**BUILDING SCIENCE II [ARC 3413 / BLD 60803]**

**BACHELOR OF SCIENCE (HONS) IN ARCHITECTURE**

## Project 2

# LIGHTING INTEGRATION PROJECT

**DAYLIGHT, ARTIFICIAL LIGHTING & PSALI ANALYSIS**

Art Centre , Jalan Sulaiman , Kajang

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## Objectives

The project aims to integrate students' understanding of the principles of lighting into proposed learning centre for all within the context of Jalan Sulaiman, Klang. It incorporates advanced daylighting systems and the integration of electrical lighting, and PSALI method as strategies for better lighting condition and produce architectural poetic qualities. Student are to show their understanding of their final design and to solve design problems in relation to sustainability issues (natural lighting and site analysis).

## Project Background - Art Centre

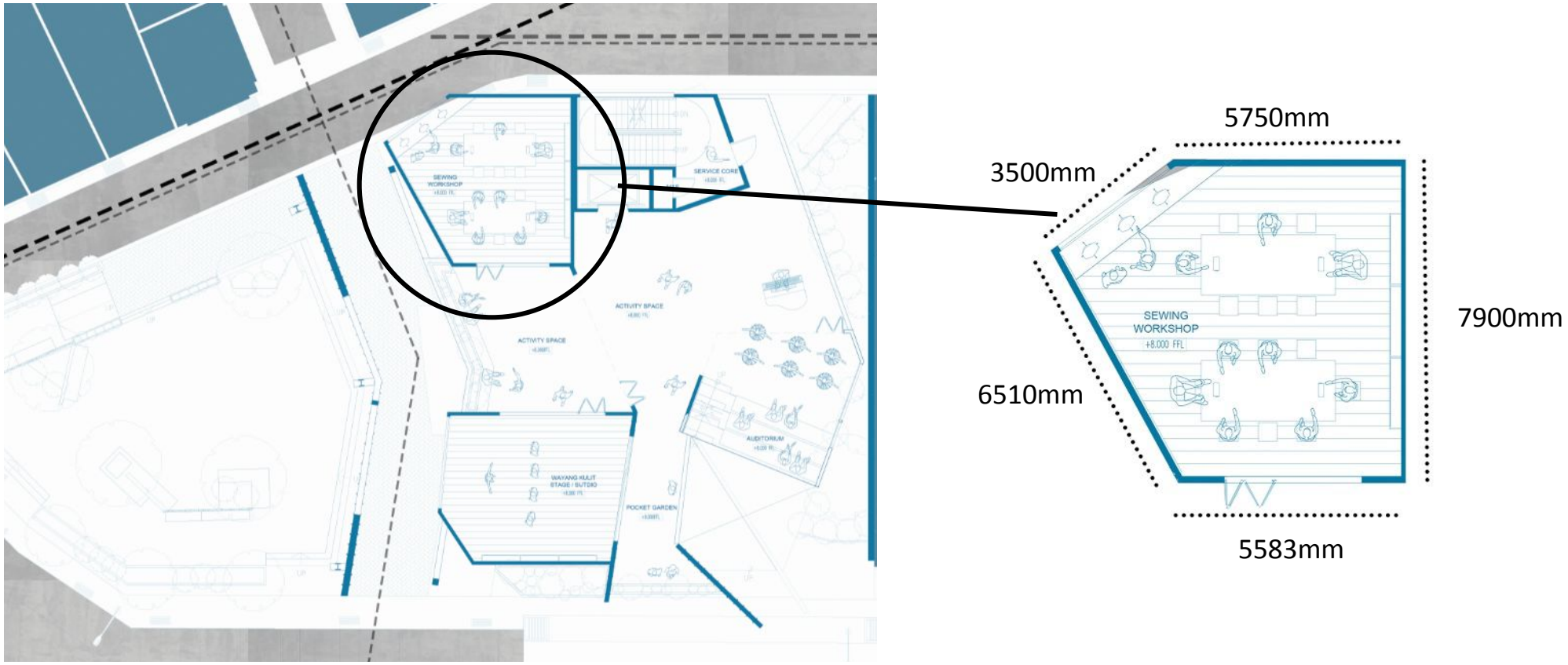
The Design Studio V brief calls to design a Art Centre within an urban infill site. The design of the building is to consist of appropriate architectural responses that address the aspects of the urban street context and user behavioural patterns as discerned and analyzed in the preliminary studies.

