REPORT ROOM DATA SURVEY 2024

FTKIP

AMIRUL ANNIQ BIN MOHD YUSOF

1.0 Room Data Survey (RDS)

Room Data Survey (RDS), also known as Architectural Room Data Sheets, plays a pivotal role in architectural and interior design projects, providing comprehensive documentation of a room's interior elements. These surveys capture essential data regarding wall and floor finishes, ceilings, lighting, furniture, MEP (Mechanical, Electrical, and Plumbing) systems, fixtures, and graphical elements (Youssef et al., 2021).

1.2 Collecting and Calculating Data Recommended by Malaysian Standard MS 1525:2019

The Malaysian Standard MS 1525:2019, titled "Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings – Code of Practice," provides guidelines to ensure energy-efficient and comfortable environments in non-residential buildings. Key environmental parameters such as temperature, relative humidity, luminance level, and carbon dioxide (CO_2) level are included in this standard.

1.2.1 Temperature

The MS 1525:2019 standard recommends maintaining an indoor temperature between 24°C to 26°C for air-conditioned spaces. This range ensures a comfortable environment for occupants while optimizing energy use. Maintaining the temperature within this range helps reduce the need for excessive heating or cooling, contributing to overall energy efficiency and sustainability.

1.2.2 Relative Humidity

Relative humidity (RH) levels are crucial for both comfort and the prevention of issues like mold growth or static electricity. MS 1525:2019 advises maintaining RH between 50% and 70% for air-conditioned spaces. This range helps ensure comfort, health, and productivity of the occupants while preventing the growth of microorganisms and the deterioration of building materials.

1.2.3 Luminance Level

Adequate lighting is essential for productivity and well-being in non-residential buildings. The standard specifies that luminance levels should be appropriate to the activities performed in various areas of the building. For general office work, the recommended luminance level is around 300 lux. Proper lighting design according to these guidelines helps reduce eye strain and improves task performance while conserving energy through the use of efficient lighting systems and controls. In this study, the luminance level for each room was measured three times, and the average was calculated. The average luminance level was then subtracted from the recommended luminance level of 300 lux to determine the deviation. To calculate the percentage deviation, the deviation was divided by the recommended luminance level of 300 lux, as specified by MS1525. The tolerance for the percentage deviation was set at ±20%, allowing the results to be categorized as within, over, or under the recommended levels according to MS1525 standards. The illuminance levels were categorized into three groups: within the recommended range (±20%), overlit (more than +20%), and underlit (lower than -20%).

1.2.4 Carbon Dioxide Level

Indoor air quality is a vital aspect of the overall environment in buildings. MS 1525:2019 emphasizes maintaining indoor CO_2 levels below 1,000 parts per million (ppm). Higher levels of CO_2 can indicate poor ventilation and can lead to discomfort, reduced cognitive function, and

health issues. Effective ventilation systems are necessary to manage CO_2 levels, ensuring a supply of fresh air and the removal of stale air, thereby promoting a healthier indoor environment.

In summary, MS 1525:2019 provides comprehensive guidelines for maintaining optimal indoor environmental conditions in non-residential buildings. By adhering to recommended levels of temperature, relative humidity, luminance, and carbon dioxide, building managers can enhance occupant comfort, health, and productivity while achieving significant energy savings.

1.3 Selected Location of the Case Study

This study was located in Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan, Universiti Teknikal Malaysia Melaka. The purpose of the study was to evaluate the room data survey (RDS) which including measuring temperature, carbon dioxide, relative humidity and luminance level. The faculty was chosen for this study because it can help to reduce energy waste while still offering a productive visual environment with energy efficient lighting. Overall total rooms and spaces are as many as 242 rooms that must be taken the measurements and Figure 3.2 shows the example room at FTKIP.

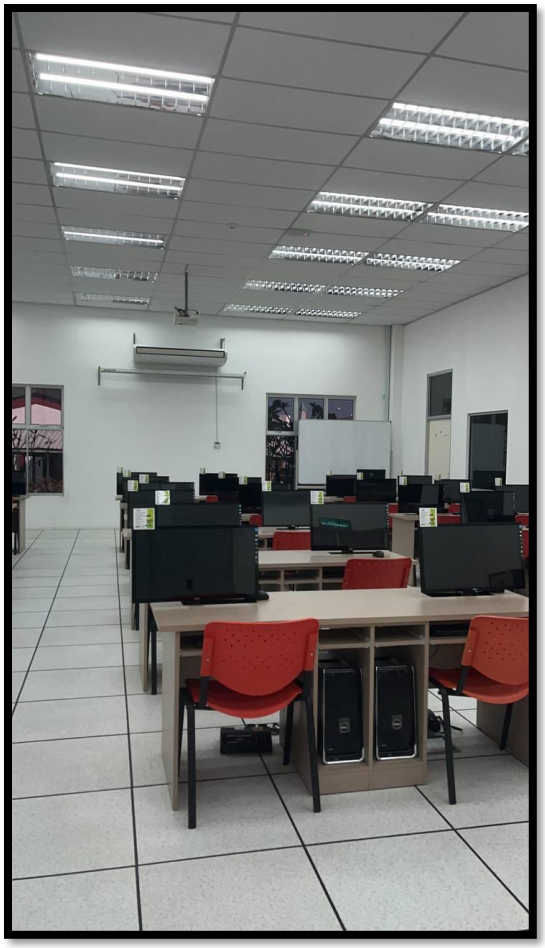

Figure 3. 1: Example room in FTKIP

2.0 Measuring Instrument for Data Collection

There are some measuring instruments used for the data collection in this study. These measuring instruments are to measure the luminance level, carbon dioxide, temperature and relative humidity.

2.1 Multifunctional Air Quality Tester

Figure 3. 2: Jadeshay Multifunctional Air Quality Tester

The Jadeshay Multifunctional Air Quality Tester, but it is also sold under a number of other brand names including KKmoon. It is a device that can measure a variety of air quality factors, including carbon dioxide (CO2), total volatile organic compounds (TVOCs), temperature and humidity. It is designed to be used in a variety of environments, including homes, offices, and schools.

The tester has a digital display that shows the readings for each of the four metrics it measures. It also has a number of buttons that can be used to change the units of measurement (e.g., from Celsius to Fahrenheit) and to set alarms. The tester is powered by a rechargeable lithium battery.

Here are some additional things to keep in mind when using an air quality tester. Firstly, air quality can vary from place to place and over time. So, it is important to take multiple readings in different locations and at different times of day to get an accurate picture of your air quality. Next, air quality testers can be a useful tool for identifying potential air quality problems. However, they should not be used as the sole basis for making decisions about your health. If you are concerned about your air quality, you should consult with a qualified professional.

2.2 Laser Distance Measurer

Figure 3. 3: Kalei Digital Laser Distance Measurer

On all terrains, laser measurers are a highly effective technique for measuring distances. The device calculates and displays the distance to that location with high accuracy after utilizing a laser to target and record a point of reference. Laser distance meters transmit a laser beam to a certain point and then measure the distance using the time it takes for the light beam to return to the instrument. Because the laser pointer is visible to the naked eye, the user can rapidly pinpoint the appropriate measurement region, ensuring that the measurement is as accurate as possible.

Kalei Digital Laser Distance Measurer is a pocket-size laser measurer that is easy to carry on. This device can be applied for a single measurement, continuous measurement (Max/Min), area/volume calculation, and indirect stake-out function. It has high accuracy, which has a laser precision technology accuracy of up to ±0.06 inch. Easy and quick measurement with a single hand and improves working efficiency.

2.3 Lux Meter

Figure 3. 4: UT383/UT383BT Mini Light Meters

The UT383/UT383BT Mini Light Meters is a small, entry-level device that is specifically designed for spot checks in the workplace, stores and offices. The light sensor is based on the spectral sensitivity of the human eye and is ideal for assessing lighting conditions in an assortment of situations. The compact, easy-to-use meter has several useful functions and features, including a large, easy-to-read display, min/max values shown at the touch of a button, a hold function that allows you to freeze the last reading, and a protective function cap for safe storage. The measuring range is 0 to 99999 lux, with a ±3 lux accuracy. The sampling rate is 0.5 seconds per reading.

Measurements were made during the day. Each measurement point is measured three times at the planned point of measurement. The value of the amount of illuminance at the planned measurement location in each room is determined using a lux meter.

3.0 Analyze Data Recommended by Malaysian Standard MS 1525:2019

To thoroughly analyze the data for luminance level, temperature, relative humidity, and carbon dioxide level as outlined in the Malaysian Standard MS 1525:2019, a detailed and systematic approach is required. The process involves accurate data collection, meticulous recording, precise calculations, and clear visualization to ensure compliance with the standard and to maintain optimal indoor environmental conditions.

Luminance Level Analysis:

Begin by measuring the luminance level in each room using a lux meter. Conduct three separate measurements for each room to ensure reliability and accuracy of the data. Record these measurements on an Excel sheet with columns labeled Room, Measurement 1, Measurement 2, and Measurement 3. Calculate the average luminance level for each room by summing the three measurements and dividing them by three. Enter this average in a new column labeled Average Luminance.

Next, determine the deviation from the recommended luminance level of 300 lux by subtracting the average luminance from 300 lux. Calculate the percentage deviation by dividing the deviation by 300 lux and multiplying by 100. Categorize the luminance levels into three groups: within the recommended range (±20%), overlit (more than +20%), and underlit (lower than -20%). This categorization helps in identifying areas that need adjustment. Create graphs in Excel to visualize these categories, using different colors to represent each group, which makes it easier to compare the actual luminance levels with the standard.

Temperature Analysis:

Measure the indoor temperature of air-conditioned spaces using a calibrated thermometer. Record these temperature readings in an Excel sheet with columns for Room and Temperature. Compare each recorded temperature with the recommended range of 24°C to 26°C. Categorize the temperature readings into three groups: within the recommended range, below the range, and

above the range. This categorization helps identify rooms where the temperature may need to be adjusted to meet the standard.

In Excel, create graphs to display the temperature variations across different rooms. Use different colors or markers to indicate whether the temperatures fall within, below, or above the recommended range. This visual representation provides a clear overview of the temperature conditions in various rooms and highlights areas that may require adjustments to achieve energy efficiency and occupant comfort.

Relative Humidity Analysis:

Measure the relative humidity levels in various rooms using a hygrometer. Record the readings in an Excel sheet with columns for Room and Relative Humidity. Compare each recorded humidity level with the recommended range of 50% to 70%. Categorize the readings into three groups: within the recommended range, below the range, and above the range. This analysis helps in identifying areas where humidity control may be needed to maintain comfort, health, and productivity.

Create graphs in Excel to display the relative humidity levels, using different colors to indicate the categories. This visual tool allows for a quick comparison of actual humidity levels against the recommended range, making it easier to identify and address any discrepancies.

Carbon Dioxide Level Analysis:

Measure the indoor CO_2 levels in each room using a CO_2 meter. Record these readings in an Excel sheet with columns for Room and CO_2 Level. Compare each recorded CO_2 level with the recommended maximum of 1,000 ppm. Categorize the CO_2 levels into two groups: below 1,000 ppm and above 1,000 ppm. This categorization helps identify areas with potentially poor ventilation, which can impact occupant health and comfort.

Create graphs in Excel to display the CO_2 levels across different rooms, highlighting whether they exceed the recommended maximum. Use different colors to differentiate between levels below and above the standard. This visual representation aids in identifying rooms with high CO_2 levels that may require improved ventilation to ensure a healthy indoor environment.

Data Visualization and Reporting:

For each environmental parameter, ensure that the Excel sheet is well organized and that all calculations are accurate. Create separate graphs for luminance level, temperature, relative humidity, and carbon dioxide level to provide clear and concise visual representations of the data. Use different colors, markers, or labels to indicate the various categories within each graph, making it easy to interpret the results in relation to the MS 1525:2019 standards.

These visual tools not only help in communicating the findings effectively but also support decision-making processes for maintaining optimal indoor environmental conditions. By adhering to the guidelines of MS 1525:2019, building managers can enhance occupant comfort, health, and productivity while achieving significant energy savings. Regular monitoring and analysis of these parameters ensure ongoing compliance with the standard and contribute to the sustainability of non-residential buildings.

4.1 Room Data Surveys (RDS) Findings

The Room Data Surveys (RDS) provided comprehensive data on the current state of the indoor environment and facilities within FTKIP. Key findings include measurements of illuminance levels, temperature, relative humidity, and carbon dioxide (CO2) levels.

4.1.1 Illuminance Levels

Table 4. 1: Illuminance level of 242 rooms

Room No/ Description	Illuminance [Lux]				MS 1525	Deviation	Tolerance ±20%	Judgement
	P1	P2	P3	Avg				MS1525
DEWAN KULIAH	1103	832	854	930	300	630	210%	OVERLIT
AUDITORIUM	350	380	330	353	300	53	18%	WITHIN
BILIK HOLDING	174	237	260	224	300	-76	-25%	UNDERLIT
SURAU	1202	910	905	1006	300	706	235%	OVERLIT
LOBI PENTADBIRAN	570	1721	527	939	300	639	213%	OVERLIT
RUANG SOLAT (P)	267	242	306	272	300	-28	-9%	WITHIN
RUANG SOLAT (L)	267	242	306	272	200	72	36%	OVERLIT
BILIK PROFESSOR 1	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 2	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 3	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 4	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 5	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 6	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 7	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 8	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 9	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 10	372	266	172	270	300	-30	-10%	WITHIN
PANTRI	267	242	306	272	300	-28	-9%	WITHIN
BILIK MESYUARAT COSSID	372	266	172	270	100	170	170%	OVERLIT
STOR ALAT TULIS 4	334	254	167	252	300	-48	-16%	WITHIN
PEJABAT PENTADBIRAN	234	366	164	255	300	-45	-15%	WITHIN
PENOLONG PENDAFTAR	376	315	271	321	300	21	7%	WITHIN
STOR AM 1 (FAIL)	286	259	305	283	300	-17	-6%	WITHIN
STOR ALAT (PERALATAN) 1	260	372	258	297	200	97	48%	OVERLIT

Room No/ Description	Illuminance [Lux]				MS 1525	Deviation	Tolerance ±20%	Judgement
	P1	P2	P3	Avg				MS1525
STOR ALAT (PERALATAN) 2	260	372	258	297	300	-3	-1%	WITHIN
STOR ALAT (PERALATAN) 3	260	372	258	297	300	-3	-1%	WITHIN
BILIK CETAK 1	305	234	172	237	300	-63	-21%	UNDERLIT
BILIK PENSYARAH 1	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 2	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 1	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 3	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 4	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 5	307	354	165	275	100	175	175%	OVERLIT
BILIK PENSYARAH 6	307	354	165	275	200	75	38%	OVERLIT
BILIK PENSYARAH 7	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 8	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 9	307	354	165	275	200	75	38%	OVERLIT
BILIK PENSYARAH 10	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 11	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 12	307	354	165	275	200	75	38%	OVERLIT
BILIK PENSYARAH 13	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 14	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 15	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 16	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 17	307	354	165	275	100	175	175%	OVERLIT
BILIK PENSYARAH 18	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 19	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 20	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 21	307	354	165	275	300	-25	-8%	WITHIN
BILIK PENSYARAH 22	307	354	165	275	200	75	38%	OVERLIT
RUANG PELAJAR	341	276	255	291	300	-9	-3%	WITHIN
BILIK CETAK 1	333	287	345	322	300	22	7%	WITHIN
STOR PERALATAN PELAJAR 1	256	267	310	278	200	78	39%	OVERLIT
STOR PERALATAN PELAJAR 2	256	267	310	278	300	-22	-7%	WITHIN
BILIK SUMBER FAKULTI	244	355	321	307	300	7	2%	WITHIN
B.PBI 1	237	312	188	246	300	-54	-18%	WITHIN
B.PBI 2	237	312	188	246	300	-54	-18%	WITHIN
BILIK KULIAH 1	259	321	278	286	300	-14	-5%	WITHIN
BILIK KULIAH 2	259	321	278	286	300	-14	-5%	WITHIN
BILIK KULIAH 3	259	321	278	286	300	-14	-5%	WITHIN
BILIK KULIAH 4	259	321	278	286	200	86	43%	OVERLIT
BILIK KULIAH 5	259	321	278	286	300	-14	-5%	WITHIN
BILIK KULIAH 6	259	321	278	286	200	86	43%	OVERLIT
BILIK KULIAH 7	259	321	278	286	300	-14	-5%	WITHIN
BILIK KULIAH 8	259	321	278	286	300	-14	-5%	WITHIN

