buildings

MDPI

Article

Façade-Level Biophilic Design and Consumer Behaviour in Luxury Retail: A Stimulus–Organism–Response Analysis of Modular Living Walls

Huan Yi [1], Qingwei Wang [2] and Azmiah Abd-Ghafar [1,*]

[1] Faculty of Design and Architecture, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia; gs67550@student.upm.edu.my
[2] Faculty of Educational Studies, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia; gs71444@student.upm.edu.my
* Correspondence: azmiah@upm.edu.my

Abstract

Modular living walls (MLWs) are increasingly adopted as biophilic façade interventions in high-end commercial environments, yet their behavioural effects at luxury retail entrances remain underexplored. Grounded in the stimulus–organism–response framework, this study investigates how MLWs integrated into luxury retail façades influence visitors' perceptual, emotional, and behavioural responses at the Beauty Galleria of The Exchange TRX, Kuala Lumpur. Using a field-based survey and structural equation modelling with 400 visitors, the study examines the relationships among MLW presence, perceived naturalness, pleasure, arousal, perceived restorativeness, façade attractiveness, and behavioural intentions. The results show that MLWs significantly enhance perceived naturalness, pleasure, arousal, and perceived restorativeness. These organismic responses positively influence perceived façade attractiveness, which in turn strongly predicts both approach intention and photo-taking intention. Façade attractiveness emerged as a central mediating mechanism, while the indirect effect of MLWs on behavioural intentions was significant. The model explained a substantial proportion of variance in façade attractiveness and confirmed that consumer responses to biophilic façades are primarily shaped through sequential perceptual and affective processes rather than direct stimulus effects. This study extends the application of the S–O–R framework to façade-level biophilic design and provides practical evidence that MLWs can enhance first impressions and consumer engagement in luxury retail environments.

Keywords: biophilic façade design; modular living walls; stimulus–organism–response framework; luxury retail environments; consumer behavioural intentions; façade attractiveness

Academic Editor: Xuan Ma

Received: 25 March 2026
Revised: 16 April 2026
Accepted: 17 April 2026
Published: 18 April 2026

1. Introduction

Sustainable retail architecture has gained increasing attention in rapidly urbanising regions, particularly within high-density commercial districts of Southeast Asia [1]. Beyond environmental performance, contemporary retail developments are increasingly expected to deliver experiential quality, psychological comfort, and symbolic value aligned with evolving consumer expectations for sustainability and well-being [2–4]. In luxury retail environments, architectural design plays a decisive role in shaping first impressions, emotional appraisal, and pre-entry behavioural responses, as consumers often form judgements within a limited time before engaging with interior spaces [5,6].

Despite growing academic and institutional advocacy for green building practices, the implementation of comprehensive sustainability strategies in luxury retail developments remains uneven [7,8]. Previous studies consistently identify high initial investment costs, limited technical capacity, fragmented stakeholder coordination, and uncertainty regarding economic returns as key barriers to adopting advanced green building technologies [9–12]. These challenges are particularly pronounced in retail-oriented projects, where commercial priorities often favour construction efficiency, leasable floor area, and brand visibility over environmental integration [13–15]. As a result, sustainability objectives are frequently negotiated or deferred during the design and delivery of high-end commercial buildings.

Within this context, modular living wall (MLW) architectural interventions have emerged as a pragmatic strategy for integrating sustainability-oriented design without requiring full-scale modification of building systems [16,17]. Façades function as the most immediate architectural interface between retail buildings and the public realm, conveying identity, quality, and experiential promise within brief visual encounters [18,19]. In retail architecture, entrance façades are particularly influential because they operate under conditions of limited exposure time and must rapidly stimulate approach-oriented decisions, such as entry or avoidance [20]. Empirical research has shown that façade composition, material articulation, and visual coherence significantly influence aesthetic preference and customer approach behaviour [21,22].

Biophilic design has been increasingly recognised as an effective architectural strategy for enhancing emotional well-being and perceptual comfort in built environments [23,24]. Rooted in the concept of humans' innate affinity for nature [25], biophilic interventions have been shown to elicit positive affective responses, reduce stress, and support cognitive restoration, even under brief visual exposure [26–28]. In retail settings, visual contact with natural elements is associated with increased pleasure, moderate arousal, and stronger engagement intentions [29], contributing to more favourable evaluations of commercial spaces [30,31]. These effects are especially relevant at retail entrances, where visitors rely on rapid visual cues to form initial judgements prior to physical entry [32,33].

Among biophilic strategies, MLWs represent a distinctive façade-level intervention that integrates vegetation into vertical architectural surfaces through prefabricated and scalable systems [34]. Compared with horizontal landscaping or planter-based greenery, MLWs offer heightened visual salience and adaptability to dense urban contexts where ground-level green space is limited [35,36]. Existing research has documented their environmental benefits, including thermal regulation, air-quality improvement, and ecological enhancement [37,38]. Psychological studies further suggest that living wall systems enhance perceived naturalness, tranquillity, and restorativeness, contributing to mood improvement and stress recovery [39,40].

However, empirical evidence on the psychological and behavioural effects of MLWs at retail entrance façades remains limited. Research has predominantly focused on interior environments, residential settings, or general urban streetscapes, while studies on retail façades continue to emphasise transparency, signage, and material expression. Consequently, the role of façade-integrated vegetation in shaping consumers' pre-entry psychological appraisal, aesthetic evaluation, and behavioural intentions has not been systematically examined under real-world conditions, particularly within luxury retail contexts. Field-based studies comparing consumer responses to retail entrance façades with and without MLWs within controlled spatial environments are notably lacking.

The stimulus–organism–response (S–O–R) framework provides a robust theoretical foundation for addressing this gap. Originally developed in environmental psychology [41], the framework explains how environmental stimuli activate internal perceptual and affective states that subsequently shape behavioural responses. In retail architecture, S–O–R has

been widely applied to examine how physical environments influence emotional appraisal and approach behaviour [42,43]. Façade-level applications of this framework are particularly appropriate, as entrance design functions as a pre-entry stimulus encountered before consumers engage with interior atmospherics.

This study focuses on the Beauty Galleria at The Exchange TRX, Kuala Lumpur, a luxury retail zone that incorporates entrance façades both with and without MLWs within the same architectural and commercial setting. This configuration enables a quasi-experimental comparison of façade conditions while holding broader contextual factors constant. Accordingly, the objectives of this study are threefold:

- To examine the effects of MLWs at luxury retail entrance façades on visitors' perceived naturalness, pleasure, arousal, and perceived restorativeness.
- To investigate how these perceptual and emotional responses influence perceived fa-çade attractiveness.
- To assess whether façade attractiveness mediates the relationship between these organismic responses and visitors' behavioural intentions, specifically approach intention and photo-taking or sharing intention.

Specifically, this research investigates the sequential psychological mechanisms through which façade-level biophilic design affects consumer behaviour, focusing on perceived naturalness, emotional and restorative responses, and perceived façade attractiveness as mediating constructs. In doing so, the study makes a clear theoretical contribution by advancing S–O–R theory from interior retail environments to façade-level biophilic stimuli, and by identifying façade attractiveness as a central evaluative mechanism linking environmental cues to behavioural intentions. From a practical perspective, the findings offer evidence-based insights into how modular living walls can function as low-intrusion, high-impact design interventions capable of enhancing first impressions and consumer engagement in luxury retail environments.

2. Research Model and Hypotheses

2.1. Conceptual Framework

This study develops a conceptual framework grounded in the S–O–R paradigm to examine how façade-level biophilic interventions influence visitors' emotional appraisal, aesthetic evaluation, and behavioural intentions in luxury retail environments. The S–O–R framework conceptualises the built environment as an external stimulus that activates internal perceptual and affective states, which subsequently shape behavioural responses [41,44]. This framework is particularly appropriate for retail entrance contexts, where visitors are exposed to architectural cues briefly and form rapid pre-entry evaluations.

