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The Effect of Natural Light, on the Quality of Visual Comfort in the Reading Rooms. A Case Study of the Lrbi Ben Mhidi University Library in oum El Bouaghi, Algeria

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Natural light has lost its prime importance due to the development and growth in the use of artificial light over the past century, this dearth of natural light in educational systems causes a significant problem in educational spaces, which makes an impact negative on human behaviour, which contributes to a decline in educational performance. In the absence of research on the subject, it is necessary to explore the influence of natural light, on the visual comfort of users in order to improve the quality of space in reading areas. The aim of the subject, is the necessity to explore the influence of natural light, on the visual comfort of users of network focuses on the region of Oum El Bouaghi characterized by a hot and dry semi-arid climate, uses the Post OccupationalEvaluation(POE)based on a questionnaire, with 70 participants to study the qualities of the visual comfort of the reading room of the university library. The results collected indicate the level of luminosity in the studied area is insufficient with unsatisfactory conditions leading users to use artificial lighting during the majority of the day throughout the year. Although glare, contrast and shadow effect have no direct influence on reading activity, also the role of aperture is totally ignored, which gives a gloomy and boring impression reading by analysing the Independent and dependent variables it has been stated that although all independent variables affect dependent variable. Therefore, this contribution has revealed significant results that could be used by managers in their mission to develop the natural lighting system in university library reading rooms.

Key words: Natural Light, Visual Comfort, POE, Architectural quality, University reading room.

Abbreviations: POE (Post Occupational Evaluation)

INTRODUCTION

For a long time several attempts have been made with the aim of defining the notion of architectural quality contributing to highlight its multidimensional aspect. To clarify the reflection on architectural quality, the challenge is therefore to define the essential characteristics of architecture and to characterize the multiple parameters, which confer quality of the building, in particular its interior comfort. One of the most notable features is natural light. It is located at the intersection of the major programming, design and construction conditions for improved visual comfort in buildings. (Bean and Luo, 2017), It should be respected and exploited in an intelligent way to achieve the desired quantity and qualitative objectives of architectural quality.

The impact of sunlight on human life, health and comfort, as well as the environment, is vast (Kittler, 2007), However, when daylight is not used properly, it causes discomfort and requires unnecessary amounts of energy. (Leslie, 2003). In most of the existing research, improvements in both of these factors have been achieved by using windows with natural views; Furthermore, studies have shown that daylight tends to have a positive effect on human behavior. (Canazei, et al, 2016)

Finding an optimal system for lighting is a very complex task. It uses a set of detailed and diverse characteristics related to the openings, their positions, and the properties of the surfaces that make up the space (Touré, 2007). However, a university library should not be illuminated by a single window, but advanced natural systems need to ensure a good

level of indoor lighting. There are many daylighting strategies in buildings designed to redirect and redistribute natural light deeper into the space; their main objectives are to improve light comfort for users and to improve the quality of interior natural light by reducing discomfort linked to glare. (Courret G, Scartezzini J L, 1998).

Faced with this situation, it was necessary to carry out a complete analysis, which makes it possible to rethink the problems linked to the use of natural light at the level of university libraries. While examining the visual comfort parameter of the EPO University library, which affects visitors' attendance, we will try to identify potential causes for the uncomfortable summer and winter conditions while also focusing on the users' perspective.

LITERATURE REVIEW

A literature review is an essential and helpful synthesis on a particular subject. It can identify what is known (and unknown) on the ground, identify areas of controversy or debate, and help frame questions that require further research (Amanda Bolderston 2008).

This part gives an overview in several relevant scientific fields which are at the intersection between the Light, visual comfort and library. Specifically, this part addresses issues relating to the effect of access to daylight on perception. The creation of visual interest in space, the impact of space function, and the existence of cultural differences in the evaluation of spaces lit by daylight, and finally, how existing research has attempted to quantify and quantify the effect of natural light on the comfort of architectural space.

Natural Light

Artificial lightweights, which date back to the early 18th century, have always supported natural light in some way. However, after this time, when technological advancements made it possible to produce an infinite number of artificial lights, such as fluorescents and light bulbs, the roles of artificial and natural lighting in buildings appear to have been reversed.Now, due to designers' exposure to sustainability and environmentally friendly design ideas, natural lights play a leading role in modern styles and constructions. (Chemsa Zemmouri M 2018).

