



PLANNING MALAYSIA:

Journal of the Malaysian Institute of Planners

VOLUME 24 ISSUE 4 (2026), Page 130 – 146

THE IMPACT OF SPATIAL FACTORS ON STUDENTS' PERCEIVED RESTORATION IN CAMPUS TRANSITIONAL SPACES

Yizhi Shu¹, Massoomeh Hedayati Marzbali², Zongai Song³

*^{1,2}School of Housing, Building and Planning,
UNIVERSITI SAINS MALAYSIA*

*^{1,3}School of Fine Arts and Art Design,
HUNAN UNIVERSITY OF SCIENCE AND ENGINEERING*

Abstract

University academic buildings contain extensive transitional spaces such as corridors, entrance halls, and terraces that students use daily between classes. However, how the spatial conditions of these everyday environments are associated with students' perceived restoration remains insufficiently understood. Drawing on Attention Restoration Theory (ART), this study develops and tests a conceptual model linking spatial factors, student preferences, and perceived restoration in academic building transitional spaces. A questionnaire survey was conducted among undergraduate students at Hunan University of Science and Engineering (HUSE), a comprehensive public university in Hunan Province, China, capturing their evaluations of key spatial conditions and activity-related preferences across different transitional space types. Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to examine the proposed direct and indirect associations. The results indicate that supportive spatial conditions are positively associated with students' perceived restoration, with this relationship partially mediated by preferences for using transitional spaces for informal learning and social interaction. Spatial attributes related to legibility and accessibility, short-stay usability (including layout and furniture), and basic study-support facilities emerge as particularly important. This study extends ART to routine academic building contexts and offers design implications for supporting students' everyday restorative experiences.

Keywords: Campus transitional spaces; Spatial factors; Perceived restoration; Student preferences

² Corresponding author. Email: hedayati@usm.my

INTRODUCTION

University students increasingly experience sustained psychological strain and attention fatigue amid academic demands and continuous task switching (An et al., 2025; Pérez-Jorge et al., 2025). A large body of restoration research indicates that exposure to natural cues and restorative environments is associated with attention restoration, lower mental fatigue, and concentration and emotional regulation (Ahmad et al., 2025; Wen et al., 2025). Yet, many students spend substantial time in academic buildings during a typical study day, which may limit their opportunities for prolonged contact with nature (Makaremi et al., 2024). In this context, transitional spaces in academic buildings—such as corridors, terraces, and entrance halls—form an interface between indoor learning settings and the outdoor environment, and may provide opportunities for brief, everyday exposure to restorative cues (Bell et al., 2025). Accordingly, understanding how spatial factors in academic building transitional spaces relate to students' perceived restoration is of both practical and theoretical importance.

Despite growing interest in restorative campus environments, current evidence largely concentrates on campus landscapes, and much less is known about how restorative mechanisms operate in everyday academic building transitional spaces (Aghabozorgi et al., 2024; Xu et al., 2024). From an ART perspective, restorative experience is commonly linked to exposure to natural or nature-related cues; in academic building transitional spaces, such cues may be encountered through outside visibility, openness, and less effortful spatial use (Rhee et al., 2023). It is also unclear whether students' activity preferences across transitional space types play an indirect role in the association between spatial factors and perceived restoration.

These issues are also relevant in Chinese higher education, where academic buildings are intensively used and transitional spaces function as high-frequency settings for short breaks, circulation, and informal stays (Lu et al., 2026; Ou et al., 2025). Recent evidence also suggests that campus environments may be associated with stronger restorative experience compared with other common daily activity settings, underscoring the value of examining restorative experience within university premises (Zhu et al., 2026). However, transitional spaces in many Chinese academic buildings are still often organised primarily for circulation (Li et al., 2025), underscoring the need to identify which spatial factors most strongly associated with students' perceived restoration.

This study develops and tests an ART-informed model linking spatial factors, student preferences, and perceived restoration in university academic building transitional spaces. PLS-SEM examines direct and indirect associations. The findings contribute to restorative-environment research in everyday academic-building settings and offer design considerations for supporting students' perceived restoration.

LITERATURE REVIEW

In this study, transitional spaces refer to the in-between areas within a university academic building (e.g., corridors, terraces, and entrance halls) that are used for circulation and short informal stays between classes (Hou et al., 2024; Pitts & Saleh, 2006). Consistent with typology-based approaches in campus space research, four transitional space types (Type I–IV), illustrated in Figure 2, were identified in the study setting and used as anchors for measuring students' activity preferences (Jiao et al., 2023).