In the proposed model, the presence of MLWs integrated into a retail entrance façade is operationalised as the environmental stimulus. As a visually salient biophilic feature, MLWs introduce natural form, texture, and colour into the façade plane, distinguishing them from conventional retail entrances dominated by hard materials and branding elements. Encountered prior to physical entry, MLWs function as first-impression stimuli rather than interior atmospheric conditions. The organismic stage of the model captures visitors' internal responses triggered by façade exposure and includes four constructs: perceived naturalness, pleasure, arousal, and perceived restorativeness. Perceived naturalness reflects the cognitive recognition of natural cues, pleasure and arousal represent core affective dimensions relevant to visually mediated architectural experience, and perceived restorativeness captures a higher-order psychological response associated with mental relaxation and cognitive recovery.

Perceived façade attractiveness is positioned as a central evaluative construct that integrates perceptual, emotional, and restorative responses into an overall aesthetic judgement.

In retail architecture, façade attractiveness plays a critical role in shaping first impressions and mediating the translation of internal responses into behavioural tendencies [20,22]. The response stage of the model consists of approach intention and photo-taking or sharing intention, reflecting both physical engagement with the retail environment and visually driven interaction that is increasingly relevant in contemporary luxury retail settings. The proposed framework, therefore, captures a sequential process through which MLWs influence behavioural intentions indirectly via perceptual, affective, and evaluative mechanisms.

2.2. Hypothesis Development

2.2.1. MLWs, Organismic Responses, and Façade Attractiveness

Biophilic design theory suggests that exposure to natural elements enhances perceptions of naturalness and elicits positive emotional and restorative responses [45]. As MLWs visually introduce vegetation into the façade plane, they are expected to strengthen visitors' perceptions of naturalness and stimulate favourable affective and psychological reactions [46]. Accordingly, the following hypotheses are proposed:

H1a. *The presence of MLWs at retail entrance façades positively influences visitors' perceived naturalness.*

H1b. *The presence of MLWs at retail entrance façades positively influences visitors' pleasure.*

H1c. *The presence of MLWs at retail entrance façades positively influences visitors' arousal.*

H1d. *The presence of MLWs at retail entrance façades positively influences visitors' perceived restorativeness.*

Emotional and restorative responses play a key role in shaping aesthetic judgements of architectural environments [47]. Prior research indicates that perceptions of naturalness, pleasure, arousal, and restorativeness contribute to more favourable evaluations of spatial quality and visual appeal [48]. In pre-entry retail contexts, these organismic responses are expected to inform visitors' overall assessment of façade attractiveness [49]. Thus, the following hypotheses are formulated:

H2a. *Perceived naturalness is positively associated with perceived façade attractiveness.*

H2b. *Pleasure is positively associated with perceived façade attractiveness.*

H2c. *Arousal is positively associated with perceived façade attractiveness.*

H2d. *Perceived restorativeness is positively associated with perceived façade attractiveness.*

2.2.2. Façade Attractiveness, Behavioural Intentions, and Mediation Effects

Façade attractiveness represents a critical determinant of pre-entry behavioural tendencies in retail environments [50]. Attractive façades are more likely to encourage approach-oriented behaviour and visually driven engagement, particularly in luxury retail contexts where aesthetic distinction and experiential value are emphasised [51]. Accordingly, the following hypotheses are proposed:

H3. *Perceived façade attractiveness positively influences visitors' approach intention toward the retail environment.*

H4. *Perceived façade attractiveness positively influences visitors' photo-taking or sharing intention.*

Based on the S–O–R framework, behavioural intentions are theorised to arise indirectly through internal organismic processes rather than as direct responses to environmental stimuli. In this study, perceived façade attractiveness is expected to function as a key mediating mechanism through which perceptual, emotional, and restorative responses influence behavioural intentions. Therefore, the final hypothesis is stated as follows:

H5. *Perceived façade attractiveness mediates the relationships between perceived naturalness, pleasure, arousal, perceived restorativeness, and visitors' behavioural intentions.*

Figure 1 illustrates the proposed research model. The presence of a modular living wall is operationalised as a binary façade-level stimulus distinguishing entrances with and without MLW exposure. This stimulus is hypothesised to activate organismic responses that shape perceived façade attractiveness, which in turn influences behavioural intentions. Consistent with the S–O–R logic, the model specifies a sequential mediation structure linking architectural stimulus, internal appraisal processes, aesthetic evaluation, and behavioural outcomes under real-world retail exposure conditions.

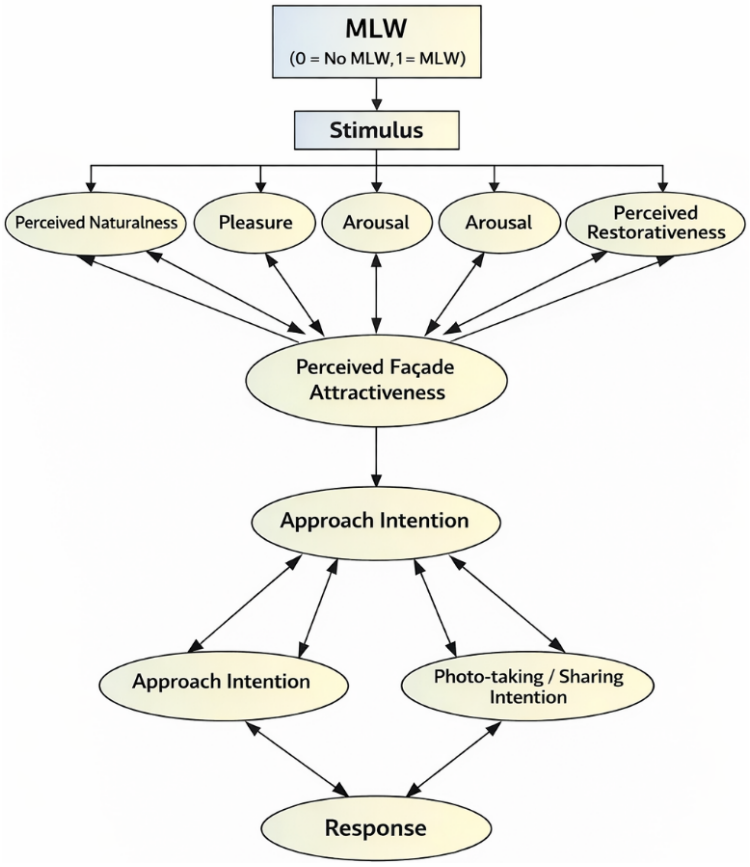


Figure 1. Research model.

3. Methods

3.1. Research Design

This study employs a quantitative, cross-sectional research design to evaluate how MLWs at retail entrances influence visitor emotions, aesthetic appraisals, and behavioural intentions. Grounded in the S–O–R framework [41], the model conceptualises biophilic architectural features as environmental stimuli (S) that elicit internal organismic states (O), which subsequently drive behavioural outcomes (R). Data were collected via direct field surveys at Beauty Galleria, Kuala Lumpur, between October and November 2025.

This period was selected to capture regular on-site visitor responses under normal mall operating conditions rather than during a single short-term promotional event. Although October–November may coincide with variations in weekend footfall and pre-year-end consumer activity, the study did not target any specific festive campaign or seasonal intervention. Data collection was conducted across multiple weekends and evening periods to reduce the influence of short-term temporal fluctuations and to obtain responses from a broader range of mall users. This in situ approach ensures high ecological validity, as participants experienced the architectural features in a real-world luxury retail setting rather than through simulated or experimental manipulation. Such field-based designs are well-established in environmental psychology for capturing authentic relationships between spatial attributes and consumer responses [52,53]. The research utilises a quasi-experimental comparative structure:

- Stimulus (S): MLWs' presence, operationalized as a binary independent variable (0 = without MLWs, n = 198; 1 = with MLWs, n = 202).
- Organism (O): Mediating variables including perceived naturalness, pleasure, arousal, and perceived restorativeness.
- Response (R): Dependent variables comprising perceived facade attractiveness and behavioural intentions (approach and photo-taking).

To ensure robust statistical power, a G*Power 3.1 analysis determined an optimal sample size of N = 387 (for effect size f^2 = 0.15, a = 0.05). The final sample (N = 400) exceeds the requirements for covariance-based structural equation modelling (SEM). While the design primarily yields associational insights, the comparative grouping within a single mall environment enhances internal validity by controlling for broader contextual variables [54,55].