Research by Alibaba (2016) from define daylight as the combination of sunlight, skylight and light reflected from the ground. According to Hasirci (2011), the behaviour and perception of occupiers are strongly affected by daylight, as it is a controlled architectural tool. However, daylight can also affect the time spent by increasing the quality and duration of a person's stay in a space. In addition, daylight is crucial for student communities to improve their performance.

Light in Educational Spaces

The first objective of educational spaces is to facilitate learning (Elseragy et al. 2009). It is very important to consider lighting in designing indoor spaces. In educational spaces, it is even more important to think about light, especially natural daylight, because of the high level of visual activity. Activities in dark environments pose psychological, physical and visual problems to those who use educational spaces. In addition, artificial lighting is one of the biggest consumers of electrical energy. Therefore, it is very important to reduce the use of artificial lighting where it can save energy (Boyce, P 2003).

Some factors need to be considered in educational buildings, such as ensuring a comfortable environment for learning and providing sufficient and appropriate lighting with equal distribution (Yene 2002). Most research focuses on the amount of daylight in a space as a function of luminance, window size, and other daylight factors (Moscoso, et al 2015; Wang and Boubekri 2011).Most architects use daylight for aesthetic design and energy efficiency purposes, which creates contrast and shadows in space (Rockcastle and Andersen, 2014).

In his doctoral work, which was conducted on the grounds of the University of Biskra in 2019, Saadi, M calculated how the physical light environment affected users of space. This demonstrates the significance and complexity of the relationship between man and the physical environment as well as the concern for the impact of the built environment on the occupants, both architecturally and psychologically.

Natural light in Libraries

The university library plays a crucial part in the context of the learning paradigm. For activities that require visual tasks like reading, writing, and using a computer screen, high visual comfort conditions should be prioritised in library learning

spaces. This is because prolonged visual task performance can have an impact on consumer behaviour, productivity, and health. According to Joseph Brennan (2007), schools, universities, and other educational institutions present an intriguing challenge for lighting designers because people who live there must be able to concentrate for extended periods of time, which is why comfort is a crucial design consideration. According to Mohanty. S (2002) lighting is an important element of library ambiance, but one of the most difficult to control.

Despite the satisfaction lighting levels (a combination of the two light sources), Luisa Brotas (2013) in her article on libraries presented results that indicated a preference for natural light over artificial lighting. They also highlighted the significance of natural light for productivity in comparison to other factors like temperature, ventilation, encumbrance, and noise. The respondents didn't perceive the answers to questions about user control and user bloat as being particularly unsatisfactory.

On the other hand, Anugrah and Munawaroh (2017) in the work on the university library of Bandar Lampung in Indonesia, they proposed the solution for better visual comfort in the library is the use of colours and materials lighter which can reflect more light. Increase the intensity of light in the room from the best use of openings.

Kurniasih and Saputra are at the forefront of research into natural lighting systems to provide a better visual experience in the university of Budi Luhur's lecture hall (2019). Two researchers combined a quantitative analysis method with a descriptive approach, measuring the levels of natural clarity and calculating the size of the obstructing devices during the research phase. The use of umbrage devices is an independent variable in this study, whereas the dependent variables that were observed were natural lighting levels and natural lighting factors. The study's findings are naturally applied lighting systems in the form of design solutions that allow for use in the third-floor conference room.

RESEARCH METHODOLOGY

Based on previous studies, the research of the effect of natural light, on visual comfort in the reading rooms of the university library requires an evaluation study that clearly explains the notion of natural light and the relationship between light, building and visual comfort.

A procedure called post-occupancy evaluation (POE) measures how well a facility serves its intended purpose and its users. This strategy is described as a logical and methodical approach to assessing a built place after it has been in use for a predetermined amount of time.(Preiser and Rabinowitz, 1988)

Post-Occupational Evaluation (POE) is a concept inherent in living, finished and inhabited spaces, drawing inspiration from academic studies in the 1960s and 1970s, as curious reviewers want to know the user inside their niches, or they fulfil the purpose of defining the design process according to logical models drawn from information obtained through research.(S Mazouz and H Mezrag 2013)

We conclude that in order to qualify an architectural route by means of an in situ experimentation, we use POE a questionnaire and observation that must be faithful to the truth and systematically reported (Paul N'DAn., 2002). This dynamic method offers analysis potential for a better evaluation of the reading room comfort and to give creative leads to designers wishing to enrich the design favouring light diversity in the architectural experience.

