



PLANNING MALAYSIA:

Journal of the Malaysian Institute of Planners

VOLUME 24 ISSUE 4 (2026), Page 790 – 805

HOW INDOOR ENVIRONMENTAL QUALITY AFFECTS RESIDENTIAL SATISFACTION BY CONSIDERING THE ROLE OF LIFE STRESS AND GENDER

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Abstract

Residential satisfaction, defined as individuals' evaluative responses to their living environments, is shaped by the interaction between physical environmental quality and psychological well-being. Although Indoor Environmental Quality (IEQ) has been widely studied in relation to residential comfort, the psychological mechanisms linking IEQ to satisfaction remain insufficiently understood. In particular, the role of life stress as a mediating or moderating factor has received limited empirical attention. Guided by Stimulus–Organism–Response (SOR) theory, this study examines how key IEQ dimensions—air quality, visual comfort, and acoustic comfort—influence residential satisfaction among working-age residents in high-rise apartment complexes, and whether these relationships are mediated by life stress and moderated by gender. A structured questionnaire survey was conducted with 454 residents of the Shengda Jingdu Apartment Complex in Haikou, China. Structural equation modelling (SEM) indicates that IEQ significantly predicts residential satisfaction both directly and indirectly through life stress. Furthermore, gender moderates these effects, with male residents deriving stronger life stress reducing benefits from IEQ. These results suggest that residential design should integrate environmental quality improvement with psychological well-being considerations to foster healthier and more satisfying indoor living environments.

Keywords: Indoor Environmental Quality, Life Stress, Residential Satisfaction, Apartment Complexes

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INTRODUCTION

In recent years, the indoor environment has been widely recognized as a critical determinant of residential satisfaction, particularly in high-density urban contexts where living conditions exert substantial influences on individuals' mental health and subjective well-being (Zhang & Yan, 2023). The World Health Organization (2022) emphasizes that indoor air quality, thermal comfort, acoustic conditions, and lighting constitute key environmental factors shaping quality of life. With the rapid advancement of urbanization in China and the continuous increase in residential density, the role of Indoor Environmental Quality (IEQ) in enhancing residential satisfaction has attracted growing scholarly attention (Bangwal et al., 2023; Xue et al., 2016). Existing studies further demonstrate that improvements in IEQ not only enhance perceived comfort but also foster positive emotional experiences and favourable behavioural responses (Xu & Zhang, 2024). Urban office workers in high-density housing commonly experience high stress and anxiety due to frequent work-home mobility, making residential spaces key settings for psychological restoration (Chan et al., 2021). Accordingly, examining how residential environments influence psychological states and residential satisfaction is both theoretically and practically significant for housing optimization (F. Chen et al., 2023).

Despite growing interest in IEQ, two challenges remain. First, although technical studies show that optimal temperature and air velocity can improve satisfaction and energy efficiency (Rajput & Thomas, 2025), the psychological mechanisms linking IEQ to residential satisfaction remain unclear. Second, environmental psychology suggests that life stress may mediate the IEQ-satisfaction relationship. Bagais and Pati (2023) argue that indoor environments influence emotional regulation, while Bonanno (2004) notes that life stress affects how individuals process environmental stimuli. However, few studies have empirically tested life stress as a mediating or moderating factor between IEQ and residential satisfaction. Accordingly, this study examines both its mediating and moderating roles. Thirdly, gender differences also shape environmental perception. Men and women differ in sensory sensitivity and evaluative criteria (Hendy, 2015), and women are more likely to report dissatisfaction with residential conditions (Mridha, 2020), although gender effects across IEQ dimensions remain inconsistent (Psomas et al., 2024).

To address these gaps, this study adopts Stimulus-Organism-Response (SOR) theory, which conceptualises IEQ as an external stimulus influencing internal states (life stress) and behavioural outcomes (residential satisfaction). The objectives are to: (1) examine the effects of multiple IEQ dimensions on residential satisfaction; (2) test the mediating role of life stress; and (3) explore the moderating roles of gender difference. Data were collected from working-age residents in Shengda Jingdu Apartment Complex, Haikou, China. The findings

contribute to environmental psychology by clarifying psychological pathways linking IEQ and residential satisfaction and offer implications for personalised and health-oriented interior design in rapidly urbanising contexts.

