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Lighting Characterization of the General Bank Operation Center in Panama

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Abstract

Illumination represents one of the main factors that affect energy consumption on a building, this consumption is even more on an office building. This study presents quantitative and qualitative data of the south façade of an open-plan office in Panama of a building that has a system to regulate internal light. To accomplish this, several measurements of illuminance in three different sceneries: evaluating daylight factor, measuring illuminance levels (lx) and luminance levels with users? perception. It was concluded that the building requires this system of light control to operate correctly, 75

Index terms— post occupancy evaluation, daylight, daylight factor, open-plan office.

1 I. Introduction

n Panama there are no official standards that regulate illumination standards in building design and construction. Being lighting one of the principal factors of electricity consumption [1], it can suppose an issue in terms of energy efficiency. In tropical climates, artificial conditioning, and lighting are the highest factors. This last one depends on four principal aspects: building use, daylight availability, levels of illumination, and operation hours. [2].

Office buildings usually emit more heat than other building types because of the equipment and large groups of people in them [3], this means that the energy they require is higher. Appropriate lighting level is indispensable in a work area because it improves performance, helps to make fewer mistakes, decreases accidents, and therefore improves productivity. [4].

There are different classifications of office spaces: private offices, shared offices (two to five employees), and open offices (more than five employees) [5]. This last configuration is the one studied in this paper, under the criterion that it is the most critical scenario because it is the one with the most people under the same conditions.

It is essential to mention that natural light is a source that fluctuates in color, intensity, direction, and availability, making field studies hard to conduct and potentially challenging to translate between different types of climates [6]. The objective of this study is to collect quantitative and qualitative data from an open office in Panama and to know if the illuminance, a

2 II. Methodology a) Case Study

The case study for this research is the Bank Operations Center (Centro de Operaciones de Banco General) in Panama City, Panama (Fig. **??** and 2). It is an eight-story parallelepiped facing north with approximate dimensions of 85.00 m x 43.00 m. It has a control system for artificial lighting and blinds. The artificial lighting system for the most part works with Alera Lighting 28watt lights, RI 85 (T5) Model CV-4-2T5-FCM18-ESD-MW along with an electrical transformer (Lutron Ecosystems H-Series Dimming fluorescent ballast for T5 lights 28 watts) that regulates the intensity of the light depending on the global horizontal light (lx outside). Every light fixture is regulated by Quantum Vue software on each story.

The blinds are located around the entire perimeter of the building and operate electronically as well. Their model is Tapparelle Reflex 4000 and the engine they operate with is Somfy Sonesse model: 50RS485. They usually work automatically taking constant data from the horizontal global light but can be adjusted manually using the Animeo software. The lighting levels were calibrated by a private vendor.

Three different scenarios are studied (Table 1): daylight factor, illuminance levels (lx), and illuminance levels together with the user's perception, this last one, through a post-occupancy evaluation (POE: Postoccupancy evaluation). In all cases, three EXTECH SD 4000 light meters are used in manual mode, each meter corresponding to one of the three axes A, B, and C (Fig. **??** and 5). Measurements were made from west to east at the height of the user's work plane (0.73 m) (Fig. **??**).5.00 m x 43.00 m.

3 b) Daylight Factor

The Daylight Factor (DF) is the ratio of the internal illuminance to the external horizontal illuminance under a cloudy sky. This lighting tool is criticized for its lack of realism [8], it is ideally applied in simulations because the parameter to evaluate it is a completely cloudy sky. However, it is the most common tool currently in practice for calculating lighting levels [9]. On July 14 (Table 1), the lights in the study area were turned off and the blinds were opened to assess the lighting conditions of the workspace without the assistance of any resource outside the architecture of the building itself. Subsequently, the natural light factor was calculated for each case.???? = ??????????????????? ð ??"ð ??"????ð ??"ð ??"???? ?????????????????????????? ???????????????? ???? × 100 c) Illuminance Measurement

The previous methodology was repeated, only the results were placed in the architectural plan in lx.

4 d) Post-Occupancy Evaluation

A visual evaluation survey [7] [8] was applied to the users of the third floor, south façade on July 26 under normal working conditions (Table 1). Not all users were available to participate due to the type of work they did, it is worth mentioning that more than half of the users in the study area did not participate in the survey. Simultaneously with the post-occupation evaluation, internal illuminance measurements were made, for this reason the duration of the measurements on this day is greater than ten minutes (Table 1).