3.2. Study Site

The study was conducted at the Beauty Galleria within The Exchange TRX, Kuala Lumpur. The Exchange TRX is a major mixed-use development positioned as a high-end commercial and financial hub, incorporating luxury retail environments with a strong emphasis on architectural quality and experiential design. The Beauty Galleria represents a designated luxury beauty retail zone within the mall and features multiple flagship stores with visually comparable entrance façades, some of which integrate modular living wall systems (Figure 2) while others do not.

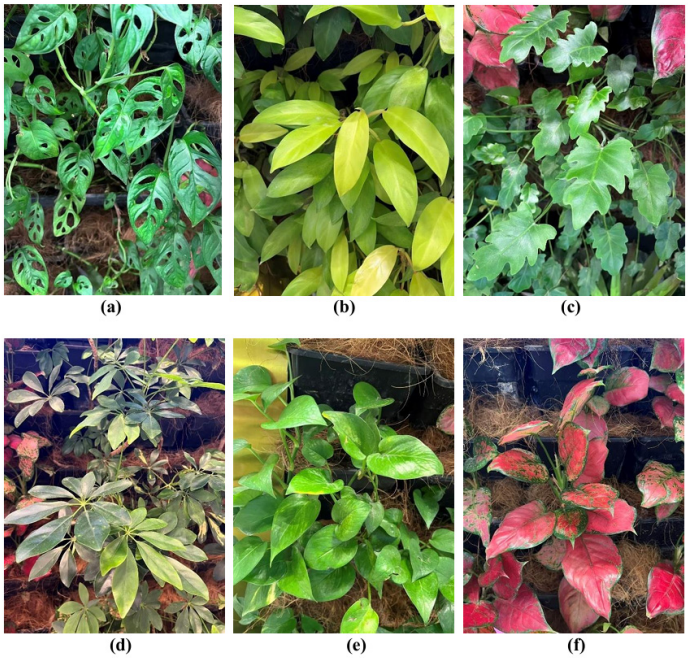
This spatial configuration provides a suitable research setting for a controlled comparison of façade conditions, as visitors are exposed to both MLW and non-MLW entrances within the same climatic, cultural, and commercial environment. The site was selected not because it represents typical Malaysian commercial architecture in a general sense, but because it offers a well-defined luxury retail context in which façade-level biophilic interventions are visibly integrated and can be compared under relatively consistent environmental conditions. In this respect, The Exchange TRX should be understood as a strategically selected case study rather than a fully representative example of all Malaysian retail architecture.

Accordingly, the findings are most directly applicable to contemporary high-end urban retail settings that prioritise experiential design and strong visual branding. While the underlying perceptual mechanisms identified in this study may also be relevant to other commercial environments, caution is needed in generalising the results to more conventional retail buildings, suburban malls, or lower-cost commercial typologies.

(a) (b)

Figure 2. MLW installations at the entrances of luxury retail stores (Givenchy and Guerlain) in the Beauty Galleria, The Exchange TRX. (**a**) MLWs left-side view; (**b**) MLWs right-side view.

As illustrated in Figure 3, the MLWs at Beauty Galleria employ a diverse palette of tropical plant species to enhance visual salience and organic complexity. These include varieties such as *Monstera adansonii* (Figure 3a), *Philodendron hederaceum 'Lemon Lime'* (Figure 3b), *Philodendron xanadu* (Figure 3c), *Heptapleurum arboricola Hayata* (Figure 3d), *Epipremnum aureum* (Figure 3e), and *Aglaonema* (Figure 3f), which were selected for their contrasting leaf textures and vibrant hues (greens and reds) [56,57]. This botanical diversity is essential for stimulating 'soft fascination' and cognitive restoration among visitors to the Beauty Galleria [58]. While the quasi-experimental design offers high realism, it is acknowledged that certain botanical and physical attributes of the MLWs were not strictly controlled in the structural model.



(a) (b) (c)

(d) (e) (f)

Figure 3. Detailed botanical composition of the MLWs. (**a**) *Monstera adansonii*; (**b**) *Philodendron hederaceum 'Lemon Lime'*; (**c**) *Philodendron Xanadu*; (**d**) *Heptapleurum arboricola Hayata*; (**e**) *Epipremnum aureum*; (**f**) *Aglaonema*.

3.3. Participants and Sampling

Participants were adult visitors of The Exchange TRX Mall, Kuala Lumpur, aged 18–60 years (N = 432). Surveys were administered within a <20 m radius from retail entrances. A non-probability intercept sampling method was employed, whereby visitors encountered in public circulation zones near retail entrances were invited to participate voluntarily. Although non-probability sampling limits statistical generalisability, this approach is appropriate for site-specific architectural perception studies focusing on real users in situ. This sampling approach is widely accepted in architectural and environmental behaviour research, where the population of interest consists of real-time users of a specific built environment [52,59,60]. Eligibility criteria required participants to be 18 years of age or older and to have visually experienced at least one retail entrance façade during their visit. Visitors who had not approached or observed a retail entrance were excluded to ensure meaningful architectural exposure. Participation was voluntary, and no incentives were offered. Cases with missing values or straight-lining responses were excluded, resulting in a final usable sample of 400 (92.6% response rate). The final sample size exceeded recommended minimum thresholds for SEM, satisfying both absolute sample size and parameter-to-observation ratio guidelines [54,55]. All participants participated after providing informed consent. We maintained anonymity and confidentiality throughout the study.

3.4. Survey Instrument

We gathered data using a structured, closed-ended survey questionnaire with multiple-item scales measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The survey instrument consisted of six latent constructs adapted from the earlier literature: perceived naturalness and perceived restorativeness [61], pleasure and arousal, perceived façade attractiveness [62], approach intention, and photo-taking intention [63] to ensure content validity. MLW exposure was coded as a binary variable (0 = absence of MLWs; 1 = presence of MLWs) based on the façade condition observed by participants, enabling direct comparison of perceptual and behavioural responses within the SEM framework. This operationalisation was appropriate for testing the overall S–O–R mechanism in a real retail setting; however, it should be noted that MLWs are not uniform design elements. Their effects may vary according to specific characteristics such as plant species composition, physiological condition, colour contrast, lighting, maintenance quality, and the degree of integration with the broader façade design.

3.5. Pilot Study

We conducted a pilot study involving 50 visitors to the Beauty Galleria to assess reliability and validity of the survey instrument using SPSS 26.0. N = 50 pre-test. Cronbach's α = 0.87 (subscales 0.82–0.88). EFA: KMO = 0.89, Bartlett's χ^2 = 1243.6 ($p < 0.001$), 68.4% variance explained (6 factors, eigenvalues > 1.0). Two items deleted (NAT3 λ = 0.58, ATT2 cross-loading = 0.42). Items with less factor loadings, cross-loadings, or weak communalities were excluded from the study. Refined survey instrument was used for further data collection.

3.6. Procedure

Data was collected during a four-week period between October and November 2025, during weekends to ensure peak visitor activity at the mall. We collected data during weekends and evenings when foot traffic is higher with various populations in order to avoid sampling bias [64]. Each subject received a brief information sheet containing the study's purpose, voluntary participation, confidentiality of gathered information, and estimated completion time. Informed consent was obtained prior to participation, consistent with ethical standards for minimal-risk behavioural research [65]. The duration of the survey

was nearly eight minutes. Questionnaire items were shown as construct-based blocks, and perceptual items were randomised to reduce priming effects during administration. We used fully completed questionnaires for analysis, and incomplete survey forms were excluded [66]. Approval to gather survey responses was obtained from The Exchange TRX Mall management prior to data collection. Participation was entirely voluntary, and no personal data were collected to maintain confidentiality. Given the non-invasive nature of our study and use of anonymous survey data from human subjects, our research followed standard ethical guidelines for minimal-risk behavioural research.

3.7. Data Analysis

Data analysis was done using SPSS in a multi-stage procedure. Preliminary analyses were conducted to assess missing data, outliers, and normality. Descriptive statistics were estimated to summarise the demographic profile of subjects. SEM was performed using AMOS 29. Our measurement model was assessed using confirmatory factor analysis (CFA) to quantify factor loadings, composite reliability, convergent validity, and discriminant validity. Model fitness was assessed using χ^2/df ratio, Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardised Root Mean Square Residual (SRMR), and Goodness-of-Fit index (GFI), following established criteria by [67,68].