LITERATURE REVIEW

SOR Theory

The SOR model explains how environmental stimuli (S) shape internal cognitive or emotional states (O) and behavioural responses (R) (Mehrabian & Russell, 1974) and has been widely applied to examine links between environmental quality, psychological well-being, and satisfaction (F. Y. Wong et al., 2018; Zhou et al., 2021). In residential contexts, IEQ—comprising indoor air quality, visual comfort, and acoustic comfort (Y. Chen et al., 2023; Lai et al., 2009)—affects home experiences and mental health (Dreyer et al., 2018; Guo et al., 2024), with life stress acting as a key organismic mechanism linking IEQ to residential satisfaction (H. Tang et al., 2020; Xiaoxue & Huang, 2024), which represents the response component (Fernández-Portero et al., 2017; Xu & Zhang, 2024); accordingly, this study adopts the SOR framework to test IEQ–satisfaction pathways and gender differences (Goi et al., 2018; Hew et al., 2018).

IEQ and Residential Satisfaction

IEQ is a key determinant of residential satisfaction and occupant comfort, particularly in mid- to high-rise housing (H. Tang et al., 2020), and strongly affects physical health, psychological well-being, and quality of life. It is commonly defined by three interrelated dimensions—indoor air quality, luminous comfort, and acoustic comfort—which shape environmental adequacy and health-supportive housing (Dimitroulopoulou et al., 2023; Ma et al., 2021). Empirical studies show that IEQ and indoor greening enhance residential satisfaction and performance, with air quality exerting the strongest influence, followed by luminous and acoustic comfort (Xu & Zhang, 2024); however, the psychological effects of IEQ on working adults in high-rise apartments remain insufficiently examined, raising uncertainty about whether IEQ improvements enhance psychological perceptions and residential satisfaction in this group. Based on this premise, the following hypothesis is proposed:

H1: IEQ positively affects the residential satisfaction of apartment users.

The Role of Life Stress

Previous studies indicate that improved IEQ can reduce life stress (Thach et al., 2020). High noise levels increase tension and life stress, whereas better acoustic conditions enhance cognitive performance and psychological well-being (Lu & Kwan, 2025), and perceptions of indoor air quality and acoustic comfort are key

predictors of life stress symptoms (Awada et al., 2021). Life stress is therefore closely linked to higher residential satisfaction (Fornara et al., 2022), and individuals with greater life satisfaction show lower life stress reactivity over time (K. N. S. Tang & Chan, 2017). Although the life stress-mitigating role of IEQ has been acknowledged, its specific function in alleviating worry and its mediating role between IEQ and residential satisfaction remain underexplored, particularly among working residents in high-rise buildings. Accordingly, the following hypotheses are proposed:

H2: IEQ positively affects the life stress of apartment users.

H3: Life stress positively affects the residential satisfaction of apartment users.

H4: Life stress mediates the relationship between IEQ and residential satisfaction.

Demographic Differences: Gender

Gender differences in IEQ perception, especially regarding thermal comfort, are well established (Kim et al., 2013), with women showing greater sensitivity to low temperatures and distinct optimal comfort ranges (Hu et al., 2022). Given inconsistent findings across contexts, this study examines whether gender moderates the IEQ–residential satisfaction relationship and its underlying life stress.

H5: Associations between study variables differ by gender.

Figure 1 illustrates the proposed conceptual model, which examines the relationships among apartment complexes, IEQ, life stress, and residential satisfaction, while accounting for the moderating effects of gender.