Room No/ Description	Illuminance [Lux]				MS 1525	Deviation	Tolerance ±20%	Judgement
	P1	P2	P3	Avg				MS1525
BILIK PERSATUAN PELAJAR	276	313	255	281	300	-19	-6%	WITHIN
RUANG KERJA SETIAUSAHA 1	390	271	310	324	300	24	8%	WITHIN
RUANG MENUNGGU	390	271	310	324	200	124	62%	OVERLIT
BILIK DEKAN	370	268	316	318	300	18	6%	WITHIN
RUANG KERJA SETIAUSAHA 1	144	236	202	194	300	-106	-35%	UNDERLIT
TIMB. DEKAN (AKADEMIK)	277	243	188	236	300	-64	-21%	UNDERLIT
TIMB. DEKAN (PENYELIDIKAN DAN PENGAJIAN SISWAZAH)	256	277	157	230	300	-70	-23%	UNDERLIT
TIMB. DEKAN (PEMBANGUNAN PELAJAR)	256	277	157	230	200	30	15%	WITHIN
STOR AM 2	272	185	235	231	300	-69	-23%	UNDERLIT
BILIK MESYUARAT PENGURUSAN	206	143	271	207	300	-93	-31%	UNDERLIT
PENOLONG PENDAFTAR KANAN	206	165	286	219	300	-81	-27%	UNDERLIT
BILIK PROFESSOR 1	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 2	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 3	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 4	372	266	172	270	200	70	35%	OVERLIT
BILIK PROFESSOR 5	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 6	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 7	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 8	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 9	372	266	172	270	100	170	170%	OVERLIT
BILIK PROFESSOR 10	372	266	172	270	200	70	35%	OVERLIT
BILIK CETAK	345	254	154	251	300	-49	-16%	WITHIN
BILIK KEBAL	305	234	172	237	200	37	19%	WITHIN
PANTRI 1	832	453	547	611	300	311	104%	OVERLIT
PANTRI 2	832	453	547	611	100	511	511%	OVERLIT
BILIK KETUA JABATAN 1	577	453	324	451	300	151	50%	OVERLIT
BILIK KETUA JABATAN 2	577	453	324	451	100	351	351%	OVERLIT
BILIK PENYELARAS KEJURUTERAAN 1	543	453	324	440	300	140	47%	OVERLIT
BILIK PENYELARAS KEJURUTERAAN 2	543	453	324	440	300	140	47%	OVERLIT
BILIK PENYELARAS KEJURUTERAAN 3	543	453	324	440	200	240	120%	OVERLIT
BILIK PENYELARAS KEJURUTERAAN 4	543	453	324	440	300	140	47%	OVERLIT
BILIK FAIL 1	322	432	418	391	300	91	30%	OVERLIT
BILIK KOSONG 1	488	696	543	576	300	276	92%	OVERLIT
BILIK KOSONG 2	488	696	543	576	300	276	92%	OVERLIT
BILIK KOSONG 3	488	696	543	576	300	276	92%	OVERLIT
BILIK KOSONG 4	488	696	543	576	300	276	92%	OVERLIT
BILIK KOSONG 1	345	468	247	353	300	53	18%	WITHIN
BILIK KOSONG 2	345	468	247	353	300	53	18%	WITHIN
BILIK KOSONG 3	345	468	247	353	300	53	18%	WITHIN
BILIK KOSONG 4	345	468	247	353	300	53	18%	WITHIN

Room No/ Description	Illuminance [Lux]				MS 1525	Deviation	Tolerance ±20%	Judgement
	P1	P2	P3	Avg				MS1525
BILIK KOSONG 5	345	468	247	353	300	53	18%	WITHIN
BILIK KOSONG 6	345	468	247	353	300	53	18%	WITHIN
BILIK JAMUAN	247	163	234	215	300	-85	-28%	UNDERLIT
BILIK MESYUARAT	345	255	344	315	300	15	5%	WITHIN
BILIK PENSYARAH 1	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 2	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 3	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 4	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 5	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 6	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 7	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 8	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 9	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 10	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 11	453	274	311	346	200	146	73%	OVERLIT
BILIK PENSYARAH 12	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 13	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 14	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 15	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 16	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 17	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 18	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 19	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 20	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 21	453	274	311	346	300	46	15%	WITHIN
BILIK PENSYARAH 22	453	274	311	346	300	46	15%	WITHIN
ICT (COMRACK)	233	322	437	331	100	231	231%	OVERLIT
BILIK PROFESSOR 1	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 2	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 3	372	266	172	270	200	70	35%	OVERLIT
BILIK PROFESSOR 4	372	266	172	270	100	170	170%	OVERLIT
BILIK PROFESSOR 5	372	266	172	270	200	70	35%	OVERLIT
BILIK PROFESSOR 6	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 7	372	266	172	270	200	70	35%	OVERLIT
BILIK PROFESSOR 8	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 9	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 10	372	266	172	270	300	-30	-10%	WITHIN
BILIK PENSYARAH 1	344	257	318	306	300	6	2%	WITHIN
BILIK PENSYARAH 2	344	257	318	306	300	6	2%	WITHIN
BILIK PROFESSOR 1	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 2	372	266	172	270	300	-30	-10%	WITHIN

Room No/ Description	Illuminance [Lux]				MS 1525	Deviation	Tolerance ±20%	Judgement
	P1	P2	P3	Avg				MS1525
BILIK PROFESSOR 3	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 4	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 5	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 6	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 7	372	266	172	270	200	70	35%	OVERLIT
BILIK PROFESSOR 8	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 9	372	266	172	270	200	70	35%	OVERLIT
BILIK PROFESSOR 10	372	266	172	270	200	70	35%	OVERLIT
BILIK PROFESSOR 11	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR 12	372	266	172	270	300	-30	-10%	WITHIN
BILIK PROFESSOR MADYA 1	453	274	311	346	300	46	15%	WITHIN
BILIK PROFESSOR MADYA 2	453	274	311	346	300	46	15%	WITHIN
BILIK PROFESSOR MADYA 3	453	274	311	346	300	46	15%	WITHIN
BILIK PROFESSOR MADYA 4	453	274	311	346	300	46	15%	WITHIN
BILIK PROFESSOR MADYA 5	453	274	311	346	300	46	15%	WITHIN
BILIK PROFESSOR MADYA 6	453	274	311	346	300	46	15%	WITHIN
BILIK PROFESSOR MADYA 7	453	274	311	346	300	46	15%	WITHIN
BILIK PROFESSOR MADYA 8	453	274	311	346	200	146	73%	OVERLIT
BILIK PROFESSOR MADYA 9	453	274	311	346	300	46	15%	WITHIN
MAKMAL KOMPUTER (EGL)	305	234	172	237	300	-63	-21%	UNDERLIT
MAKMAL KOMPUTER 1	305	301	172	259	300	-41	-14%	WITHIN
MAKMAL KOMPUTER 2	305	306	172	261	200	61	31%	OVERLIT
PENOLONG JURUTERA	311	254	366	310	300	10	3%	WITHIN
MAKMAL BAHAN 1	322	201	265	263	300	-37	-12%	WITHIN
MAKMAL BAHAN 2	317	231	209	252	300	-48	-16%	WITHIN
MAKMAL ANALISIS TERMA	317	231	209	252	300	-48	-16%	WITHIN
MAKMAL PERKAKAS	311	254	366	310	300	10	3%	WITHIN
MAKMAL BAHAN	356	304	274	311	300	11	4%	WITHIN
RUANG PEMPROSESAN GETAH	276	254	322	284	300	-16	-5%	WITHIN
BILIK FIBER	333	304	243	293	300	-7	-2%	WITHIN
BILIK RESIN	233	312	256	267	300	-33	-11%	WITHIN
STOR	271	244	249	255	300	-45	-15%	WITHIN
RUANG SINTESIS BAHAN	336	351	207	298	300	-2	-1%	WITHIN
BILIK KHAS 1	336	322	209	289	300	-11	-4%	WITHIN
BILIK KHAS 2	336	254	207	266	300	-34	-11%	WITHIN
BILIK KHAS 3	336	288	201	275	300	-25	-8%	WITHIN
BILIK KALISAN LELAS DWIPAKSI	322	241	267	277	300	-23	-8%	WITHIN
BILIK MESIN RAMAN	271	266	214	250	300	-50	-17%	WITHIN
BILIK MESIN XRD	313	215	267	265	300	-35	-12%	WITHIN
BILIK MESIN XCM	231	266	214	237	300	-63	-21%	UNDERLIT
BENGKEL MESIN	1273	1044	943	1087	300	787	262%	OVERLIT

Room No/ Description	Illuminance [Lux]				MS 1525	Deviation	Tolerance ±20%	Judgement
	P1	P2	P3	Avg				MS1525
MAKMAL GRAFIK KEJURUTERAAN 1	717	669	757	714	300	414	138%	OVERLIT
MAKMAL GRAFIK KEJURUTERAAN 2	717	669	757	714	300	414	138%	OVERLIT
MAKMAL REKABENTUK PEMBUATAN	894	882	799	858	300	558	186%	OVERLIT
MAKMAL PEMBUATAN TAMBAHAN	976	715	987	893	300	593	198%	OVERLIT
MAKMAL PEMBUATAN BERINTEGRASIKAN KOMPUTER	932	694	721	782	300	482	161%	OVERLIT
MAKMAL SIMULASI AUTOMASI 1	701	692	465	619	300	319	106%	OVERLIT
MAKMAL SIMULASI AUTOMASI 2	701	692	465	619	300	319	106%	OVERLIT
MAKMAL SIMULASI PERMODELAN 1	719	709	685	704	300	404	135%	OVERLIT
MAKMAL SIMULASI PERMODELAN 2	719	709	685	704	300	404	135%	OVERLIT
MAKMAL CAD/CAM	799	717	665	727	300	427	142%	OVERLIT
MAKMAL KAWALAN KUALITI DAN KEJURUTERAAN RELIABILITI	626	423	736	595	300	295	98%	OVERLIT
MAKMAL DIAGNOSTIK & GETARAN MESIN	420	358	363	380	300	80	27%	OVERLIT
MAKMAL PENYELENGGARAAN MESIN	431	440	435	435	300	135	45%	OVERLIT
MAKMAL PENGAGIHAN UDARA	465	461	366	431	300	131	44%	OVERLIT
MAKMAL APLIKASI HVAC	412	393	357	387	300	87	29%	OVERLIT
MAKMAL TEKNOLOGI INDUSTRI HVAC	435	400	575	470	300	170	57%	OVERLIT
MAKMAL PEMESINAN TERMAJU	431	328	376	378	300	78	26%	OVERLIT
STUDIO CNC	474	426	495	465	300	165	55%	OVERLIT
MAKMAL PEMBUATAN TERMAJU	463	350	560	458	300	158	53%	OVERLIT
MAKMAL PROTOTAIP PANTAS	412	498	385	432	300	132	44%	OVERLIT
STUDIO DFX	467	409	487	454	300	154	51%	OVERLIT
MAKMAL PENGUJIAN BAHAN	418	489	391	433	300	133	44%	OVERLIT
MAKMAL METROLOGY	456	409	447	437	300	137	46%	OVERLIT
MAKMAL TEKNOLOGI PLASTIK	498	444	512	485	300	185	62%	OVERLIT
MAKMAL TEKNOLOGI PEMBENTUKAN TERMAJU	423	390	484	432	300	132	44%	OVERLIT
MAKMAL KEJURUTERAAN INDUSTRI DAN KAWALAN KUALITI	489	421	456	455	300	155	52%	OVERLIT
MAKMAL TRIBOLOGI & TRANSMISI	550	415	475	480	300	180	60%	OVERLIT
MAKMAL FIZIK	367	450	344	387	300	87	29%	OVERLIT
MAKMAL MEKANIK PEPEJAL	336	454	439	410	300	110	37%	OVERLIT
BILIK PENOLONG JURUTEKNIK	127	207	136	157	300	-143	-48%	UNDERLIT
STOR SISA	167	188	145	167	300	-133	-44%	UNDERLIT
MAKMAL ASAS TEKNOLOGI HVAC	382	333	446	387	300	87	29%	OVERLIT
MAKMAL TEKNOLOGI PENCANTUMAN	255	268	260	261	300	-39	-13%	WITHIN
MAKMAL WATERJET	378	708	616	567	300	267	89%	OVERLIT
MAKMAL TEKNOLOGI PERMESINAN	440	340	371	384	300	84	28%	OVERLIT
STOR	454	310	300	355	300	55	18%	WITHIN
MAKMAL TEKNOLOGI TUANGAN	410	513	562	495	300	195	65%	OVERLIT
MAKMAL REKABENTUK	586	419	490	498	300	198	66%	OVERLIT

Room No/ Description	Illuminance [Lux]				MS 1525	Deviation	Tolerance ±20%	Judgement
	P1	P2	P3	Avg				MS1525
MAKMAL FABRIKASI	324	430	463	406	300	106	35%	OVERLIT
MAKMAL DINAMIK & MEKANIK MESIN	412	503	433	449	300	149	50%	OVERLIT
MAKMAL STATIK	412	470	423	435	300	135	45%	OVERLIT
MAKMAL TERMOBENDALIR	481	456	492	476	300	176	59%	OVERLIT
MAKMAL SAINS BAHAN	539	514	505	519	300	219	73%	OVERLIT
STUDIO CAD 1 (BANGUNAN FTK)	334	316	173	274	300	-26	-9%	WITHIN
STUDIO CAD 2 (BANGUNAN FTK)	354	436	388	393	300	93	31%	OVERLIT
STUDIO CAD 3 (BANGUNAN FTK)	445	463	516	475	300	175	58%	OVERLIT
STUDIO CAD 4 (BANGUNAN FTK)	477	423	555	485	300	185	62%	OVERLIT
MAKMAL KOMPOSIT DAN RAWATAN PERMUKAAN	271	275	267	271	300	-29	-10%	WITHIN
MAKMAL INOVASI DAN PSM JTKP	746	744	737	742	300	442	147%	OVERLIT
MAKMAL PEMESINAN 2	480	471	463	471	300	171	57%	OVERLIT
MAKMAL REKABENTUK ERGONOMIK DAN OSHE	506	485	492	494	300	194	65%	OVERLIT
MAKMAL REKABENTUK INDUSTRI	576	577	579	577	300	277	92%	OVERLIT
STUDIO CATIA PLM	594	600	596	597	300	297	99%	OVERLIT
MAKMAL KIMPALAN TERMAJU	247	251	252	250	300	-50	-17%	WITHIN
MAKMAL TEKNOLOGI FABRIKASI LOGAM DAN MENGGEGAS	624	626	630	627	300	327	109%	OVERLIT

Table 4.1 presents the illuminance levels measured in different rooms within a building and compares them against the MS 1525 standard for optimal lighting levels. Measurements were taken at three different points (P1, P2, P3) in each of the 242 rooms to determine the average illuminance, with four representative rooms highlighted in this summary.

In Dewan Kuliah, the average illuminance measured is 930 lux, which significantly exceeds the MS 1525 standard of 300 lux. The deviation from the standard is 630 lux, resulting in an over-illumination tolerance of 210%. This suggests that Dewan Kuliah is overlit according to the MS 1525 guidelines, indicating a potential for energy wastage and discomfort due to excessively bright lighting.