Spatial Factors in Campus Transitional Spaces

In this study, spatial factors refer to perceived conditions in academic building transitional spaces, including outside visibility, furniture provision, space layout, Wi-Fi connection, power-point availability, and visibility/ease of access (Alnusairat et al., 2021; Lei Peng et al., 2022; Salih et al., 2024). Here, outside visibility refers to visual connection to the outdoors, visibility/ease of access to how easily the space is found and entered, and space layout to how circulation and short stays are supported.

These spatial factors were selected as salient, actionable conditions associated with students' brief use of academic building transitional spaces, providing a parsimonious basis for examining associations with preferences and perceived restoration.

Student Preference across Transitional Space Types

In this study, student preference reflect students' evaluative inclination (approach tendency) to choose and use transitional spaces for specific non-classroom purposes (Ramu, 2022; Wu et al., 2021). It is conceptualised with reference to two common activity domains in transitional settings: informal learning (e.g., brief individual study, reading, checking course materials) and social activities (e.g., short conversations, meeting peers, informal interaction) (Wu et al., 2020). Prior research indicates that beyond circulation, informal learning and social interaction are among the most commonly reported activity domains in university transitional/in-between spaces (Valtonen et al., 2020).

Accordingly, student preferences measure activity-specific preferences across four transitional space types (Type I–IV) for informal learning and social activities. This typology-based approach reflects context-dependent preferences and allows examination of associations among spatial factors and perceived restoration.

Perceived Restoration

In this study, perceived restoration refers to students' self-reported restorative experience in a transitional space—namely the extent to which the setting is

perceived as associated with emotional ease, relaxation, interest, and focus during short inter-class intervals (Han, 2003; Xu et al., 2024). Operationally, perceived restoration is measured using a validated perceived-restoration measure adapted for built settings, reflecting both affective responses (e.g., feeling comfortable and relaxed) and attention-related responses (e.g., staying focused) (Li et al., 2024).

Perceived restoration is particularly relevant to academic building transitional spaces because restoration on campus often is reported during brief, everyday exposures rather than prolonged breaks, and students' restorative judgments are associated with how the space feels and functions in-the-moment (Ning et al., 2023). Recent campus-based research continues to use perceived restoration to assess how everyday environmental experiences relate to students' psychological states, indicating its relevance as an outcome construct in university contexts.

Attention Restoration Theory and Hypotheses Development

Attention Restoration Theory (ART), proposed by Rachel and Stephen Kaplan (1989), offers a lens for understanding perceived recovery from directed-attention fatigue in environments perceived as restorative, particularly when they are compatible with users' purposes (Kaplan, 1995). Although ART has often been applied to natural and campus green spaces, recent restorative-environment research has extended ART to urban and built settings, where perceived legibility, compatibility, outside visibility, and lower directed-attention demands are relevant to restorative evaluation (Liu et al., 2024). Academic building transitional spaces are appropriate for this extension because they connect indoor learning areas with outdoor conditions and may contain restorative cues such as outside visibility, openness, ease of access, and short-stay compatibility. This study therefore applies ART to examine associations between spatial factors, student preferences, and perceived restoration in everyday academic-building transitional spaces.

Spatial factors and perceived restoration

Under ART, perceived restoration is more likely when a setting is perceived as less demanding of directed attention and more compatible with users' purposes (Ohly et al., 2016). In academic building transitional spaces, legibility/access, short-stay support (layout and furniture), and basic study facilities (Wi-Fi and power points) may be associated with lower perceived friction and more compatible inter-class pauses (Gath-Morad et al., 2024; Yin et al., 2025). Evidence from recent built-environment research further suggests that everyday environmental qualities and short exposures can be associated with restoration-related evaluations and attention outcomes (Bell et al., 2025; Rhee et al., 2023),

providing a basis for expecting a positive association between spatial factors and perceived restoration in routine campus contexts.

H1: Spatial factors in academic building transitional spaces are positively associated with students' perceived restoration.

The mediating role of student preferences

From an ART perspective, spatial qualities that are perceived as easier to find and use, workable for short stays, and supportive of everyday tasks may be associated with stronger approach tendencies, reflected in higher preferences for using specific space types for informal learning and social activities (Salih et al., 2024); accordingly, spatial factors are expected to be positively associated with student preferences, consistent with evidence that perceived design qualities are related to students' preference evaluations and well-being-relevant responses (Mt Akhir & Amir, 2025). In turn, when students prefer a space type for their intended activities, the setting is more likely to feel compatible with their purposes and to be associated with brief attentional recovery (Stragà et al., 2023), implying a positive association between student preferences and perceived restoration. Together, these arguments suggest that spatial factors may indirectly associated with perceived restoration through students' activity-based preferences for transitional spaces.