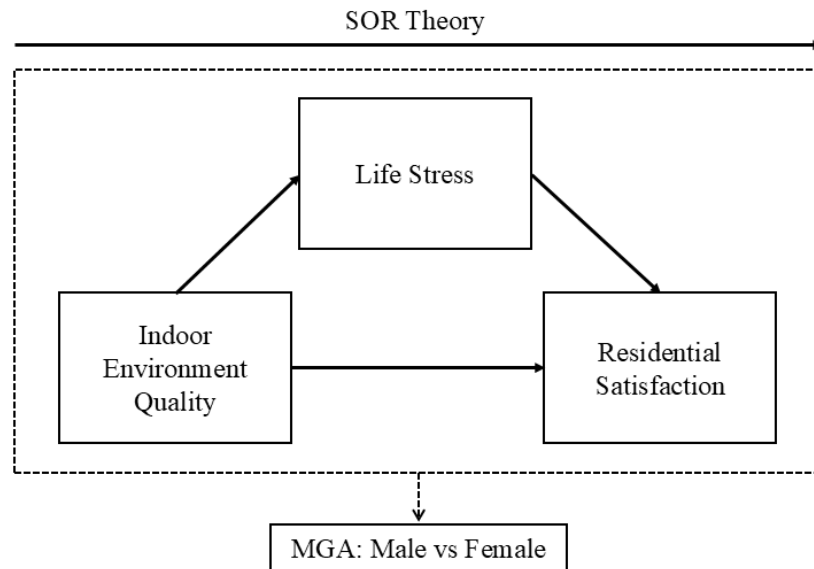


Figure 1: The Conceptual Pathway Between the Study Variables
 Source: Author's Calculation

RESEARCH METHODOLOGY

Site Selection

Under Hainan's Free Trade Port strategy and the "Million Talents Recruitment Plan" (2018–2025), large numbers of young, highly educated professionals have relocated to the province, many experiencing relocation-related life stress and residential maladaptation (Stawarz et al., 2022). This study therefore targets the working-age population most vulnerable to such anxiety, examining how Indoor Environmental Quality (IEQ) influences life stress and residential satisfaction, with implications for talent retention and sustainable urban development. Haikou's tropical marine climate and rich ecological context further provide an appropriate setting to investigate the psychological effects of IEQ and the potential value of biophilic interior design in urban housing.

The empirical study was conducted at the Shengda Jingdu Residential Apartment Complex in Meilan District, Haikou City (Figures 2), which comprises three development phases with 976 households and approximately 2,437 residents, mainly young and middle-aged working adults. A stratified sampling strategy was employed by treating each phase as a stratum, and questionnaires were proportionally distributed and collected across the three phases, yielding 454 valid responses for quantitative analysis.

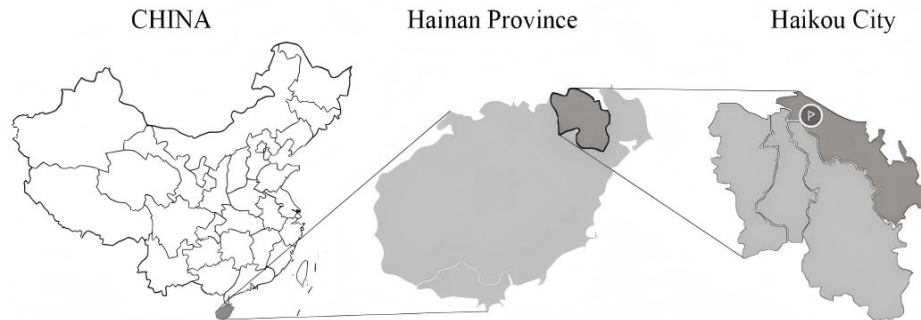


Figure 2: Location of Meilan District within Haikou City, Hainan Province, China
Source: Authors' elaboration based on Google Maps (2026)

Participants

Young working adults (≤ 35) are highly vulnerable to stress, depression, and burnout due to adverse work conditions (Baek & Yoon, 2024; Law et al., 2020), yet prior research has focused mainly on workplaces, overlooking the restorative role of residential environments (C. H. Wong & Abdul Aziz, 2020). Given elevated work–family conflict among adults aged 35–44 (Pien et al., 2020), this study targeted residents aged 18–40 and examined how interior design features, especially colour and light, contribute to life stress and residential satisfaction.