The Auditorium shows an average illuminance of 353 lux, which is within the MS 1525 standard with a deviation of only 53 lux, translating to an 18% tolerance. This indicates that the lighting in the Auditorium is appropriately balanced, adhering to the recommended standards for optimal lighting conditions.

Bilik Holding, on the other hand, has an average illuminance of 224 lux, which is below the MS 1525 standard of 300 lux. The deviation here is -76 lux, with a -25% tolerance, classifying the room as underlit. This suggests insufficient lighting, which could impair visibility and comfort for the occupants.

Surau has an average illuminance of 1006 lux, which far exceeds the MS 1525 standard. The deviation is 706 lux, resulting in a 235% over-illumination tolerance. Similar to Dewan Kuliah, Surau is significantly overlit, indicating excessive lighting beyond the recommended levels.

In summary, the table highlights significant variations in the illuminance levels across different rooms. Dewan Kuliah and Surau are notably overlit, which implies potential energy inefficiency and the need for lighting adjustments to meet the MS 1525 standard. The Auditorium maintains an optimal lighting level within the standard, whereas Bilik Holding is underlit, necessitating improvements to enhance visibility and comfort. Adjusting the lighting in these areas could lead to improved energy efficiency and better adherence to the MS 1525 guidelines.

4.1.2 Temperature

Table 4. 2: Temperature of 242 rooms

Room No/ Description	Temp [°C]	Judgement MS1525	Within (24-26)	Cold <24	Warm >26	MS Temp
DEWAN KULIAH	26	WITHIN	1			24-26
AUDITORIUM	25	WITHIN	1			24-26
BILIK HOLDING	23	COLD		1		24-26
SURAU	29.9	WARM			1	24-26
LOBI PENTADBIRAN	25.2	WITHIN	1			24-26
RUANG SOLAT (P)	25.3	WITHIN	1			24-26
RUANG SOLAT (L)	25.3	WITHIN	1			24-26
BILIK PROFESSOR 1	25.1	WITHIN	1			24-26
BILIK PROFESSOR 2	25.1	WITHIN	1			24-26
BILIK PROFESSOR 3	25.1	WITHIN	1			24-26
BILIK PROFESSOR 4	25.1	WITHIN	1			24-26
BILIK PROFESSOR 5	25.1	WITHIN	1			24-26
BILIK PROFESSOR 6	25.1	WITHIN	1			24-26
BILIK PROFESSOR 7	25.1	WITHIN	1			24-26
BILIK PROFESSOR 8	25.1	WITHIN	1			24-26
BILIK PROFESSOR 9	25.1	WITHIN	1			24-26
BILIK PROFESSOR 10	25.1	WITHIN	1			24-26
PANTRI	25.1	WITHIN	1			24-26
BILIK MESYUARAT COSSID	25.1	WITHIN	1			24-26
STOR ALAT TULIS 4	23	COLD		1		24-26
PEJABAT PENTADBIRAN	24.1	WITHIN	1			24-26
PENOLONG PENDAFTAR	24.1	WITHIN	1			24-26
STOR AM 1 (FAIL)	25.7	WITHIN	1			24-26
STOR ALAT (PERALATAN) 1	26.2	WARM			1	24-26
STOR ALAT (PERALATAN) 2	26.2	WARM			1	24-26
STOR ALAT (PERALATAN) 3	26.2	WARM			1	24-26
BILIK CETAK 1	26.1	WARM			1	24-26
BILIK PENSYARAH 1	24	COLD	1			24-26
BILIK PENSYARAH 2	24	COLD	1			24-26
BILIK PENSYARAH 1	24	COLD	1			24-26
BILIK PENSYARAH 3	24	COLD	1			24-26
BILIK PENSYARAH 4	24	COLD	1			24-26
BILIK PENSYARAH 5	24	COLD	1			24-26
BILIK PENSYARAH 6	24	COLD	1			24-26
BILIK PENSYARAH 7	24	COLD	1			24-26
BILIK PENSYARAH 8	24	COLD	1			24-26
BILIK PENSYARAH 9	24	COLD	1			24-26

Room No/ Description	Temp [°C]	Judgement MS1525	Within (24-26)	Cold <24	Warm >26	MS Temp
BILIK PENSYARAH 10	24	COLD	1			24-26
BILIK PENSYARAH 11	24	COLD	1			24-26
BILIK PENSYARAH 12	24	COLD	1			24-26
BILIK PENSYARAH 13	24	COLD	1			24-26
BILIK PENSYARAH 14	24	COLD	1			24-26
BILIK PENSYARAH 15	24	COLD	1			24-26
BILIK PENSYARAH 16	24	COLD	1			24-26
BILIK PENSYARAH 17	24	COLD	1			24-26
BILIK PENSYARAH 18	24	COLD	1			24-26
BILIK PENSYARAH 19	24	COLD	1			24-26
BILIK PENSYARAH 20	24	COLD	1			24-26
BILIK PENSYARAH 21	24	COLD	1			24-26
BILIK PENSYARAH 22	24	COLD	1			24-26
RUANG PELAJAR	23.5	COLD		1		24-26
BILIK CETAK 1	24	COLD	1			24-26
STOR PERALATAN PELAJAR 1	23	COLD		1		24-26
STOR PERALATAN PELAJAR 2	23	COLD		1		24-26
BILIK SUMBER FAKULTI	24.3	WITHIN	1			24-26
B.PBI 1	24.5	WITHIN	1			24-26
B.PBI 2	24.5	WITHIN	1			24-26
BILIK KULIAH 1	23.6	COLD		1		24-26
BILIK KULIAH 2	23.6	COLD		1		24-26
BILIK KULIAH 3	23.6	COLD		1		24-26
BILIK KULIAH 4	23.6	COLD		1		24-26
BILIK KULIAH 5	23.6	COLD		1		24-26
BILIK KULIAH 6	23.6	COLD		1		24-26
BILIK KULIAH 7	23.6	COLD		1		24-26
BILIK KULIAH 8	23.6	COLD		1		24-26
BILIK PERSATUAN PELAJAR	24.3	WITHIN	1			24-26
RUANG KERJA SETIAUSAHA 1	24.8	WITHIN	1			24-26
RUANG MENUNGGU	24.8	WITHIN	1			24-26
BILIK DEKAN	26.5	WARM			1	24-26
RUANG KERJA SETIAUSAHA 1	24.8	WITHIN	1			24-26
TIMB. DEKAN (AKADEMIK)	24.8	WITHIN	1			24-26
TIMB. DEKAN (PENYELIDIKAN DAN PENGAJIAN SISWAZAH)	23.6	COLD		1		24-26
TIMB. DEKAN (PEMBANGUNAN PELAJAR)	23.6	COLD		1		24-26
STOR AM 2	24	COLD	1			24-26
BILIK MESYUARAT PENGURUSAN	23.8	COLD		1		24-26
PENOLONG PENDAFTAR KANAN	23.6	COLD		1		24-26
BILIK PROFESSOR 1	25.1	WITHIN	1			24-26

Room No/ Description	Temp [°C]	Judgement MS1525	Within (24-26)	Cold <24	Warm >26	MS Temp
BILIK PROFESSOR 2	25.1	WITHIN	1			24-26
BILIK PROFESSOR 3	25.1	WITHIN	1			24-26
BILIK PROFESSOR 4	25.1	WITHIN	1			24-26
BILIK PROFESSOR 5	25.1	WITHIN	1			24-26
BILIK PROFESSOR 6	25.1	WITHIN	1			24-26
BILIK PROFESSOR 7	25.1	WITHIN	1			24-26
BILIK PROFESSOR 8	25.1	WITHIN	1			24-26
BILIK PROFESSOR 9	25.1	WITHIN	1			24-26
BILIK PROFESSOR 10	25.1	WITHIN	1			24-26
BILIK CETAK	23.2	COLD		1		24-26
BILIK KEBAL	26.1	WARM			1	24-26
PANTRI 1	28.2	WARM			1	24-26
PANTRI 2	28.2	WARM			1	24-26
BILIK KETUA JABATAN 1	23	COLD		1		24-26
BILIK KETUA JABATAN 2	23	COLD		1		24-26
BILIK PENYELARAS KEJURUTERAAN 1	23	COLD		1		24-26
BILIK PENYELARAS KEJURUTERAAN 2	23	COLD		1		24-26
BILIK PENYELARAS KEJURUTERAAN 3	23	COLD		1		24-26
BILIK PENYELARAS KEJURUTERAAN 4	23	COLD		1		24-26
BILIK FAIL 1	24	COLD	1			24-26
BILIK KOSONG 1	24	COLD	1			24-26
BILIK KOSONG 2	24	COLD	1			24-26
BILIK KOSONG 3	24	COLD	1			24-26
BILIK KOSONG 4	24	COLD	1			24-26
BILIK KOSONG 1	24	COLD	1			24-26
BILIK KOSONG 2	24	COLD	1			24-26
BILIK KOSONG 3	24	COLD	1			24-26
BILIK KOSONG 4	24	COLD	1			24-26
BILIK KOSONG 5	24	COLD	1			24-26
BILIK KOSONG 6	24	COLD	1			24-26
BILIK JAMUAN	26.1	WARM			1	24-26
BILIK MESYUARAT	25	WITHIN	1			24-26
BILIK PENSYARAH 1	23	COLD		1		24-26
BILIK PENSYARAH 2	23	COLD		1		24-26
BILIK PENSYARAH 3	23	COLD		1		24-26
BILIK PENSYARAH 4	23	COLD		1		24-26
BILIK PENSYARAH 5	23	COLD		1		24-26
BILIK PENSYARAH 6	23	COLD		1		24-26
BILIK PENSYARAH 7	23	COLD		1		24-26
BILIK PENSYARAH 8	23	COLD		1		24-26
BILIK PENSYARAH 9	23	COLD		1		24-26

Room No/ Description	Temp [°C]	Judgement MS1525	Within (24-26)	Cold <24	Warm >26	MS Temp
BILIK PENSYARAH 10	23	COLD		1		24-26
BILIK PENSYARAH 11	23	COLD		1		24-26
BILIK PENSYARAH 12	23	COLD		1		24-26
BILIK PENSYARAH 13	23	COLD		1		24-26
BILIK PENSYARAH 14	23	COLD		1		24-26
BILIK PENSYARAH 15	23	COLD		1		24-26
BILIK PENSYARAH 16	23	COLD		1		24-26
BILIK PENSYARAH 17	23	COLD		1		24-26
BILIK PENSYARAH 18	23	COLD		1		24-26
BILIK PENSYARAH 19	23	COLD		1		24-26
BILIK PENSYARAH 20	23	COLD		1		24-26
BILIK PENSYARAH 21	23	COLD		1		24-26
BILIK PENSYARAH 22	23	COLD		1		24-26
ICT (COMRACK)	24	COLD	1			24-26
BILIK PROFESSOR 1	25.1	WITHIN	1			24-26
BILIK PROFESSOR 2	25.1	WITHIN	1			24-26
BILIK PROFESSOR 3	25.1	WITHIN	1			24-26
BILIK PROFESSOR 4	25.1	WITHIN	1			24-26
BILIK PROFESSOR 5	25.1	WITHIN	1			24-26
BILIK PROFESSOR 6	25.1	WITHIN	1			24-26
BILIK PROFESSOR 7	25.1	WITHIN	1			24-26
BILIK PROFESSOR 8	25.1	WITHIN	1			24-26
BILIK PROFESSOR 9	25.1	WITHIN	1			24-26
BILIK PROFESSOR 10	25.1	WITHIN	1			24-26
BILIK PENSYARAH 1	24.3	WITHIN	1			24-26
BILIK PENSYARAH 2	24.3	WITHIN	1			24-26
BILIK PROFESSOR 1	25.1	WITHIN	1			24-26
BILIK PROFESSOR 2	25.1	WITHIN	1			24-26
BILIK PROFESSOR 3	25.1	WITHIN	1			24-26
BILIK PROFESSOR 4	25.1	WITHIN	1			24-26
BILIK PROFESSOR 5	25.1	WITHIN	1			24-26
BILIK PROFESSOR 6	25.1	WITHIN	1			24-26
BILIK PROFESSOR 7	25.1	WITHIN	1			24-26
BILIK PROFESSOR 8	25.1	WITHIN	1			24-26
BILIK PROFESSOR 9	25.1	WITHIN	1			24-26
BILIK PROFESSOR 10	25.1	WITHIN	1			24-26
BILIK PROFESSOR 11	25.1	WITHIN	1			24-26
BILIK PROFESSOR 12	25.1	WITHIN	1			24-26
BILIK PROFESSOR MADYA 1	23	COLD		1		24-26
BILIK PROFESSOR MADYA 2	23	COLD		1		24-26
BILIK PROFESSOR MADYA 3	23	COLD		1		24-26

Room No/ Description	Temp [°C]	Judgement MS1525	Within (24-26)	Cold <24	Warm >26	MS Temp
BILIK PROFESSOR MADYA 4	23	COLD		1		24-26
BILIK PROFESSOR MADYA 5	23	COLD		1		24-26
BILIK PROFESSOR MADYA 6	23	COLD		1		24-26
BILIK PROFESSOR MADYA 7	23	COLD		1		24-26
BILIK PROFESSOR MADYA 8	23	COLD		1		24-26
BILIK PROFESSOR MADYA 9	23	COLD		1		24-26
MAKMAL KOMPUTER (EGL)	23.8	COLD		1		24-26
MAKMAL KOMPUTER 1	23.8	COLD		1		24-26
MAKMAL KOMPUTER 2	23.8	COLD		1		24-26
PENOLONG JURUTERA	24	COLD	1			24-26
MAKMAL BAHAN 1	26.4	WARM			1	24-26
MAKMAL BAHAN 2	23.8	COLD		1		24-26
MAKMAL ANALISIS TERMA	23.8	COLD		1		24-26
MAKMAL PERKAKAS	24	COLD	1			24-26
MAKMAL BAHAN	23.3	COLD		1		24-26
RUANG PEMPROSESAN GETAH	24	COLD	1			24-26
BILIK FIBER	23.3	COLD		1		24-26
BILIK RESIN	23.3	COLD		1		24-26
STOR	24	COLD	1			24-26
RUANG SINTESIS BAHAN	24.2	WITHIN	1			24-26
BILIK KHAS 1	24.2	WITHIN	1			24-26
BILIK KHAS 2	24.5	WITHIN	1			24-26
BILIK KHAS 3	24.5	WITHIN	1			24-26
BILIK KALISAN LELAS DWIPAKSI	24	COLD	1			24-26
BILIK MESIN RAMAN	23.4	COLD		1		24-26
BILIK MESIN XRD	24	COLD	1			24-26
BILIK MESIN XCM	23.4	COLD		1		24-26
BENGKEL MESIN	29.2	WARM			1	24-26
MAKMAL GRAFIK KEJURUTERAAN 1	27.4	WARM			1	24-26
MAKMAL GRAFIK KEJURUTERAAN 2	27.4	WARM			1	24-26
MAKMAL REKABENTUK PEMBUATAN	24.4	WITHIN	1			24-26
MAKMAL PEMBUATAN TAMBAHAN	27.9	WARM			1	24-26
MAKMAL PEMBUATAN BERINTEGRASIKAN KOMPUTER	27.6	WARM			1	24-26
MAKMAL SIMULASI AUTOMASI 1	27.8	WARM			1	24-26
MAKMAL SIMULASI AUTOMASI 2	27.8	WARM			1	24-26
MAKMAL SIMULASI PERMODELAN 1	27.9	WARM			1	24-26
MAKMAL SIMULASI PERMODELAN 2	27.9	WARM			1	24-26
MAKMAL CAD/CAM	28.1	WARM			1	24-26
MAKMAL KAWALAN KUALITI DAN KEJURUTERAAN RELIABILITI	27	WARM			1	24-26
MAKMAL DIAGNOSTIK & GETARAN MESIN	23.3	COLD		1		24-26