The measurement model demonstrated a good fit to the data, with χ^2 (362) = 855.32, χ^2/df = 2.36, CFI = 0.964, TLI = 0.959, RMSEA = 0.052 (90% CI: 0.048–0.056), and SRMR = 0.045. These values indicate that the proposed measurement structure was acceptable and suitable for subsequent structural model testing. All fit indices exceeded Hu and Bentler (1999) [67] thresholds. Harman's single-factor test extracted 32.4% variance (<50% threshold). Full collinearity VIFs ranged 1.8–2.8 (<3.3 threshold). Following satisfactory measurement validation, the structural model was tested to examine hypothesised relationships among façade conditions, emotional responses, perceived attractiveness, and retail approach intention. Indirect and mediation effects were assessed using bootstrapping with 5000 resamples and 95% confidence intervals. SEM was selected due to its ability to account for latent construct measurement error, test complex mediation pathways, and provide a theory-driven understanding of architectural influence on consumer behaviour.

4. Results

4.1. Demographic Profile of Respondents

SEM was conducted using responses from 400 The Exchange TRX visitors to the Beauty Galleria. Sample characteristics are summarised in Table 1.

The demographic profile of the respondents is summarised in Table 1. The sample (N = 400) was relatively balanced across age groups, with each category representing approximately one-fifth of the respondents. Gender distribution was also balanced, with similar proportions of male, female, and respondents who preferred not to disclose their gender. Visit frequency indicated that a substantial proportion of respondents were regular visitors to the mall, while familiarity with the Beauty Galleria was generally high, with 67.0% reporting that they were very familiar with the setting. Visit purposes were also broadly distributed across leisure, shopping, dining, passing through, and work-related activities, suggesting that the sample captured a diverse range of users of the luxury retail environment.

The motivations for visiting the Beauty Galleria were highly diversified, reflecting a representative cross-section of luxury retail users. As depicted in Figure 4, the visit purposes were nearly evenly distributed across five primary categories:

- Entertainment/Leisure: 20.50%.
- Shopping: 20.25%.

- Dining: 20.00%.
- Passing through: 20.00%.
- Work/Meeting: 19.25%. This balanced distribution indicates that the "Perception–Emotion–Behaviour" pathways identified in the S–O–R model remain stable across various functional goals, supporting the generalizability of the biophilic impact within luxury retail environments.

Table 1. Sample characteristics (N = 400).

Variables	n	%	M	SD
Age category (coded)			3.02	1.435
18–24	83	20.75		
25–34	75	18.8		
35–44	76	19		
45–55	83	20.75		
55+	83	20.75		
Gender			2.00	0.816
Male	134	33.5		
Female	134	33.5		
Prefer not say	132	33.0		
Visit Frequency			2.56	1.111
1–2 times	91	22.8		
3–5 times	100	25.0		
6–10 times	103	25.8		
>10 times	106	26.5		
Familiarity				
Very familiar	268	67.0		
Somewhat familiar	132	33.0		

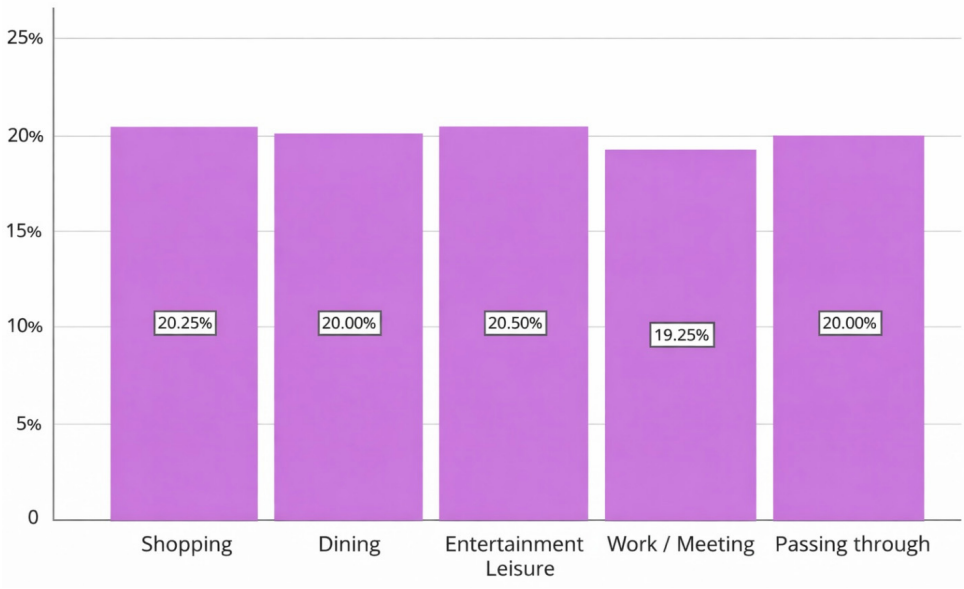


Figure 4. Visit purpose distribution bar chart.

4.2. Measurement Model: Reliability and Validity

The measurement model was quantified using confirmatory factor analysis. Reliability and validity of the findings were reported in Table 2. All constructs showed a satisfactory level of internal consistency. Arousal showed the highest reliability (α = 0.922, AVE = 0.68), indicating strong one-dimensionality among emotional factors. All constructs exceeded Fornell–Larcker (1981) [69] thresholds (CR > 0.70, AVE > 0.50), where perceived attractiveness revealed optimal balance (CR = 0.88, AVE = 0.59). Scale means ranged from M = 19.85 to 20.57, reflecting consistently positive visitor appraisals of MLWs-enhanced façades. We assessed discriminant validity using the Fornell–Larcker criterion. Our results show that AVE value of each construct exceeds its squared correlations with other constructs. Our findings indicated that our measurement model demonstrated acceptable psychometric properties.

Table 2. Measurement model results (N = 400).

Construct	Cronbach's α	CR	AVE	Scale Mean	Scale SD
Perceived Naturalness (B)	0.880	0.88	0.58	19.85	5.61
Pleasure (C)	0.880	0.88	0.59	20.57	5.51
Arousal (D)	0.922	0.92	0.68	20.41	6.49
Perceived Restorativeness (E)	0.887	0.89	0.60	20.28	5.57
Perceived Attractiveness (F)	0.883	0.88	0.59	20.31	5.55
Approach Intention (G1)	0.885	0.89	0.57	20.38	5.56
Photo-taking Intention (G2)	0.886	0.88	0.58	20.68	5.62

Table 3 shows the model fit indices of structural and measurement models. Measurement model demonstrated good fit to the data (χ^2/df = 2.36, CFI = 0.964, TLI = 0.959, RMSEA = 0.052, and SRMR = 0.045) and the structural model also revealed acceptable fitness (χ^2/df = 2.42, CFI = 0.958, TLI = 0.953, RMSEA = 0.054, and SRMR = 0.047), meeting threshold levels for SEM model Hu and Bentler (1999) [67] criteria. A slight increase in χ^2 values shows the addition of structural paths without evidence of model misspecification.

Table 3. Model fit indices.

Index	Measurement Model	Structural Model	Threshold
χ^2 (362)	855.32	1328.45 (548)	-
χ^2/df	2.36	2.42	$\leq$3.0
CFI	0.964	0.958	$\geq$0.95
TLI	0.959	0.953	$\geq$0.95
RMSEA	0.052 [0.048,0.056]	0.054 [0.050,0.058]	$\leq$0.08
SRMR	0.045	0.047	$\leq$0.08

4.3. Structural Model and Hypothesis Testing

Standardised path estimates for the structural model are presented in Table 4 and illustrated in Figure 5. The presence of MLWs at luxury beauty retail entrance façades was positively associated with perceived naturalness (β = 0.372, $p < 0.001$), pleasure (β = 0.341, $p < 0.001$), arousal (β = 0.289, $p < 0.001$), and perceived restorativeness (β = 0.318, $p < 0.001$).

Table 4. Structural path estimates (standardised β, $N = 400$).