Data were collected via face-to-face questionnaires in Shengda Jingdu Residential Complex (September–November 2024). A total of 454 valid responses were analysed. The sample consisted mainly of females (68.3%) and Chinese nationals (96.3%), and was restricted to working-age adults aged 18–40 years, with the largest proportion aged 26–30 (43.2%). Most respondents had tertiary education (88.5%), were married (61.5%), and had children (54.8%). Household income was broadly distributed across income groups, with the largest share earning RMB 4,001–7,000 per month (40.3%), and residential tenure in the complex was relatively balanced, ranging from less than 3 years (17.0%) to more than 16 years (19.2%).

Survey Instrument

A structured questionnaire was used to examine the relationships among IEQ features, life stress and residential satisfaction (Table 1). It consisted of two sections: the first collected sociodemographic information (gender, age, education, nationality, marital status, parental status, income, and residential tenure), and the second measured the core constructs. IEQ was assessed through three validated dimensions—air quality, visual comfort, and acoustic comfort—using items adapted from prior studies (Jain & Bhandari, 2024; Larsen et al., 2020). Life stress and residential satisfaction were measured using established

scales (Shahid et al., 2011; Wang et al., 2024). All items were rated on a five-point Likert scale (1 = extremely unsatisfied, 5 = extremely satisfied).

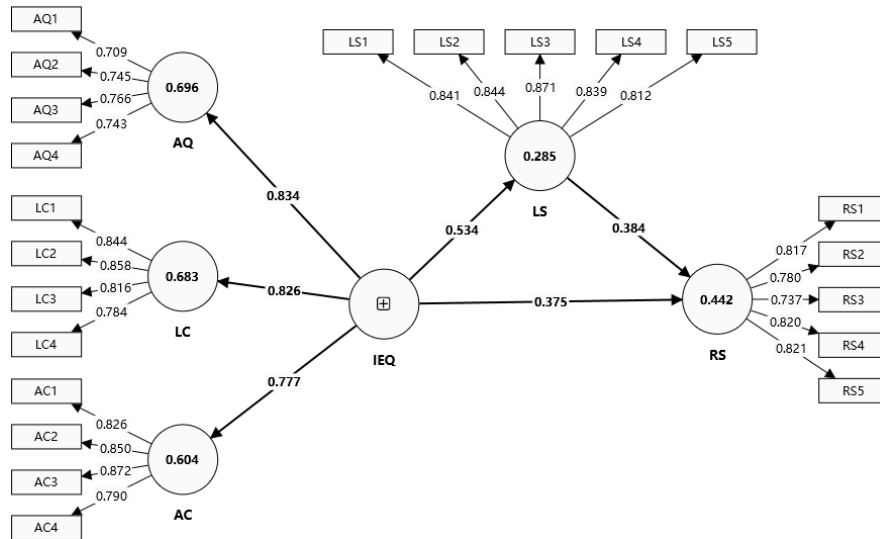
Analytical Techniques

Given that the primary aim of this study is exploratory rather than focused on theoretical model development, an empirical analytical strategy was adopted to investigate both the direct and indirect effects of IEQ on residential satisfaction within apartment complexes. Structural Equation Modelling (SEM) was employed to test and validate the hypothesized relationships among the latent constructs. To further explore potential subgroup differences, a Multiple Group Analysis (MGA) was conducted to examine gender-based moderation effects, assessing whether the structural pathways differ significantly between male and female respondents.