H2: Spatial factors are positively associated with student preferences.

H3: Student preferences are positively associated with perceived restoration.

H4: Student preferences play an indirect role in the association between spatial factors and perceived restoration.

Based on these hypotheses, Figure 1 presents the conceptual framework linking spatial factors, student preferences, and perceived restoration in academic-building transitional spaces.

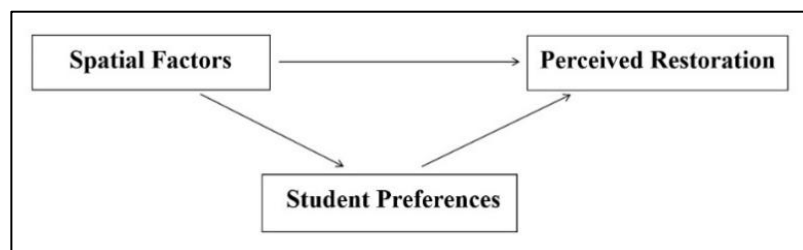


Figure 1: Conceptual Framework Linking Spatial Factors, Student Preferences, and Perceived Restoration in Academic Building Transitional Spaces.

Source: Author's illustration.

RESEARCH METHODOLOGY

Study Setting and Sampling

This study was conducted in a teaching building at Hunan University of Science and Engineering (HUSE), a public university located in Yongzhou, Hunan Province, China. The study area comprised academic building transitional spaces routinely used by students between scheduled activities, such as circulation, brief waiting, short stays, and informal interaction. The building was selected based on two criteria: it housed the target college whose undergraduate students formed the sampling frame, and it contained all four transitional space types examined in the student preferences construct. This provided a consistent typology-based evaluation within one academic setting. Figure 2 illustrates the four transitional space typologies in the selected academic building through simplified diagrams and representative site photographs.

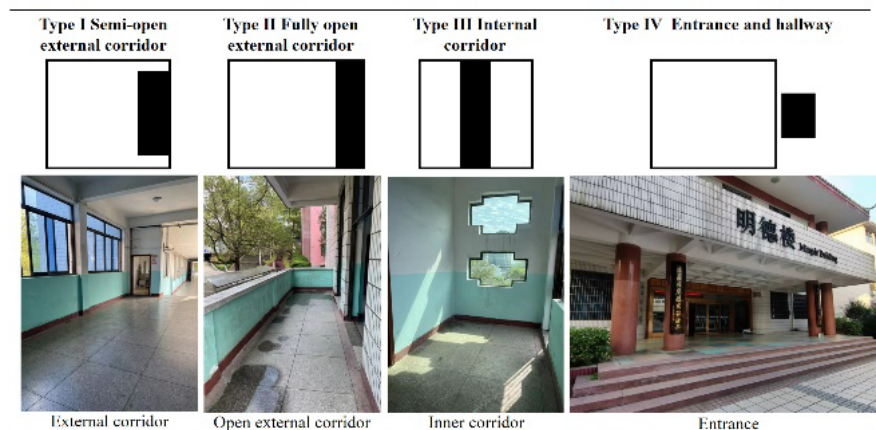


Figure 1: Transitional Space Typologies in the Selected Academic Building: Simplified Diagrams and Representative Photographs

Source: Author's photograph.

Note. The upper row shows simplified schematic diagrams of the four transitional space typologies, and the lower row presents representative site photographs.

The sampling frame comprised Year 1–4 undergraduate students from the college housed in the selected building (N = 1,531, according to college administrative records). Convenience sampling with voluntary participation was used through two channels: an online questionnaire link distributed through class communication channels and on-site paper surveys administered in the building's transitional spaces. A total of 394 questionnaires were received, and all passed screening and were retained as valid responses for analysis.

Questionnaire Design

The questionnaire was developed to measure the three constructs in the proposed model. It contained 20 items covering spatial factors, student preferences, and perceived restoration (Table 1), all referring to students' perceptions of the academic building transitional spaces under study.