The survey and the measurements were carried out at the same time to obtain a relationship between the existing illuminance levels on a regular day, with the light regulation system in automatic mode, and the perception of the users.

To determine if the illuminance levels are adequate, we refer to the lighting standards of the Illuminating Engineering Society (IES), American standards, and MS1525:2014, Malaysian standards. These two were chosen to have as a reference a more widely used standard worldwide, the IES, and another that would be applied in a climate like Panama's. (Table **??**).

5 Days and scenarios description during the evaluation

6 Date

7 a) Daylight Factor

The values of July 14 were quite high (Fig. **??**). The workstations closest to the façade present a higher natural light factor than those closest to the core of the building.

As the measurements were made towards the east façade, the light levels were reduced in both cases because the shutters on the east façade were kept permanently closed (Table 1).

8 b) Illuminance Level Measurement

Under normal working conditions, that is, using automated support systems for interior light control, illuminance levels remained quite similar (Fig. **??**). The approximate ranges in which the system-maintained illuminance was between 300 lx -400 lx for the most part (Fig. **??**). It means that within the MS1525:2014 standards, it is at an appropriate level. However, there are workspaces that marked in the range of 200 lx, below this standard and even much lower than that of the IES. (Table **??**).

9 c) Post-Occupancy Evaluation

A total of 37 surveys were completed throughout the study area. 75% of the surveyed users describe their work space as comfortable in terms of lighting (Fig. **??**). As for performing tasks on the computer, 51% feel satisfied and 30% choose the neutral option. Regarding paper tasks, 43% say they feel satisfied and 43% choose the neutral option. (Fig. **??**)

Only 16% of the participants reported experiencing glare in their work area. Of them, 50% said that the glare is from sunlight on the computer screen and 33% said that it is from direct sunlight. 35% prefer equal dependence on electric light and natural light, followed by 30% who prefer predominant dependence on natural light with electric light support (Fig. **??**).

10 IV. Discussion

Volume Xx XII Issue III V ersion I 28 Year 2022 ( )F

We consider that the Malaysian standards are more valid than those of the IES because in countries with tropical climates the incidence of the sun is greater, which means that the illuminance in areas with this climate is higher. When the shutters were opened on the 14th there were not so many people because it was a Saturday, however, the staff in charge of the automated system received complaints, from this fact we deduce a feeling of discomfort in the few people who were there.

This may indicate that the building requires an additional system to function, this implies an extra cost for it, since the architectural design does not respond to changing weather conditions. According to [9], if there is disagreement in 20% of users, changes must be made. The results gave 16% but considering that only 37 people of the jobs that exist in the entire floor (including the north facade) there is a great probability that the 4% missing for this parameter to be met may exist. Future long-term studies should be done on the entire floor to verify this. This 16% (yellow Fig. **??**0) is located on the east side where there is a sill on the south façade (Fig. **??**2). Our deduction is that the software is programmed for the window of (Fig. **??**1) and takes its full height to adjust its closing percentages. This height is different from that of the window (Fig. **??**2), so when the closing percentage is adjusted, on the side where the sill is, the adjustment will always be wrong. Year 2022 © 2022 Global Journals ( ) F Lighting Characterization of the General Bank Operation Center in Panama V. Conclusions Banco General's Operations Center with its natural light entry control system mostly satisfies the needs of users, since 75% of the participants in the post-occupancy evaluation described their workspace as comfortable. We could conclude that a building in the tropics with the same characteristics: north-south orientation, predominantly glass facades and for commercial use, requires automated systems outside of architecture to function properly. This light control system inside the building is a good option to correct this type of design pathology; however, it does not adapt to the entire morphology of the building, as it has deficiencies when there is a sill on the façade.

A considerable percentage of the people answered neutral regarding such and such. This parameter can cause confusion, so it is recommended to use another level of evaluation in future postoccupancy evaluations. Likewise, case studies are recommended where people are more willing to stop their work to participate in a post-occupation evaluation.

Fig. 1 Fotografía del Centro de Operaciones Banco General.

