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**ASSESSMENT OF SPATIAL PLANNING CRITERIA
ASSOCIATED WITH INDOOR AIR QUALITY CONSIDERATIONS
IN REFURBISHED KINDERGARTENS WITHIN
SHOP OFFICE SETTINGS**

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Abstract

Indoor air quality (IAQ) plays a role in the health, comfort, and cognitive development of young children. This issue is critical in early childhood education environments. In urban areas, many kindergartens operate in commercial buildings, particularly converted shop office units. However, these buildings often lack spatial planning features that support indoor environments. This study evaluates the compliance level of spatial planning features associated with IAQ-related planning considerations in refurbished kindergarten settings. A quantitative observational case study approach was adopted. The study involved six kindergartens located in refurbished shop office buildings in Selangor, Malaysia. Spatial planning criteria were synthesised from several Malaysian guidelines and standards. These included the Guidelines on the Establishment of Kindergarten and Child Care Centre (2017), Ministry of Education Malaysia Guidelines (2021), Uniform Building By-Laws (1984, Amendment 2021), ICOP IAQ 2010, and MS 1525:2019. The assessment focused on ten key spatial features. These features included floor area per child, window-to-floor ratio, open space provision, natural lighting and ventilation, back-up air-conditioning systems, operable windows, kitchen separation, zoning between clean and wet areas, building orientation, and room depth. Each feature was scored using a structured rubric. The scores were converted into percentages to determine the compliance level for each kindergarten. The compliance scores ranged from 57% to 87%, showing different levels of compliance among the case studies. Common weaknesses included insufficient operable windows, overcrowded classrooms,

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and poor kitchen zoning. The study recommends improving existing guidelines by integrating spatial planning criteria associated with IAQ considerations to support healthier refurbished kindergarten environments.

Keywords: Spatial Planning, Indoor Air Quality, Kindergarten, Refurbished, Shop Office

INTRODUCTION

Spatial planning in kindergarten environments is essential for supporting young children's health, safety, and developmental needs. As early childhood is a formative stage for cognitive, emotional, social, and physical growth, the physical arrangement of space can significantly influence children's learning experiences and overall well-being (Moreira *et al.*, 2023). Well-designed kindergarten environment typically include clearly defined zones for key activities such as learning, play, eating, and resting, while also ensuring smooth circulation and easy supervision. Kindergarten environment also role as a "third teacher," shaping how children interact, explore, and construct meaning through their daily experiences. Therefore, spatial planning in kindergartens must be approached not merely as a functional design task, but as a fundamental component supporting the children's holistic development.

To ensure safe and developmentally appropriate environments, various guidelines and regulations have been established to guide the spatial planning of kindergartens. Key references in Malaysia include the Guidelines for the Establishment, Registration and Operation of Private Kindergartens (Ministry of Education, 2021), Guidelines on the Establishment of Kindergarten and Child Care Centre (2017), and the Uniform Building By-Laws (UBBL) 1984 (Amendment 2021). These documents provide recommendations on the minimum floor area per child, the inclusion of open spaces, natural ventilation and lighting, zoning between clean and wet areas, and the provision of safety measures. Nevertheless, while these guidelines outline important spatial considerations, they often lack emphasis on environmental performance, particularly IAQ.

Spatial planning is typically associated with functional layout and child engagement; at the same time, it plays a significant role in determining IAQ within educational settings (Salleh *et al.*, 2016). Poor spatial decisions such as insufficient window openings, ineffective zoning, high occupant density, and the use of pollutant-emitting materials can result in inadequate ventilation and elevated concentrations of indoor pollutants (Zainudin *et al.*, 2019). This is particularly problematic in kindergartens, where children are more vulnerable to air quality issues due to their developing respiratory systems and longer indoor exposure times. The lack of proper integration of IAQ strategies into spatial

design could cause classrooms and common areas to be confined, poorly ventilated, and uncomfortable. Therefore, spatial planning must also consider environmental quality to ensure that learning environments are not only pedagogically supportive but also health-protective (Zhang *et al.*, 2021).