Table 1: Constructs and questionnaire items

Construct	Item code	Item	Source
Spatial Factors (SF)	SF1	How would you describe the outside visibility in the transitional space?	(Velusamy, 2022)
	SF2	How would you describe the available furniture in this space?	
	SF3	How would you describe the space layout in this space?	
	SF4	The space has a good wireless internet connection.	
	SF5	The space has enough electrical power points.	
	SF6	The place is visible and easily accessible.	
Student Preference (SP)	SP1	Preference for Type I transitional space for informal learning	(Beckers et al., 2016; Velusamy, 2022)
	SP2	Preference for Type II transitional space for informal learning	
	SP3	Preference for Type III transitional space for informal learning	
	SP4	Preference for Type IV transitional space for informal learning	
	SP5	Preference for Type I transitional space for social activities	
	SP6	Preference for Type II transitional space for social activities	
	SP7	Preference for Type III transitional space for social activities	
	SP8	Preference for Type IV transitional space for social activities	
Perceived restoration (PR)	PR1	I feel emotionally comfortable in this space.	(Han, 2003)
	PR2	I feel relaxed in this space.	
	PR3	I am interested in the design of this space.	
	PR4	This space helps me stay focused.	
	PR5	I would like to visit here more often.	
	PR6	I would like to stay here longer.	

Source: Authors' compilation based on the studies cited in the "Source" column.

All questionnaire items used five-point response scales, tailored to each construct (Table 1). For spatial factors, quality-oriented items (SF1–SF3: outside visibility, furniture availability, and space layout) were rated from 1 = very poor to 5 = excellent, while facility-oriented items (SF4–SF6: Wi-Fi connection, power points, and visibility/accessibility) were rated from 1 = strongly disagree to 5 = strongly agree. For student preferences, eight items were rated from 1 =

absolutely not preferred to 5 = definitely preferred, capturing preferences for informal learning (SP1–SP4) and social activities (SP5–SP8) across four transitional space types. For perceived restoration, six items were rated from 1 = extremely disagree to 5 = extremely agree, reflecting comfort, relaxation, design interest, focus, and approach tendencies (e.g., willingness to revisit and stay longer).

To test the hypothesised associations among spatial factors, student preferences, and perceived restoration, partial least squares structural equation modelling (PLS-SEM) was employed. PLS-SEM allows simultaneous assessment of measurement quality (indicator reliability; internal consistency; convergent and discriminant validity) and estimation of structural paths in a single model. Accordingly, the Analysis and Discussion section reports measurement model evaluation followed by bootstrapped tests of direct and indirect associations.

RESULTS

Descriptive statistics

Descriptive statistics were computed using latent variable scores exported from SmartPLS. The mean scores were above the scale midpoint for spatial factors ($M = 3.183$, $SD = 0.688$), student preferences ($M = 3.217$, $SD = 0.577$), and perceived restoration ($M = 3.283$, $SD = 0.719$), indicating generally positive evaluations of academic building transitional spaces. For all constructs, observed responses spanned the full scale range (minimum = 1.000; maximum = 5.000), suggesting adequate variability for subsequent PLS-SEM analyses. The valid sample size was 394 (listwise).

Measurement Model

The measurement model was evaluated in terms of indicator reliability, internal consistency reliability, convergent validity, and discriminant validity (Table 2–3). Indicator loadings were generally acceptable. Most loadings exceeded 0.70, while several student preferences indicators fell within the lower but acceptable range of 0.40–0.70 (Hair Jr. et al., 2021). Internal consistency reliability was confirmed for all constructs, with Cronbach's alpha, rho_A, and composite reliability values exceeding the recommended thresholds (Table 2). Convergent validity was adequate for spatial factors and perceived restoration. Although the average variance extracted for student preferences was slightly below the conventional 0.50 criterion, its composite reliability remained high; therefore, the construct was retained for further analysis following Fornell and Larcker's (1981) guideline, which has also been applied in prior structural equation modelling research (Pervan et al., 2017).

Discriminant validity was assessed using the heterotrait–monotrait ratio (Table 3). All values were below the recommended threshold of 0.85, indicating the distinctiveness of the three latent constructs (Franke & Sarstedt, 2019; Henseler et al., 2015).

