



LIGHTING DESIGN FRAMEWORK; RECOMMENDATION STUDY FOR NEW-CASTLE MOSQUE, NEW SOUTH WALES

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ABSTRACT

This research explores the analysis method of the current situation and injects direct design proposal analysis to the mosque from the existing condition. The exploration of lighting fundamentally and significantly impacts holistic and ritual performance in any religious building. However, regarding the conversion of typology to the mosque, there were a few research that focus on the existing condition in lighting design performance for Newcastle Mosque. Therefore, this study explores approximately four designs of three-dimensional recommendations as a methodology which include passive and active design implications used recorded as part of the discussion. The result shows that the proposed design helped in repairing the conditions of the mosque through the implementation of the skylight, curtain, designated window, and sunbreak for the best rectification recommendation. Furthermore, the result of the study suggests such minimum glare and effective lighting distribution contribute to the amount reduction of energy consumption, improve the quality of reading, and properly enlighten the religious congregational activities and other exercises carried out to optimum brightness of the mosque.

KEYWORDS:

Lighting; Design; Religious building; Culture; Mosque; Australia

INTRODUCTION

Where visual work is involved, such a brightness relationship within the normal field of view should be controlled to allow the eye to adapt to the overall environment brightness consistent with the brightness of the task itself. In this way, the 'shock' of excessive contrast, as well as the need for continual readoption, can be reduced to carry out an activity. Any religious building is normally well equipped with meeting and discussion spaces apart from the main spiritual or congregational area [1].

Hence, this research indicated the need for proper lighting for the interior and exterior buildings, including the ceiling and walls of relevant spaces to avoid uncomfortable visual conditions due to excessive contrast. In addition, the rhythm of lighting indicates a special role and emphasizes the hierarchy of space planning in religious buildings [2].

The lighting in the mosques and the advancement of the mosque's light framework are viewed as supernatural and spiritual images, just as designs. Besides, lighting adds energy and soul to Islamic decoration and ornamentation in mosques in both passive and active design treatment [3].

In addition, in religious and divine dwellings, usually, an appropriate lighting framework is viewed as an amazing asset to communicate the set of historical and revolutionary movements of the places. In other words, the builders and architects should also consider the lighting framework, and represent the social impact on the nature of the building, especially on the surrounding community [2]. Therefore, in modern society nowadays, the designers are urged to accentuate the lighting framework aligned to the character and identity of the social site.

RESEARCH BACKGROUND ISSUES AND PROBLEM STATEMENT

Inadequate lighting performance for optimum comfort level in common and intermediary areas of the mosque has significantly lowered the inconsistency during day conditions. Located in Newcastle City in the New South Wales state of Australia, Newcastle Mosque is a single-storey building adorned with the main prayer hall, female praying room, and meeting room. The mosque can also accommodate approximately 200 people, as shown in Figures 1 and 2.



Figure 1. Newcastle Mosque in Newcastle, New South Wales, Australia

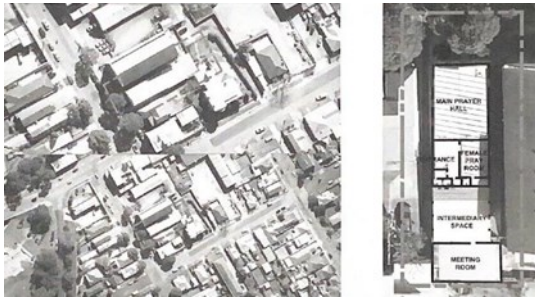


Figure 2. Location and plan of Newcastle Mosque in Mayfield Street

This study focuses on the lighting preassessment effect on the specular surfaces, diffuse spaces, transparent surfaces, glossy work, and excessive surface brightness which can be found in the mosque. Based on the preliminary site study, it is found that the main prayer hall space was inadequately bright for night praying activities with the current usage of artificial lighting as shown in Figures 3-4.

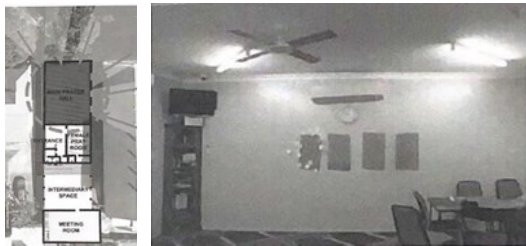


Figure 3. The meeting room is at the back of the mosque area.