The design intention of this Art Centre for all is to re-establish connection between old and young. As part of the design strategy consideration, the corner double skin facade is specifically treated to reactive the street and public realm of Jalan Sulaiman by bringing vibrancy and attracting the young to stay within the monotonous town of Kajang. The architecture express a playful respond to the existing rhythm of the shophouses and also incorporates contemporary way of reinterpreting traditions to reflect the modern- in order to gentrify attention and interest from people of different age groups into the building at street level or from far.

# DAYLIGHT FACTOR ANALYSIS

## Space A- Sewing Workshop (Makerspace)

Located at the third floor, the sewing workshop is a DIY space for the user, with one (L) 3m x (W) 2.5m double glazing window facing towards the back alley lanes.The room does not receive adequate amount of daylight, the only light penetration is through the windows. The office is shaded most of the day to protect the digital accessories from the strong daylighting.



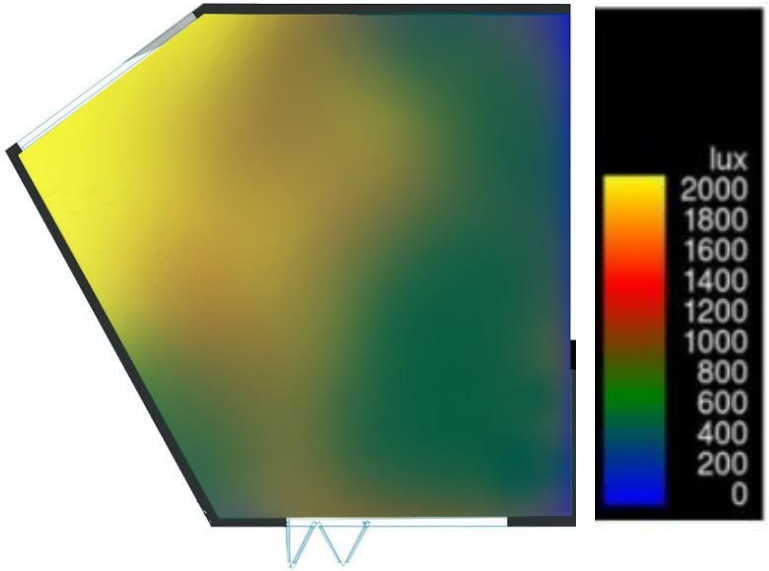

Second floor plan highlighting the location of Sewing workshop (left) and detailed dimension of the space (right)

| **Average Daylight Factor Calculation** | |
|---|---|
| Total Floor Area ($m^2$) | 56.6 |
| Area of Windows (W, $m^2$) | Window = (L) 3.5 x (W) 3 = 10.5 |
| Total Area of Internal Surfaces (A,$m^2$) | (3.5 x 3.6)+(5.75 x 3.6)+(7.9 x 3.6)+(5.583 x 3.6)+(6.5 x 3.6)+(56.6 x 2)=218.34 |
| Glass Transmittance Corrected For Dirt (T) | 0.6 |
| Visible Sky Angle In Degrees From The Centre Of The W Window (θ) | 43° (from the angle of the back alley shop - 3 floor height) |
| Average Reflectance Of Area (R) | 0.5 (considering light coloured room surfaces) |
| Average Daylight Factor (DF) | w= 10.5 x T= 0.6 θ=43 =270.9<br>A=218.34 x 1-0.5 =109.17<br>=2.48%<br><br>( According to MS1525 , this room is consider average ) |

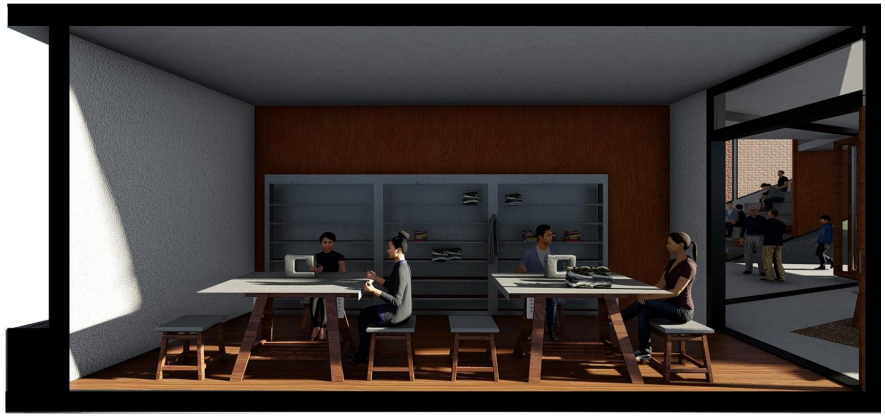
## Space A Daylight Analysis :

The sewing workshop has distribution of average daylight factor of 2.48% which is categorized by the Ms1525 requirement as fair.However artificial lights are needed as this space does not received much light in the morning due the location at the part of the building.
Installation of light filter such as louver to control the uncomfortable glare problem is needed.