Methodology

The study was initiated in two steps:

In the first step, direct observation and writing comments on the current situation, supported by the reading of digital photos inside and outside the room. The observation was made in the month of December as the least illuminated month of June the months as the brightest of the academic year 2019 according to the global climatedatabase (Meteonorm. com), for a whole week from 8.00 to 17.00 in each month.

While for the second step, A five-point Likert scale questionnaire was adopted. A Likert scale is a psychometric tool to measure an attitude in individuals (Rensis L 1932) ,when the interviewee expresses his level of agreement or disagreement with one or more affirmations (statements or items).

The scale contains for each item a graduation generally comprising five orseven choices that allow you to qualify the degree of agreement or satisfection, for exemple:

1.Very unsatisfied

2.Dissatisfied

3.Neutral

4.Satisfied

5.very Satisfied.

The questionnaire was treated by SPSS 28softwar, these evaluations will be presented by figures, graphs and tables. The population concerned with the study was students, professors and the library staff, of which 55.70% were women and 44.30% men. The majority of respondents more than 30% were between 20-30 years old. The questionnaire was distributed to 85 people during the first week of October 2019 (Sunday to Thursday) from 8.00 a.m. to 17.00 p.m. in Arabic and we received 70 complete responses. According to the working hours of the university library. A 40-questions has been divided into two parts, each of which includes a certain number of parameters:

The first part: General information, The first part includes basic information and learning behaviour divided into questions about the personal information (Gender, Age, user group, visual equity), and questions on the attendance of the reading room.

The second part; brings together 32 questions, concerns the user's relationship to natural light as well as his assessment of the light environment of the reading room he frequents during the four seasons of the year. The questions asked are divided on7dimensionsaccording to visual comfort (Light environment, Illuminance and the effect of the sun, Glare, Shadows,Colours, Windows, Artificial lighting).

To ensure the quality of the questionnaire, it was tested by the Cronbach internal consistency (reliability) technique, which demonstrated that each parameter had a Cronbach's alpha value greater than 0.70. For a work structure validity test.

CASE STUDY

Geographic Location



Figure 1. Geographical location of Oum el Bouaghi city Source : Google Earth 2019



Figure 2. Map of Oum El Bouaghi the city Source : Google Earth 2019

Oum el Bouaghi is located in the high plateau area in the centere of the cities of eastern Algeria. It is located on the southern borders of the tell atlas, thus occupying a median position in the eastern "highlands" part of the country. Located between 35°53 00" north 7°07 00" east for latitude, and 5°59'n and 7°56' east for longitude. Oum El Bouaghi, capital of its city is situated in the centere. It includes the capital of 11.41% of the population of the city and a density of 158.19h.

Climatology of the City

The climate of the province of Oum El Bouaghi is semi-arid, with cold, rainy winters and frequent frosts, and dry, hot summers. It is characterized by high daily and annual temperatures and irregular rainfall, with an average of 300 to 350 mm per year. Thus, the temperature generally ranges from 1°C to 33°C and is rarely below -3°C or above 38°C. The length of the day in Oum el Bouaghi varies significantly over the course of the year. (Weather station of Oum El Bouaghi)

Case Study Presentation

Larbi Ben M'hidi University was initially established as a high school professors under Executive Decree No. 83-314 of 05/07/1983, then the National Institute of Higher Education for Mechanics was established in parallel by Executive Decree No. 84-255 of 08/18/1984, and in accordance with Executive Decree No. 97-158 of 05/10/1997.By virtue of a ministerial decree issued in November 1999, it was changed into a university headquarters made up of the four institutes previously mentioned and known under the name of the martyr Larbi Ben Mhidi.

The university ranking was elevated to the rank of universities under Executive Resolution No. 09-06 of 01/04/2009, which was amended by Executive Resolution No. 13-164 of 04/15/2013.

