A Post-Occupancy Evaluation Study of the Impact of Daylighting and Electric Lighting in the Workplace

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INTRODUCTION

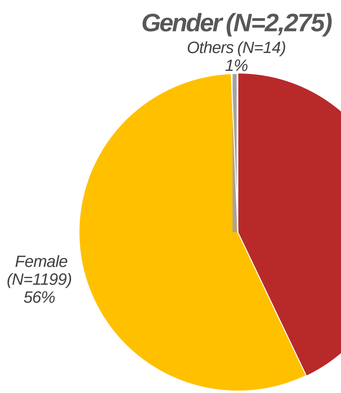
Post-Occupancy Evaluations (POEs) have been recognized for documenting occupants' well-being and responses to indoor environmental quality (IEQ) factors such as thermal, lighting, and acoustic conditions. Lighting is one of the most highly visible, controllable, and functional IEQ attributes of interior environments and, therefore, has been found to be highly predictive of occupant satisfaction and performance. Interior lighting can be measured both quantifiably and qualitatively; it is controllable by occupants; it makes up a significant portion of the design budget; it has been shown to contribute to occupants' satisfaction and performance; and it contributes to energy efficiency and building performance. Sustainable post-occupancy evaluation survey (SPOES) developed by a Midwest University interdisciplinary team provides an evidence-based quantitative analysis of occupants' satisfaction to help direct attention to successful areas and areas that need improvement in buildings. The SPOES questionnaire has twelve IEQ categories which impact occupant health and well-being. Daylighting and electric lighting conditions are two main categories in the questionnaire.

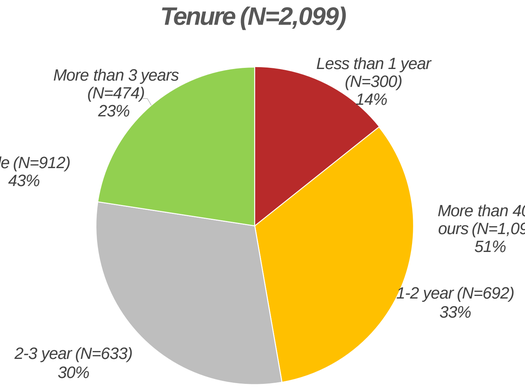
The authors present an analysis of daylighting and electric lighting conditions in 30 workplace buildings to study the impact on occupant satisfaction.

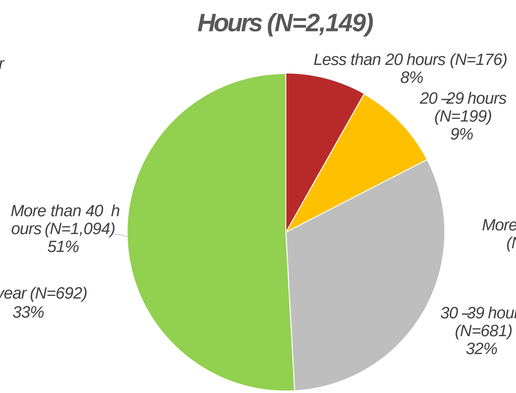
METHODOLOGY

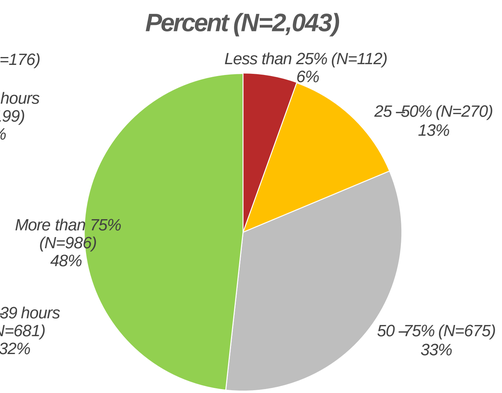
SPOES consists of a self-administered, Internet-based, questionnaire completed by building occupants. Participants rate their level of satisfaction on a Likert-type scale from 1 (very dissatisfied) to 7 (very satisfied). They also rate the influence of their physical environment on their perception of their academic performance and health on a scale from 1 (hinders) to 7 (enhances). A total of 2275 responses from 30 different workplaces were analyzed to investigate occupants' perception of daylighting and electric lighting. In the questionnaire, the daylighting (DL) IEQ has two attributes; amount of DL and adjustability of DL. The electric lighting (EL) IEQ has three attributes; amount of EL, adjustability of EL, and task lighting (TL).

