting is more appreciated than static lighting system. In an experiment on white light effects on employees' mind alertness vitality and mood, the white light exposure showed significant effect on these variables(Smolder & De Kort 2014). Light lux level was found related with alertness and vitality. In another research researcher investigated effects of two light levels (200 lx and 1000 lx) on vitality and mood(Smolder & Cluitmans 2016). Results showed that 1000 lx level increased mind alertness vitality, mood and performance. In a study researchers proved daily sunlight exposure relationship with vitality and mood(Smolder etal 2013). They found that daily exposure to sunlight increased vitality. Respondents of the research spent some time in sunlight and reported that more exposure to sunlight increases vitality and mind alertness.

The available literature on relationship between light and human health showed that light intensity and colour can improve mind alertness and vitality in day time and sleep quality at night. Light therapies are used to cure different diseases like arthritis, ADARD etc. Researcher found contextual and theoretical gap in existing literature. All these researches are conducted in those areas where day light is less, countries like Pakistan where summer season is very long; people avoid sunlight because of its ultra violet effect on body. Buildings are designed to restrict sunlight to reducing cooling cost. People are not aware about the positive effect of sunlight.

All above research indicated that proper light intensity provides visual and non visual comfort for performing different tasks including reading, writing etc. In Pakistan researches are available on visual effect of light but non visual effect is still untouched.

Method

This was a cross sectional survey research. Quantitative data was collected to asses banks' lighting conditions and employees' opinion about office lighting. Employees fatigue level was also measured while working in office.

In Pakistan State Bank of Pakistan is responsible for policy making and performance evaluation of banks. All commercial banks listed with state bank were universe for this study. The sample was selected in two steps. Proportionate sampling techniques were used to select banks' sample. Out of 4 public sector banks, two were selected and seven private banks were selected out of seventeen.

In second step branches of banks were selected. Purposive sampling techniques were used for selection of branches of selected banks. Purposive sampling method was adopted to control extraneous factors like space, furniture lay out and heating & cooling system. Those branches were selected which were located in same locality also.

Questionnaires were given to all employees from VP to Grade 1 officers of all selected branches. 406 employees participated in this research.

A checklist was used to study the lighting conditions of selected banks. Checklist included, lux levels, lamp type, luminary type, reflection shadows etc. A questionnaire was developed to collect demographic data, employees' opinion about their office lighting conditions. Employees' rated their office lighting for reading, writing etc on five point likert scale from v.poor to excellent (Appendix 1). Questionnaire was pre tested before data

FACES adjective fatigue scale (Shahid, Wilkinson, Marcu and Shaprio) was used to asses employees' fatigue levels. Its reliability was .8.

Results

The one of the objective of this research was to study bank buildings lighting conditions. The lighting conditions mentioned as lighting design in this research are, light levels (lux levels), light color, light direction, light source placement and availability of natural light. It was observed that lux level is very low(50lx-100) in reception areas of all selected banks. Although there are few areas where lux level is above standard(300lx TSS) but when average lux level was calculated it was less than standard in every bank. The total number of branches was forty five so out of forty-five manager offices 55-60% have lux level close to standard.

Bank lighting conditions were observed through check list including lux lvels, colour , type of lamp etc. Three different types of lighting

design were observed and mention as lighting design I, II and III (Table 1). It was observed that out of nine three banks (HBL, Faysal & UBL) are using energy savers, four banks(Allied, Alfalah, NBP and BOP) tubular fluorescent and two banks (MCB and Standard Chartered) LED lamps. Three hundred lux level is required for reading, writing and computer work according to TSS (Time, Saver Standard). The lux level (250) is less than standard (300) in all banks. Lux level is extremely low in those banks where energy savers are installed. This was the first step of this data analysis. These findings help to achieve first objective of research.

To achieve second and third objective of research employees' fatigue score was calculated then variation and correlation between variables were studied.

The mean analysis of employees fatigue level proved that although all banks employees have high fatigue level. But employees working under LED lamps are more fatigued than other two types of lamps. Bank employees rate their lighting system on five point likert scale to perform different activities like, reading, writing computer work etc. The results highlighted that employees working under LED lamps are less satisfied than other two types (Table 2) So less satisfied from office lighting resulted high fatigue level.

The figure 1 further supported above findings that employees working under LED lighting system are very much fatigued as compare to other systems. This fatigue level is calculated on standardized (FACES) scale. The employees' who scored 80-82 were considered fatigued, 83-85 much fatigued and 85-87 very much fatigued.

The ANOVA results of employees' fatigue score and light assessment level indicated that employees' fatigue level varies significant at 0.05 level. Lighting assessment on five point Likert scale (v. poor to Excellent) did not vary significantly.

The ANOVA test was applied to find out variation in male and female bank employees' fatigue level. Male and female employees fatigue level varies significantly. Male are highly fatigued and female fatigue level is also higher than other types while working under LED lighting design.