Mostly are dull during the 8 am morning sun due to the sun path



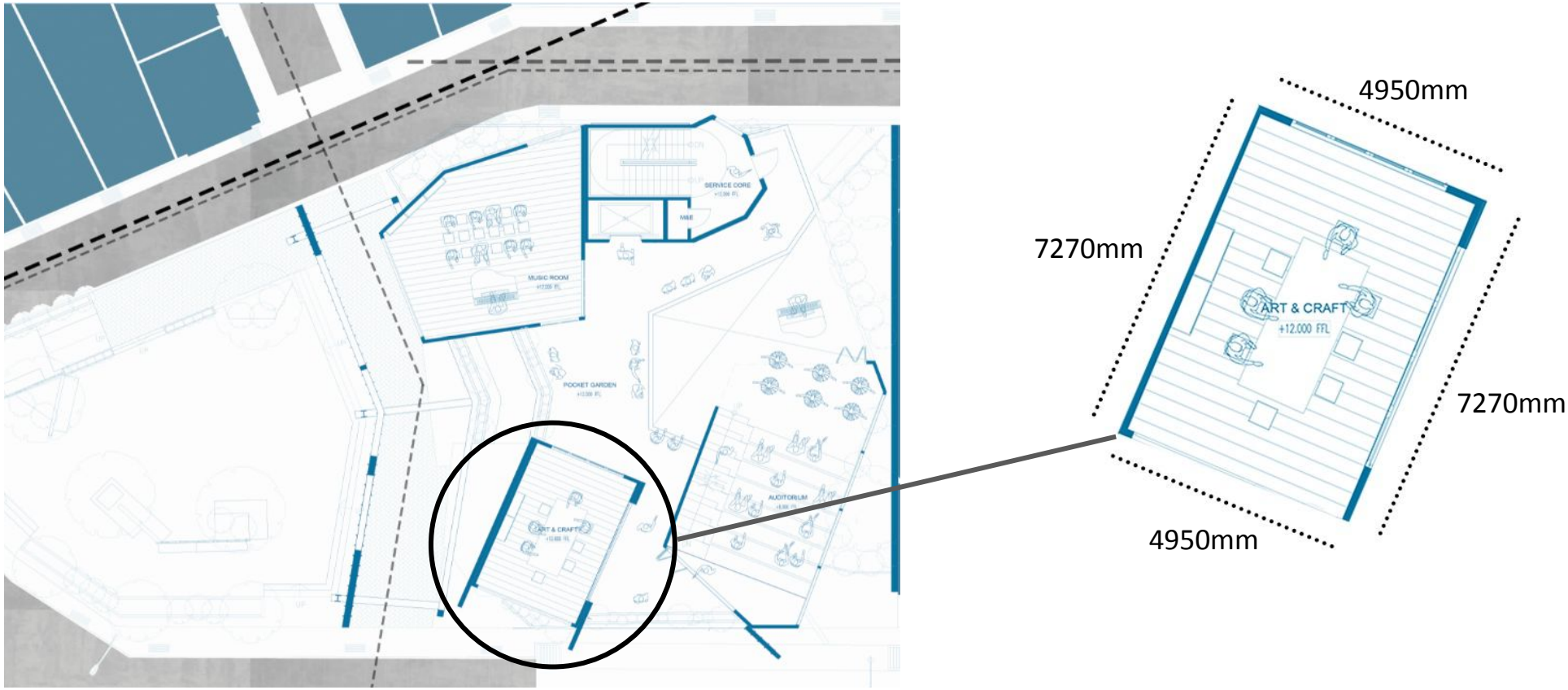

The space is brightly lit on the corner side facade as it is a huge window that maximizes sunlight penetration but grows darker approaching the areas without openings



Sewing Workshop receives evening sunlight from the openings facing the back street

## Space B- Art Workshop (Makerspace)

Located at the forth floor, the art workshop is also a DIY space for the user, with one (L) 3m x (W) 2.5m double glazing window facing towards the front street.The space is fully equipped with variety of tools and material allowing the young to have hands-on experience on  starting up their own business. The young adapt what they have learnt into creating their own, which are then brought down to the market to showcase their work and to be marketed.