(www.univ-oeb.dz)



Figure 3. Main facade of the library of Larbi Ben Mhidi University. Source : Author, 2019



Figure 4. Main facade of the library of Larbi Ben Mhidi University.Source : Author, 2019

Larbi Ben M'hidi University located in the west of oum el bouaghi city has an important central library structure that plays a distinguished scientific and cultural role. It is placed at the disposal of students, staff and professors for their use for their benefits. The building with 35 52'44" N 7 05'28"E situeted in the centre of the university, consists of 3 floors: the ground floor with a reception and an internet room , First floora with the main reading room and foreign languages reading room, Second floor with a group work and a periodic room.



Figure 5. Library floor plans. Source : Technical office of the university of Larbi Ben M'hidi,2019.

The Main Reeding Room

The main reading room represents the large reading room in the library with a semi-circular shape with an area of 790.00 m2, located on the first floor of the library to a remarkable height. The colours and textures of the interior space are clear from the white walls and the beige floor, unlike the openings with dark blue masonry and light blue glass, the tables are arranged in a manner parallel to the rings of the books. The windows are scattered around the perimeter of the hall in a circular motion on three facades, north, east and west, unlike the southern facade, which does not have windows, as it overlooks the interior of the library.







Figure 7. Internal views of the study areas of the main reeding room. Source : Author, 2019.

RÉSULTS AND DISCUSIONS



Figure 8. Internal views of the central study areas of the main reading room with and without artificial light (Left to right) Source : Author, 2019



By investigating on daylighting quality, We see through the results of the questionnaire that the age ratio is more than 30% between 20-23 years old, which means that most of the students are in bright years of university studies, the lowest percentage representing 24 -30 years old, and this can be explained by the fact that 85% of students visit the library due to the importance of the library and its role in academic and cultural pathways.

It can also be noted that the percentage of good vision exceeds 67% of the results, which contribute positively to the success of the test of the importance and efficiency of natural light in the reading room.

By local observation, without the use of artificial light the room represents a dark place during whether in the summer or winter (Fig 08), which explains the reason why more than 50% of users visit it regularly, between 8 a.m and 12 a.m (Fig 09) to benefit from the good lighting conditions in the morning, and spent more than 3 hours in day.





Concerning the light environment, 54,3% affirm that the room is not well lit, in summer for example, 60% are dissatisfied with the lighting, and 52,9 % of them also in winter, because the solar energy is significantly less during the summer period in the evening hours on the east side. In winter all day, especially on the north side, despite the large number of windows and their considerable size, they are covered with blinding arches and a light fence, which hinders the angle of sunlight to reach the farthest point inside the room, that hinders the reading process, causes a state of dispersion, lack of focus and reduces the general comfort rate for the reader.

Another result show that 55,7% of answers qualifying the natural light as completely unsuitable for the reading process, due to the fact that the space of the room and the distribution of windows and the internal arrangementdoes not respect the natural light factor from the inception of the idea to the implementation of the project that explains that 5.70 % of users estimated thatnatural light is well distributed throughout the reading room.(Table 01)





Figure 10. Appreciation of the presence of direct solar light. Figure 11. The precense of sunspots on books Source : Source : Author, 2019





Figure 12. Internal views of the western study areas near windows of the main reading room with and without artificial light (Left to right). Source : Author, june05, 2019 at 12am



Figure 13. User satisfection with Glare of solar rays on eyes. Source : Author, 2019

As for the physical dimension, it is measured by several factors, so it can be said that it is an important dimension and has a close relationship with the goals of the work, where the Glare represents a basic dimension that directly affects the activities inside the main room. 54.30% is a significant percentage that completely denies the presence of light spots on the tables (Fig 10) and also 57.10% deny its presence on books (Fig 11). On the other sideFigure 12displays, the reason whyonly 5,7 percent of users suffer from the intensity of light raysfrequently, as the proximity of the tables to the windows explains these results, because the northern side does not contain places for reading, but rather a place for electronic research, and it is the place that receives the least sunlight, especially in the winter season, and suffers from large light spots and annoying reflection. (Fig 13). The sun represent the first cause inside the room for such a problem, and this describe that more then 17% they change their places to the center of the room, even though the light colour of the materials increases the lighting quality of interior space.









Also, just 11.40 % of users suffer from annoying shadows, Light reflection does not negatively affect the psyche of users because it is not directly present in the middle of study area, since the factors studied respectfully represent 41.4% and 58.6%, these results show that users prefer clear and calm colours which are completely satisfied and very satisfied.(Fig 14,15)

Users prefer to stay away from windows, because there is no internal protection from the sun's rays, even if it is a small percentage, because it requires a lot of concentration, and this causes fatigue and pain on the psychological side.