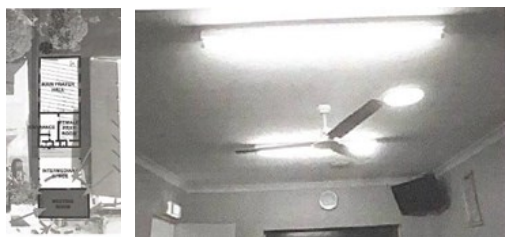


Figure 4. The current ordinary lighting fixture in the female prayer room in which, to some degree, brings out the glare experience to the users

NATURAL LIGHTING BASED INCULCATION TO THE NEWCASTLE MOSQUE

Choosing the appropriate screening arrangement for daylighting is an excellent light source for almost all interior spaces [2]. The selection of sunscreen arrangements (fixed or adjustable sunbreak), external or internal curtains, particular window glass, or a combination of two or more can be introduced to the building to improve the quality of light in the building. Screening assessment gives guidance on preliminary selection and performance of different types of sunbreaks concerning the aspects of each window or roof light.

In every building, there should be a need to maintain good interior daylight even when the sky is overcast which can reduce the amount of energy consumption by the building. Although, it depends on the necessity or otherwise of excluding sunlight as distinct from excess solar heat gain. Besides, this is essential to provide an outdoor view that impacts the occupants' psychological well-being, especially when dealing with something spiritual and sacred [4].

Apart from the architectural aesthetic representing the identity and character of the building capital, maintenance costs issue would rather be another major source to be catered with. Nonetheless, the following criteria should be fulfilled concerning the natural lighting inculcation:

- a. Eliminate glare and strong contrast
- b. Maintaining adequate natural lighting controlling sunlight penetration involves some sacrifices of daylight. For example, with many louvers systems, some reflective glasses, and plastic films, the daylight would be reduced from $\frac{2}{3}$ to $\frac{3}{4}$. It may be unacceptable when the sky is overcast and the available daylight is already at a low level. Therefore, the daylight loss can be minimized by a) retractable shading devices, b) some adjustable, and c) light-colored louver systems which reflect sunlight into the interior.
- c. Providing a view of the outdoors, people who engaged in the meeting room for the visual task benefit from occasional eye relaxation provided by an outdoor view. When planning sunlight control arrangements, their effects obstruct the view through windows.
- d. Unimpeded natural ventilation
- e. Admit solar heat when desirable

METHODS

To complete this recommendation study, the methods involved are observation at the site and interviews with end-users. Based on all information and graphical evidence collected, recommendations were tested using three-dimensional software to identify the feasible design solutions for the mosque. The collected data is the primary type of data, and the conducted study is qualitative research. Hence, the proposed recommendation layout will be injected and

imparted into the mosque's design to ensure an achievable scheme for repurposing religious buildings as shown in Figure 5.

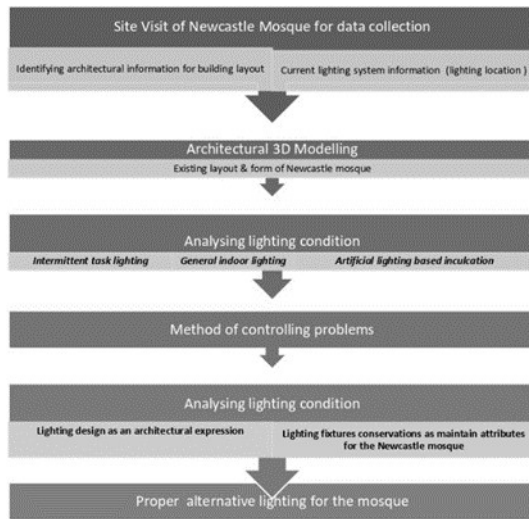


Figure 5. Methodology for lighting recommendation in Newcastle Mosque

DISCUSSION

Based on the three-dimensional software recommendations' assessment of the interior and exterior part of the Newcastle Mosque, the new propositions suggested better lighting condition performances, efficiency, and the control needs of tasks to be carried on.