Hypothesis	Structural Path	Standardised β	CR (z)	p-Value	Result
H1a	MLWs → Perceived Naturalness	0.372	7.85	<0.001	Supported
H1b	MLWs → Pleasure	0.341	7.42	<0.001	Supported
H1c	MLWs → Arousal	0.289	6.91	<0.001	Supported
H1d	MLWs → Perceived Restorativeness	0.318	7.26	<0.001	Supported
H2a	Perceived Naturalness → Perceived Façade Attractiveness	0.320	8.14	<0.001	Supported
H2b	Pleasure → Perceived Façade Attractiveness	0.472	10.36	<0.001	Supported
H2c	Arousal → Perceived Façade Attractiveness	0.278	6.88	<0.001	Supported
H2d	Perceived Restorativeness → Perceived Façade Attractiveness	0.242	6.31	<0.001	Supported
H3	Perceived Façade Attractiveness → Approach Intention	0.618	13.47	<0.001	Supported
H4	Perceived Façade Attractiveness → Photo-taking Intention	0.590	12.92	<0.001	Supported

Note: CR refers to the critical ratio (z-value). All paths are statistically significant at $p < 0.001$. The predictors jointly explained 68% of the variance in perceived façade attractiveness ($R^2 = 0.68$). Perceived façade attractiveness explained 42% of the variance in approach intention.

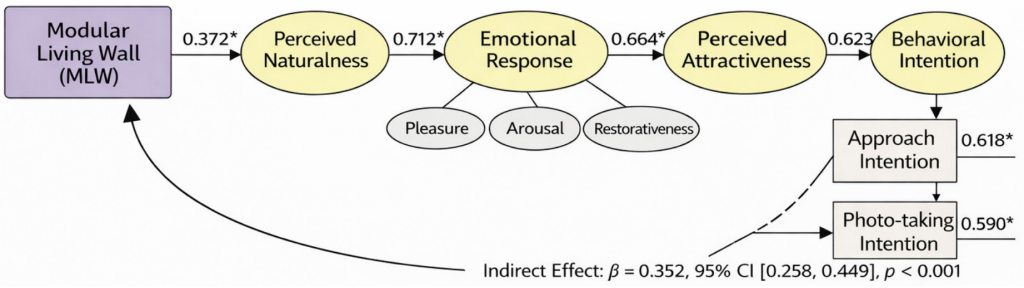


Figure 5. SOR model. Note: The coefficients are standardised composite effects indicating statistical significance at * $p < 0.001$. Emotional response and behavioural intention are modelled as second-order latent constructs.

These organismic responses were, in turn, positively associated with perceived façade attractiveness, including perceived naturalness ($\beta = 0.320$, $p < 0.001$), pleasure ($\beta = 0.472$, $p < 0.001$), arousal ($\beta = 0.278$, $p < 0.001$), and perceived restorativeness ($\beta = 0.242$, $p < 0.001$), jointly explaining 68% of the variance in façade attractiveness ($R^2 = 0.68$).

Perceived façade attractiveness further predicted both approach intention (β = 0.618, $p < 0.001$) and photo-taking intention ($\beta = 0.590$, $p < 0.001$), accounting for 42% of the variance in approach intention. For clarity, measurement loadings are omitted, and all displayed structural paths are significant at $p < 0.001$.

Indirect effects were evaluated using bootstrapping with 5000 resamples. Table 5 shows the indirect effects of MLWs on behavioural intentions through perceived façade attractiveness (β = 0.352, 95% CI 0.258, 0.449). As the confidence interval excluded zero, the sequential indirect effect was statistically significant. We found that sequential indirect pathways, including perceived naturalness, pleasure, and arousal, were statistically significant with confidence intervals and did not include zero. This indicates that the effect of MLWs is transmitted through a structured chain of perceptual and affective responses rather than its direct occurrence. When perceived façade attractiveness was included in the model, direct paths from MLW presence to behavioural intentions were non-significant, suggesting its full mediation role.

Table 5. Mediation effects.

Effect Type	Path	Standardised Effect (β)	SE	95% Bootstrap CI	*p*-Value
Direct effect	MLWs → Behavioural intentions	—	—	—	n.s.
Total indirect effect	MLWs → Façade attractiveness → Behavioural intentions	0.352	0.048	0.258, 0.449	<0.001
Total effect	Direct + Total indirect	—	—	—	—

Note: "n.s." indicates non-significant. The indirect effect and confidence interval are taken from the SEM output shown in Figure 5.

We also conducted additional diagnostic tests to support model strength. Harman's single-factor test indicated that a single factor accounted for 32.4% of the variance, below the 50% threshold. Full collinearity variance inflation factors ranged from 1.8 to 2.8, suggesting no multicollinearity concerns. Measurement invariance across MLW exposure groups was supported (ΔCFI = 0.008). Residual analyses revealed no systematic patterns exceeding ±2.58 standard deviations. Measurement invariance was assessed using multi-group CFA by sequentially testing configural and metric models.

Statistically significant indirect mediation effect of MLWs supports our proposed S–O–R model, where MLW exposure increases perceived naturalness, triggering positive emotional responses, and strengthens façade attractiveness. This indirect effect suggests the role of affective and cognitive factors as key explanatory mechanisms linking biophilic façade design to influencing consumer behaviour.

5. Discussion

This study provides empirical evidence on how visible MLW exposure at luxury retail entrance façades was associated with consumers' psychological appraisal and behavioural intentions under real-world conditions. Drawing on the S–O–R framework, the findings suggest that, in this study context, façade-level biophilic intervention shaped consumer behaviour indirectly through a structured sequence of perceptual, emotional, and evaluative processes. Specifically, the presence of MLWs was associated with higher perceived naturalness, pleasure, arousal, and perceived restorativeness, which in turn contributed to stronger perceived façade attractiveness and greater approach and photo-taking intention. These results support, rather than conclusively establish, the proposition that façade-level biophilic design may influence pre-entry behaviour primarily through internal organismic mechanisms rather than direct stimulus-response effects.

5.1. Interpretation of Key Findings in Relation to the Existing Literature

The strong positive association between MLWs' presence and perceived naturalness underscores the role of façade-level vegetation in shaping immediate cognitive interpretations of retail environments. This finding aligns with prior research indicating that visible greenery enhances environmental naturalness even in highly commercialised settings [30,46]. Importantly, the present study extends this evidence to luxury retail entrance façades, where exposure time is brief, and judgements are formed rapidly. The results suggest that MLWs effectively counterbalance the visual dominance of hard materials and branding, allowing visitors to cognitively reframe the entrance as a more human-centred and restorative environment.

Perceived naturalness was found to activate a set of emotional and restorative responses, including pleasure, arousal, and perceived restorativeness. This supports the growing body of literature suggesting that naturalness functions as a foundational perceptual cue that primes affective states rather than acting as an isolated aesthetic attribute [70–72].

The simultaneous activation of pleasure and moderate arousal observed in this study is consistent with retail atmosphere research that indicates that emotionally engaging environments are more likely to support approach-oriented behaviour [29,53]. Moreover, the significant effect of MLWs on perceived restorativeness reinforces findings from biophilic and restorative environment studies, which show that even brief visual exposure to vegetation can elicit feelings of mental relaxation and cognitive relief [33,40].

A key contribution of this study lies in identifying perceived MLW attractiveness as a central evaluative mechanism linking organismic responses to behavioural intentions. The results demonstrate that emotional and restorative responses jointly explain a substantial proportion of variance in MLW attractiveness, highlighting that aesthetic judgements of retail façades are not purely formal or material-based but are deeply grounded in affective experience. This finding corroborates aesthetic emotion research suggesting that architectural appreciation is shaped by integrated emotional states rather than by isolated visual features [47,48]. In the context of luxury retail, where façade design plays a symbolic and experiential role, MLWs appear to enhance façade attractiveness by embedding emotional comfort and psychological value into the entrance experience.