Mean analysis(Table 5) of fatigue score of male and female employees of selected banks indicated that female fatigue level is significantly less than male. Male fatigue level is highest in standard chartered bank, in National bank male and female fatigue level is same.

The Comparison of male and female employees' fatigue level and lighting assessment (Table 6 and figure 2) illustrated that male and female fatigue level varies significantly. To generate this graph employees fatigue score is scaled as 1,2,3 and same as lighting assessment using table 6 values. Employees of all three types of lighting design rate their light between poor and not good that's why they are fatigued. All these findings prove the second objective of study i.e. Male and Female fatigue level varies significantly.

Chi square analysis between light variables and fatigue and demograph variables and fatigue to find out association between them (Tables 7 & 8)

Age of the employees' is significantly associated with fatigue. Employees' assessment of office lighting (from poor to excellent) is significantly associated $P < 0.05$ with employees' fatigue level. Lux level is significantly $p<0.01$ associated with fatigue. Lux level measurement on lux meter showed that in all three types it is less than standard (300 lx for reading, writing etc. (Time Saver Standard).

The Correlation test (Table 9) indicated that fatigue in not correlated with lux level and lamp type.

The findings of table 8 & 9 helped to achieve third objective of this research i.e. Employees' fatigue level is associated with lux level. But it proved that fatigue is not correlated with lux level or with other light variables.

Discussion

The study aimed to assess banks 'lighting conditions and employees' fatigue level. Male and female fatigue level analysis was also one of the objectives of this research. The finding of study indicated that lighting is one of the

neglected interior elements in all bank buildings (table 1) because ambiance lighting is provided instead of task lighting except for cash counters. Lux level is less than standard (300 lx Time Saver Standard) for reading, writing, computer work etc. It was observed during data collection that employees are not satisfied from their office lighting in both public (NBP & BOP) and private sector banks (HBL Alfalah etc.). In public sector banks employees can alter their lighting devices according to their needs but it is impossible in all private sector banks.

The low intensity (lux level) of light not only affects eyesight but hormonal system also(Wolska 2003) The employees' fatigue level analysis proved that bank employees are fatigued (visual and non visual) while working under all three lighting systems. This fatigue level can be outcome of many other extraneous factors like, economic, domestic and psychological but all these variables were controlled for this research. Employees were clearly instructed that to report fatigue level caused by lighting conditions. The researcher observed during data collection that employees are aware about impact of poor lighting conditions but can't demand to change it because of job insecurities.

An important finding of this research is that employees' both male and female have highest fatigue level while working under LED lighting system (Table 4).The architects and designer now using LED lighting devices in homes and offices because of its energy efficiency. This area needs to investigate further for its impact on health and well being in Pakistani context. The ideal lighting system according to this research and researches mentioned in literature (Smolder & Cluitmans 2016; Smolder etal 2013). is combination of artificial and natural light. There is no substitute of sunlight (in term of color, spectrum & intensity) for regulating body systems(Figueiro & White 2013) and improving vitality and mind alertness (De Kort etal 2009). In old age lux level requirement increases so bank lighting conditions needs to redesign to cater all age groups.

Table 1.
Lighting Design of Different Banks

Lighting Design 1.	Bank Buildings using only energy Savers. Lux level 50-175. HBL , Faysal & UBL
Lighting Design II	Bank buildings using Tubular Fluorescent. Lux level 200- 250 Allied, Alfalah, NBP & BOP.
Lighting Design III	Bank buildings using LED lamps. Lux Levels 200-250 MCB & Standard Chartered

Table 2.
Employees Fatigue and Lighting Assessment under Three Different Types of Lighting Design

	N	Mean Fatigue score	Mean Score of Lighting Assessment
Lighting Design I	120	82	44
Lighting Design II	208	84	46
Lighting Design III	78	87	42
Total	406	84	44

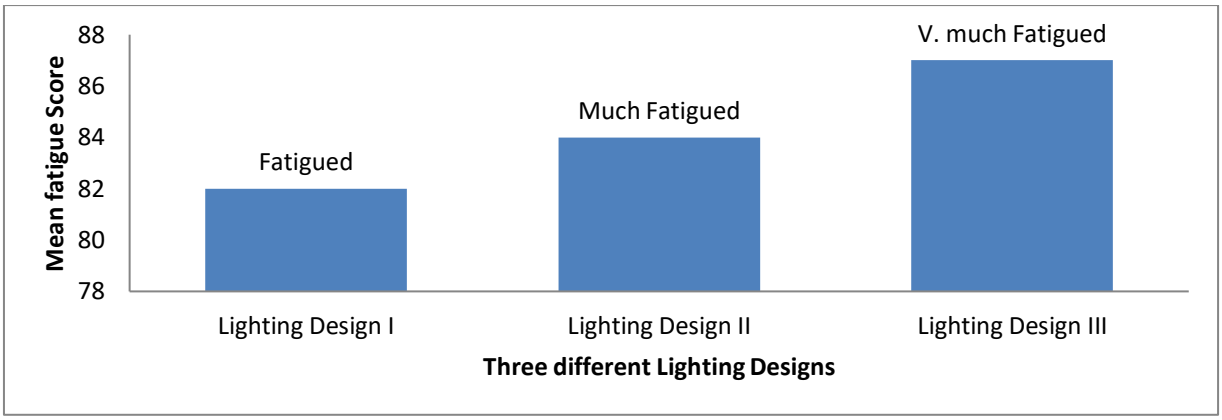

Figure 1. Fatigue Level of Employees' while working under three different types of lighting Design.