RECOMMENDATION METHOD OF NATURAL LIGHTING BASED INCULCATION TO THE NEWCASTLE MOSQUE

A. SKYLIGHT



Figure 6. The example of Bait Rouf Mosque by Marina Tabassum, located in an economically-challenged area, makes the use of daylight as the main source of nature in the building

A full daylight mosque is appropriate, but the design must provide great attention to thermal comfort and brightness control [5]. One of the most common ways to introduce daylighting is through the skylight (Figure 6). As the mosque's roof is pitched roof, the best way to encounter this problem is by implementing a skylight in the building [6]. The older approach to architectural mosque lighting emphasized

the fittings themselves, like muqarnas in Sheikh Lotfollah mosque, Iran. However, the approach is usually different; the fitting can be inconspicuous or emphasize their effect [7]. In this particular Newcastle Mosque, having a skylight in the main prayer will be more appropriate to make use of the natural lighting in the building where Newcastle mosques did not apply it at the moment as shown in Figures 7 and 8.



Figure 7. The targeted area where a skylight could be implemented

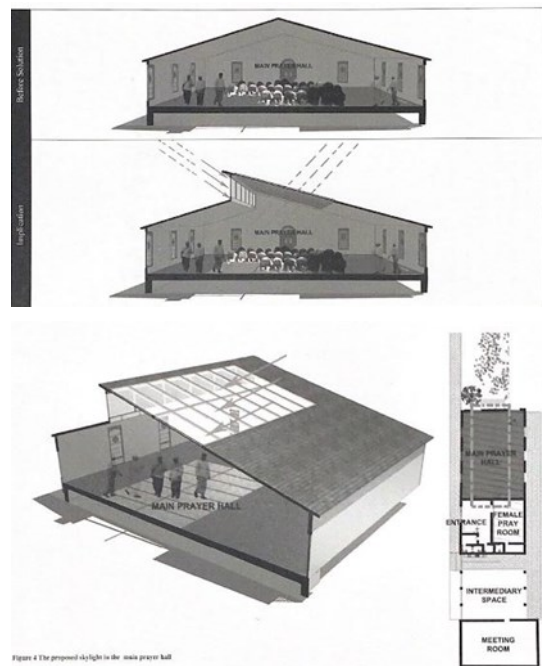


Figure 8. (a) Before and after the recommendation of the skylight proposal for the Newcastle Mosque, (b) The 3D view of the proposed skylight in the main prayer hall

B. SUNBREAK

If one building is properly designed for daylight, they reject most of the direct sunlight. In addition, they admit an ample supply of useful ones, and there are many ways to control the sun's radiant heat. One of them is through the sunbreak designed to capture the only wanted sun rays, as shown in Figures 10 and 11. As for the Newcastle Mosque, having a sunbreak around

the main prayer hall would be the best way to overcome the hot evening sun.

- Fixed horizontal sunbreak
It comprises projecting eaves, verandas, and other fixed horizontal architectural features which provides shade for window and walls.

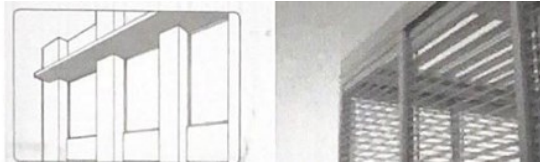


Figure 9. The horizontal sunbreaks have a wide range of application

- Fixed vertical sunbreak
Comprises projecting piers, vertical fins or blades, vertical louvers, and other fixed vertical architectural features used to shade windows from sunlight.

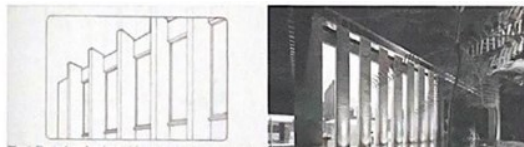


Figure 10. Fixed vertical sunbreak, which is useful for some aspects when the sun is low and at an oblique angle

Due to their effect on daylight and structural reasons, fixed vertical sunbreak should be generally not more than 150% V. Some legislation may also limit their projection on street frontages. To minimize the loss of daylight, inclined blades should preferably not be turned more than 30 degrees from normal. The sunbreak introduced should allow windows to open fully, and the window shall be designed to permit convenient access to the outside surface of the glass for cleaning. Besides, the manufacturing detail of the blade spacing should be sufficient for cleaning or painting.

- Adjustable



Figure 11. Adjustable sunbreak, either vertical or horizontal, which are very suitable for easterly and westerly aspects

Concerning the adjustable style and additional provision, such as deep reveals or projecting frames around windows is needed to prevent sunlight penetration around sides and top sunbreak. It may contribute to the sustainability of resistance to wind forces. The color and texture of blades should be

selected, whether darker or brighter façade that may affect a small percentage of heat gained to the building (Figure 11-13).