5.2. Behavioural Implications and Theoretical Advancement

The full mediation effect of façade attractiveness between organismic responses and behavioural intentions provides strong empirical support for the S–O–R framework in façade-level retail research. The absence of significant direct paths from MLW presence to behavioural intentions indicates that consumers do not respond behaviourally to biophilic façades simply because greenery is present [73]. Instead, behavioural intentions emerge through a sequential process in which perceptual naturalness and emotional responses are translated into an overall aesthetic evaluation before influencing approach and phototaking behaviour [30,74]. This finding reinforces the argument that affect-driven models are essential for understanding consumer behaviour in built environments [42,43].

The strong effect of façade attractiveness on both approach intention and phototaking intention reflects contemporary luxury retail consumption patterns, where visual engagement and experiential value are central to consumer behaviour [50]. MLWs appear to support not only physical approach tendencies but also visually mediated engagement, suggesting their relevance in both on-site experience and image-based interaction. These results are consistent with prior research indicating that emotionally engaging and visually warm retail environments foster approach behaviour and consumer involvement [51].

From a broader perspective, the findings also align with sustainability-oriented consumer research, which suggests that visible environmental initiatives enhance store legitimacy, consumer identification, and psychological well-being [3,75]. By integrating MLWs into entrance façades, retailers can simultaneously convey environmental responsibility and enhance experiential quality, supporting the integration of sustainability into customer experience design rather than treating it as a purely symbolic or technical attribute.

This study makes a significant theoretical advancement by bridging environmental psychology with luxury retail architectural design through the S–O–R framework:

- Extension of the S–O–R Framework: This study extends the S–O–R framework to fa-çade-level biophilic stimuli, demonstrating that brief pre-entry exposure to MLWs can activate structured perceptual–affective–evaluative pathways that shape behavioural intentions.
- Identification of a Higher-Order Integrative Construct: It also identifies façade attractiveness as a higher-order integrative construct that translates emotional and restorative responses into consumer action.

- Validation of Sequential Mediation: The findings confirm that the influence of MLWs on consumer behaviour occurs through a structured chain of internal processes rather than a direct stimulus–response effect.

5.3. Practical Implications for Industry Stakeholders

The findings have practical implications for several stakeholder groups involved in luxury retail development. For clients, developers, and retail asset owners, the results suggest that MLWs are not merely decorative green features, but façade-level interventions that can enhance first impressions and strengthen consumer engagement. This is consistent with previous studies showing that exterior greenery and retail atmospherics can influence customer perception and behavioural responses [6,29,30].

For architects and retail designers, the findings indicate that MLWs should be considered as psychologically active façade elements rather than purely aesthetic additions. Prior research has shown that façade composition and exterior design affect customer judgments and entry decisions [20–22,50]. The present study extends this by showing that MLWs can enhance perceived naturalness, emotional response, and façade attractiveness in pre-entry retail settings.

The findings are also relevant to façade manufacturers and green-wall contractors. While earlier studies mainly emphasised the technical and environmental performance of living wall systems [17,18,37,38], this study suggests that their psychological and behavioural value should also be considered. In luxury retail environments, planting quality, visual coherence, and maintenance are likely to influence the effectiveness of MLWs as consumer-facing design interventions.

Finally, for mall operators and brand managers, the strong effect of façade attractiveness on approach and photo-taking intention suggests that MLWs may serve both as sustainability features and as experiential branding devices in high-end retail contexts [31,51,63].

5.4. The Impact of Sustainable Building Policies

The findings also have policy relevance for sustainable architecture, particularly in Malaysia. Existing research has shown that sustainable building implementation is often constrained by cost, technical limitations, and uncertainty about returns [7–13]. As a result, sustainability in commercial buildings is frequently treated as a technical issue rather than a user-centred design strategy. The present study adds to this discussion by showing that MLWs can generate not only environmental benefits, but also perceptual, emotional, and behavioural benefits in real retail settings.

In the Malaysian context, previous studies on MLWs have mainly focused on thermal and environmental performance [38–40]. This study extends that evidence by highlighting their potential contribution to user experience and façade attractiveness. This suggests that sustainable design policies, urban design guidelines, and green-building assessment systems could place greater emphasis on façade greening as a strategy that supports both environmental quality and public experience.

These implications are also relevant to Southeast Asia and other rapidly urbanising Asian cities, where dense development and limited horizontal green space make vertical greenery especially practical. In such contexts, MLWs may help connect sustainability goals with experiential architectural quality in commercial environments.

5.5. Limitations and Future Research Directions

Several limitations should be acknowledged. First, the cross-sectional design restricts causal inference, and future studies employing longitudinal or experimental designs could provide stronger evidence regarding temporal and causal dynamics. Second, data were

collected at a single luxury retail mall, which may limit generalisability across different cultural, climatic, or architectural contexts. Comparative studies across multiple retail environments, including Western luxury malls, would help to test the robustness of the proposed model. In addition, MLW exposure was operationalised in this study as a general façade-level environmental stimulus. However, MLWs are not static or uniform design elements, and their effects may vary according to plant species composition, physiological condition, lighting, maintenance quality, and the degree of integration with the wider façade design. Therefore, the findings should be interpreted with caution when extended beyond this specific luxury retail context. While this study offers valuable insights, certain limitations provide avenues for further investigation:

- Objective Behavioural Measures: Future research should incorporate objective behavioural measures, such as footfall analysis and dwell time tracking, to complement the self-reported intentions captured in this study.
- Experimental Manipulation: Subsequent studies could involve the experimental manipulation of MLW density, biodiversity, and colour composition to determine the specific botanical configurations that yield the strongest psychological benefits and consumer engagement outcomes
- Cross-Cultural Replication: To enhance the generalizability of the proposed model, cross-cultural replication across different international luxury retail markets (e.g., Europe or North America) is recommended.

6. Conclusions

This study provides field-based evidence that, within a luxury retail setting, visible MLW exposure can influence consumer behavioural intentions through structured psychological mechanisms. Grounded in the S–O–R framework, the findings indicate that the presence of MLWs was associated with higher perceived naturalness, more favourable affective and restorative responses, and stronger evaluations of façade attractiveness, which in turn predicted approach and photo-taking intention. Perceived façade attractiveness emerges as the central evaluative pathway translating internal appraisal into behavioural intentions, explaining a substantial proportion of variance in both approach intention and photo-taking intention ($R^2 \approx 0.68$). The strong effects of façade attractiveness on approach intention ($\beta \approx 0.61$) and photo-taking intention ($\beta \approx 0.59$) highlight the importance of aesthetic evaluation in pre-entry retail decision-making.

These findings should, however, be interpreted with appropriate caution. In the present study, MLWs were modelled as a general façade-level biophilic stimulus rather than as a set of differentiated botanical and design conditions. Therefore, the conclusions do not imply that all MLW systems will produce identical effects irrespective of plant species, planting quality, physiological condition, lighting environment, maintenance level, or design integration. Moreover, because the study was conducted in a single luxury retail context in Kuala Lumpur, cultural and contextual factors should be taken into account when extending the findings to other retail typologies or geographic settings.

Accordingly, the main contribution of this study is not to claim a universal effect of all living wall systems, but to demonstrate a plausible and empirically supported perceptual–affective pathway through which façade-level biophilic design may shape pre-entry consumer response in a specific high-end commercial environment.

Author Contributions: Conceptualization, H.Y. and A.A.-G.; methodology, H.Y. and A.A.-G.; formal analysis, H.Y. and Q.W.; investigation, H.Y. and Q.W.; data curation, H.Y. and Q.W.; writing—original draft preparation, H.Y.; writing—review and editing, A.A.-G.; supervisor, A.A.-G. All authors have read and agreed to the published version of the manuscript.

Funding: The authors would like to express their sincere appreciation to all contributors for their invaluable insights, expertise, and continuous guidance, which have greatly enriched this research. This work was supported by Universiti Putra Malaysia under the Putra Grant (IPS), No. [GP-IPS/2023/9781800].