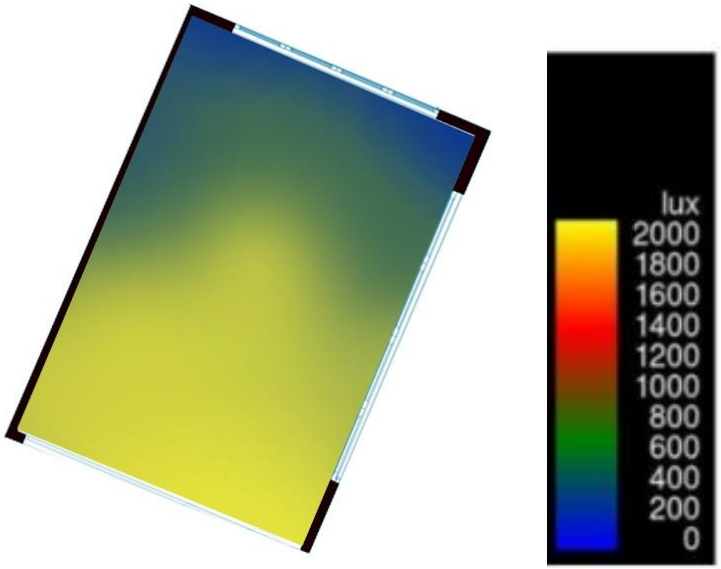



Fourth floor plan highlighting the location of art workshop (left) and detailed dimension of the space (right)

| **Average Daylight Factor Calculation** | |
|---|---|
| Total Floor Area ($m^2$) | 36 |
| Area of Windows (W, $m^2$) | Window = (L) 3 x (W) 2.5 = 7.5<br>Sliding Door = (L) 2 x (W) 2.5 = 5 |
| Total Area of Internal Surfaces (A,$m^2$) | 2(7.27 x 3.6)+2(4.95 x 3.6)+(36x2)<br>=152 |
| Glass Transmittance Corrected For Dirt (T) | 0.6 |
| Visible Sky Angle In Degrees From The Centre Of The W Window (θ) | 56° (from the angle of the metro plaza - 7 floor height) |
| Average Reflectance Of Area (R) | 0.5 (considering light coloured room surfaces) |
| Average Daylight Factor (DF) | w= 12.5 x T= 0.6 θ=56 =420<br>A=160 x 1-0.5 =80<br>=5.25%<br><br>( According to MS1525 , this room is consider bright ) |

## Space B Daylight Analysis :

The art workshop has distribution of average daylight factor of 5.25% which is categorized by the Ms1525 requirement as good. The space is for working, creating and painting which need focus and attention all time, therefore decent amount of light is required throughout the day. The art workshop receives high amount of daylight during the morning .However, with support from the artificial lighting in the evening , this space will have a gentle lighting ambience for working purpose.




The space is brightly lit on the frontside facade as it is a huge window that maximizes sunlight penetration but grows darker approaching the areas without openings

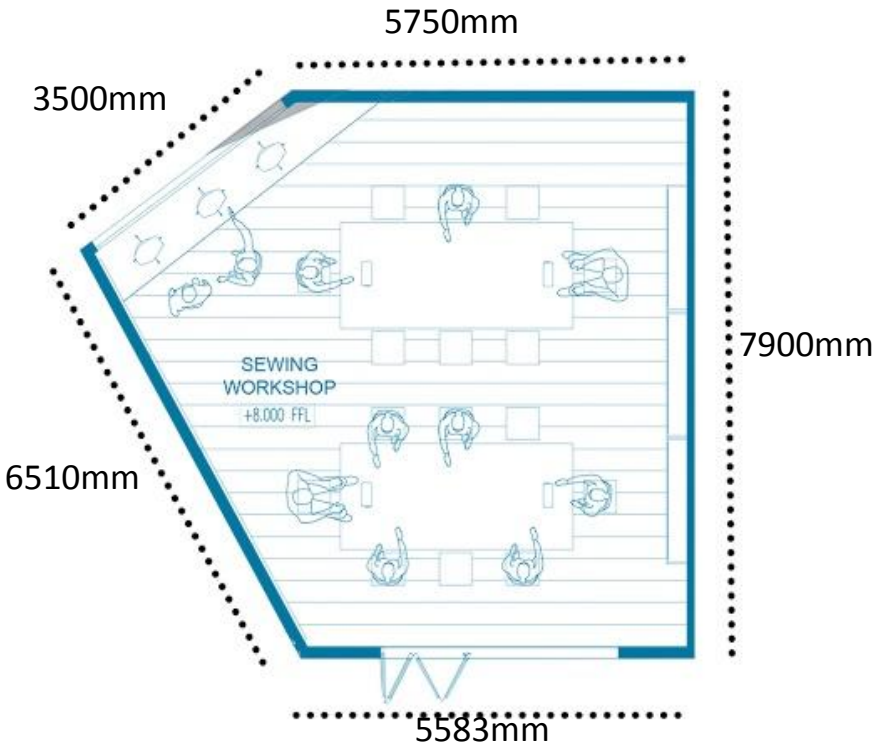
Mostly are bright during the 8 am morning sun due to the sun path