In Malaysia, the scarcity of affordable urban land has led many kindergarten operators to establish their centres within refurbished shop office units. These buildings were originally designed for commercial rather than educational purposes. While adaptive reuse of these structures offers a cost-effective solution, it also introduces spatial compliance challenges echo the ‘dynamic space formation’ described by Haryanto *et al.* (2020). These settings often lack adequate natural ventilation, appropriate spatial zoning, and compliance with the IAQ guideline. As a result, children in such environments may be exposed to higher levels of indoor air pollutants, as recently highlighted by Zakaria *et al.* (2025).

This study focuses on assessing the extent to which spatial planning features in refurbished kindergartens align with IAQ strategies and regulatory requirements. By evaluating elements such as floor area per child, ventilation provision, room configuration, and functional zoning, the research aims to identify compliance gaps and propose spatial improvements to support healthier indoor environments in non-purpose-built kindergarten settings.

LITERATURE REVIEW

Kindergarten Spatial Planning

In Malaysia, most resources related to kindergartens emphasize the quality of teacher teaching and the scope of the curriculum, while spatial planning receives insufficient attention (Chai & Mohidin, 2021). This is important because children at the kindergarten level are more sensitive to the arrangement of physical space (Matthews & Lippman, 2020). The design of an effective kindergarten environment needs to meet the needs and interests of children, and this can only be achieved through the provision of a quality physical learning environment (Shaari *et al.*, 2016). Therefore, attention to global spatial planning under the manipulation of architectural design features should be the first focus to create an effective learning environment as a fundamental category of the physical learning environment, as shown in Figure 1.

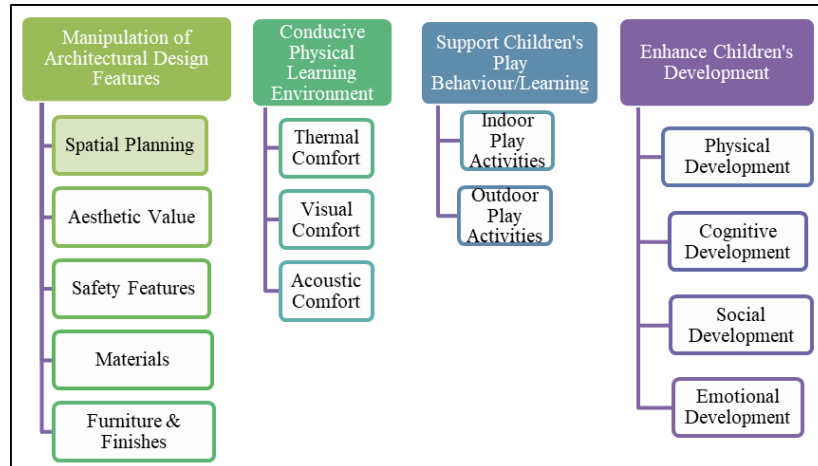


Figure 1: Kindergarten physical environment categories
 Source: Shaari *et al.* (2016)

Activity based zoning is a fundamental principle in architectural design where spaces are organized based on their function, frequency of use, and intensity of activity. In understanding the intricate dynamics of a kindergarten environment, it is essential to consider spatial planning strategies proposed by Stankovic *et al.* (2015), who advocate for segmenting spaces into wet and dry regions, further subdivided into active, quiet, and outdoor zones. Additionally, Sotuku *et al.*, (2016) propose categorizing the space into five distinct areas: entrance, learning area, playing area, kitchen and toilet. These divisions are based on the children's specific activities and learning practices.

Spatial Planning Guidelines for Kindergartens

Various acts and guidelines have been established to ensure the quality of kindergartens in Malaysia. The establishment of kindergartens is governed by a set of Acts and guidelines, including Guidelines on the Establishment of Kindergarten and Child Care Centre (2017), Guidelines for the Establishment, Registration and Operation of Private Kindergartens of the Ministry of Education Malaysia (2021), Uniform Building By-Laws 1984 (Amendment 2021) and Malaysian Standard MS 1525:2019 (on energy efficiency and use of natural ventilation). These regulations aim to facilitate kindergarten setup and building design.