Room No/ Description	Temp [°C]	Judgement MS1525	Within (24-26)	Cold <24	Warm >26	MS Temp
MAKMAL PENYELENGGARAAN MESIN	22.5	COLD		1		24-26
MAKMAL PENGAGIHAN UDARA	21.8	COLD		1		24-26
MAKMAL APLIKASI HVAC	25.2	WITHIN	1			24-26
MAKMAL TEKNOLOGI INDUSTRI HVAC	27.2	WARM			1	24-26
MAKMAL PEMESINAN TERMAJU	22.9	COLD		1		24-26
STUDIO CNC	22.2	COLD		1		24-26
MAKMAL PEMBUATAN TERMAJU	21.7	COLD		1		24-26
MAKMAL PROTOTAIP PANTAS	22.7	COLD		1		24-26
STUDIO DFX	23.1	COLD		1		24-26
MAKMAL PENGUJIAN BAHAN	22.6	COLD		1		24-26
MAKMAL METROLOGY	23.5	COLD		1		24-26
MAKMAL TEKNOLOGI PLASTIK	23.3	COLD		1		24-26
MAKMAL TEKNOLOGI PEMBENTUKAN TERMAJU	24.1	WITHIN	1			24-26
MAKMAL KEJURUTERAAN INDUSTRI DAN KAWALAN KUALITI	23.7	COLD		1		24-26
MAKMAL TRIBOLOGI & TRANSMISI	25	WITHIN	1			24-26
MAKMAL FIZIK	23.6	COLD		1		24-26
MAKMAL MEKANIK PEPEJAL	23.4	COLD		1		24-26
BILIK PENOLONG JURUTEKNIK	23.8	COLD		1		24-26
STOR SISA	23.8	COLD		1		24-26
MAKMAL ASAS TEKNOLOGI HVAC	24.4	WITHIN	1			24-26
MAKMAL TEKNOLOGI PENCANTUMAN	26.6	WARM			1	24-26
MAKMAL WATERJET	25.7	WITHIN	1			24-26
MAKMAL TEKNOLOGI PERMESINAN	22.5	COLD		1		24-26
STOR	22.8	COLD		1		24-26
MAKMAL TEKNOLOGI TUANGAN	21.8	COLD		1		24-26
MAKMAL REKABENTUK	22.9	COLD		1		24-26
MAKMAL FABRIKASI	23	COLD		1		24-26
MAKMAL DINAMIK & MEKANIK MESIN	23.1	COLD		1		24-26
MAKMAL STATIK	21.8	COLD		1		24-26
MAKMAL TERMOBENDALIR	22.3	COLD		1		24-26
MAKMAL SAINS BAHAN	22.7	COLD		1		24-26
STUDIO CAD 1 (BANGUNAN FTK)	20.3	COLD		1		24-26
STUDIO CAD 2 (BANGUNAN FTK)	21.8	COLD		1		24-26
STUDIO CAD 3 (BANGUNAN FTK)	23.1	COLD		1		24-26
STUDIO CAD 4 (BANGUNAN FTK)	23.6	COLD		1		24-26
MAKMAL KOMPOSIT DAN RAWATAN PERMUKAAN	26.8	WARM			1	24-26
MAKMAL INOVASI DAN PSM JTKP	26.4	WARM			1	24-26
MAKMAL PEMESINAN 2	26.6	WARM			1	24-26
MAKMAL REKABENTUK ERGONOMIK DAN OSHE	23.7	COLD		1		24-26

Room No/ Description	Temp [°C]	Judgement MS1525	Within (24-26)	Cold <24	Warm >26	MS Temp
MAKMAL REKABENTUK INDUSTRI	23.8	COLD		1		24-26
STUDIO CATIA PLM	24	COLD	1			24-26
MAKMAL KIMPALAN TERMAJU	24.2	WITHIN	1			24-26
MAKMAL TEKNOLOGI FABRIKASI LOGAM DAN MENGGEGAS	25.1	WITHIN	1			24-26

Table 4.2 presents the temperature measurements of total 242 rooms in an academic building and compares them to the recommended thermal comfort range set by the Malaysian Standard MS1525, which is between 24-26°C. Measurements were taken in each of the 242 rooms to determine the temperature, with four representative rooms highlighted in this summary.

For Dewan Kuliah, the measured temperature is 26°C, which falls within the recommended range, thus it is judged as "WITHIN" the MS1525 standard. Similarly, the Auditorium, with a temperature of 25°C, also falls within the acceptable range, receiving the same judgment. Bilik Holding has a measured temperature of 23°C, which is below the recommended range. Therefore, it is judged as "COLD" according to the MS1525 standard. Lastly, the Surau has a temperature of 29.9°C, which exceeds the recommended range, and it is judged as "WARM".

The columns "Within," "Cold," and "Warm" quantify the number of rooms that fall within each category. In this case, two rooms (Dewan Kuliah and Auditorium) fall within the acceptable range, one room (Bilik Holding) is categorized as cold, and one room (Surau) is categorized as warm. The column "MS Temp" reaffirms the standard temperature range of 24-26°C as per MS1525.

4.1.3 Relative Humidity

Table 4. 3: Relative humidity of 242 rooms

Room No/ Description	RH [%]	Judgement MS1525	Within	Wet	Dry	MS RH
DEWAN KULIAH	62.9	WITHIN	1			50-70
AUDITORIUM	52.7	WITHIN	1			50-70
BILIK HOLDING	51.8	WITHIN	1			50-70
SURAU	78.3	WET		1		50-70
LOBI PENTADBIRAN	60.1	WITHIN	1			50-70
RUANG SOLAT (P)	60.1	WITHIN	1			50-70
RUANG SOLAT (L)	60.1	WITHIN	1			50-70
BILIK PROFESSOR 1	45.9	DRY			1	50-70
BILIK PROFESSOR 2	45.9	DRY			1	50-70
BILIK PROFESSOR 3	45.9	DRY			1	50-70
BILIK PROFESSOR 4	45.9	DRY			1	50-70
BILIK PROFESSOR 5	45.9	DRY			1	50-70
BILIK PROFESSOR 6	45.9	DRY			1	50-70
BILIK PROFESSOR 7	45.9	DRY			1	50-70
BILIK PROFESSOR 8	45.9	DRY			1	50-70
BILIK PROFESSOR 9	45.9	DRY			1	50-70
BILIK PROFESSOR 10	45.9	DRY			1	50-70
PANTRI	45.9	DRY			1	50-70
BILIK MESYUARAT COSSID	45.9	DRY			1	50-70
STOR ALAT TULIS 4	55	WITHIN	1			50-70
PEJABAT PENTADBIRAN	56.7	WITHIN	1			50-70
PENOLONG PENDAFTAR	56.7	WITHIN	1			50-70
STOR AM 1 (FAIL)	59.5	WITHIN	1			50-70
STOR ALAT (PERALATAN) 1	67	WITHIN	1			50-70
STOR ALAT (PERALATAN) 2	67	WITHIN	1			50-70
STOR ALAT (PERALATAN) 3	67	WITHIN	1			50-70
BILIK CETAK 1	56	WITHIN	1			50-70
BILIK PENSYARAH 1	53	WITHIN	1			50-70
BILIK PENSYARAH 2	53	WITHIN	1			50-70
BILIK PENSYARAH 1	53	WITHIN	1			50-70
BILIK PENSYARAH 3	53	WITHIN	1			50-70
BILIK PENSYARAH 4	53	WITHIN	1			50-70
BILIK PENSYARAH 5	53	WITHIN	1			50-70
BILIK PENSYARAH 6	53	WITHIN	1			50-70
BILIK PENSYARAH 7	53	WITHIN	1			50-70
BILIK PENSYARAH 8	53	WITHIN	1			50-70
BILIK PENSYARAH 9	53	WITHIN	1			50-70

Room No/ Description	RH [%]	Judgement MS1525	Within	Wet	Dry	MS RH
BILIK PENSYARAH 10	53	WITHIN	1			50-70
BILIK PENSYARAH 11	53	WITHIN	1			50-70
BILIK PENSYARAH 12	53	WITHIN	1			50-70
BILIK PENSYARAH 13	53	WITHIN	1			50-70
BILIK PENSYARAH 14	53	WITHIN	1			50-70
BILIK PENSYARAH 15	53	WITHIN	1			50-70
BILIK PENSYARAH 16	53	WITHIN	1			50-70
BILIK PENSYARAH 17	53	WITHIN	1			50-70
BILIK PENSYARAH 18	53	WITHIN	1			50-70
BILIK PENSYARAH 19	53	WITHIN	1			50-70
BILIK PENSYARAH 20	53	WITHIN	1			50-70
BILIK PENSYARAH 21	53	WITHIN	1			50-70
BILIK PENSYARAH 22	53	WITHIN	1			50-70
RUANG PELAJAR	62	WITHIN	1			50-70
BILIK CETAK 1	57	WITHIN	1			50-70
STOR PERALATAN PELAJAR 1	54	WITHIN	1			50-70
STOR PERALATAN PELAJAR 2	54	WITHIN	1			50-70
BILIK SUMBER FAKULTI	60	WITHIN	1			50-70
B.PBI 1	58	WITHIN	1			50-70
B.PBI 2	58	WITHIN	1			50-70
BILIK KULIAH 1	55.7	WITHIN	1			50-70
BILIK KULIAH 2	55.7	WITHIN	1			50-70
BILIK KULIAH 3	55.7	WITHIN	1			50-70
BILIK KULIAH 4	55.7	WITHIN	1			50-70
BILIK KULIAH 5	55.7	WITHIN	1			50-70
BILIK KULIAH 6	55.7	WITHIN	1			50-70
BILIK KULIAH 7	55.7	WITHIN	1			50-70
BILIK KULIAH 8	55.7	WITHIN	1			50-70
BILIK PERSATUAN PELAJAR	67	WITHIN	1			50-70
RUANG KERJA SETIAUSAHA 1	58.6	WITHIN	1			50-70
RUANG MENUNGGU	58.6	WITHIN	1			50-70
BILIK DEKAN	66.8	WITHIN	1			50-70
RUANG KERJA SETIAUSAHA 1	58.6	WITHIN	1			50-70
TIMB. DEKAN (AKADEMIK)	58.6	WITHIN	1			50-70
TIMB. DEKAN (PENYELIDIKAN DAN PENGAJIAN SISWAZAH)	59	WITHIN	1			50-70
TIMB. DEKAN (PEMBANGUNAN PELAJAR)	59	WITHIN	1			50-70
STOR AM 2	62	WITHIN	1			50-70
BILIK MESYUARAT PENGURUSAN	55	WITHIN	1			50-70
PENOLONG PENDAFTAR KANAN	66.3	WITHIN	1			50-70
BILIK PROFESSOR 1	45.9	DRY			1	50-70

Room No/ Description	RH [%]	Judgement MS1525	Within	Wet	Dry	MS RH
BILIK PROFESSOR 2	45.9	DRY			1	50-70
BILIK PROFESSOR 3	45.9	DRY			1	50-70
BILIK PROFESSOR 4	45.9	DRY			1	50-70
BILIK PROFESSOR 5	45.9	DRY			1	50-70
BILIK PROFESSOR 6	45.9	DRY			1	50-70
BILIK PROFESSOR 7	45.9	DRY			1	50-70
BILIK PROFESSOR 8	45.9	DRY			1	50-70
BILIK PROFESSOR 9	45.9	DRY			1	50-70
BILIK PROFESSOR 10	45.9	DRY			1	50-70
BILIK CETAK	74.2	WET		1		50-70
BILIK KEBAL	56	WITHIN	1			50-70
PANTRI 1	85.9	WET		1		50-70
PANTRI 2	85.9	WET		1		50-70
BILIK KETUA JABATAN 1	55	WITHIN	1			50-70
BILIK KETUA JABATAN 2	55	WITHIN	1			50-70
BILIK PENYELARAS KEJURUTERAAN 1	55	WITHIN	1			50-70
BILIK PENYELARAS KEJURUTERAAN 2	55	WITHIN	1			50-70
BILIK PENYELARAS KEJURUTERAAN 3	55	WITHIN	1			50-70
BILIK PENYELARAS KEJURUTERAAN 4	55	WITHIN	1			50-70
BILIK FAIL 1	58	WITHIN	1			50-70
BILIK KOSONG 1	53.5	WITHIN	1			50-70
BILIK KOSONG 2	53.5	WITHIN	1			50-70
BILIK KOSONG 3	53.5	WITHIN	1			50-70
BILIK KOSONG 4	53.5	WITHIN	1			50-70
BILIK KOSONG 1	53.5	WITHIN	1			50-70
BILIK KOSONG 2	53.5	WITHIN	1			50-70
BILIK KOSONG 3	53.5	WITHIN	1			50-70
BILIK KOSONG 4	53.5	WITHIN	1			50-70
BILIK KOSONG 5	53.5	WITHIN	1			50-70
BILIK KOSONG 6	53.5	WITHIN	1			50-70
BILIK JAMUAN	42.5	DRY			1	50-70
BILIK MESYUARAT	47.9	DRY			1	50-70
BILIK PENSYARAH 1	55	WITHIN	1			50-70
BILIK PENSYARAH 2	55	WITHIN	1			50-70
BILIK PENSYARAH 3	55	WITHIN	1			50-70
BILIK PENSYARAH 4	55	WITHIN	1			50-70
BILIK PENSYARAH 5	55	WITHIN	1			50-70
BILIK PENSYARAH 6	55	WITHIN	1			50-70
BILIK PENSYARAH 7	55	WITHIN	1			50-70
BILIK PENSYARAH 8	55	WITHIN	1			50-70
BILIK PENSYARAH 9	55	WITHIN	1			50-70

Room No/ Description	RH [%]	Judgement MS1525	Within	Wet	Dry	MS RH
BILIK PENSYARAH 10	55	WITHIN	1			50-70
BILIK PENSYARAH 11	55	WITHIN	1			50-70
BILIK PENSYARAH 12	55	WITHIN	1			50-70
BILIK PENSYARAH 13	55	WITHIN	1			50-70
BILIK PENSYARAH 14	55	WITHIN	1			50-70
BILIK PENSYARAH 15	55	WITHIN	1			50-70
BILIK PENSYARAH 16	55	WITHIN	1			50-70
BILIK PENSYARAH 17	55	WITHIN	1			50-70
BILIK PENSYARAH 18	55	WITHIN	1			50-70
BILIK PENSYARAH 19	55	WITHIN	1			50-70
BILIK PENSYARAH 20	55	WITHIN	1			50-70
BILIK PENSYARAH 21	55	WITHIN	1			50-70
BILIK PENSYARAH 22	55	WITHIN	1			50-70
ICT (COMRACK)	51	WITHIN	1			50-70
BILIK PROFESSOR 1	45.9	DRY			1	50-70
BILIK PROFESSOR 2	45.9	DRY			1	50-70
BILIK PROFESSOR 3	45.9	DRY			1	50-70
BILIK PROFESSOR 4	45.9	DRY			1	50-70
BILIK PROFESSOR 5	45.9	DRY			1	50-70
BILIK PROFESSOR 6	45.9	DRY			1	50-70
BILIK PROFESSOR 7	45.9	DRY			1	50-70
BILIK PROFESSOR 8	45.9	DRY			1	50-70
BILIK PROFESSOR 9	45.9	DRY			1	50-70
BILIK PROFESSOR 10	45.9	DRY			1	50-70
BILIK PENSYARAH 1	45	DRY			1	50-70
BILIK PENSYARAH 2	45	DRY			1	50-70
BILIK PROFESSOR 1	45.9	DRY			1	50-70
BILIK PROFESSOR 2	45.9	DRY			1	50-70
BILIK PROFESSOR 3	45.9	DRY			1	50-70
BILIK PROFESSOR 4	45.9	DRY			1	50-70
BILIK PROFESSOR 5	45.9	DRY			1	50-70
BILIK PROFESSOR 6	45.9	DRY			1	50-70
BILIK PROFESSOR 7	45.9	DRY			1	50-70
BILIK PROFESSOR 8	45.9	DRY			1	50-70
BILIK PROFESSOR 9	45.9	DRY			1	50-70
BILIK PROFESSOR 10	45.9	DRY			1	50-70
BILIK PROFESSOR 11	45.9	DRY			1	50-70
BILIK PROFESSOR 12	45.9	DRY			1	50-70
BILIK PROFESSOR MADYA 1	55	WITHIN	1			50-70
BILIK PROFESSOR MADYA 2	55	WITHIN	1			50-70
BILIK PROFESSOR MADYA 3	55	WITHIN	1			50-70