Figure 1:

Fig. 2 Localización y orientación del caso de estudio, Centro de Operaciones Banco General, Ciudad Radial

Figure 2:

Fig. 3 Factor de luz natural en fachada sur, nivel 3

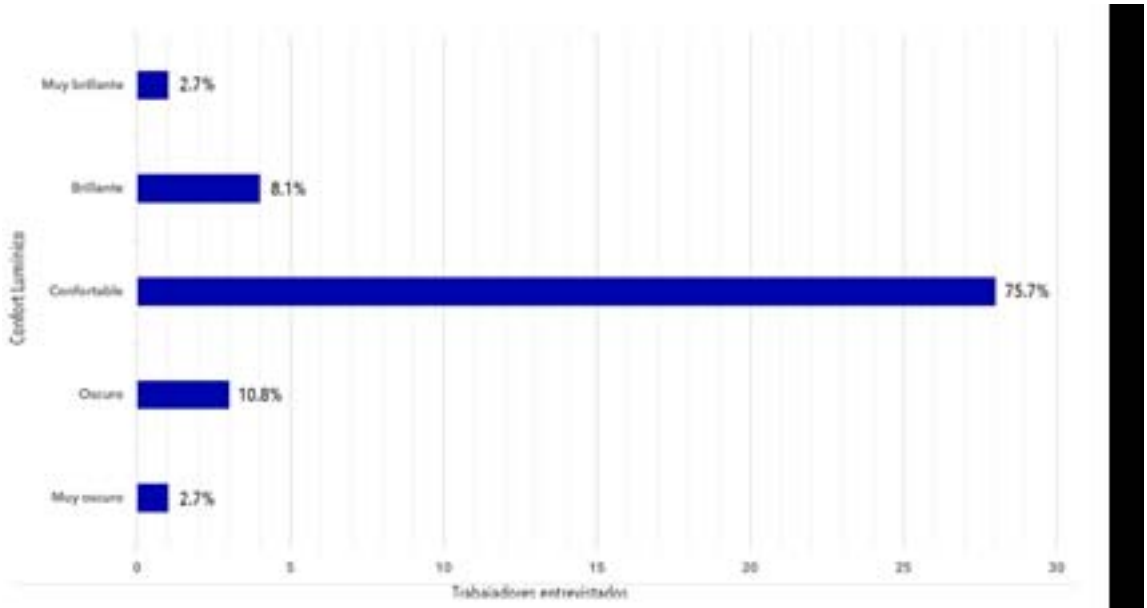


Fig. 7 Resultados de percepción de confort lumínico en puestos de trabajo.

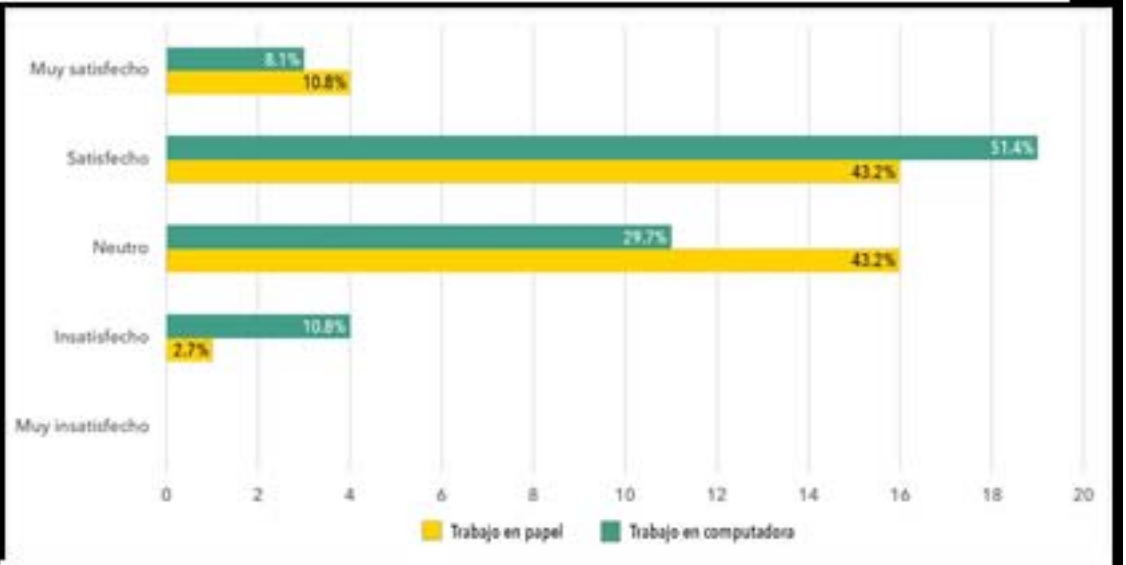
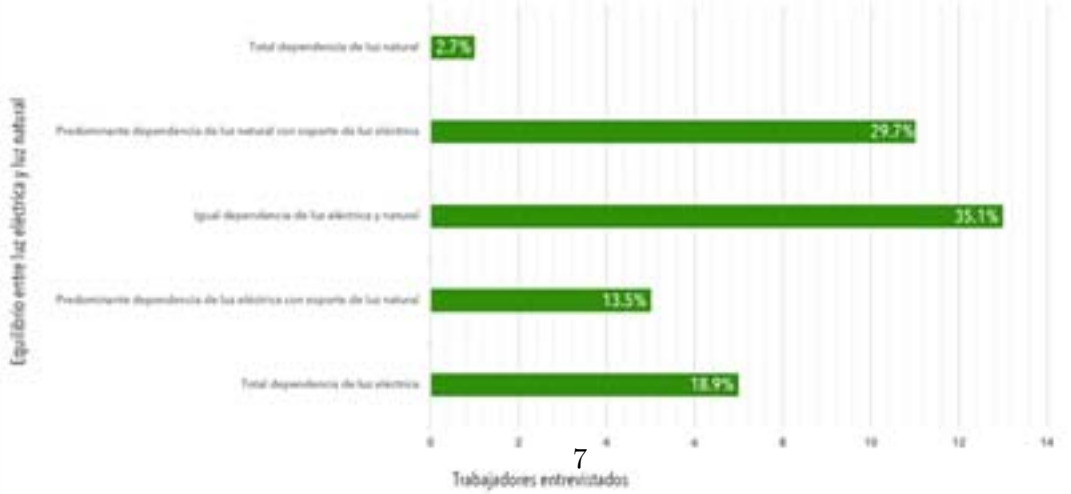