Guidelines on the Establishment of Kindergarten and Child Care Centre (2017)

The Guideline on the Establishment of Kindergarten and Child Care Centre 2017 (*Garis panduan Perancangan dan Penubuhan Tadika dan Taska 2017*) guides local authorities, planners and those considering starting kindergartens or

childcare centres. It also serves as a useful resource for developers, architects and builders in preparing the site and building, as well as for entrepreneurs going through the process of setting up, registering and applying for business licenses for kindergartens and childcare centres (Town and Regional Planning Department, 2017). The components and areas suggested by the guidelines comprise the minimum area for a child, kitchen area, toilet area, staff room area, store area, corridor area, open space/ play area and parking area.

Guidelines for the Establishment, Registration and Operation of Private Kindergartens of the Ministry of Education Malaysia (2021)

The Guidelines for the Establishment, Registration and Operation of Private Kindergartens of the Ministry of Education Malaysia 2021 (Ministry of Education Malaysia, 2021)(*Garis Panduan Penubuhan, Pendaftaran dan Pengoperasian Tadika Swasta Kementerian Pendidikan Malaysia 2021*) are provided to facilitate and provide guidance to Officials in the Private Education Division, State Education Department and District Education Office in matters of establishment, registration, regulation and enforcement. Among applicable sections to be highlighted are Section 4: Premises and location. Kindergarten design should consider aspects of natural lighting and ventilation, especially in new buildings, as stated in the Uniform Building By-Laws, 1984 and the requirements of the Department of Health and the Department of Fire and Rescue Malaysia. For the establishment of kindergartens in complexes or business lots, an indoor play area should be provided to replace the open space, with an approximate allocation area of 50 square meters.

Uniform Building By-Laws 1984 (Amendment 2021)

Kindergarten design must comply with UBBL 1984 (Amendment 2021) and health and fire regulations emphasizing natural lighting and ventilation. By-law 39(3) requires classrooms to have windows covering at least 20% of the floor area for light and air flow. By-law 41 allows air-conditioned spaces but mandates a permanent system with backup ventilation capable of supplying fresh air within 30 minutes of failure. Cooking is limited to electric stoves, while LPG use requires separation per By-law 139. The Seventh Schedule sets the classroom occupant load at 2 persons/m², differing from the 1.4 m² per child specified in kindergarten guidelines.

Malaysian Standard MS 1525:2019 (energy efficiency and use of renewable energy for non-residential buildings)

The Malaysian Standard MS 1525:2019 provides guidelines for energy efficiency and the use of renewable energy in non-residential buildings. In equatorial regions, the code emphasizes the importance of proper building orientation to

maximize energy efficiency. One fundamental principle is to minimize exposure of building openings, such as windows and entrances, to intense sunlight from the east and west directions. Facades with the highest number of openings facing east or west should be avoided to achieve optimal building orientation. In the context of rooms with single windows or single-sided ventilation, the recommendation to keep the effective room depth within 6 meters is crucial for optimizing IAQ. With the limited opening, maintaining a shallow room depth ensures that fresh outdoor air introduced through the single window can effectively reach all parts of the room. Beyond this limit, the efficiency of ventilation diminishes, potentially leading to stagnant air and uneven distribution of airflow.

Indoor Air Quality in Educational Settings

IAQ is a term referring to the air quality in and around buildings, which is related to the health and comfort of building occupants. IAQ is a critical component of environmental health in early childhood facilities, where young children are particularly vulnerable to air pollutants due to their developing respiratory systems and high breathing rates. In this regard, as mentioned in the Industry Code of Practice on Indoor Air Quality (ICOP IAQ, 2010), low IAQ can result from pollutants such as carbon dioxide (CO₂), particulate matter (PM_{2.5}, PM₁₀), total volatile organic compounds (TVOCs), and biological contaminants such as bacteria and fungi. International guidelines from WHO and the U.S. EPA, underscore the significance of ensuring good IAQ in schools (U.S. EPA, 2025; WHO, 2011). WHO describes standardised IAQ monitoring approaches for school settings, while the U.S. EPA provides a dedicated Indoor Air Quality Design Tools for Schools framework. However, equivalent school specific IAQ guidelines are currently not available in Malaysia.