Room No/ Description	RH [%]	Judgement MS1525	Within	Wet	Dry	MS RH
BILIK PROFESSOR MADYA 4	55	WITHIN	1			50-70
BILIK PROFESSOR MADYA 5	55	WITHIN	1			50-70
BILIK PROFESSOR MADYA 6	55	WITHIN	1			50-70
BILIK PROFESSOR MADYA 7	55	WITHIN	1			50-70
BILIK PROFESSOR MADYA 8	55	WITHIN	1			50-70
BILIK PROFESSOR MADYA 9	55	WITHIN	1			50-70
MAKMAL KOMPUTER (EGL)	56	WITHIN	1			50-70
MAKMAL KOMPUTER 1	56	WITHIN	1			50-70
MAKMAL KOMPUTER 2	56	WITHIN	1			50-70
PENOLONG JURUTERA	57	WITHIN	1			50-70
MAKMAL BAHAN 1	49.5	DRY			1	50-70
MAKMAL BAHAN 2	62.1	WITHIN	1			50-70
MAKMAL ANALISIS TERMA	62.1	WITHIN	1			50-70
MAKMAL PERKAKAS	57	WITHIN	1			50-70
MAKMAL BAHAN	57.4	WITHIN	1			50-70
RUANG PEMPROSESAN GETAH	55	WITHIN	1			50-70
BILIK FIBER	57.4	WITHIN	1			50-70
BILIK RESIN	55	WITHIN	1			50-70
STOR	55.5	WITHIN	1			50-70
RUANG SINTESIS BAHAN	46.7	DRY			1	50-70
BILIK KHAS 1	46.7	DRY			1	50-70
BILIK KHAS 2	48	DRY			1	50-70
BILIK KHAS 3	48	DRY			1	50-70
BILIK KALISAN LELAS DWIPAKSI	54	WITHIN	1			50-70
BILIK MESIN RAMAN	55.5	WITHIN	1			50-70
BILIK MESIN XRD	56	WITHIN	1			50-70
BILIK MESIN XCM	55.5	WITHIN	1			50-70
BENGKEL MESIN	78.3	WET		1		50-70
MAKMAL GRAFIK KEJURUTERAAN 1	76	WET		1		50-70
MAKMAL GRAFIK KEJURUTERAAN 2	76	WET		1		50-70
MAKMAL REKABENTUK PEMBUATAN	56	WITHIN	1			50-70
MAKMAL PEMBUATAN TAMBAHAN	77.5	WET		1		50-70
MAKMAL PEMBUATAN BERINTEGRASIKAN KOMPUTER	73.4	WET		1		50-70
MAKMAL SIMULASI AUTOMASI 1	69.9	WITHIN	1			50-70
MAKMAL SIMULASI AUTOMASI 2	69.9	WITHIN	1			50-70
MAKMAL SIMULASI PERMODELAN 1	76.5	WET		1		50-70
MAKMAL SIMULASI PERMODELAN 2	76.5	WET		1		50-70
MAKMAL CAD/CAM	76.6	WET		1		50-70
MAKMAL KAWALAN KUALITI DAN KEJURUTERAAN RELIABILITI	77.2	WET		1		50-70
MAKMAL DIAGNOSTIK & GETARAN MESIN	84	WET		1		50-70

Room No/ Description	RH [%]	Judgement MS1525	Within	Wet	Dry	MS RH
MAKMAL PENYELENGGARAAN MESIN	60.9	WITHIN	1			50-70
MAKMAL PENGAGIHAN UDARA	64.2	WITHIN	1			50-70
MAKMAL APLIKASI HVAC	82.7	WET		1		50-70
MAKMAL TEKNOLOGI INDUSTRI HVAC	75.6	WET		1		50-70
MAKMAL PEMESINAN TERMAJU	76.3	WET		1		50-70
STUDIO CNC	78.3	WET		1		50-70
MAKMAL PEMBUATAN TERMAJU	79.8	WET		1		50-70
MAKMAL PROTOTAIP PANTAS	72.4	WET		1		50-70
STUDIO DFX	79.1	WET		1		50-70
MAKMAL PENGUJIAN BAHAN	71.4	WET		1		50-70
MAKMAL METROLOGY	72.6	WET		1		50-70
MAKMAL TEKNOLOGI PLASTIK	79.1	WET		1		50-70
MAKMAL TEKNOLOGI PEMBENTUKAN TERMAJU	74.1	WET		1		50-70
MAKMAL KEJURUTERAAN INDUSTRI DAN KAWALAN KUALITI	71.1	WET		1		50-70
MAKMAL TRIBOLOGI & TRANSMISI	78.3	WET		1		50-70
MAKMAL FIZIK	75.1	WET		1		50-70
MAKMAL MEKANIK PEPEJAL	80.8	WET		1		50-70
BILIK PENOLONG JURUTEKNIK	78.6	WET		1		50-70
STOR SISA	77.1	WET		1		50-70
MAKMAL ASAS TEKNOLOGI HVAC	79.4	WET		1		50-70
MAKMAL TEKNOLOGI PENCANTUMAN	76.2	WET		1		50-70
MAKMAL WATERJET	74.5	WET		1		50-70
MAKMAL TEKNOLOGI PERMESINAN	75.4	WET		1		50-70
STOR	80.7	WET		1		50-70
MAKMAL TEKNOLOGI TUANGAN	78.7	WET		1		50-70
MAKMAL REKABENTUK	76.3	WET		1		50-70
MAKMAL FABRIKASI	78	WET		1		50-70
MAKMAL DINAMIK & MEKANIK MESIN	76.3	WET		1		50-70
MAKMAL STATIK	79.8	WET		1		50-70
MAKMAL TERMOBENDALIR	79.8	WET		1		50-70
MAKMAL SAINS BAHAN	77.9	WET		1		50-70
STUDIO CAD 1 (BANGUNAN FTK)	69.9	WITHIN	1			50-70
STUDIO CAD 2 (BANGUNAN FTK)	64.2	WITHIN	1			50-70
STUDIO CAD 3 (BANGUNAN FTK)	60.8	WITHIN	1			50-70
STUDIO CAD 4 (BANGUNAN FTK)	62.1	WITHIN	1			50-70
MAKMAL KOMPOSIT DAN RAWATAN PERMUKAAN	68.4	WITHIN	1			50-70
MAKMAL INOVASI DAN PSM JTKP	66.3	WITHIN	1			50-70
MAKMAL PEMESINAN 2	66.4	WITHIN	1			50-70
MAKMAL REKABENTUK ERGONOMIK DAN OSHE	74	WET		1		50-70

Room No/ Description	RH [%]	Judgement MS1525	Within	Wet	Dry	MS RH
MAKMAL REKABENTUK INDUSTRI	73.8	WET		1		50-70
STUDIO CATIA PLM	74	WET		1		50-70
MAKMAL KIMPALAN TERMAJU	71.3	WET		1		50-70
MAKMAL TEKNOLOGI FABRIKASI LOGAM DAN MENGGEGAS	67.6	WITHIN	1			50-70

Table 4.3 displays the relative humidity (RH) levels in 242 rooms within an academic building and compares these values against the recommended range set by the Malaysian Standard MS1525, which is 50-70%. Measurements were taken in each of the 242 rooms to determine the relative humidity, with four representative rooms highlighted in this summary.

In Dewan Kuliah, the measured relative humidity is 62.9%, which falls within the acceptable range. Consequently, it is judged as "WITHIN" the MS1525 standard. Similarly, the Auditorium has an RH level of 52.7%, also within the acceptable range, receiving the same judgment. For Bilik Holding, the RH level is 45.9%, which is below the recommended range. Therefore, it is judged as "DRY" according to the MS1525 standard. In contrast, the Surau has an RH level of 78.3%, which exceeds the recommended range, and it is judged as "WET".

The columns "Within," "Wet," and "Dry" quantify the number of rooms that fall within each category. Two rooms (Dewan Kuliah and Auditorium) fall within the acceptable RH range, one room (Bilik Holding) is categorized as dry, and one room (Surau) is categorized as wet. The column "MS RH" reaffirms the standard relative humidity range of 50-70% as per MS1525.

4.1.4 Carbon Dioxide (CO2) Levels

Table 4. 4: Carbon dioxide level of 242 rooms

Room No/ Description	CO_2 [ppm]	Judgement MS1525	Recommended	Below	Over	Recommended [ppm]	DOSH [ppm]
DEWAN KULIAH	534	BELOW		1		800	1000
AUDITORIUM	566	BELOW		1		800	1000
BILIK HOLDING	667	BELOW		1		800	1000
SURAU	547	BELOW		1		800	1000
LOBI PENTADBIRAN	587	BELOW		1		800	1000
RUANG SOLAT (P)	587	BELOW		1		800	1000
RUANG SOLAT (L)	587	BELOW		1		800	1000
BILIK PROFESSOR 1	616	BELOW		1		800	1000
BILIK PROFESSOR 2	616	BELOW		1		800	1000
BILIK PROFESSOR 3	616	BELOW		1		800	1000
BILIK PROFESSOR 4	616	BELOW		1		800	1000
BILIK PROFESSOR 5	616	BELOW		1		800	1000
BILIK PROFESSOR 6	616	BELOW		1		800	1000
BILIK PROFESSOR 7	616	BELOW		1		800	1000
BILIK PROFESSOR 8	616	BELOW		1		800	1000
BILIK PROFESSOR 9	616	BELOW		1		800	1000
BILIK PROFESSOR 10	616	BELOW		1		800	1000
PANTRI	616	BELOW		1		800	1000
BILIK MESYUARAT COSSID	616	BELOW		1		800	1000
STOR ALAT TULIS 4	576	BELOW		1		800	1000
PEJABAT PENTADBIRAN	641	BELOW		1		800	1000
PENOLONG PENDAFTAR	641	BELOW		1		800	1000
STOR AM 1 (FAIL)	616	BELOW		1		800	1000
STOR ALAT (PERALATAN) 1	571	BELOW		1		800	1000
STOR ALAT (PERALATAN) 2	571	BELOW		1		800	1000
STOR ALAT (PERALATAN) 3	571	BELOW		1		800	1000
BILIK CETAK 1	627	BELOW		1		800	1000
BILIK PENSYARAH 1	632	BELOW		1		800	1000
BILIK PENSYARAH 2	632	BELOW		1		800	1000
BILIK PENSYARAH 1	632	BELOW		1		800	1000
BILIK PENSYARAH 3	632	BELOW		1		800	1000
BILIK PENSYARAH 4	632	BELOW		1		800	1000
BILIK PENSYARAH 5	632	BELOW		1		800	1000
BILIK PENSYARAH 6	632	BELOW		1		800	1000
BILIK PENSYARAH 7	632	BELOW		1		800	1000
BILIK PENSYARAH 8	632	BELOW		1		800	1000

Room No/ Description	CO_2 [ppm]	Judgement MS1525	Recommended	Below	Over	Recommended [ppm]	DOSH [ppm]
BILIK PENSYARAH 9	632	BELOW		1		800	1000
BILIK PENSYARAH 10	632	BELOW		1		800	1000
BILIK PENSYARAH 11	632	BELOW		1		800	1000
BILIK PENSYARAH 12	632	BELOW		1		800	1000
BILIK PENSYARAH 13	632	BELOW		1		800	1000
BILIK PENSYARAH 14	632	BELOW		1		800	1000
BILIK PENSYARAH 15	632	BELOW		1		800	1000
BILIK PENSYARAH 16	632	BELOW		1		800	1000
BILIK PENSYARAH 17	632	BELOW		1		800	1000
BILIK PENSYARAH 18	632	BELOW		1		800	1000
BILIK PENSYARAH 19	632	BELOW		1		800	1000
BILIK PENSYARAH 20	632	BELOW		1		800	1000
BILIK PENSYARAH 21	632	BELOW		1		800	1000
BILIK PENSYARAH 22	632	BELOW		1		800	1000
RUANG PELAJAR	543	BELOW		1		800	1000
BILIK CETAK 1	611	BELOW		1		800	1000
STOR PERALATAN PELAJAR 1	543	BELOW		1		800	1000
STOR PERALATAN PELAJAR 2	543	BELOW		1		800	1000
BILIK SUMBER FAKULTI	456	BELOW		1		800	1000
B.PBI 1	577	BELOW		1		800	1000
B.PBI 2	577	BELOW		1		800	1000
BILIK KULIAH 1	548	BELOW		1		800	1000
BILIK KULIAH 2	548	BELOW		1		800	1000
BILIK KULIAH 3	548	BELOW		1		800	1000
BILIK KULIAH 4	548	BELOW		1		800	1000
BILIK KULIAH 5	548	BELOW		1		800	1000
BILIK KULIAH 6	548	BELOW		1		800	1000
BILIK KULIAH 7	548	BELOW		1		800	1000
BILIK KULIAH 8	548	BELOW		1		800	1000
BILIK PERSATUAN PELAJAR	612	BELOW		1		800	1000
RUANG KERJA SETIAUSAHA 1	556	BELOW		1		800	1000
RUANG MENUNGGU	556	BELOW		1		800	1000
BILIK DEKAN	541	BELOW		1		800	1000
RUANG KERJA SETIAUSAHA 1	556	BELOW		1		800	1000
TIMB. DEKAN (AKADEMIK)	556	BELOW		1		800	1000
TIMB. DEKAN (PENYELIDIKAN DAN PENGAJIAN SISWAZAH)	610	BELOW		1		800	1000
TIMB. DEKAN (PEMBANGUNAN PELAJAR)	610	BELOW		1		800	1000
STOR AM 2	576	BELOW		1		800	1000
BILIK MESYUARAT PENGURUSAN	614	BELOW		1		800	1000