RESULTS

Measurement Model Results

The reliability and validity of the constructs were assessed using statistical indices generated by SmartPLS based on the proposed measurement model. As shown in Table 2, all factor loadings (0.709–0.872) exceeded 0.708, indicating satisfactory indicator reliability (Hair et al., 2021). Cronbach's alpha (0.726–0.897) and composite reliability (0.830–0.924) both surpassed 0.70, confirming internal consistency. Convergent validity was supported by AVE values ranging from 0.549 to 0.708, all above the 0.50 threshold (Hair et al., 2021). Discriminant validity was established as HTMT values were below 0.85 and the square root of each construct's AVE exceeded its inter-construct correlations (Table 3), satisfying the Fornell–Larcker criterion (Hair et al., 2021). Overall, the measurement model demonstrated adequate reliability and validity, as illustrated by the parameter estimates of the PLS analysis in Figure 3.



Source: Author's Calculation

Figure 3: Parameter estimates of the PLS analysis

Table 2. Reliability and Convergent Validity Results

Variable	Item	Factor loadings	Cronbach's alpha	CR	AVE
AQ	AQ1	0.709	0.726	0.830	0.549
	AQ2	0.745			
	AQ3	0.766			
	AQ4	0.743			
LC	LC1	0.844	0.844	0.896	0.682
	LC2	0.858			
	LC3	0.816			
	LC4	0.784			
AC	AC1	0.826	0.855	0.902	0.698
	AC2	0.850			
	AC3	0.872			
	AC4	0.790			
LS	LS1	0.841	0.897	0.924	0.708
	LS2	0.844			
	LS3	0.871			
	LS4	0.839			
	LS5	0.812			
RS	RS1	0.817	0.855	0.896	0.633
	RS2	0.780			
	RS3	0.737			
	RS4	0.820			
	RS5	0.821			

Source: Author's Calculation

Table 3. Results of HTMT Ratios

	AC	AQ	LC	LS	RS
AC					
AQ	0.608				
LC	0.471	0.755			
LS	0.54	0.528	0.457		
RS	0.477	0.697	0.541	0.664	

Source: Author's Calculation

Following Hair et al. (2021), the R^2 value for residential satisfaction (RS) was 0.274, indicating modest but meaningful explanatory power without evidence of overfitting. All Q^2 values exceeded zero, confirming adequate predictive relevance of the PLS model (Hair et al., 2021), and the GoF index surpassed the conservative threshold of 0.462, suggesting a strong overall model fit (Hedayati Marzbali et al., 2016). Moreover, consistent with Shmueli et al. (2019), the PLS model outperformed the linear model in predictive accuracy, as indicated by lower prediction errors, demonstrating the robustness of the structural relationships among IEQ, life stress, and residential satisfaction.

Table 4. Coefficient of determination and predictive relevance and GOF of model calculation

	Items	PLS- SEM RMSE	LM RMSE	Q2	R2	AVE	GOF
IEQ (second order)	-	-	-	-	-	0.422	
LS	LS1	1.056	1.062	0.199	0.285	0.708	0.462
	LS2	1.048	1.070				
	LS3	1.007	1.020				
	LS4	1.001	1.024				
	LS5	0.982	0.999				
RS	RS1	0.802	0.809	0.274	0.442	0.633	
	RS2	0.761	0.763				
	RS3	1.034	1.046				
	RS4	0.819	0.830				
	RS5	0.887	0.896				

Source: Author's Calculation

Structural Model Results

As shown in Table 5, the structural model was evaluated following the PLS-SEM mediation guidelines of Hair Jr et al. (2021). IEQ is positively associated with Residential Satisfaction (H1: $\beta = 0.375$, $p < 0.01$) and life stress (H2: $\beta = 0.534$, $p < 0.01$), while life stress is also positively related to Residential Satisfaction (H3: $\beta = 0.384$, $p < 0.01$). A significant mediating effect of LS on the IEQ–RS relationship was confirmed (H4: $\beta = 0.205$, $p < 0.01$). Effect size (f^2) values met

the criteria proposed by Chin (1998), indicating meaningful explanatory power, and all VIF values were below 3.0, suggesting no multicollinearity concerns.