Spatial Planning and Indoor Air Quality

Although spatial planning is traditionally discussed in terms of functional layout, it significantly influences IAQ. Spatial features such as room size, window-to-wall ratio, depth of room, occupancy density, and operable windows directly affect ventilation efficiency and pollutant dispersion. For instance, single-sided ventilation in deep rooms limits airflow, while inadequate zoning between clean and wet areas can increase microbial growth. Moreover, the use of synthetic or non-breathable materials in poorly ventilated classrooms may lead to higher concentrations of VOCs. Research indicates that kindergartens with integrated spatial and environmental strategies such as cross-ventilation, shading, and operable windows demonstrate better IAQ outcomes. This highlights the importance of incorporating IAQ-sensitive design features into spatial planning from the outset.

Adaptive Reuse of Shop Office Buildings for Kindergartens

Shop office units, originally not designed for educational use, often have deep plans, limited windows, and fixed layouts, restricting ventilation, lighting, and zoning flexibility. Studies show that such repurposed spaces frequently fail to meet spatial and IAQ standards, creating unhealthy environments for children (Chai & Mohidin, 2021). Windowless classrooms are common, leading to higher stress hormone levels, reduced focus, and poor health outcomes. The lack of daylight and ventilation also increases dependence on artificial lighting, further compromising visual comfort and air quality (Tan & Majid, 2023).

RESEARCH METHODOLOGY

This study employed a quantitative observation case study approach involving six kindergartens located within refurbished shop office buildings in Selangor, Malaysia (Table 1). The selection of case studies was based on accessibility, consent from operators, and representation of varied spatial layouts (Figure 2). Data collection focused on spatial layout assessment through on-site measurements, architectural plan reviews, and observational audits. The assessment was conducted by the researcher using structured observational checklists during site visits. Key spatial features assessed as depicted in Table 2. Each feature was evaluated using a structured scoring scale to quantify compliance with relevant regulatory and design guidelines. To calculate the compliance score, each spatial feature was assigned a score ranging from 1 to 3 based on its degree of conformity to the benchmark. For borderline conditions, the dominant spatial characteristic and overall functional suitability of the space were considered to ensure consistent interpretation across all case studies.

Table 1: Profile of the Case Studies

Kinder-garten	Storey	Area investigated	Ventilation mode	Year of occupancy
K1	1	3 classes, 1 common area, 1 kitchen	Air-conditioning only	2012
K2	1	2 classes, 1 common area, 1 kitchen	Air-conditioning only	2015
K3	2	3 classes, 1 common area, 1 kitchen	Air-conditioning only	2014
K4	1	2 classes, 1 common area, 1 kitchen	Air-conditioning only	2018
K5	1	1 class, 1 common area, 1 kitchen	Air-conditioning only	2018
K6	2	3 classes, 1 common area, 1 kitchen	Air-conditioning only	2017



Figure 2: Six kindergartens at the shop office building
 Source: Author's own work

Table 2: Spatial Planning Compliance Matrix

Spatial Feature	Source/Status	Scoring scale
1. Minimum floor area per child (1.4 m ²)	Kindergarten guidelines /Mandatory	3 = ≥ 1.4 m ² ; 2 = 1.0–1.39; 1 = < 1.0
2. Minimum 20% of floor area as window opening	UBBL 1984/Mandatory	3 = $\geq 20\%$; 2 = 10–19%; 1 = $< 10\%$
3. Open space/play area (min. 50 m ²)	Kindergarten guidelines /Mandatory	3 = ≥ 50 m ² ; 2 = 30–49 m ² ; 1 = < 30 m ² or none
4. Natural lighting and ventilation consideration	Kindergarten guidelines & UBBL/Recommended	3 = Good daylight & cross-ventilation; 2 = One aspect present; 1 = None present
5. Air-conditioned rooms must have back-up ventilation	UBBL 1984/Mandatory	3 = Dedicated back-up ventilation system (e.g., operable windows or mechanical fans) is fully functional in all air-conditioned rooms