Institutional Review Board Statement: Ethical review and approval were waived for this study because the survey was fully anonymous, participation was voluntary, and no personally identifiable or sensitive private information was collected from the respondents.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Li, J.; Gou, Z.; Cai, S. Bridging the Development Gap of Green Building in Southeast Asia: Comparison Between Singapore and Vietnam. *J. Green Build.* **2025**, *20*, 199–220. [CrossRef]
2. Corazon, S.S.; Sidenius, U.; Poulsen, D.V.; Gramkow, M.C.; Stigsdotter, U.K. Psycho-physiological stress recovery in outdoor nature-based interventions: A systematic review of the past eight years of research. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1711. [CrossRef]
3. Vadakkepatt, G.G.; Winterich, K.P.; Mittal, V.; Zinn, W.; Beitelspacher, L.; Aloysius, J.; Reilman, J. Sustainable retailing. *J. Retail.* **2021**, *97*, 62–80. [CrossRef]
4. Brengman, M.; Willems, K.; Joye, Y. The impact of in-store greenery on customers. *Psychol. Mark.* **2012**, *29*, 807–821. [CrossRef]
5. Joye, Y.; Willems, K.; Brengman, M.; Wolf, K. The effects of urban retail greenery on consumer experience: Reviewing the evidence from a restorative perspective. *Urban For. Urban Green.* **2010**, *9*, 57–64. [CrossRef]
6. Mower, J.M.; Kim, M.; Childs, M.L. Exterior atmospherics and consumer behavior: Influence of landscaping and window display. *J. Fash. Mark. Manag. Int. J.* **2012**, *16*, 442–453. [CrossRef]
7. Kamranfar, S.; Azimi, Y.; Gheibi, M.; Fathollahi-Fard, A.M.; Hajiaghaei-Keshteli, M. Analyzing green construction development barriers by a hybrid decision-making method based on DEMATEL and the ANP. *Buildings* **2022**, *12*, 1641. [CrossRef]
8. Darko, A.; Chan, A.P. Review of barriers to green building adoption. *Sustain. Dev.* **2017**, *25*, 167–179. [CrossRef]
9. Chan, A.P.; Darko, A.; Ameyaw, E.E.; Owusu-Manu, D.G. Barriers affecting the adoption of green building technologies. *J. Manag. Eng.* **2017**, *33*, 04016057. [CrossRef]
10. Chan, A.P.C.; Darko, A.; Olanipekun, A.O.; Ameyaw, E.E. Critical barriers to green building technologies adoption in developing countries: The case of Ghana. *J. Clean. Prod.* **2018**, *172*, 1067–1079. [CrossRef]
11. Darko, A.; Chan, A.P.C.; Ameyaw, E.E.; He, B.J.; Olanipekun, A.O. Examining issues influencing green building technologies adoption: The United States green building experts' perspectives. *Energy Build.* **2017**, *144*, 320–332. [CrossRef]
12. Häkkinen, T.; Belloni, K. Barriers and drivers for sustainable building. *Build. Res. Inf.* **2011**, *39*, 239–255. [CrossRef]
13. Xian, L.M.; Mydin, M.A.O. Critical Pathways for Advancing Sustainable and Environmentally Responsible Design in Commercial Building Projects. *Prog. Energy Environ.* **2025**, *31*, 35–48. [CrossRef]
14. Garrido, J.P.; Martani, C.; Atta, N.; Talamo, C.; Paganin, G. Integrating cir ating circularity in the design of futur cularity in the design of future-proof retail spaces etail spaces. In *CIB Conferences*; Purdue University: West Lafayette, IN, USA, 2025; pp. 77–87. [CrossRef]
15. De Simone, L.; Pezoa, M. Urban shopping malls and sustainability approaches in Chilean cities: Relations between environmental impacts of buildings and greenwashing branding discourses. *Sustainability* **2021**, *13*, 7228. [CrossRef]
16. Bustami, R.A.; Brien, C.; Ward, J.; Beecham, S.; Rawlings, R. A statistically rigorous approach to experimental design of vertical living walls for green buildings. *Urban Sci.* **2019**, *3*, 71. [CrossRef]
17. Azkorra-Larrinaga, Z.; Erkoreka-González, A.; Martín-Escudero, K.; Pérez-Iribarren, E.; Romero-Antón, N. Thermal characterization of a modular living wall for improved energy performance in buildings. *Build. Environ.* **2023**, *234*, 110102. [CrossRef]
18. Naghibi Rad, P.; Shahroudi, A.A.; Shabani, H.; Ajami, S.; Lashgari, R. Encoding pleasant and unpleasant expression of the architectural window shapes: An ERP study. *Front. Behav. Neurosci.* **2019**, *13*, 186. [CrossRef]
19. Moghtadernejad, S.; Mirza, M.S.; Chouinard, L.E. Facade design stages: Issues and considerations. *J. Archit. Eng.* **2019**, *25*, 04018033. [CrossRef]

20. Majid, Z.K. Exterior façade design and its impact on boosting business and attracting customers in retail sectors. *J. Des. Bus. Soc.* **2022**, *8*, 69–86. [CrossRef]
21. Majid, Z.K. Exterior Façade Design and its Impact on Attracting Customers in Retail Sectors. *J. Emerg. Trends Eng. Appl. Sci.* **2021**, *12*, 172–179. [CrossRef]
22. Khomeiri, F.; Pazhouhanfar, M.; Stoltz, J. The Impact of Architectural Facade Attributes on Shopping Center Choice: A Discrete Choice Modeling Approach. *Buildings* **2025**, *15*, 3161. [CrossRef]
23. Tekin, B.H.; Izmir Tunahan, G.; Disci, Z.N.; Ozer, H.S. Biophilic design in the built environment: Trends, gaps and future directions. *Buildings* **2025**, *15*, 2516. [CrossRef]
24. De Souza, M.; Lee, A.B.; Cook, S. Healthy patients, workforce and environment: Coupling climate adaptation and mitigation to wellbeing in healthcare. *Int. J. Environ. Res. Public Health* **2023**, *20*, 7059. [CrossRef]
25. Becerik-Gerber, B.; Lucas, G.; Aryal, A.; Awada, M.; Bergés, M.; Billington, S.; Zhu, R. The field of human building interaction for convergent research and innovation for intelligent built environments. *Sci. Rep.* **2022**, *12*, 22092. [CrossRef]
26. Yin, J.; Zhu, S.; MacNaughton, P.; Allen, J.G.; Spengler, J.D. Physiological and cognitive performance of exposure to biophilic indoor environment. *Build. Environ.* **2018**, *132*, 255–262. [CrossRef]
27. Yin, J.; Arfaei, N.; MacNaughton, P.; Catalano, P.J.; Allen, J.G.; Spengler, J.D. Effects of biophilic interventions in office on stress reaction and cognitive function: A randomized crossover study in virtual reality. *Indoor Air* **2019**, *29*, 1028–1039. [CrossRef]
28. Tekin, B.H.; Corcoran, R.; Gutiérrez, R.U. A systematic review and conceptual framework of biophilic design parameters in clinical environments. *HERD Health Environ. Res. Des. J.* **2023**, *16*, 233–250. [CrossRef] [PubMed]
29. Van Rompay, T.J.; Tanja-Dijkstra, K.; Verhoeven, J.W.; van Es, A.F. On store design and consumer motivation: Spatial control and arousal in the retail context. *Environ. Behav.* **2012**, *44*, 800–820. [CrossRef]
30. Ortegón-Cortázar, L.; Royo-Vela, M. Nature in malls: Effects of a natural environment on the cognitive image, emotional response, and behaviors of visitors. *Eur. Res. Manag. Bus. Econ.* **2019**, *25*, 38–47. [CrossRef]
31. Rosenbaum, M.S.; Ramirez, G.C.; Camino, J.R. A dose of nature and shopping: The restorative potential of biophilic lifestyle center designs. *J. Retail. Consum. Serv.* **2018**, *40*, 66–73. [CrossRef]
32. Tifferet, S.; Vilnai-Yavetz, I. Phytophilia and service atmospherics: The effect of indoor plants on consumers. *Environ. Behav.* **2017**, *49*, 814–844. [CrossRef]
33. Purani, K.; Kumar, D.S. Exploring restorative potential of biophilic servicescapes. *J. Serv. Mark.* **2018**, *32*, 414–429. [CrossRef]
34. Serra, V.; Bianco, L.; Candelari, E.; Giordano, R.; Montacchini, E.; Tedesco, S.; Schiavi, A. A novel vertical greenery module system for building envelopes: The results and outcomes of a multidisciplinary research project. *Energy Build.* **2017**, *146*, 333–352. [CrossRef]
35. Abd Ghafar, A.; Said, I.; Yeo, L. The Effectiveness of Modular Living Wall System for Heat Reduction A Case Study of an Urban Transformation Center in Pasir Gudang. *Malays. J. Sustain. Environ.* **2025**, *12*, 113–132. [CrossRef]
36. Abd-Ghafar, A.; Hashim, M.S.; Mohd-Fauzi, A. Modular Living Wall System Response to Relative Humidity and Air Temperature in Malaysia. *Int. J. Acad. Res. Bus. Soc. Sci.* **2023**, *13*, 14–21. [CrossRef] [PubMed]
37. Ghazalli, A.J.; Brack, C.; Bai, X.; Said, I. Physical and non-physical benefits of vertical greenery systems: A review. *J. Urban Technol.* **2019**, *26*, 53–78. [CrossRef]
38. Yi, H.; Abd Ghafar, A.; Ghazalli, A.J.; Mohd Fauzi, A. Impact of vertical greening systems on particulate matter in China: A review. *Alam Cipta* **2025**, *18*, 178–201. [CrossRef]
39. Shao, Y.; Zhou, Z.; Ding, D.; Cui, Y.; Wu, X. Psychological Effects of a Living Wall System on Office Occupants: A Comparative Study Based on Physiological Responses. *Buildings* **2024**, *14*, 1981. [CrossRef]
40. Yeom, S.; Kim, H.; Hong, T. Psychological and physiological effects of a green wall on occupants: A cross-over study in virtual reality. *Build. Environ.* **2021**, *204*, 108134. [CrossRef]
41. Russell, J.A.; Mehrabian, A. Distinguishing anger and anxiety in terms of emotional response factors. *J. Consult. Clin. Psychol.* **1974**, *42*, 79. [CrossRef]
42. Donovan, R.J.; Rossiter, J.R.; Marcoolyn, G.; Nesdale, A. Store atmosphere and purchasing behavior. *J. Retail.* **1994**, *70*, 283–294. [CrossRef]
43. Chang, H.J.; Eckman, M.; Yan, R.N. Application of the Stimulus-Organism-Response model to the retail environment: The role of hedonic motivation in impulse buying behavior. *Int. Rev. Retail. Distrib. Consum. Res.* **2011**, *21*, 233–249. [CrossRef]
44. Liu, J.; Zhu, Y.; Liu, J.; Wang, P. Unraveling tourist behavioral intentions in historic urban built environment: The mediating role of perceived value via SOR MODEL in Macau's heritage sites. *Buildings* **2025**, *15*, 2316. [CrossRef]
45. Ratnasari, A.; Dwisusanto, Y.B. Biophilic Design as a Bridge for Human-Environment Interaction to Enhance Users' Health and Well-Being. In *IOP Conference Series: Earth and Environmental Science*; IOP Publishing: Bristol, UK, 2025; Volume 1488, p. 012068. [CrossRef]
46. White, E.V.; Gatersleben, B. Greenery on residential buildings: Does it affect preferences and perceptions of beauty. *J. Environ. Psychol.* **2011**, *31*, 89–98. [CrossRef]