Room No/ Description	CO_2 [ppm]	Judgement MS1525	Recommended	Below	Over	Recommended [ppm]	DOSH [ppm]
PENOLONG PENDAFTAR KANAN	661	BELOW		1		800	1000
BILIK PROFESSOR 1	616	BELOW		1		800	1000
BILIK PROFESSOR 2	616	BELOW		1		800	1000
BILIK PROFESSOR 3	616	BELOW		1		800	1000
BILIK PROFESSOR 4	616	BELOW		1		800	1000
BILIK PROFESSOR 5	616	BELOW		1		800	1000
BILIK PROFESSOR 6	616	BELOW		1		800	1000
BILIK PROFESSOR 7	616	BELOW		1		800	1000
BILIK PROFESSOR 8	616	BELOW		1		800	1000
BILIK PROFESSOR 9	616	BELOW		1		800	1000
BILIK PROFESSOR 10	616	BELOW		1		800	1000
BILIK CETAK	542	BELOW		1		800	1000
BILIK KEBAL	627	BELOW		1		800	1000
PANTRI 1	650	BELOW		1		800	1000
PANTRI 2	650	BELOW		1		800	1000
BILIK KETUA JABATAN 1	433	BELOW		1		800	1000
BILIK KETUA JABATAN 2	430	BELOW		1		800	1000
BILIK PENYELARAS KEJURUTERAAN 1	430	BELOW		1		800	1000
BILIK PENYELARAS KEJURUTERAAN 2	430	BELOW		1		800	1000
BILIK PENYELARAS KEJURUTERAAN 3	478	BELOW		1		800	1000
BILIK PENYELARAS KEJURUTERAAN 4	540	BELOW		1		800	1000
BILIK FAIL 1	650	BELOW		1		800	1000
BILIK KOSONG 1	568	BELOW		1		800	1000
BILIK KOSONG 2	568	BELOW		1		800	1000
BILIK KOSONG 3	568	BELOW		1		800	1000
BILIK KOSONG 4	568	BELOW		1		800	1000
BILIK KOSONG 1	568	BELOW		1		800	1000
BILIK KOSONG 2	568	BELOW		1		800	1000
BILIK KOSONG 3	568	BELOW		1		800	1000
BILIK KOSONG 4	568	BELOW		1		800	1000
BILIK KOSONG 5	568	BELOW		1		800	1000
BILIK KOSONG 6	568	BELOW		1		800	1000
BILIK JAMUAN	472	BELOW		1		800	1000
BILIK MESYUARAT	513	BELOW		1		800	1000
BILIK PENSYARAH 1	540	BELOW		1		800	1000
BILIK PENSYARAH 2	540	BELOW		1		800	1000
BILIK PENSYARAH 3	540	BELOW		1		800	1000

Room No/ Description	CO_2 [ppm]	Judgement MS1525	Recommended	Below	Over	Recommended [ppm]	DOSH [ppm]
BILIK PENSYARAH 4	540	BELOW		1		800	1000
BILIK PENSYARAH 5	540	BELOW		1		800	1000
BILIK PENSYARAH 6	540	BELOW		1		800	1000
BILIK PENSYARAH 7	540	BELOW		1		800	1000
BILIK PENSYARAH 8	540	BELOW		1		800	1000
BILIK PENSYARAH 9	540	BELOW		1		800	1000
BILIK PENSYARAH 10	540	BELOW		1		800	1000
BILIK PENSYARAH 11	540	BELOW		1		800	1000
BILIK PENSYARAH 12	540	BELOW		1		800	1000
BILIK PENSYARAH 13	540	BELOW		1		800	1000
BILIK PENSYARAH 14	540	BELOW		1		800	1000
BILIK PENSYARAH 15	540	BELOW		1		800	1000
BILIK PENSYARAH 16	540	BELOW		1		800	1000
BILIK PENSYARAH 17	540	BELOW		1		800	1000
BILIK PENSYARAH 18	540	BELOW		1		800	1000
BILIK PENSYARAH 19	540	BELOW		1		800	1000
BILIK PENSYARAH 20	540	BELOW		1		800	1000
BILIK PENSYARAH 21	540	BELOW		1		800	1000
BILIK PENSYARAH 22	540	BELOW		1		800	1000
ICT (COMRACK)	430	BELOW		1		800	1000
BILIK PROFESSOR 1	616	BELOW		1		800	1000
BILIK PROFESSOR 2	616	BELOW		1		800	1000
BILIK PROFESSOR 3	616	BELOW		1		800	1000
BILIK PROFESSOR 4	616	BELOW		1		800	1000
BILIK PROFESSOR 5	616	BELOW		1		800	1000
BILIK PROFESSOR 6	616	BELOW		1		800	1000
BILIK PROFESSOR 7	616	BELOW		1		800	1000
BILIK PROFESSOR 8	616	BELOW		1		800	1000
BILIK PROFESSOR 9	616	BELOW		1		800	1000
BILIK PROFESSOR 10	616	BELOW		1		800	1000
BILIK PENSYARAH 1	488	BELOW		1		800	1000
BILIK PENSYARAH 2	488	BELOW		1		800	1000
BILIK PROFESSOR 1	616	BELOW		1		800	1000
BILIK PROFESSOR 2	616	BELOW		1		800	1000
BILIK PROFESSOR 3	616	BELOW		1		800	1000
BILIK PROFESSOR 4	616	BELOW		1		800	1000
BILIK PROFESSOR 5	616	BELOW		1		800	1000
BILIK PROFESSOR 6	616	BELOW		1		800	1000
BILIK PROFESSOR 7	616	BELOW		1		800	1000
BILIK PROFESSOR 8	616	BELOW		1		800	1000

Room No/ Description	CO_2 [ppm]	Judgement MS1525	Recommended	Below	Over	Recommended [ppm]	DOSH [ppm]
BILIK PROFESSOR 9	616	BELOW		1		800	1000
BILIK PROFESSOR 10	616	BELOW		1		800	1000
BILIK PROFESSOR 11	616	BELOW		1		800	1000
BILIK PROFESSOR 12	616	BELOW		1		800	1000
BILIK PROFESSOR MADYA 1	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 2	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 3	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 4	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 5	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 6	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 7	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 8	540	BELOW		1		800	1000
BILIK PROFESSOR MADYA 9	540	BELOW		1		800	1000
MAKMAL KOMPUTER (EGL)	498	BELOW		1		800	1000
MAKMAL KOMPUTER 1	498	BELOW		1		800	1000
MAKMAL KOMPUTER 2	498	BELOW		1		800	1000
PENOLONG JURUTERA	513	BELOW		1		800	1000
MAKMAL BAHAN 1	458	BELOW		1		800	1000
MAKMAL BAHAN 2	498	BELOW		1		800	1000
MAKMAL ANALISIS TERMA	498	BELOW		1		800	1000
MAKMAL PERKAKAS	513	BELOW		1		800	1000
MAKMAL BAHAN	693	BELOW		1		800	1000
RUANG PEMPROSESAN GETAH	513	BELOW		1		800	1000
BILIK FIBER	532	BELOW		1		800	1000
BILIK RESIN	532	BELOW		1		800	1000
STOR	476	BELOW		1		800	1000
RUANG SINTESIS BAHAN	456	BELOW		1		800	1000
BILIK KHAS 1	456	BELOW		1		800	1000
BILIK KHAS 2	511	BELOW		1		800	1000
BILIK KHAS 3	511	BELOW		1		800	1000
BILIK KALISAN LELAS DWIPAKSI	532	BELOW		1		800	1000
BILIK MESIN RAMAN	476	BELOW		1		800	1000
BILIK MESIN XRD	488	BELOW		1		800	1000
BILIK MESIN XCM	476	BELOW		1		800	1000
BENGKEL MESIN	400	BELOW		1		800	1000
MAKMAL GRAFIK KEJURUTERAAN 1	400	BELOW		1		800	1000
MAKMAL GRAFIK KEJURUTERAAN 2	400	BELOW		1		800	1000
MAKMAL REKABENTUK PEMBUATAN	400	BELOW		1		800	1000
MAKMAL PEMBUATAN TAMBAHAN	400	BELOW		1		800	1000

Room No/ Description	CO_2 [ppm]	Judgement MS1525	Recommended	Below	Over	Recommended [ppm]	DOSH [ppm]
MAKMAL PEMBUATAN BERINTEGRASIKAN KOMPUTER	400	BELOW		1		800	1000
MAKMAL SIMULASI AUTOMASI 1	400	BELOW		1		800	1000
MAKMAL SIMULASI AUTOMASI 2	400	BELOW		1		800	1000
MAKMAL SIMULASI PERMODELAN 1	400	BELOW		1		800	1000
MAKMAL SIMULASI PERMODELAN 2	400	BELOW		1		800	1000
MAKMAL CAD/CAM	401	BELOW		1		800	1000
MAKMAL KAWALAN KUALITI DAN KEJURUTERAAN RELIABILITI	400	BELOW		1		800	1000
MAKMAL DIAGNOSTIK & GETARAN MESIN	512	BELOW		1		800	1000
MAKMAL PENYELENGGARAAN MESIN	493	BELOW		1		800	1000
MAKMAL PENGAGIHAN UDARA	529	BELOW		1		800	1000
MAKMAL APLIKASI HVAC	504	BELOW		1		800	1000
MAKMAL TEKNOLOGI INDUSTRI HVAC	513	BELOW		1		800	1000
MAKMAL PEMESINAN TERMAJU	465	BELOW		1		800	1000
STUDIO CNC	454	BELOW		1		800	1000
MAKMAL PEMBUATAN TERMAJU	459	BELOW		1		800	1000
MAKMAL PROTOTAIP PANTAS	469	BELOW		1		800	1000
STUDIO DFX	488	BELOW		1		800	1000
MAKMAL PENGUJIAN BAHAN	510	BELOW		1		800	1000
MAKMAL METROLOGY	499	BELOW		1		800	1000
MAKMAL TEKNOLOGI PLASTIK	513	BELOW		1		800	1000
MAKMAL TEKNOLOGI PEMBENTUKAN TERMAJU	460	BELOW		1		800	1000
MAKMAL KEJURUTERAAN INDUSTRI DAN KAWALAN KUALITI	444	BELOW		1		800	1000
MAKMAL TRIBOLOGI & TRANSMISI	617	BELOW		1		800	1000
MAKMAL FIZIK	594	BELOW		1		800	1000
MAKMAL MEKANIK PEPEJAL	541	BELOW		1		800	1000
BILIK PENOLONG JURUTEKNIK	555	BELOW		1		800	1000
STOR SISA	542	BELOW		1		800	1000
MAKMAL ASAS TEKNOLOGI HVAC	505	BELOW		1		800	1000
MAKMAL TEKNOLOGI PENCANTUMAN	553	BELOW		1		800	1000
MAKMAL WATERJET	543	BELOW		1		800	1000
MAKMAL TEKNOLOGI PERMESINAN	505	BELOW		1		800	1000

Room No/ Description	CO_2 [ppm]	Judgement MS1525	Recommended	Below	Over	Recommended [ppm]	DOSH [ppm]
STOR	549	BELOW		1		800	1000
MAKMAL TEKNOLOGI TUANGAN	571	BELOW		1		800	1000
MAKMAL REKABENTUK	524	BELOW		1		800	1000
MAKMAL FABRIKASI	502	BELOW		1		800	1000
MAKMAL DINAMIK & MEKANIK MESIN	531	BELOW		1		800	1000
MAKMAL STATIK	518	BELOW		1		800	1000
MAKMAL TERMOBENDALIR	518	BELOW		1		800	1000
MAKMAL SAINS BAHAN	549	BELOW		1		800	1000
STUDIO CAD 1 (BANGUNAN FTK)	538	BELOW		1		800	1000
STUDIO CAD 2 (BANGUNAN FTK)	604	BELOW		1		800	1000
STUDIO CAD 3 (BANGUNAN FTK)	689	BELOW		1		800	1000
STUDIO CAD 4 (BANGUNAN FTK)	667	BELOW		1		800	1000
MAKMAL KOMPOSIT DAN RAWATAN PERMUKAAN	400	BELOW		1		800	1000
MAKMAL INOVASI DAN PSM JTKP	400	BELOW		1		800	1000
MAKMAL PEMESINAN 2	400	BELOW		1		800	1000
MAKMAL REKABENTUK ERGONOMIK DAN OSHE	400	BELOW		1		800	1000
MAKMAL REKABENTUK INDUSTRI	400	BELOW		1		800	1000
STUDIO CATIA PLM	400	BELOW		1		800	1000
MAKMAL KIMPALAN TERMAJU	400	BELOW		1		800	1000
MAKMAL TEKNOLOGI FABRIKASI LOGAM DAN MENGGEGAS	400	BELOW		1		800	1000

The Table 4.4 displays the carbon dioxide (CO2) levels measured in 242 rooms that has been measured. Measurements were taken in each of the 242 rooms to determine the carbon dioxide level, with four representative rooms highlighted in this summary and evaluates these levels against the recommended standards set by MS 1525 and the Department of Occupational Safety and Health (DOSH).

For Dewan Kuliah, the CO2 concentration is recorded at 534 ppm, which is well below the MS 1525 recommended maximum of 800 ppm and DOSH's permissible exposure limit of 1000 ppm. This indicates that the indoor air quality in Dewan Kuliah is good, with CO2 levels comfortably within the safe range for occupant health and comfort.

Similarly, the Auditorium has a CO2 concentration of 566 ppm, again below the MS 1525 guideline of 800 ppm and DOSH's limit of 1000 ppm. This measurement confirms that the air quality in the Auditorium is within acceptable limits, ensuring a healthy environment for occupants.

Bilik Holding shows a CO2 level of 667 ppm, which also remains below the recommended thresholds of both MS 1525 and DOSH. This further demonstrates that the air quality in Bilik Holding is satisfactory and adheres to the established standards for indoor environments.

Finally, Surau has a CO2 concentration of 547 ppm, below the MS 1525 recommendation and the DOSH limit. This reading suggests that the air quality in Surau is within safe and acceptable limits, ensuring a healthy indoor environment for its users.

Overall, all the measured rooms – Dewan Kuliah, Auditorium, Bilik Holding, and Surau – have CO2 levels below the MS 1525 recommended value of 800 ppm and the DOSH limit of 1000 ppm. This indicates that the indoor air quality in these rooms is well-managed and adheres to the standards, promoting a healthy and comfortable environment for all occupants. The consistent results across all rooms suggest effective ventilation and air management practices within the building.

4.2 Room Data Survey Analysis

The Room Data Survey (RDS) conducted at the Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan (FTKIP) at Universiti Teknikal Malaysia Melaka (UTeM) aimed to assess and document various indoor environmental quality (IEQ) parameters, including illuminance levels, temperature, relative humidity (RH), and carbon dioxide (CO2) levels across different rooms. The analysis of these parameters is crucial for understanding the current state of the indoor environment and identifying areas for improvement.

4.2.1 Illuminance Levels Analysis

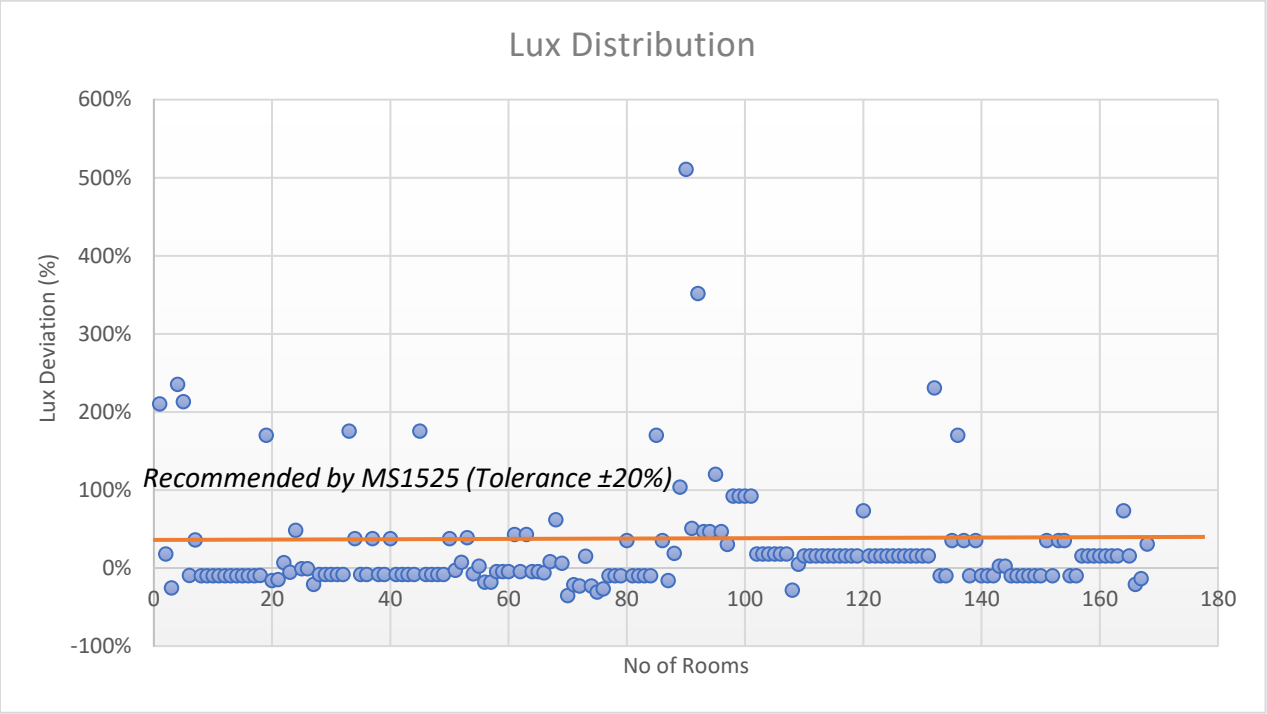

Figure 4. 1: Scatter plot showing the percentage of rooms recommended by Lux Distribution according to their deviation from the MS 1525 standard.