		2 = Partial or passive back-up available (e.g., some operable windows but not in every room) 1 = No backup ventilation system present; fully reliant on air-conditioning
6. Operable window presence and placement	Kindergarten guidelines/ Recommended	3 = All rooms have operable windows; 2 = Some operable; 1 = No operable windows
7. Proper separation of gas stove area	Kindergarten guidelines & UBBL/ Mandatory	3 = Fully separated kitchen with exhaust; 2 = Partially separated; 1 = No separation
8. Zoning between clean and wet areas	Kindergarten guidelines/ Recommended	3 = Zoning present with barriers; 2 = Partial zoning; 1 = No zoning
9. Building orientation to avoid east/west exposure	MS 1525:2019/ Recommended	3 = Not face East/West; 2 = Face East/West with shading; 1 = Face East/West
10. Room depth limit: ≤6 m for single-sided	MS 1525:2019/ Recommended	3 = ≤6 m with window 2 = ≤6 m depth without window 1 = > 6 m

The total score obtained for each kindergarten was then converted into a percentage by dividing it by the maximum possible score and multiplying by 100, as shown in Table 3. Compliance Score (%) = (Total/ Maximum Score) × 100.

Table 3: Compliance score classification

Compliance Category	Score Range (%)	Interpretation
Compliant	80 – 100%	Meets or exceeds most spatial planning guidelines
Moderately Compliant	50 – 79%	Meets some key criteria but has notable gaps
Non-Compliant	< 50%	Fails to meet minimum spatial planning standards

ANALYSIS AND DISCUSSION

The spatial layout assessment showed compliance scores from 57% to 87%. K1, K3, and K4 (>80%) were compliant, reflecting layouts that support good IAQ. K5 (73%), K6 (67%), and K2 (57%) were moderately compliant, with K5 showing minor zoning or ventilation issues, while K6 and K2 had significant weaknesses needing improvement as in Table 3.

Room Size per Child

Most kindergartens (K1, K2, K3, K5, K6) scored 2, indicating moderately acceptable space per child, while K4 scored 3, reflecting spacious classrooms that enhance air dilution and comfort. Smaller rooms with higher occupant density

elevate CO₂ levels and limit air circulation. As 91.1% of classrooms house over 15–20 children, maintaining at least 2 m² per child (Manuel *et al.*, 2021). is essential. Moderately compliant centres should reduce class size, reconfigure layouts, or adopt space-saving, multipurpose furniture to optimize usable area.

Window Placement and Size

Many classrooms also fall below the 20% window-to-floor ratio, causing stale air and high CO₂ levels. K3 and K4 scored 3 for excellent window design, K1 and K6 scored 2 for moderate performance, while K2 and K5 scored 1, indicating critically poor fenestration (<10% window area). To improve air quality in windowless rooms, installing exhaust and supply fans on opposite ends or near the ceiling is recommended (Department of Occupational Safety and Health, Ministry of Human Resources, 2010). Limiting class size in enclosed spaces can further reduce CO₂ build-up and enhance comfort.

Zoning of Kitchen

The assessment of gas stove separation and zoning shows mixed compliance. K3 and K5 scored 3, indicating well-separated kitchens and clear zoning that minimize pollutant spread. K4 scored 1, showing poor separation and zoning, allowing cooking emissions to affect nearby classrooms (Zainudin *et al.*, 2019). To improve, physical barriers or door seals should be added between wet and clean areas, with independent exhaust systems for kitchens and toilets. Future layouts should include isolated service cores to enhance IAQ and hygiene.

Building Orientation

All kindergartens use air-conditioning, but five scored 3 for favourable orientation, minimizing east–west exposure and reducing heat gain. K6 scored 1 due to east–west orientation without shading, causing higher indoor temperatures and energy use. East–west façades increase heat and glare while north–south orientations maintain stable temperatures. Spatial constraints in refurbished units often lead to design compromises that affect IAQ and comfort.

Common Area Configuration

All kindergartens except K2 and K6 scored well in providing common areas, indicating sufficient space for shared activities. In contrast, the lack of such space in K2 and K6 likely forces multiple activities into classrooms, increasing occupancy levels and contributing to higher CO₂ concentrations, especially when classrooms double as dining or sleeping areas.