Table 3.

Variation between Employees' Fatigue and Lighting Assessment

source		Fatigue Level		Lighting Assessment	
		MS	P	MS	P
Between Groups	1	1008	*0.02	9.49	0.73
Within Groups	405	190		82.55	

Table 4.

Variation in Male and Female Fatigue Score working under three different Lighting design

Light System		Male Fatigue		Female Fatigue
	N	Mean	N	Mean
Lighting System I	80	83	40	80
Lighting System II	142	85	66	80
Lighting System III	60	88	I8	83
Total	282		124	406

Table 5.

Mean of Employees' Fatigue Score of Selected Banks.

	Fatigue Scoring					
		Male			Female	
	N	Mean	Variance	N	Mean	Variance
UBL/ LD I	23	87	95.03	17	77	252.13
HBL/ LD I	29	80	90.76	15	85	162.60
Faysal bank/ LD II	28	82	145.07	8	78	90.27
Allied Bank/ LD II	16	87	210.47	24	84	144.43
Alfalah/ LD II	67	82	193.60	18	79	234.12
Bank of Punjab/ LD II	32	89	153.50	12	7	153.52
National Bank/ LD II	27	*81	187.00	12	*81	116.79
MCB/ LD III	43	85	205.82	10	83	247.12
Standard Chartered / LD III	17	**91	565.03	8	83	190.84
Total	282	84	195.47	124	81	177.84

Table 6.

Employees' Mean fatigue Score and Lighting Assessment.

	Mean Fatigue Score		Mean Lighting Assessment	
	Male	Female	Male	Female
LD I	83	80	45	43
LDII	85	80	45	47
LDIII	88	83	45	43

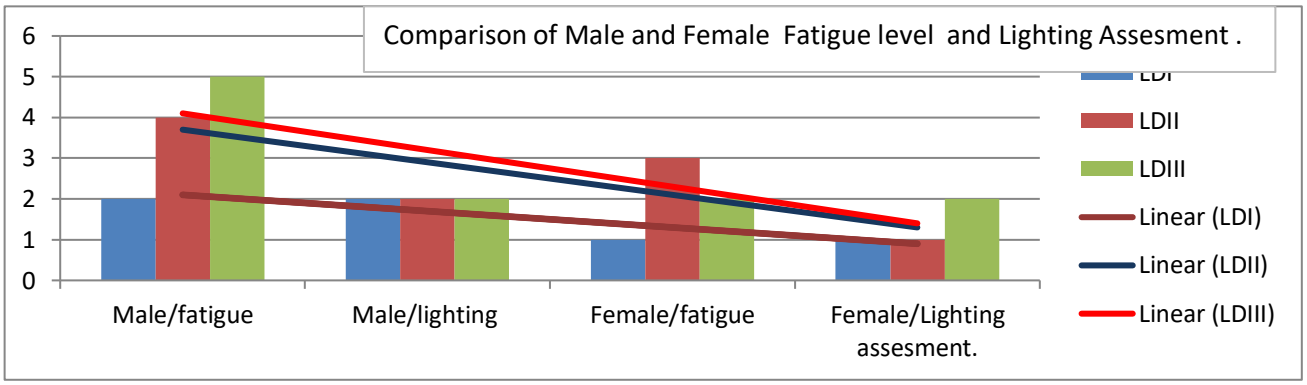

Figure 2. Comparison of Employees' fatigue level in relation to light assessment.

Table 7.

Association between fatigue and Demographic Feature

	Fatigue χ^2
Employees groups by banks.	4.8
Gender	0.98
age	*14.58
Private & Public Employees	0.02
Designation	10.01

The age of employees is significantly associated with fatigue.

Table 8.

Association between Light Variables and Fatigue.

	Fatigue χ^2
Light Assessment by Employees	*4.97
Lux Level	**7.18
Color Temperature	0.00
Lamp Type	1.51
Luminary Type	3.38

*P< 0.05 & **p< 0.01

Table 9.

Correlation between light variables and Fatigue.

	1	2	3	4
1.Lux levels				
2. Lamp color	0.246**			
3. Lamp type	0.219**	0.146**		
4. Luminary type	0.195**	0.134**	0.050	
5.Fatigue score	0.036	0.004	-0.018	-0.109*

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