Figure 12. The proposed area is to be installed with sunbreak to maintain the excessive daylight into the building

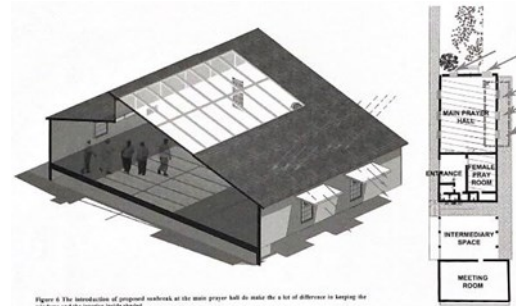
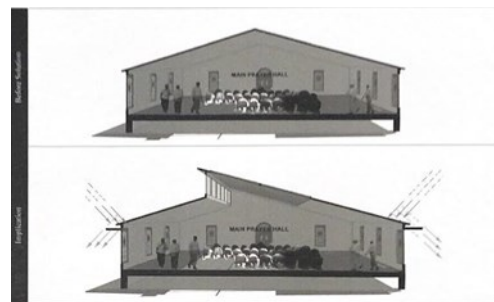


Figure 13. (a) Before and after the recommendation of the horizontal sunbreak proposal for the Newcastle Mosque to reduce the long evening heat gained during summer (b) The proposed sunbreak at the main prayer hall keeps the windows

Figure 13. (a) Before and after the recommendation of the horizontal sunbreak proposal for the Newcastle Mosque to reduce the long evening heat gained during summer (b) The proposed sunbreak at the main prayer hall keeps the windows

C. PARTICULAR WINDOW GLASS

Partial control of sunlight penetration can be obtained by using special window glazing in the mosque. However, the contrast between sunlit and shaded areas is not sufficiently reduced. Hence, curtains areas are also required. There is a distinction selection when it comes to glass. Below are the lists of glass and its characteristic:

- Heat-reflecting glass
It has a metallic coating which should be dense enough to reduce the entry of solar heat due to its infrared reflectance. However, it is quite transparent to admit sufficient daylight and provide an outdoor view. Clear glass can be made

- 'heat reflective' by applying plastics film
- Heat-absorbing glass
Heat-absorbing glass absorbs more of the infrared spectrum with less reduction in light transmission. However, much of this absorbed radiation is re-radiated into the room as heat. This effect is reduced when the heat-absorbing glass is the outer pane of a sealed double-glazed system which is not appropriate to be recommended for Newcastle Mosque.
- Glare-reducing glass, e.g., 'natural grey' and 'bronze', helps control the sky's glare and bright surroundings suitable to be placed in Newcastle Mosque (Figure 14-15).



Figure 14. The windows, especially in the main prayer hall are highly recommended to be replaced with glare-reducing glass to overcome the long hot evening sun during summer.

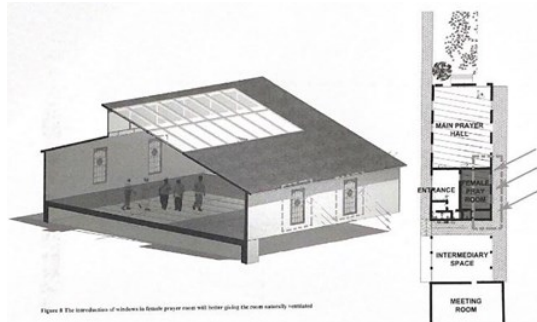
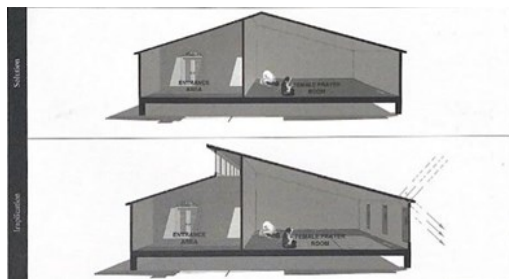


Figure 15. (a) Before and after the recommendation of the glare-reducing glass window proposal in the female praying room (b) The inadequate natural lighting in the female prayer room is highly recommended to be proposed with new window installation to prevent glare better, illuminate & ventilate the room

D. BLINDS

The Blinds are also one factor that supports the daylighting design in a building that controls the excessive contrast of interior and exterior luminance in

the mosque. Accordingly, it is recommended that Newcastle mosques implement it. Despite it is not as durable as sunbreak, external blinds or awnings are quite effective and acceptable in many situations. Internal blinds and some types of curtains can control glare, and if their outer surfaces are light-colored and placed close to the glass, some solar radiation reaching them is reflected outwards through the glass (Figure 16-18).