Table 4: Comparative analysis by spatial-IAQ features

Kinder- garden	Floor area per child (≥ 1.4 m ² /child) ^a	Min.20% of floor area as window opening ^b	Open space/Play area (≥50 m ²) ^c	Natural lighting and ventilation consideration ^a	Air- conditioned rooms must have backup ventilation ^b	Operable window presence and placement ^a	Proper separation of gas stove area ^{a,b}	Zoning between clean and wet areas ^c	Building orientation to avoid east/west exposure ^c	Room depth limit: ≤6 m for single- sided ^f	Total score	% Comply	Compliance level
K1	2	2	3	2	2	2	2	3	3	3	25/30	83	Compliant
K2	2	1	2	2	1	1	2	2	3	2	17/30	57	Moderately Compliant
K3	2	2	3	3	3	3	3	3	3	1	26/30	87	Compliant
K4	3	3	3	2	3	3	1	1	3	3	25/30	83	Compliant
K5	2	1	3	2	2	1	3	3	3	2	22/30	73	Moderately Compliant
K6	2	2	2	2	2	2	2	3	1	2	20/30	67	Moderately Compliant

^a Guidelines on the Establishment of Kindergartens and Child Care Centres (2017), Guidelines for the Establishment, Registration and Operation of Private Kindergartens of the Ministry of Education Malaysia (2021)
^b Uniform Building By-Laws 1984 (Amendment 2021)
^c Malaysian Standard MS 1522:2018 (energy efficiency and use of renewable energy for non-residential buildings)

FUTURE RESEARCH

Future research should develop a standardized spatial layout model for kindergartens in shop offices by comparing existing plans to identify layouts that enhance IAQ, space efficiency, and safety. The model should define minimum spatial standards, integrate IAQ-sensitive design aligned with UBBL 1984, MS 1525:2019, and ICOP IAQ 2010. The model can be validated through post occupation evaluation (POE) and IAQ monitoring. The Spatial Planning Compliance Matrix introduced in this study evaluates spatial and architectural design inputs affecting IAQ, complementing the Green Building Index (GBI), which focuses on performance outcomes and certification. Furthermore, IAQ is also closely interconnected with human-related factors (Nurwidyaningrum *et al.*, 2022). Assessing elements such as knowledge, attitudes and practices of occupants significantly shape overall IAQ outcomes.

CONCLUSION

The total compliance scores across the six kindergartens range from 57% to 87%, demonstrated varying levels of compliance with spatial planning criteria associated with IAQ considerations. Common shortcomings included insufficient operable windows, overcrowded classrooms, and poor zoning of the kitchen. These findings highlight the need to strengthen the integration of IAQ-related spatial planning considerations within existing guidelines to support healthier and more effective learning environments from the planning stage.

ETHICAL APPROVAL

This study received ethical approval from Universiti Malaya Research Ethics Committee (UMREC) under the reference number UM. TNC2/UMREC_1594.

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REFERENCES

- Chai, M. Y., & Mohidin, H. H. B. (2021). Comparative Study on Lighting and Ventilation of Two Kindergarten Typologies in Selangor. *Journal of Building Performance*, 12(1), 2021. <http://spaj.ukm.my/jsb/index.php/jbp/index>
- Department of Occupational Safety and Health Ministry of Human Resources. (2010). *Industry Code of Practice on Indoor Air Quality 2010*.
- Haryanto, R., Indriastjario, Saidah, K., & Sugiri, A. (2020). The transformation from residential to commercial space towards dynamic space. *Journal of the Malaysian*