We note that the size of the windows is stable as we have noted, but in general the situation and the orientation are not satisfactory because of the small number of tables located near the windows at the back of the room while the shelves of the books are distributed in the middle of the east and west side.Results in figure 16 and figure 17 show that58.60%, 51.4% in order of users are unsatisfactory because the shelves are positioned in a row and their distance from the source of natural light causes dark corners when searching (Fig 18). In the summer, the users prefer to be away from the window by more than 30%, and also in the winter by 40% in the winter season, and this confirms the unimportant importance of using natural light in the room.(Fig 19)







Figure 18. Location of shelving and tables away from windows in natural light only. Source : Author, December10, 2019 at 10 a.m



Figure 17. User satisfaction with window distribution in the reading room. Source : Author, 2019



Figure 19. Reading area near the windows in the summer season with natural light only Source : Author, juin 02, 2019 at 14 p.m

Artificial light in the room imposes its existence strongly, we notice it is the most dominant as choice of users by 64.30% of its use is mainly due to the results obtained in advance (Fig 20), and it is also due to the fact that the answers were the majority of them to light. Amixed lighting by 38.60%, 48.60% and artificial light by 34.40%, 40% in order, meaning that natural light alone is not enough, not the best choice for them compared to the use of artificial light. (Fig 21)

Treatment of Visual Comfortquality

We are now going to analyse the quality of the seven (7) dimensions while using the LIKERT scale and calculating the arithmetic mean of each index with:

Table 2, shows that the samples had a mean of no more than 4.00 for each dimension. Which demonstrates that the users of the main reading room are not at all satisfied with quality of visual comfort inside the room.

The lowest degree of agreement in our sample is in the light environment variable with amean of 2.064, which means that most of the users suffer from a problem with lighting by natural light. We note that even for the dimensions of glare illuminance and shadows; a degree of agreement that is weak with means of 2.10, 2.370, 2.521 and 2.56 respectively in order. We can then conclude that the majority of respondents have a problem with sunspots and light intensities. A moderately high degree of agreement was given to artificial light by our study sample, with a mean of 3.55 which expresses that most people strongly agreed on the importance of using artificial light In the reading room throughout the day.

By the end the most dominant dimension with respect to its degree of agreement of 3.55 out of 5 with colour, represents the only strong level in the analysis where the majority of users are satisfied with light colours of walls and ceilings.

Variables	Min	Max	SD	Mean	Order	Level
Light environment	1	5	0.95	2.064	2	Weak
Illuminance	1	5	1.20	2.370	2	Weak
Glare	1	5	1.30	2.10	2	Weak
shadows and contrst	1	5	1.132	2.56	2	Weak
Colors	1	5	0.750	3.55	4	Strong
Windows effect	1	5	1.220	2.521	2	Weak
Artificial Lighting	1	5	1.334	3.16	3	Medium

Table 2. Variable frequencies. Source : Author, 2019

CONCLUSION

The goal of the current research is to study the impact of natural light on the dimensions of visual comfort in the main reading room of the University of Larbi Ben Mhidi library.

Regarding daylight in educational environments and the potential use of daylight in libraries, the results show that the users' point of view towards the reading room on their general impression as well as the light environment created by natural light represents more than 60 % of users are dissatisfied with a low mean of 2.99 which shows a disagreement on the quality of space .

The role and importance of the window in a library are clear as the majority of occupants who prefer to be next to the window for natural light and ventilation, but glare and lack of solar obstructions interiors and the contrast sometimes creates, make the situation uncomfortable.

Users have also expressed their feelings towards the importance of artificial light in the reading room where the lighting is weak, it is nevertheless perceived differently by the occupants according to the seasons, where the orientation of the openings influences the choice of location in the middle of the main room.

Finally, natural natural light should be respected, library designers should be required to use interior and exterior shading devices, an ideal window size with a texture that suits all while minimizing sources of bluing and contrast with the taking in consideration of architectural quality when designing to help reduce energy consumption.

This study proposes the following analysis to improve interior daylight scenarios of library reading rooms for favorable parameters and user visual comfort.

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