Table 2: Measurement model results for the latent constructs

Constructs	Indicators	Outer Loadings	Cronbach's Alpha	rho_A	CR	AVE
Spatial Factors (SF)	SF1	0.756	0.833	0.848	0.878	0.546
	SF2	0.797				
	SF3	0.823				
	SF4	0.698				
	SF5	0.672				
	SF6	0.672				
Perceived Restoration (PR)	PR1	0.884	0.945	0.945	0.956	0.783
	PR2	0.903				
	PR3	0.890				
	PR4	0.854				
	PR5	0.885				
	PR6	0.893				
Student Preferences (SP)	SP1	0.767	0.832	0.844	0.872	0.463
	SP2	0.586				
	SP3	0.692				
	SP4	0.620				
	SP5	0.778				
	SP6	0.587				
	SP7	0.741				
	SP8	0.638				

Note. rho_A = reliability coefficient rho_A; CR = composite reliability; AVE = average variance extracted.
 Source: Author's calculation

Table 3: Discriminant Validity (HTMT)

Constructs	1	2	3
1. Spatial Factors			
2. Perceived Restoration	0.752		
3. Student Preferences	0.356	0.443	

Note. HTMT = heterotrait-monotrait ratio. All values were below the recommended threshold of 0.85.
 Source: Author's calculation

Structural Model

The structural model was evaluated using collinearity diagnostics, explanatory power, direct and indirect associations, and predictive assessment. Inner variance inflation factor values were low (Table 4), indicating no multicollinearity concerns. Bootstrapping with 10,000 resamples and 95% confidence intervals provided support for all direct hypotheses (Table 4) (Ringle et al., 2022). As shown in Figure 3, spatial factors showed a strong positive association with

perceived restoration, supporting H1 with a large effect size. Spatial factors also positively associated with student preferences, and student preferences positively predicted perceived restoration, supporting H2 and H3 with small effect sizes.

The mediation test further indicated a significant indirect association between spatial factors and perceived restoration via student preferences (Table 5). Since the direct effect remained significant and the variance accounted for value was modest (VAF = 0.096), H4 was supported, consistent with partial mediation in the PLS-SEM model (Ramayah et al., 2018). The model explained 50.1% of the variance in perceived restoration ($R^2 = 0.501$; adjusted $R^2 = 0.498$) and 9.2% of the variance in student preferences ($R^2 = 0.092$; adjusted $R^2 = 0.090$). PLS-Predict showed positive out-of-sample predictive relevance for both endogenous constructs, with PLS producing lower prediction error than the naïve benchmark and performing comparably to the linear model benchmark (Table 6) (Shmueli et al., 2019).

Table 4: Hypothesis Testing of Direct Effects

Hs	Relationship	β	M	STDEV	t-value	p-values	2.5%	97.5%	VIF	f ²
H1	SF → PR	0.61	0.61	0.042	14.70	< .00	0.52	0.688	1.10	0.68
		4	4		0	1	4		2	4
H2	SF → SP	0.30	0.31	0.057	5.372	< .00	0.18	0.404	1.00	0.10
		4	2			1	0		0	2
H3	SP → PR	0.21	0.21	0.053	4.021	< .00	0.10	0.316	1.10	0.08
		2	3			1	9		2	2

Note: β = original sample coefficient; M = bootstrap sample mean; STDEV = bootstrap standard deviation; VIF = inner variance inflation factor; f² = effect size. Confidence intervals are based on 95% bootstrap confidence intervals with 10,000 resamples. SF = spatial factors; SP = student preferences; PR = perceived restoration.

Source: Author's calculation

Table 5: Hypothesis Testing for Indirect Effect

Hs	Mediating Path	β	M	STDEV	t-value	p-values	2.5%	97.5%	VAF
H4	SF → SP → PR	0.065	0.066	0.019	3.370	0.001	0.033	0.107	0.096

Note: β = original sample coefficient; M = bootstrap sample mean; STDEV = bootstrap standard deviation; VAF = variance accounted for. Confidence intervals are based on 95% bootstrap confidence intervals with 10,000 resamples. SF = spatial factors; SP = student preferences; PR = perceived restoration.

Source: Author's calculation

Table 6: PLS-Predict Results

Construct	Q ² predict	PLS Loss	LM Loss	IA Loss	PLS-LM	PLS-IA
PR	0.454	0.433	0.430	0.667	0.003	-0.235
SP	0.080	0.695	0.704	0.722	-0.008	-0.027

Note. PLS–LM and PLS–IA are calculated as PLS minus the benchmark loss; negative values indicate better predictive performance of PLS. SP = student preferences; PR = perceived restoration.