Demographic Information









FINDINGS & DISCUSSION

There are strong, positive, and statistically significant correlations between overall DL and its two attributes, as well as overall EL and its three attributes (see Table 1). Based on the multiple regression analysis, both the amount of DL and adjustability of DL significantly predicted overall DL. The results of the regression indicated that two predictors explained 58% of variance (R^2=.58, $F(2,1920)$=1350.07, $p \leq 0.001$). The result also showed that amount of DL (β=.61, $p \leq 0.001$) had stronger association with overall DL than adjustability of DL (β=.19, $p \leq 0.001$) (see Table 2). Another multiple regression analysis implied that all three attributes of EL (amount of EL, adjustability of EL and TL) significantly predicted overall EL. Three predictors explained 81% of variance (R^2=.81, $F(3,1115)$=1636.00, $p \leq 0.001$). Amount of El (β=.79, $p \leq 0.001$) had the strongest association with overall EL than adjustability of EL (β=.20, $p \leq 0.001$) and TL (β=-.04, $p \leq 0.001$) (see Table 2). Lastly, independent sample t-test indicated that occupants within 15 feet of window space were more satisfied with overall DL IEQ (ΔM=1.69, $p \leq 0.001$) and EL IEQ (ΔM=.41, $p \leq 0.001$) (see Table 3). This implies that DL satisfaction is more impacted by proximity to window than EL satisfaction.

Table 1. Correlation between daylighting and electric lighting and its attributes

Daylighting	Overall	Amount	Adjustability	
Overall DL	-	-	-	
Amount of DL	.750 ***	-	-	
Adjustability DL	.650 ***	.745 ***	-	
Electric Lighting	Overall	Amount	Adjustability EL	Adjustability TL
Overall EL	-	-	-	-
Amount of EL	.710 ***	-	-	-
Adjustability EL	.736 ***	.732 ***	-	-
Adjustability TL	.481 ***	.614***	.624 ***	-

****. Correlation is significant at the 0.001 level (2-tailed).*
Note. DL –Daylighting, EL –Electric lighting, TL –Task Lighting. N=1,979

Table 2. Regression analysis for daylighting and electric lighting and its attributes

Daylighting	β	SE B	t
Amount of DL	.611 ***	27.202	27.202
Adjustability DL	.194 ***	8.871	8.871
Constant	.969 ***	12.494	12.494
F		1350.07	
Adjusted R^2		.584 ***	
Electric Lighting	β	SE B	t
Amount of EL	.788 ***	0.021	3.329
Adjustability EL	.195 ***	0.019	10.373
Adjustability TL	-.035 ***	0.017	-2.024
Constant	.246 ***	0.074	3.329
F		1636.00	
Adjusted R^2		.814 ***	

****. Correlation is significant at the 0.001 level (2-tailed).*
Note. DL –Daylighting, EL –Electric lighting, TL –Task Lighting. N=1,979

Table 3. Independent sample t-test between window seat or non-window seat on daylighting and electric lighting

	Window		Non-window			
	M	SD	M	SD	ΔM	t
Overall DL	5.50	1.564	3.81	2.046	1.69	15.179***
Overall EL	5.23	1.643	4.82	1.709	.41	3.919 ***

****. Correlation is significant at the 0.001 level (2-tailed).*
Note. DL –Daylighting, EL –Electric lighting, N=1,979

CONCLUSION

These results show that lighting IEQs are strongly associated with amount and adjustability of both daylighting and electric lighting. Occupants' satisfaction with the lighting conditions in the workplace has more association with the amount of lighting than the adjustability of their lighting. Our findings also indicate that occupants within 15 feet of window space in the workplace report more satisfaction with both daylighting and electric lighting conditions. Occupants within 15 feet of window space reported a significantly higher satisfaction with daylighting.

REFERENCES

Alzoubi, H., & Bataineh, R. F. (2010). Pre-versus post-occupancy evaluation of daylight quality in hospitals. *Building and Environment*, *45*(12), 2652-2665.

Hua, Y., Oswald, A., & Yang, X. (2011). Effectiveness of daylighting design and occupant visual satisfaction in a LEED Gold laboratory building. *Building and Environment*, *46*(1), 54-64.

Newsham, G.R., Aries, M.B.C., Mancini, S., & Faye, G. (2007). Individual control of electric lighting in a daylit space. *Lighting Research and Technology*, 40, 25-41.