Figure 16. The designated windows at the Newcastle mosque should be highly suggested with blinds and awning on the exterior



Figure 17. The variation of the awning design

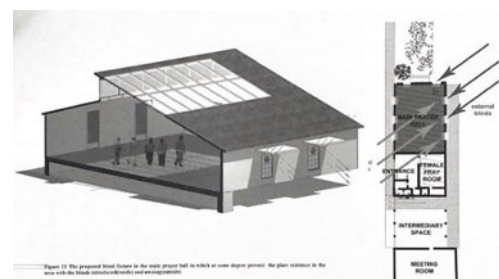
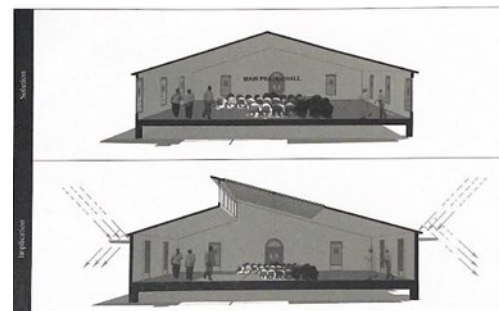


Figure 18. (a) Before and after the recommendation of the internal and external blinds proposal for the Newcastle Mosque to reduce the long evening heat gained during the summer (b) The proposed blind fixture in the main prayer hall which to some degree prevents glare existence in the area with the blinds introduced(interior) and awning(exterior)

ARTIFICIAL LICGHTING BASED INCULCATION TO THE NEWCASTLE MOSQUE

Using lamps, artificial light is generally produced by converting electrical energy to light energy. Some light is produced by the direct burning of fuels, as exemplified by a candle or kerosene lamp. For the most part, the light produced this way is used to create an atmosphere rather than lighting [8]. Other factors which influence the quality of artificial light on the work surface are the design of the light fixture (luminaries) containing the lamp and the reflectivity of the walls and ceiling. Fixtures should be designed to deliver the maximum possible useful light to a work surface as shown in Table 1. Their placement should be that glare and shadows are minimized. Reflective walls and ceilings can help lower a space's lighting requirement [9]. A few problems with the lighting fixture can be found in the Newcastle Mosque, which was unsuitably installed according to the user's comfort level.

Table 1. Some characteristics of incandescent and fluorescent lamps that are mainly being used for the mosque

Characteristic	Incandescent lamps	Fluorescent tubes
Efficiency	10-15 lm/W	30-60 lm/W
Life	1000h	5000 or 7500 h
Color rendering	Good, familiar	Poor to excellent
Color temperature	About 3000K	Choice 3000-6500K
Physical size	Small source	Relatively large
Heat dissipation	Mainly radiation	Mainly convection and conduction
Wattage range	25-1500 W	15-125 W
Control gear	None	Necessary
Noise	None	Slight
Flicker	None	Slight
Temperature	Little affected by ambient temperature	Output temperature sensitive
Vibration	Life reduced	Little effect
Switching frequency	Moderately frequent switching does not affect life	Life is reduced by frequent switching
Dimming	Simple	More complicated

A. REFLECTED GLARE TO HAPPEN IN THE FEMALE PRAYING AREA (SOLUTION: UPWARD DISTRIBUTION LIGHTING) - INTERMITTENT TASK LIGHTING

Most of the light directed downward in the female prayer room will reach the work plane with minimum absorption at the room surfaces [10]. The ideal lighting arrangement is often the combination of both direct and indirect or the downward and upward light, where it could have either a separate or combined system [11].

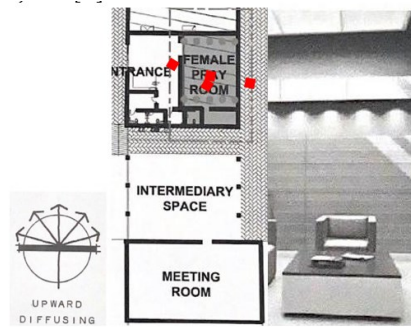


Figure 19. (a) The red dots indicate the proposed up lightdiffusing lighting fixtures for the female praying room, (b) Example of the combination of both upward and downward will create the best lighting for the user experience.