Source: Author's calculation

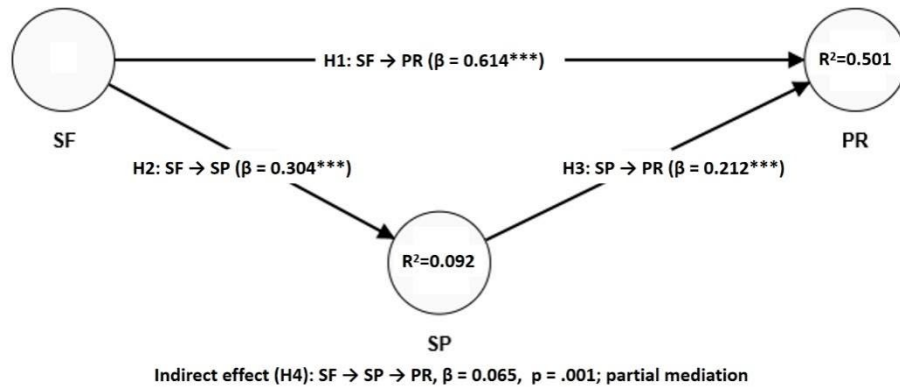


Figure 3. Structural model results for the relationships among Spatial Factors (SF), Student Preferences (SP), and Perceived Restoration (PR).

Source: Author's calculation.

Notes: Path values are standardised coefficients (β); values inside circles indicate R^2 . $^{***} p < .001$. The indirect effect indicates partial mediation via student preferences ($\beta = 0.065$, $p = .001$).

DISCUSSION

The results indicate that spatial factors were the strongest predictor of students' perceived restoration in the model in academic building transitional spaces, with student preferences showing a significant but modest indirect role. This pattern aligns with restoration research suggesting that everyday built settings are associated with attention recovery when they are perceived as less demanding of directed attention and compatible with users' purposes (Herzog et al., 2003; Ohly et al., 2016).

The strong spatial factors–perceived restoration association (H1) can be interpreted through the spatial factors items. Outside visibility and visibility/ease of access may be associated with greater legibility, lower uncertainty, and lower perceived mental effort during brief pauses—conditions linked to restorative experience in routine settings (Gath-Morad et al., 2024; Jain Kwon, 2025). Furniture provision and layout are related to functional compatibility for waiting (Hamida et al., 2024), brief study, or informal interaction; compatibility is a key component of restorative environments (Liu et al., 2024; Pham & Sanocki, 2024). Reliable Wi-Fi and sufficient power points may be associated with lower practical friction, short purposeful study, and longer stays—patterns reported in

informal learning and non-classroom study settings (Akkurt & Akbulut, 2025; L. Peng et al., 2022).

Beyond the direct association involving spatial factors, the findings also support H2 and H3, indicating that spatial factors are positively associated with student preferences, and student preferences are positively associated with perceived restoration. Together, these results suggest that evaluative judgments and approach tendencies are relevant to restorative experience in academic building transitional spaces. However, because the indirect association represented only a modest share of the total association, the supported mediation (H4) is consistent with partial mediation: spatial qualities appear to be associated with restoration not only through students' liking for or selection of space types for intended activities, but also via more immediate experiential conditions (e.g., legibility, comfort, and attentional support) (Zhang et al., 2024). This interpretation accords with ART-based accounts that restoration may be reported during brief, everyday exposures when settings are perceived as less demanding or directed attention and compatible with users' purposes (Bell et al., 2025).

Practically, the findings point to three design priorities for academic-building transitional spaces: improving legibility and access through clear entrances, visible routes, and unobstructed sightlines; strengthening short-stay usability through appropriately placed seating and layouts that do not block circulation; and providing basic study-support facilities, particularly stable Wi-Fi and accessible power points, in high-use transitional areas.

CONCLUSION

This study developed and tested an ART-informed PLS-SEM model linking spatial factors, student preferences, and perceived restoration in academic building transitional spaces. The findings contribute to extending ART within everyday academic-building contexts, indicating that perceived restoration is associated with practical spatial conditions related to lower friction during inter-class use, with student preferences showing a partial evaluative role.

For stakeholders, the findings offer a clear way forward: audit transitional areas using the three design priorities identified in this study—legibility/access, short-stay usability, and basic study-support facilities—then prioritise low-cost upgrades in high-traffic locations and monitor perceived changes through brief pulse surveys and simple occupancy checks. These actions align with China's current directions on student mental-health support and improved educational environments (State Council Information Office (China), 2025; Yuan et al., 2024). A limitation is the cross-sectional, single-building design; future research should test the model across universities and seasons and combine perceptual, behavioural, and objective measures.

FUNDING

This work was supported by the Hunan University of Science and Engineering (HUSE) General Project (Grant No. 21XKY025).

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Received: 15th May 2026. Accepted: 6th June 2026