- Institute of Planners*, 18(4), 287–298.
- Manuel, P., Jo, L., Jo, V., Ana, I., & Tiago, F. (2021). Kindergartens and nurseries in central portugal . assessments of indoor environment quality. *International Journal of Building Technology and Urban Development*, 12(1), 27–43.
- Matthews, E., & Lippman, P. C. (2020). Physical and Spatial Organization of Early Childhood Classrooms. In M. Peters & R. Heraud (Eds.), *Encyclopedia of Educational Innovation*. Springer, Singapore. https://doi.org/10.1007/978-981-13-2262-4_192-1
- Ministry of Education Malaysia. (2021). *Guidelines for the establishment, registration and operation of private kindergartens*. <https://www.mygp.gov.my/garis-panduan-penubuhan-pendaftaran-dan-pengoperasian-tadika-swasta-kementerian-pendidikan-malaysia>
- Moreira, M., Veiga, G., Lopes, F., Hales, D., Luz, C., & Cordovil, R. (2023). Kindergarten Affordances for Physical Activity and Preschoolers' Motor and Social-Emotional Competence. *Children*, 10(2), 1–13. <https://doi.org/10.3390/children10020214>
- Nurwidyaningrum, D., Kusnoputranto, H., Moersidik, S. S., & Masfuri. (2022). A human dimension model for the urban vertical housing sustainability through indoor air. *Journal of the Malaysian Institute of Planners*, 20(2), 110–121.
- Salleh, N. M., Esa, M., Kamaruzzaman, S. N., Mahyuddin, N., & Darus, F. M. (2016). Barrier of Ventilation Modes to Achieve A Balance Environment In Refurbished Preschools. *Jurnal Teknologi*, 5, 261–270.
- Shaari, M. F., Sh. Ahmad, S., & Ismail, I. S. (2016). Nurturing Environmental Stewards through Preschool Physical Design. *Environment-Behaviour Proceedings Journal*, 1(3), 3. <https://doi.org/10.21834/e-bpj.v1i3.343>
- Sotuku, N., Okeke, C. I. O., & Mathwasa, J. (2016). Early Childhood Provisioning for Children Between 3 and 5 Years Within Rural Eastern Cape Communities : The Untold Stories of the Physical Environment. *Journal of Human Ecology*, 9274, 24–34. <https://doi.org/10.1080/09709274.2016.11906983>
- Stankovic, D., Tanic, M., Kostic, A., Vrecic, S., Kekovic, A., Cekic, N., Nikolic, V., & Vrecic, S. (2015). Resurgence of indoor environment of preschool building. *Procedia Engineering*, 117(1), 742–755. <https://doi.org/10.1016/j.proeng.2015.08.203>
- Tan, H. P., & Majid, R. A. (2023). Preferences and Satisfaction of Artificial Lighting in Malaysian Shop Office. *Malaysian Journal of Sustainable Environment*, August. <https://doi.org/10.24191/myse.v10i2.23633>
- Town and Reginal Planning Department. (2017). *Guideline on the Establishment of Kindergarten and Child Care Centre*. <https://www.mygp.gov.my/garis-panduan-perancangan-dan-penubuhan-tadika-dan-taska-2017>
- U.S. EPA. (2025). *Indoor Air Quality Design Tools for Schools*. <https://www.epa.gov/iaq-schools/indoor-air-quality-design-tools-schools>
- Uniform Building By-Laws 1984 (Amendment 2021), (2021).
- WHO. (2011). *Methods for monitoring indoor air quality in schools Methods for monitoring indoor air quality in schools* (Issue April). <https://iris.who.int/server/api/core/bitstreams/594e71c8-403a-402e-a30b-828f75837de7/content>

- Zainudin, M. A., Jalaludin, J., Jalaludin, J., Sopian, N. A., Jalaludin, J., & Sopian, N. A. (2019). Indoor Air Quality (IAQ) in Preschools and Its Association with Respiratory Inflammation among Pre-schoolers. *Malaysian Journal of Medicine and Health Sciences*, 15(4), 12–18.
- Zakaria, I. B., Mahyuddin, N., & Mohd-Sahabuddin, M. F. (2025). Change of Use Challenges: Unveiling Indoor Air Quality in Converted Kindergarten Buildings. *International Journal of Environmental Research*, 19(3), 89. <https://doi.org/10.1007/s41742-025-00756-0>
- Zhang, S., Mumovic, D., Stamp, S., Curran, K., & Cooper, E. (2021). What do we know about indoor air quality of nurseries? A review of the literature. *Building Services Engineering Research and Technology*, 42(5), 603–632. <https://doi.org/10.1177/01436244211009829>

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