Fig. 8 Resultados de niveles de satisfacción para leer y escribir en computadora y en papel



Preferencia del equilibrio de fuentes de iluminación en puestos de trabajo

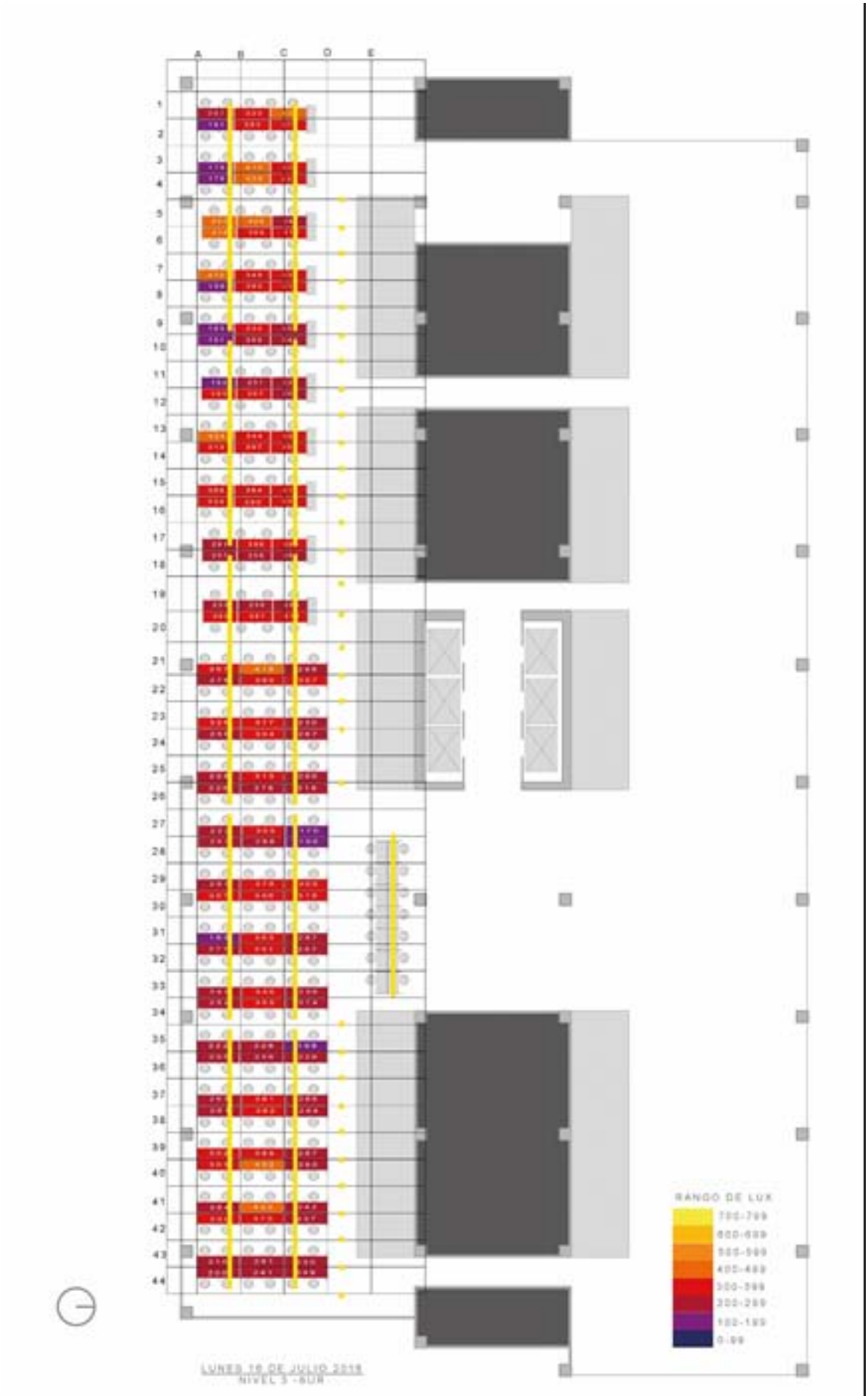
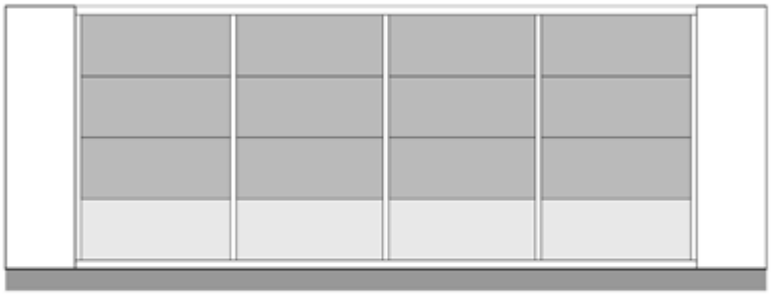


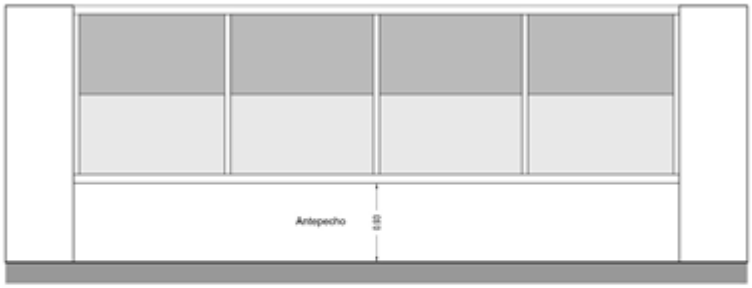
Fig. 6 Planta arquitectónica de nivel tres, niveles de iluminancia de 16 de julio

Fig. 10 Planta arquitectónica de nivel tres, participantes de la evaluación post-ocupación y sus respuestas



Persianas al 75% de área efectiva ocupada en ventanas - Fachada Sur

Fig. 11 Segmento de elevación de pared de fachada sur sin antepecho.



Persianas al 50% de área efectiva ocupada en ventanas - Fachada Sur
Sector con antepecho de 93cm

Fig. 12 Segmento de elevación de pared de fachada sur con antepecho.

Figure 7:

1

Lighting Characterization of the General Bank Operation Center in Panama

Year 2022
26
III V ersion I
Volume Xx XII
Issue
( ) F
Global Journal of Researches in Engineering

Time start July 14 12:31	Time finish 12:43	Horizontal global illumination 38.8 k lx	Lights OFF	SOUTH blind closure % 0%	EAST blind closure % 100%	WEST blind closure % 0%	Survey NO
July 16 11:43	11:52	25.9 k lx	ON	89%	100%	74%	NO
July 26 10:47	11:32	22.8 k lx	ON	80%	100%	76%	YES

Figure 8: Table 1

.1 Acknowledgement

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