Mostly are dull during the evening due to the sun path

# Artificial Lighting Analysis

## Space A- Sewing Workshop (Makerspace)

Pendant Light is commonly used in warehouse or workshop due to its minimal, contemporary and industrial look that matches the setting of the space. It also important to note that the coloring rendering index (CRI) value of at least 90 is required to ensure the true colours of the product are properly showcase while crafting

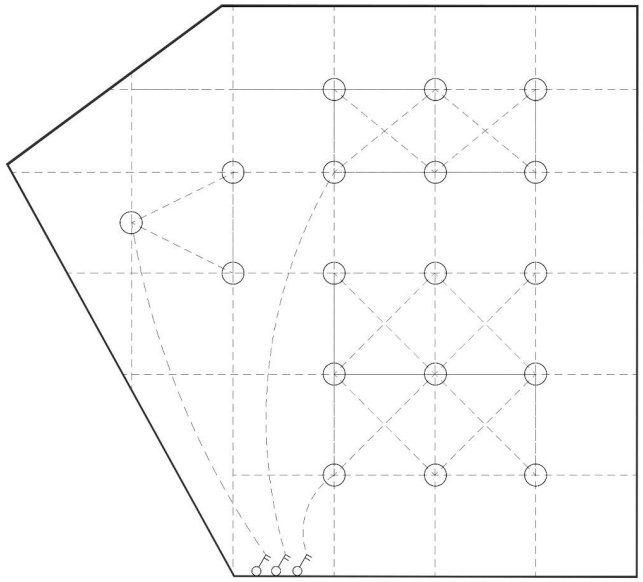



| | |
|---|---|
| Type of Lighting |  |
| Type of Lightbulb | LED Bulb with 600 lumens |
| Product Brand | IKEA HEKTAR ceiling light |
| Light Distribution | Direct distribution |
| Material Fixture | Aluminium Casing |
| Nominal Life (H) | 15000 |
| Wattage Range (W) | 60 |
| Luminous Flux (lm) | 2000 |
| Colour Temperature (K) | 3000 |
| Colour Rendering Index (CRI) | 90 |
| Colour Designation | Black |

| **Room Index Calculation** | |
|---|---|
| Dimension of room (m) | L = 7.9  W=7.16 |
| Total floor Area ($m^2$) | 56.6 |
| Height of Ceiling (m) | 3.6 |
| Type of light fixture | LED Pendant Light |
| Luminous Flux of Lighting (F, lm) | 2000 |
| Height of Luminaires (m) | 0.45 |
| Height of Working Plane (m) | 0.8 |
| Mounting Height (Hm) | 3.6-0.45-0.8 = 2.35 |
| IES Standard illuminance Level Required According to MS1525 and JKR (E, lux) | 300 (Workshop space) |
| Reflectance Factor | Ceiling - White Plastered Ceiling = 0.7<br>Wall - White Paint Concrete = 0.5<br>Floor - Timber, light = 0.3 |
| Room Index (RI) | RI= (L) 7.9 X (W) 7.16 =56.6<br>Hm = 2.35 (7.9 + 7.16) = 35.4<br><br>RI = 56.6 / 35.4 = 1.6 |