Figure 20. The current ordinary lighting fixture in the female prayer room, to some degree, brings out the glare experience to the users.

The glare in the female praying area presents the extreme contrast of lighting. A non-uniform brightness condition can be created when a low form brightness condition trough low intensity or concentrated beam distribution that are the characteristics of both upward and downward components. The upward component is adequate to relieve extreme contrasts in the space [9]. It resulted in the effective functioning and consequent appraisal of the lighting and hence prepared a new framework to facilitate the activities in the praying room (Figure 19-21).

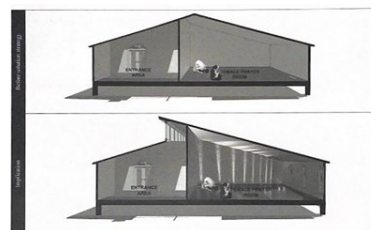


Figure 21. (a) An example of the upward diffusing fixture being installed to make the space more adequately illuminated, (b) Proposed upward lighting in the Female Praying Room in the Newcastle Mosque

B. MAIN PRAYER HALL SPACE INADEQUATE ILLUMINATED FOR NIGHT PRAYING ACTIVITIES (SOLUTION: MULTIDIRECTIONAL DISTRIBUTIONAL CONCENTRATING LIGHTING) - GENERATE INDOOR LIGHTING

The general indoor lighting in the religious building should be provided with vertical sufficient brightness to emphasize the highest position area in the hierarchy of a religion. The greater the floor area for a given ceiling height, the more efficient is the general lighting system in delivering light to the work surface [12]. For this high ceiling in the main prayer hall with the narrow room, a higher proportion of light need to strike the interior spaces and surfaces. Hence the implementation of a multi-directional diffusing fixture in the hall is recommended to provide the necessary illumination for the grandeur spaces [13].

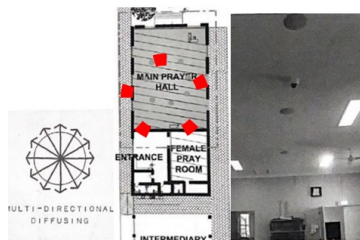


Figure 22. (a) The red dots indicate the multi-directional lighting fixture for the main prayer hall (b) The current inadequate lighting fixture in the main prayer hall, which is the most imperative space for the mosque

The proposed sort of lighting may improve the ambiance of the main prayer hall and even provide impressions of spaciousness by introducing the intensity and uniformity of the room perimeter. The distinction in the quantity of horizontal luminance from the proposed overhead system has a negligible influence on impressions of pleasantness. The proposed new condition of the lighting scenario unites people and promotes new potential visual contact in religious buildings. Increasing the intensities can reduce anonymity and unite people because facial expressions and gestures are more clearly perceptible in the mosque (Figure 22-23).

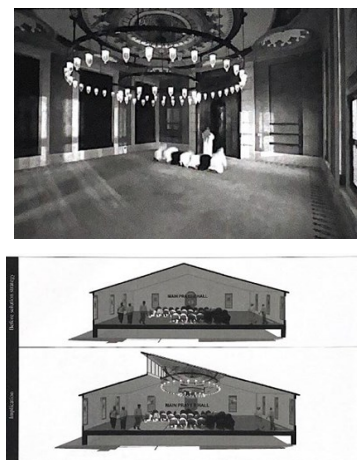


Figure 23. An example of a multi-directional diffusing fixture being installed to make the main prayer sort prominent among other spaces in the mosque.

C. HECTIC LIGHTING ENVIRONMENT OF THE MEETING ROOM (SOLUTION: DONWARD DISTRIBUTION LIGHTING) - TASK TO BE CARRIED OUT IN THE ROOM

Lighting levels should fulfill and not exceed, the requirements of the task or activities that will be performed in space. In the past, general lighting of high brightness was utilized to provide equal intensity levels over an entire room. However, much of the light was not productively utilized [14]. For the Newcastle Mosque, the amount and quality of light required to perform a given task vary from one activity to others such as reading the Quran, giving lectures to people, and having meetings among Muslims must be given different illumination to focus on. The concept of task lighting involves providing an area with the amount and quality of illumination sufficient to perform the task for which that area is intended [10]. The quality of light is extremely important. In several cases, it is a more imperative criterion than the foot candle level (quantity) (Figure 24-25).