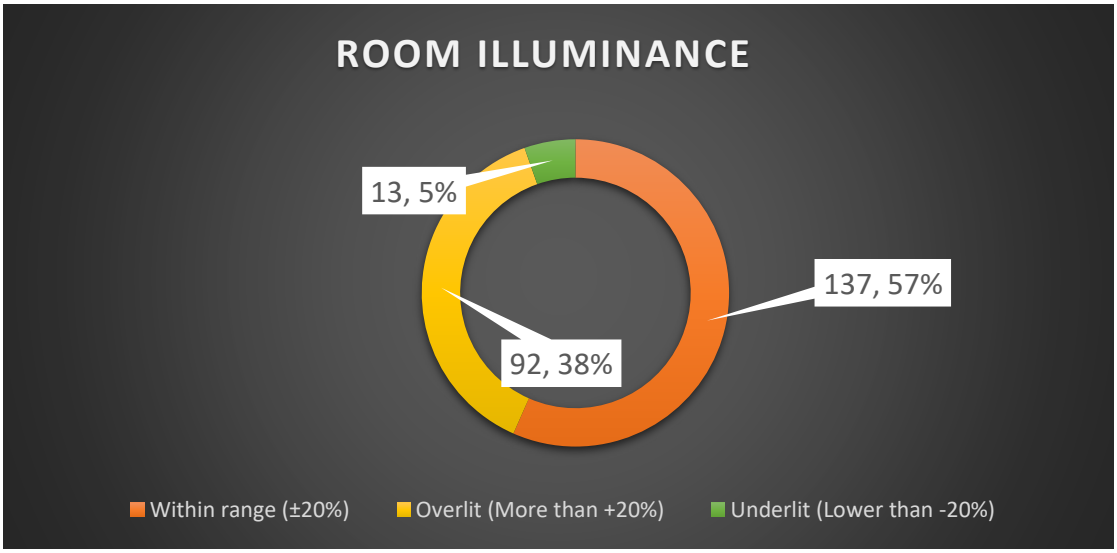

Figure 4. 2: Pie chart of distribution of illuminance levels in rooms

Table 4. 5: Percentage of rooms by illuminance category

Category	No of Room	Percentage
Within range (±20%)	137	57%
Overlit (More than +20%)	92	38%
Underlit (Lower than -20%)	13	5%
Total	242	100%

The analysis of illuminance levels across different rooms at the Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan (FTKIP) at Universiti Teknikal Malaysia Melaka (UTeM) reveals significant insights into the lighting conditions. The illuminance levels were categorized into three groups: within the recommended range (±20%), overlit (more than +20%), and underlit (lower than -20%). The distribution of these categories is summarized in the Table 4.5.

A total of 137 rooms, accounting for 57% of the surveyed rooms, fall within the recommended illuminance range of ±20% from the MS 1525 standard of 300 lux. This indicates that the majority of rooms have adequate lighting conditions, providing a balanced environment conducive to various activities without causing strain or discomfort to occupants. The compliance of these rooms with the recommended standards suggests that the lighting systems in these spaces are well-designed and maintained, ensuring energy efficiency and occupant comfort (Eleyan et al., n.d.).

Out of the 242 rooms surveyed, 92 rooms, or 38%, were found to be overlit, with illuminance levels exceeding the recommended standard by more than 20%. Overlit rooms can lead to unnecessary energy consumption and potential discomfort, such as glare and eye strain, which can negatively impact productivity and well-being. The high percentage of overlit rooms highlights the need for a review and adjustment of the lighting systems in these areas (Chi et al., 2018). Implementing measures such as installing dimmable lights, using lower wattage bulbs, or incorporating automated lighting controls could help mitigate these issues and enhance energy efficiency.

A smaller proportion of the rooms, totalling 13 (5%), were identified as underlit, with illuminance levels falling below the recommended standard by more than 20%. Underlit environments can lead to inadequate visibility, increasing the risk of accidents and reducing

occupant productivity. The low percentage of underlit rooms indicates that while this is not a widespread issue, it is still significant enough to warrant attention (Chi et al., 2018). Enhancing lighting in these rooms through the addition of more light fixtures, using higher wattage bulbs, or improving natural light access can help address these deficiencies.

4.2.2 Temperature Analysis

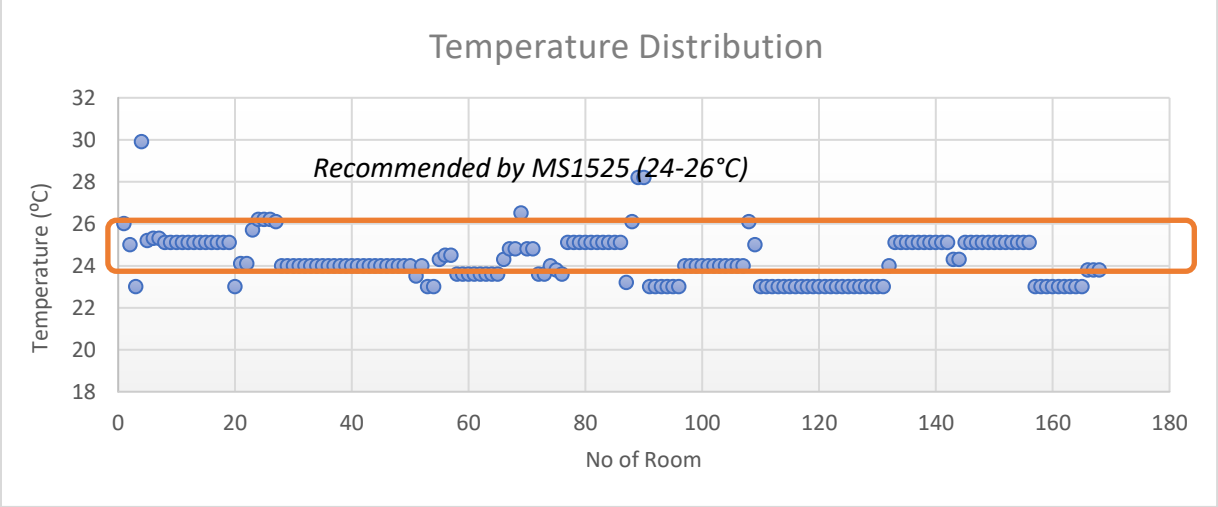

Figure 4. 3: Temperature distribution according to range MS1525 standard

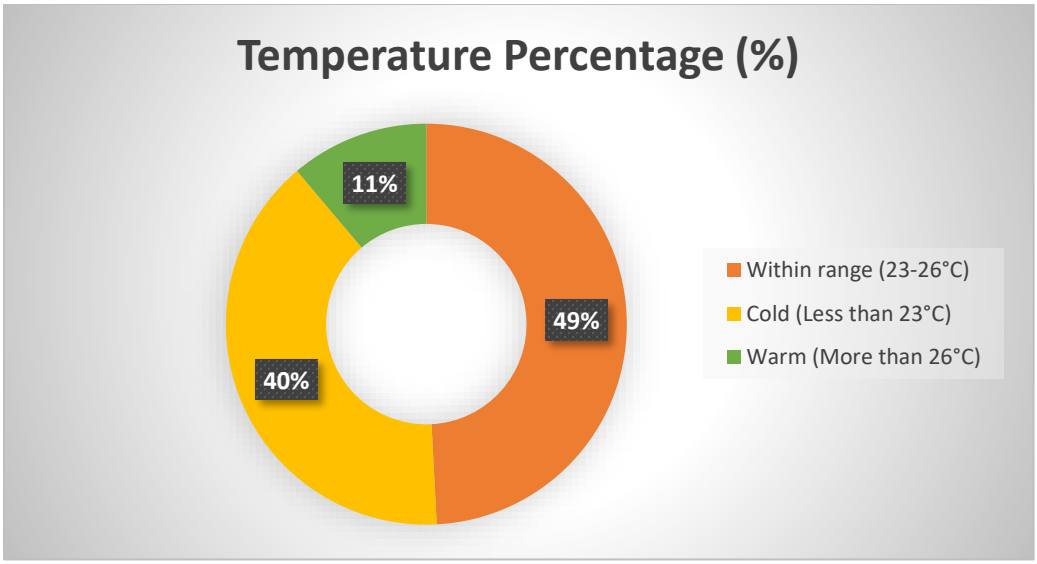

Figure 4. 4: Pie chart of distribution of temperature in rooms

Table 4. 6: Percentage of rooms by temperature category

Category	No of Room	Percentage
Within range (24-26°C)	119	49%
Cold (Less than 24°C)	96	40%
Warm (More than 26°C)	27	11%
Total	242	100%

The temperature analysis of 242 rooms at the Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan (FTKIP) at Universiti Teknikal Malaysia Melaka (UTeM) presents a varied picture of the thermal conditions within the facility. This survey categorizes the rooms based on their compliance with the Malaysian Standard MS 1525, which recommends an optimal indoor temperature range of 24-26°C.

From the Table 4.6, out of the 242 rooms surveyed, 119 rooms (49%) were found to be within the recommended temperature range of 24-26°C. This indicates that nearly half of the rooms provide an optimal thermal environment, ensuring comfort for the occupants and compliance with energy efficiency standards. These rooms likely maintain a balance between energy use and indoor

comfort, contributing positively to the overall sustainability goals of the institution (Aryal & Becerik-Gerber, 2018).

While 96 rooms (40%) were categorized as cold, with temperatures falling below 24°C. This significant portion of rooms may present challenges in terms of occupant comfort, potentially leading to an environment that is too cool for optimal productivity and well-being (Alnuaimi et al., 2022). The prevalence of cooler rooms suggests a possible overuse of air conditioning or issues with temperature control systems that need addressing to prevent excessive energy consumption and discomfort.

Lastly, 27 rooms (11%) were identified as warm, with temperatures exceeding 26°C. These rooms are likely to be less comfortable for occupants, possibly leading to decreased productivity and increased complaints. The higher temperatures could be indicative of insufficient cooling capacity, inadequate ventilation, or other HVAC-related issues that need to be resolved to ensure a comfortable indoor climate (Harriman & Kittler, 2021).

The distribution of rooms across these temperature categories highlights the need for targeted interventions. While a substantial portion of the rooms meets the recommended thermal comfort standards, the significant number of rooms that are either too cold or too warm points to the necessity for improved temperature management strategies.

Addressing the cold rooms may involve adjusting thermostat settings, recalibrating air conditioning systems, or enhancing insulation to reduce excessive cooling. For the warm rooms, solutions might include increasing cooling capacity, improving airflow and ventilation, or upgrading HVAC systems to ensure adequate temperature control.

By optimizing the thermal conditions in all rooms, FTKIP can enhance occupant comfort, improve energy efficiency, and support the university's broader sustainability objectives. This balanced approach will not only align with MS 1525 standards but also foster a more conducive learning and working environments for all occupants.

4.2.3 Relative Humidity Analysis

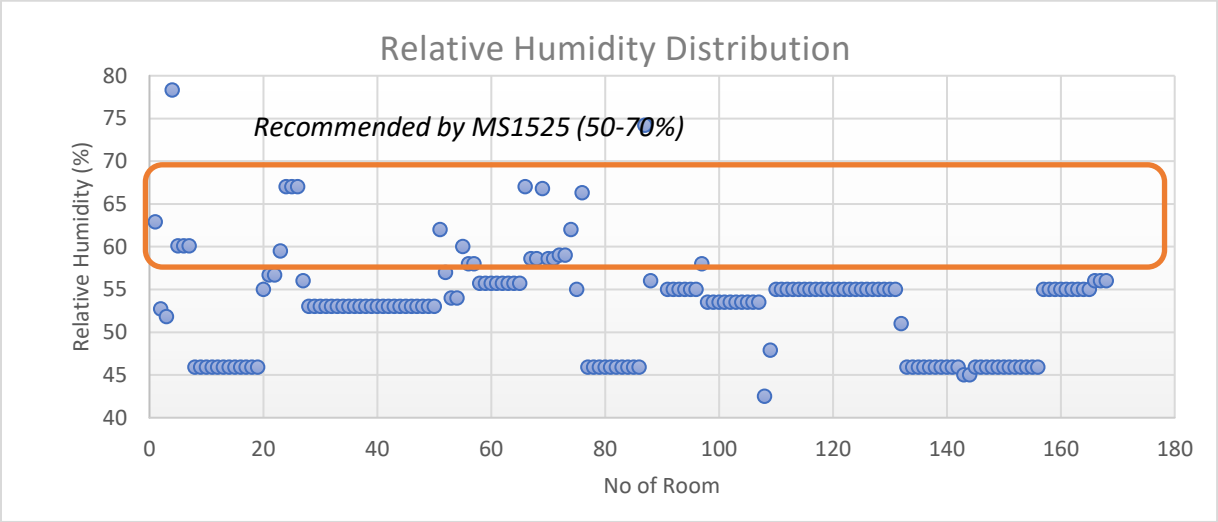

Figure 4. 5: Relative humidity distribution according to range MS1525 standard

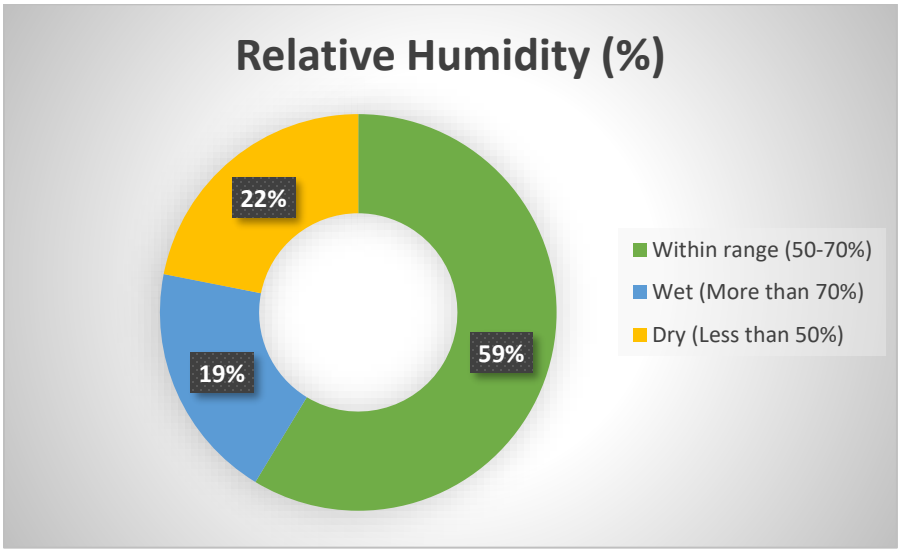

Figure 4. 6: Pie chart of distribution of relative humidity in rooms

Table 4. 7: Percentage of rooms by relative humidity category

Category	No of Room	Percentage
Within range (50-70%)	142	59%
Wet (More than 70%)	47	19%
Dry (Less than 50%)	53	22%
Total	242	100%

The relative humidity (RH) analysis of 242 rooms at the Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan (FTKIP) at Universiti Teknikal Malaysia Melaka (UTeM) provides important insights into the indoor air quality and comfort levels within the facility. This survey categorizes the rooms based on their compliance with the Malaysian Standard MS 1525, which recommends an optimal indoor RH range of 50-70%.