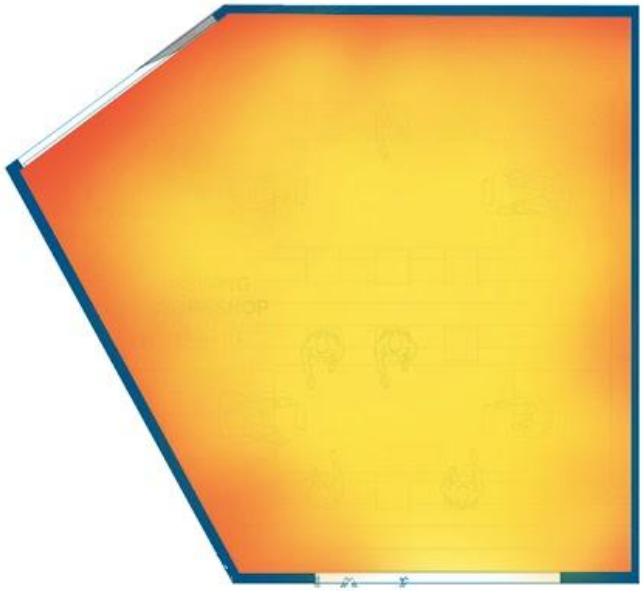
| **Lumen Method Calculation** | |
|---|---|
| IES Standard illuminance Level Required According to MS1525 and JKR (E, lux) | 300 (Workshop) |
| Area at Working Plane Height (A,$m^2$) | 56.6 |
| Luminous Flux of Lighting (F, lm) | 2000 |
| Utilization Factor (UF) | Ceiling - Wall - Floor 70%-50%-30%<br>Based on UF table,<br>RI = 1.6 UF = 0.6 |
| Maintenance Factor (MF) | 0.8 (Standard) |
| Number of Fitting Required (N) | N= (E)300 x (A)56.6 = 16980<br>(F)2000 x (UF)0.6 x (MF) 0.8 =960<br><br>N= 16980 / 960 = 17/18 Lamps |

| | |
|---|---|
| Fitting Layout | S= 1.0 x Hm (2.35) = 2.35<br>Distance between light not more than 2.35m |



Reflected ceiling plan showing light fixture layout based on the lumen calculation

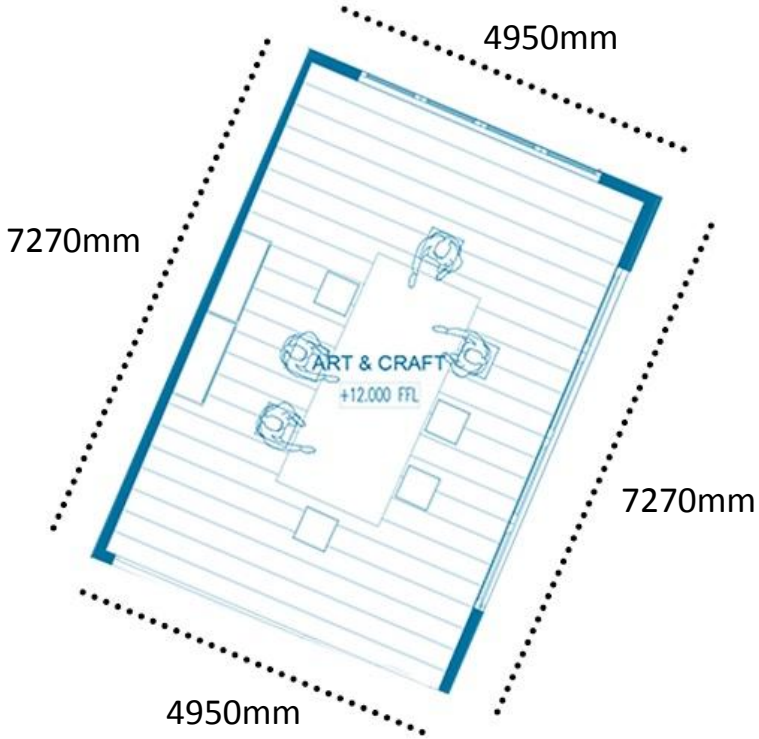

There is 18 lights to achieve a minimum of 300 lux standard requirement by MS 1525 and JKR for a sewing workshop space equipped with table, tools and materials.Light 1 and 2 balance the intensity of light in the interior , During the morning , light 1 & 2 is switch on to ensure the adequate of light in the dark interior.During night when there is no external source of light, all light are turned on to achieve sufficient lighting, including light 3.