Table 5. Results of Path Coefficient and Hypothesis Testing
(Direct and Indirect Effects)

H	Relationship	β	T	P	f ²	VIF	Decision
H1	IEQ -> RS	0.375	7.203	0** *	0.181 (moderate)	1.398	Support
H2	IEQ -> LS	0.534	12.63 8	0** *	0.398 (substantial)	1.000	Support
H3	LS -> RS	0.384	6.528	0** *	0.189 (moderate)	1.398	Support
H4	IEQ -> LS -> RS	0.205	6.412	0** *	-	-	Support

Source: Author's Calculation

MGA

MGA was conducted to test whether structural relationships differed across gender groups using non-parametric percentile bootstrapping and Henseler's MGA (Table 6). Prior to MGA, measurement invariance was verified via the MICOM procedure in SmartPLS 4.0, confirming partial invariance and the validity of cross-group comparisons (Barroso et al., 2018; Henseler et al., 2009). Significant gender differences were found in the direct effect of IEQ on LS (H1a: $P(\text{MGA}) < 0.05$; Table 7).

Table 7. Comparison of model relationships by the two groups using
Henseler's MGA test

Relationship Multi-Group: Gender	β Female	P	β Male	P	PLS- MGA	Supported
IEQ -> LS	0.484	0***	0.644	0***	0.044	Yes/Yes

Source: Author's Calculation

DISCUSSIONS

This study extends the SOR framework by introducing life stress as a mediating mechanism and demonstrates that multidimensional IEQ significantly influences residential satisfaction, confirming that environmental stimuli shape internal emotional states and behavioural outcomes (Chang et al., 2024; Zhou et al., 2021). Consistent with evidence on air quality, luminous comfort, and acoustic comfort, favourable IEQ reduces discomfort and enhances perceived environmental control (Jara-Baeza et al., 2023; Vakalis et al., 2019) and indirectly improves residential satisfaction through life stress (H. Tang et al., 2020; Yin et al., 2020). By applying a comprehensive IEQ framework, this study

reinforces the role of physical surroundings in shaping quality of life (Y. Chen et al., 2023; Mujan et al., 2019). Multi-group analysis further reveals gender differences, with men deriving greater life stress benefits from high IEQ, highlighting gender as a moderator and implying the value of gender-responsive design (Foye, 2017; Indraganti & Humphreys, 2021).

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

This study advances theory by extending the SOR model to incorporate life stress as a key psychological mechanism linking IEQ and residential satisfaction, thereby integrating emotional resilience and psychological restoration into environmental–behaviour research (Huang et al., 2025). It further contributes by adopting a multidimensional IEQ framework (acoustic, visual, thermal, and air quality), addressing the lack of integrated assessment in prior studies (F. Chen et al., 2023; Mujan et al., 2019), and by identifying gender as a moderator of stimulus–organism processes, highlighting socio-psychological differences in environmental perception (Albuainain et al., 2021). Practically, the findings support holistic residential design that enhances air quality, luminous comfort, and acoustic comfort (Jara-Baeza et al., 2023) and promote strategies such as smart ventilation, daylight optimisation, quiet zones, and biophilic features to reduce psychological stress (Beemer et al., 2021), while underscoring the need for flexible and inclusive design responsive to gender differences (Indraganti & Humphreys, 2021). Given the gender-moderated findings, residential interiors should provide flexible and user-adjustable IEQ solutions, such as dimmable lighting, controllable ventilation, acoustic zoning, and privacy regulation (Fissore et al., 2023). These strategies can help accommodate gender-related differences in comfort perception and support more inclusive, restorative, and resident-centred housing design (Andreucci et al., 2021). These IEQ-based recommendations also align with the policy direction of Malaysia’s UBBL and relevant Chinese residential standards, which emphasise adequate ventilation, daylighting, acoustic comfort, and healthy indoor living conditions (Deng et al., 2024; Mewomo et al., 2023).

This study is limited by its single-city sample in Haikou, focus on working adults, reliance on self-reported measures, and cross-sectional design, which restrict generalizability and causal inference. Future research should adopt more diverse samples, longitudinal or experimental designs, and objective indicators of environmental quality and psychological well-being.

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Received: 30th January 2026. Accepted: 14th April 2026