From the Table 4.7, out of the 242 rooms surveyed, 142 rooms (59%) were found to be within the recommended RH range of 50-70%. This majority indicates that more than half of the rooms maintain an optimal humidity level, which is essential for ensuring comfort and health for occupants. Proper humidity levels can prevent issues such as mold growth, dust mites, and respiratory problems, thus contributing positively to indoor air quality and overall well-being (Wolkoff, 2018).

While 47 rooms (19%) were categorized as wet, with RH levels exceeding 70%. These rooms are likely to experience high humidity, which can create uncomfortable conditions and potentially lead to the growth of mold and mildew. High humidity can also exacerbate health issues such as allergies and asthma (Wolkoff, 2018). The presence of a significant number of rooms with high humidity suggests the need for improved dehumidification and ventilation systems to maintain healthy and comfortable indoor environments.

Lastly, 53 rooms (22%) were identified as dry, with RH levels falling below 50%. Low humidity levels can result in dry skin, irritation of the respiratory tract, and increased static electricity, which can be uncomfortable for occupants (Wolkoff, 2018). This finding points to potential issues with over-dehumidification or inadequate humidification, especially in air-conditioned spaces. Addressing these dry conditions may involve adjusting the HVAC systems to maintain adequate moisture levels in the air.

The distribution of rooms across these RH categories highlights areas for improvement in maintaining ideal indoor humidity conditions. While a significant portion of the rooms meets the recommended RH standards, the prevalence of both excessively wet and dry rooms suggests a need for better humidity control measures.

To address the high humidity rooms, FTKIP may need to enhance ventilation, increase the use of dehumidifiers, or optimize the HVAC systems to reduce moisture levels effectively. For the dry rooms, adding humidifiers or adjusting existing HVAC settings to increase humidity can help achieve a more balanced indoor environment.

Improving humidity control across all rooms will enhance occupant comfort, support health and well-being, and ensure compliance with MS 1525 standards. This approach not only aligns with regulatory requirements but also fosters a more conducive learning and working environment for students, staff, and faculty members.

4.2.4 Carbon Dioxide (CO2) Analysis

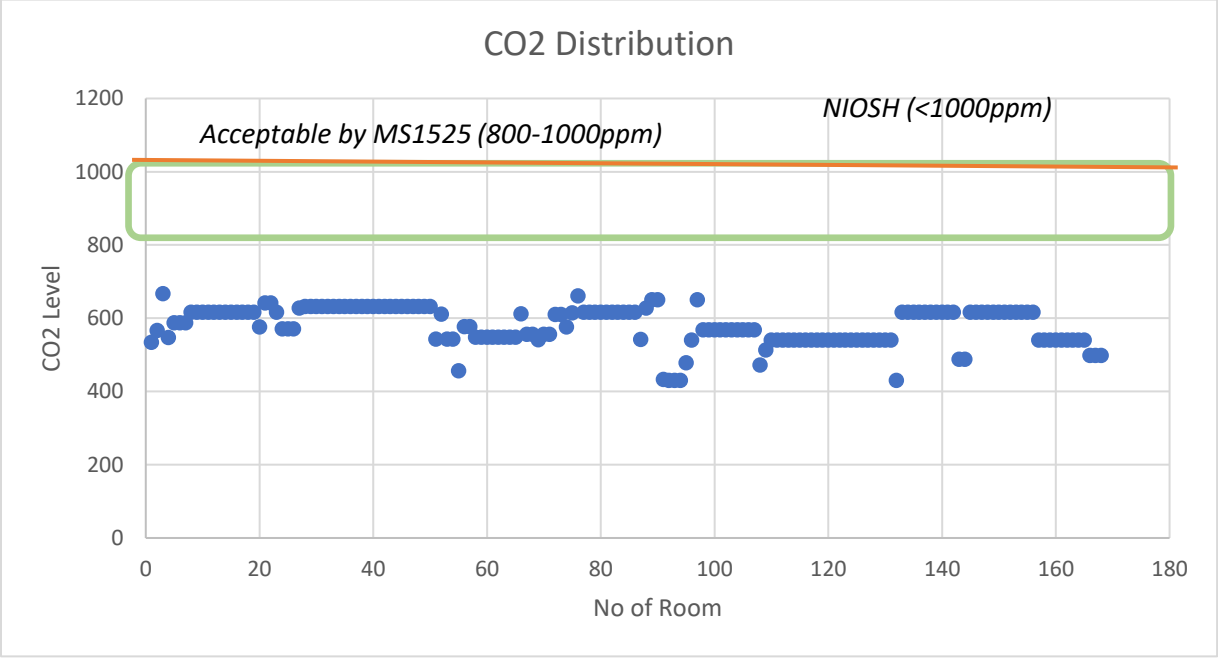

Figure 4. 7: Carbon dioxide (CO2) levels distribution according to range MS1525 standard

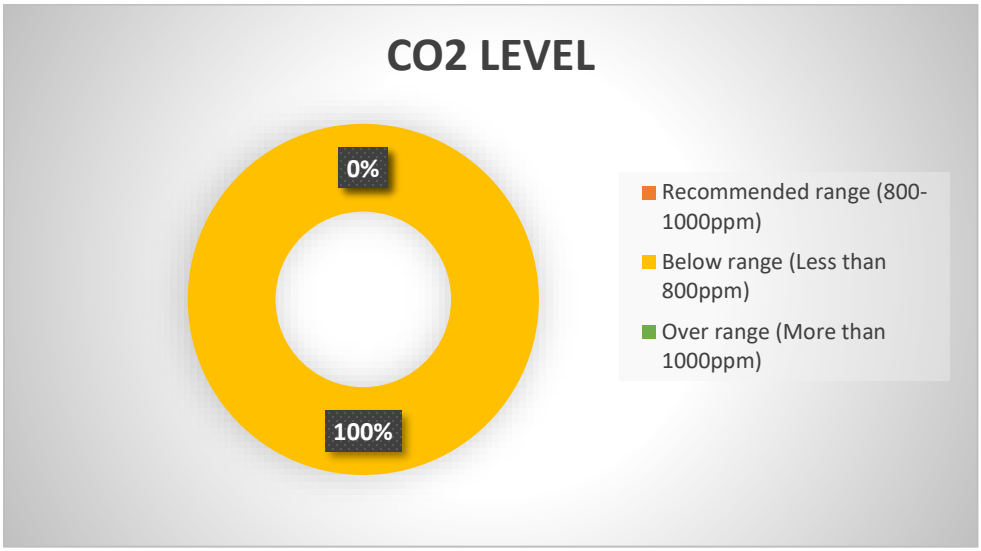

Figure 4. 8: Pie chart of distribution of carbon dioxide level in rooms

Table 4. 8: Percentage of rooms by carbon dioxide level category

Category	No of Room	Percentage
Recommended range (800-1000ppm)	0	0%
Below range (Less than 800ppm)	242	100%
Over range (More than 1000ppm)	0	0%
Total	242	100%

The analysis of carbon dioxide (CO2) levels in 242 rooms at the Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan (FTKIP) at Universiti Teknikal Malaysia Melaka (UTeM) reveals significant findings regarding indoor air quality and ventilation efficiency. The CO2 concentration levels were categorized based on the Malaysian Standard MS 1525, which recommends a range of 800-1000 parts per million (ppm) for optimal indoor air quality.

Based on the Table 4.8, the survey results show that 0 rooms (0%) were within the recommended range of 800-1000 ppm. This indicates that none of the surveyed rooms met the ideal CO2 concentration levels specified by MS 1525. This finding suggests that the ventilation systems in place are potentially more efficient than necessary, as they are maintaining CO2 levels well below the upper limit of the recommended range.

While 242 rooms (100%) were below the recommended range, with CO2 levels less than 800 ppm. This outcome is indicative of good ventilation and air exchange rates, ensuring that indoor air remains fresh and that CO2 levels do not reach concentrations that could impact occupants' comfort and cognitive function. Lower CO2 levels are typically associated with better air quality and a reduced risk of symptoms related to poor indoor air, such as headaches, dizziness, and fatigue (Azuma et al., 2018).

Lastly, 0 rooms (0%) were above the recommended range of 1000 ppm. This confirms that none of the rooms have CO2 concentrations that exceed safe and comfortable levels, which is essential for maintaining a healthy indoor environment and preventing the adverse effects associated with high CO2 levels.

The fact that all surveyed rooms have CO2 levels below the recommended range indicates an overperformance in terms of ventilation, which might lead to increased energy usage. While maintaining CO2 levels well below the upper limit ensures high indoor air quality, it is also important to consider the energy efficiency of the ventilation systems. Over-ventilation can lead to unnecessary energy consumption, which is not in line with sustainability goals and energy efficiency practices.

To optimize indoor air quality and energy use, FTKIP could consider adjusting the ventilation systems to maintain CO2 levels closer to the recommended range without exceeding it. This would ensure that air quality remains high while also improving energy efficiency. Implementing demand-controlled ventilation systems that adjust airflow based on occupancy and real-time CO2 levels could be a strategic approach to achieving this balance.

Overall, the CO2 analysis reflects positively on the indoor air quality within FTKIP, demonstrating effective ventilation practices that ensure a healthy and comfortable environment for students, staff, and faculty. However, there is an opportunity to fine-tune these systems to enhance energy efficiency while maintaining compliance with MS 1525 standards.

4.3 Implementation of Energy Conservation Measures (ECMs)

Implementing Energy Conservation Measures (ECMs) is a critical step towards improving energy efficiency and reducing operational costs in buildings. ECMs can range from simple behavioral changes to complex technological upgrades. In the context of the Fakulti Teknologi dan Kejuruteraan Industri dan Pembuatan (FTKIP) at Universiti Teknikal Malaysia Melaka (UTeM), several ECMs have been identified and implemented to optimize energy use and enhance the indoor environmental quality (IEQ).

One of the primary Energy Conservation Measures (ECMs) involves the delamping method, which means removing some lamps to ensure that rooms maintain the recommended illuminance level of 300 lux, as specified by MS1525. For example, Dewan Kuliah was determined to be overlit according to the measurements and calculations in Table 4.5. Therefore, it can be proposed to use the delamping method in Dewan Kuliah. This room has 7 rows of 7 large lamps, each containing 3 LED lamps. To maintain the appropriate illuminance level within the guidelines of MS1525, one large LED lamp from each row can be removed. Additionally, during the use of Dewan Kuliah, only a few lamps should be switched on to ensure the room is not overlit.

Step-by-Step Calculation:

1. Determine the wattage of one LED lamp:

    - Each LED lamp has a wattage of 15 watts (W).

2. Calculate the total wattage of all lamps before delamping:

    - Dewan Kuliah has 7 rows of 7 large lamps, and each large lamp contains 3 LED lamps.
    - Total number of LED lamps = 7 rows × 7 large lamps/row × 3 LED lamps/large lamp = 147 LED lamps.
    - Total wattage before delamping = 147 LED lamps × 15 W/LED lamp = 2205 W.

3. Determine the new total number of LED lamps after delamping:

    - 1 large LED lamp (containing 3 LED lamps) is removed from each row.
    - Total number of large lamps removed = 7 rows × 1 large lamp/row = 7 large lamps.

- Total number of LED lamps removed = 7 large lamps × 3 LED lamps/large lamp = 21 LED lamps.
- Total number of LED lamps after delamping = 147 LED lamps - 21 LED lamps = 126 LED lamps.

4. Calculate the total wattage of all lamps after delamping:

- Total wattage after delamping = 126 LED lamps × 15 W/LED lamp = 1890 W.

5. Calculate the reduction in electricity consumption:

- Reduction in wattage = Total wattage before delamping - Total wattage after delamping.
- Reduction in wattage = 2205 W - 1890 W = 315 W.

6. Calculate the percentage reduction in electricity consumption:

- Percentage reduction = (Reduction in wattage / Total wattage before delamping) × 100%.
- Percentage reduction = (315 W / 2205 W) $\times$ 100% $\approx$ 14.29%.

Summary of Calculations

- Original total wattage (before delamping): 2205 W
- New total wattage (after delamping): 1890 W
- Reduction in wattage: 315 W
- Percentage reduction in electricity consumption: $\approx$ 14.29%

By following the delamping method, Dewan Kuliah can reduce its electricity consumption by approximately 14.29%. This calculation can help justify the implementation of the delamping strategy as an effective Energy Conservation Measure.

To facilitate this, red stickers can be placed on the switches of lamps that should not be turned on because they can cause overlighting. This way, all lecturers, staff, and students will know that switches with red stickers should not be used during classes or programs.

Another significant ECM is the improvement of the HVAC (heating, ventilation, and air conditioning) systems. Upgrading to more efficient HVAC units, along with regular maintenance, ensures optimal performance and energy use. The installation of programmable thermostats and

advanced control systems allows for better regulation of indoor temperatures based on occupancy patterns, reducing energy wastage during unoccupied periods (Tanadecha & Khaothong, 2023). Additionally, the implementation of demand-controlled ventilation adjusts the airflow based on the actual need, maintaining indoor air quality while minimizing energy consumption (Cui & Liu, 2024).

Insulation improvements also play a crucial role in energy conservation. Enhancing the insulation of walls, roofs, and windows helps maintain desired indoor temperatures, reducing the load on HVAC systems. This measure not only lowers energy consumption but also improves thermal comfort for the occupants (Xie et al., 2023).

Furthermore, the use of energy management systems (EMS) enables real-time monitoring and control of energy use within the facility. These systems provide valuable data on energy consumption patterns, helping to identify inefficiencies and areas for further improvement. The integration of renewable energy sources, such as solar panels, has also been explored to supplement the energy needs of the building, thereby reducing dependence on non-renewable energy sources and lowering carbon emissions (Abbasi & Baleanu, 2023).

4.4 Impact on Energy Consumption and IEQ

The implementation of ECMs at FTKIP has had a significant impact on both energy consumption and indoor environmental quality (IEQ). The transition to energy-efficient lighting and the integration of control systems have resulted in substantial reductions in electricity use. LED lights, which are more efficient than traditional lighting, consume less power and produce less heat, contributing to lower cooling loads on HVAC systems (Hafez et al., 2023). This dual benefit of reducing lighting and cooling energy use underscores the importance of integrated energy conservation strategies.

The enhancements in HVAC systems, including the use of programmable thermostats and demand-controlled ventilation, have optimized energy use for heating and cooling. By adjusting

temperatures and ventilation rates based on real-time occupancy, these systems ensure that energy is used only when and where it is needed, leading to significant energy savings. The reduction in energy consumption not only lowers operational costs but also reduces the environmental footprint of the building (Zaidan et al., 2024).

In terms of IEQ, the ECMs have positively influenced thermal comfort, air quality, and lighting quality. Improved insulation and efficient HVAC systems maintain consistent indoor temperatures, preventing the discomfort associated with extreme temperature fluctuations. The demand-controlled ventilation systems ensure that fresh air is supplied in response to occupancy levels, maintaining adequate indoor air quality and preventing the build-up of CO2 and other pollutants (Lu et al., 2022).

Enhanced lighting systems have also improved visual comfort by providing adequate illumination levels and reducing glare. The use of daylight harvesting systems ensures that natural light is utilized effectively, creating a pleasant and productive indoor environment. Studies have shown that improved lighting and air quality can enhance occupant satisfaction, productivity, and overall well-being (Yu & Su, 2015).

Overall, the implementation of ECMs at FTKIP has led to a more energy-efficient and environmentally sustainable operation. The positive impact on energy consumption and IEQ highlights the effectiveness of these measures in creating a comfortable, healthy, and energy-conscious indoor environment. The continuous monitoring and optimization of these systems will further enhance their benefits, contributing to the long-term sustainability goals of the institution.