Artificial lighting contour analysis done in Revit shows the level of illumination using the same light fixture layout

## Space B- Art Workshop (Makerspace)

Adequate Lighting is important in a art workshop. The LED Wireless Recessed Downlight is chosen to act as ambient lighting for the art workshop. The slightly blue tinted helps to promote concentration of the user when drawing while giving a slightly warm hue。

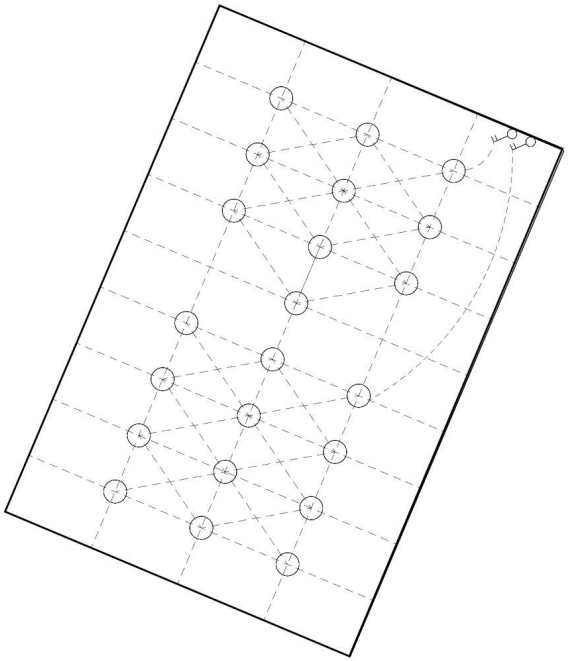



| | |
|---|---|
| Type of Lighting |  |
| Type of Lightbulb | LED Wireless Recessed Downlight |
| Product Brand | 801506 |
| Light Distribution | Direct distribution |
| Material Fixture | - |
| Nominal Life (H) | 32 years |
| Wattage Range (W) | 10 |
| Luminous Flux (lm) | 1200 |
| Colour Temperature (K) | 3500 |
| Colour Rendering Index (CRI) | 80 |
| Colour Designation | White |

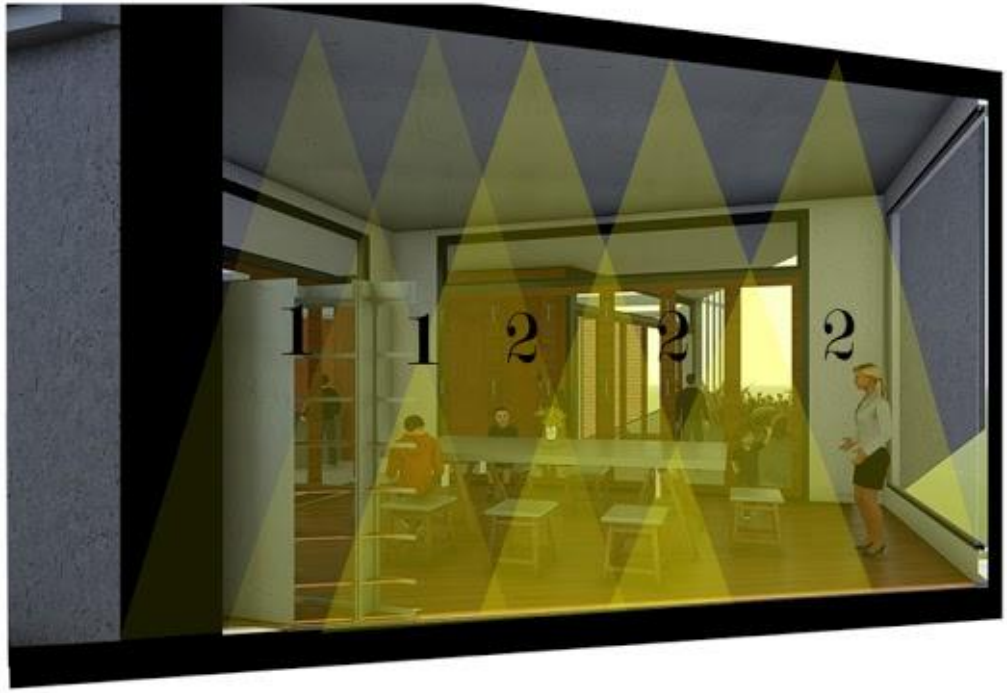
| **Room Index Calculation** | |
|---|---|
| Dimension of room (m) | L =7.27  W=4.95 |
| Total floor Area ($m^2$) | 36 |
| Height of Ceiling (m) | 3.6 |
| Type of light fixture | LED Wireless Recessed Downlight |
| Luminous Flux of Lighting (F, lm) | 1200 |
| Height of Luminaires (m) | 0 |
| Height of Working Plane (m) | 0.8 |
| Mounting Height (Hm) | 3.6--0.8 = 2.8 |
| IES Standard illuminance Level Required According to MS1525 and JKR (E, lux) | 300 (Workshop space) |
| Reflectance Factor | Ceiling - White Plastered Ceiling = 0.7<br>Wall - White Paint Concrete = 0.5<br>Floor - Timber, light = 0.3 |
| Room Index (RI) | RI= (L) 7.27 X (W) 4.95 =36<br>Hm = 2.88 (7.27 + 4.95) = 35<br>RI = 36/34 = 1.1 |