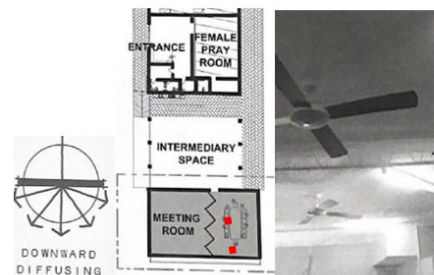


Figure 24. (a) The red dots indicate the proposed downlighting fixture in the meeting room, (b) The current lighting fixture in the mosque which unequally organized and distributed that bringing a hectic viewing experience for the users

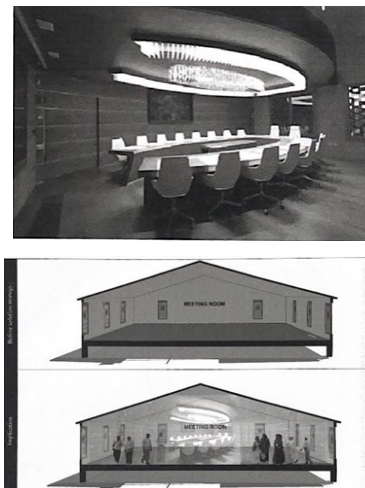


Figure 25. (a) The example of downward diffusing lighting. (b) The proposed downward diffusing fixture for the meeting room in the mosque that is suitable for carrying out meetings and discussions.

The proposed new luminaries' method for the meeting room is to encounter the uncomfortable problem of lighting distribution that gives the hectic atmosphere there with the uneven pattern of lighting

fixtures. The proposed downward distribution lighting will spread and diffuse the light source or shape [15]. Whether individual units or large-area systems, these elements emit light at wide angles, thereby increasing the incident light on the target spot vertically and horizontally and reducing the concentration of over brightness within the space [16].

CONCLUSION

LIGHTING DESIGN AS AN ARCHITECTURAL EXPRESSION (FOLLOWING AND RECOMMENDATION)

This research discussed the importance of lighting's role in mosque architecture. Based on the previous study, the light function in this architectural field can be classified into five categories: climatic, aesthetic, symbolic, and psychological. Determining the building orientation, the room's depth regarding the sunlight angle and its direction, utilizing several elements with latticed windows to reduce the light intensity, and applying the light well on the roof are the parts that are crucial in designing the lighting in a mosque.

Nowadays, in many buildings, the external facades are full of windows the size, position, and orientation are determined by architects' taste and temporary fashions. Even, those do not have any functions except climatic and aesthetic ones. Moreover, due to the wide scope of artificial illumination application in contemporary architecture, the lighting quality of interior spaces of a mosque is often monotonous and static which is undesirable.

A contemporary architect should understand the essence of these principles and allow modern building technology to be a tool in the expression of them as follow:

- **Integral lighting system and architectural form**
The integration of the light and surface (like the mosque's dome) should recognize the achievement of brightness function and light control to link the relationship.
- **Visually subordinate lighting unit**
Both indirect and concentrating direct lighting systems involve visually subordinate lighting, so that way it is necessary to emplace the level of importance for specific areas in the mosque. For example, the main prayer hall will be the highest position in the space planning, where it carries the congregational prayers.
- **Visually prominent lighting units**
The effect from outside of interior lighting may be an important part of its function for a mosque that will be a dominant factor in the visual surrounding environment.

LIGHTING FIXTURES CONSERVATIONS AS MAINTAIN ATTRIBUTES FOR THE NEWCASTLE MOSQUE (FOLLOWING AND RECOMMENDATION)

- Use fluorescent lamps in suitable areas like the toilet and pantry as they may produce more lumens per watt and have a longer life.
- Keep lamps and all lighting fixtures clean. Lighting output can be significantly reduced if the fixtures are not maintained in cleanliness.
- Maintain the light colors used for the mosque wall. It will reflect lighter than dark colors and reduce the wattage or artificial lighting fixture required.
- Consider installing solid-state dimmer switches when replacing the light switches. They reduce energy consumption by permitting lamps in mosques to be operated at a reduced power level.

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