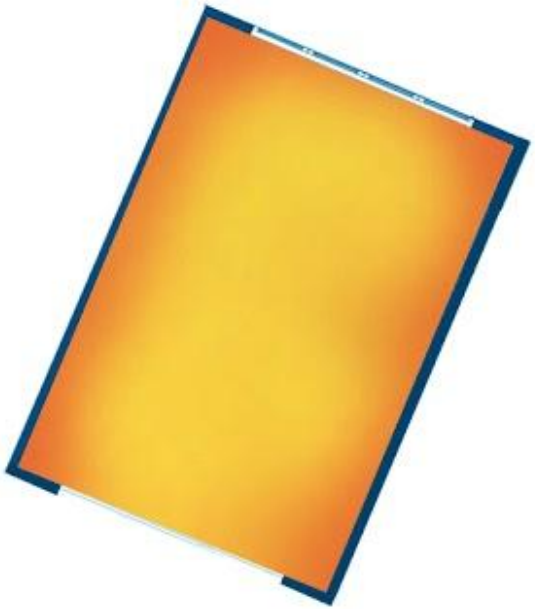
| **Lumen Method Calculation** | |
|---|---|
| IES Standard illuminance Level Required According to MS1525 and JKR (E, lux) | 300 (Workshop) |
| Area at Working Plane Height (A,$m^2$) | 36 |
| Luminous Flux of Lighting (F, lm) | 1200 |
| Utilization Factor (UF) | Ceiling - Wall - Floor 70%-50%-30%<br>Based on UF table,<br>RI = 1.1 UF = 0.5 |
| Maintenance Factor (MF) | 0.8 (Standard) |
| Number of Fitting Required (N) | N= (E)300 x (A)36 = 10800<br>(F)1200 x (UF)0.5 x (MF) 0.8 =480<br><br>N= 10800 / 480 = 22 Lamps |

| | |
|---|---|
| Fitting Layout | S= 1.0 x Hm (2.8) = 2.8<br>Distance between light not more than 2.8m |



Reflected ceiling plan showing light fixture layout based on the lumen calculation



Artificial lighting contour analysis done in Revit shows the level of illumination using the same light fixture layout

There is 22 lights to achieve a minimum of 300 lux standard requirement by MS 1525 and JKR for a art workshop space equipped with table, tools and materials.Both of the light will be turn on when the room is dull or with insufficient daylight , or it can turn on just one side for working purpose, also to save electricity cost.

## Conclusion

Daylighting consideration is a crucial part through the entire design studio project as it contribution to sustainability, especially when it comes to urban context. With sufficient integration of daylight into the building, the building ensures that the users are provided with a comfortable, bright space without the use of artificial lighting. As the art centre is a public building , saving cost of operation is also important , hence the implementation of daylight strategies is definitely required.

Meanwhile, the PSALI strategy implementation infusing natural daylight and artificial light yields both design and economic benefit to the overall building. It allows flexibility of adjusting artificial lighting according to the external daylight situation which aids to save a lot of operational costs.

Overall. The analysis conducted on the two spaces have been academically beneficial in terms of lighting consideration design process of a building.

## Reference


*Ander, G. (2003) , Daylighting Performance and Design . Hoboken, N.J. : John Wiley & Sons*

*Ikea. (2018) HEKTAR Pendant Light . Retrieved December 3, 2018, from https://www.ikea.com/my/en/catalog/products/40296108/*

*Pioneer Lighting. (2016). Room illumination Level. Retrieved December 3, 2018, from http://www.pioneerlighting.com/new/pdfs/IESLuxLevel.pdf*

*Reinhart, C. & Stein, R. Daylight Handbook. Hoboken, N.J.:John Wiley & Sons*