47. Schindler, I.; Hosoya, G.; Menninghaus, W.; Beermann, U.; Wagner, V.; Eid, M.; Scherer, K.R. Measuring aesthetic emotions: A review of the literature and a new assessment tool. *PLoS ONE* **2017**, *12*, e0178899. [CrossRef] [PubMed]
48. Coburn, A.; Kardan, O.; Kotabe, H.; Steinberg, J.; Hout, M.C.; Robbins, A.; Berman, M.G. Psychological responses to natural patterns in architecture. *J. Environ. Psychol.* **2019**, *62*, 133–145. [CrossRef]
49. Li, C.; Yuan, Y.; Sun, C.; Sun, M. The perceived restorative quality of viewing various types of urban and rural scenes: Based on psychological and physiological responses. *Sustainability* **2022**, *14*, 3799. [CrossRef]
50. Zhu, Z.; Liu, Y.; Chen, Y. The influence of emotional response and aesthetic perception of shopping mall facade color on entry decisions—Evidence from the Yangtze River Delta region of China. *Buildings* **2024**, *14*, 2302. [CrossRef]
51. Sachdeva, I.; Goel, S. Retail store environment and customer experience: A paradigm. *J. Fash. Mark. Manag.* **2015**, *19*, 290–298. [CrossRef]
52. Chebat, J.C.; Michon, R. Impact of ambient odors on mall shoppers' emotions, cognition, and spending: A test of competitive causal theories. *J. Bus. Res.* **2003**, *56*, 529–539. [CrossRef]
53. Chang, H.J.; Chen, P.Y. The influence of green atmospherics on consumers' emotional responses and behavioural intentions. *J. Retail. Consum. Serv.* **2021**, *61*, 102546. [CrossRef]
54. Hair, J.F. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*; Sage: Thousand Oaks, CA, USA, 2014.
55. Owolabi, H.O.; Ayandele, J.K.; Olaoye, D.D. A systematic review of structural equation model (SEM). *Open J. Educ. Dev.* **2020**, *1*, 27–39. [CrossRef]
56. Gonçalves, P.; Grilo, A.F.; Mendes, R.C.; Vierikko, K.; Elands, B.; Marques, T.A.; Santos-Reis, M. What's biodiversity got to do with it? Perceptions of biodiversity and restorativeness in urban parks. *Ecol. Soc.* **2021**, *26*, 25. [CrossRef]
57. Zheng, S.; Zhou, Y.; Qu, H. Physiological and psychological responses to tended plant communities with varying color characteristics. *J. For. Res.* **2024**, *35*, 32. [CrossRef]
58. Meyer-Grandbastien, A.; Burel, F.; Hellier, E.; Bergerot, B. A step towards understanding the relationship between species diversity and psychological restoration of visitors in urban green spaces using landscape heterogeneity. *Landsc. Urban Plan.* **2020**, *195*, 103728. [CrossRef]
59. Xiang, Y.; Liang, H.; Fang, X.; Chen, Y.; Xu, N.; Hu, M.; Gao, T. The comparisons of on-site and off-site applications in surveys on perception of and preference for urban green spaces: Which approach is more reliable. *Urban For. Urban Green.* **2021**, *58*, 126961. [CrossRef]
60. Turley, L.W.; Milliman, R.E. Atmospheric effects on shopping behavior: A review of the experimental evidence. *J. Bus. Res.* **2000**, *49*, 193–211. [CrossRef]
61. Malekinezhad, F.; Courtney, P.; bin Lamit, H.; Vigani, M. Investigating the mental health impacts of university campus green space through perceived sensory dimensions and the mediation effects of perceived restorativeness on restoration experience. *Front. Public Health* **2020**, *8*, 578241. [CrossRef] [PubMed]
62. El-Den, S.; Schneider, C.; Mirzaei, A.; Carter, S. How to measure a latent construct: Psychometric principles for the development and validation of measurement instruments. *Int. J. Pharm. Pract.* **2020**, *28*, 326–336. [CrossRef]
63. Rhodes, R.E.; Cox, A.; Sayar, R. What predicts the physical activity intention–behavior gap? A systematic review. *Ann. Behav. Med.* **2022**, *56*, 1–20. [CrossRef]
64. Dobler, G.; Vani, J.; Dam, T.T.L. Patterns of urban foot traffic dynamics. *Comput. Environ. Urban Syst.* **2021**, *89*, 101674. [CrossRef]
65. Kopelman, L.M. Minimal risk as an international ethical standard in research. *J. Med. Philos.* **2004**, *29*, 351–378. [CrossRef]
66. Curran, D.; Molenberghs, G.; Fayers, P.M.; Machin, D. Incomplete quality of life data in randomized trials: Missing forms. *Stat. Med.* **1998**, *17*, 697–709. [CrossRef]
67. Hu, L.T.; Bentler, P.M. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct. Equ. Model. Multidiscip. J.* **1999**, *6*, 1–55. [CrossRef]
68. Magno, F.; Cassia, F.; Ringle, C.M. A brief review of partial least squares structural equation modeling (PLS-SEM) use in quality management studies. *TQM J.* **2024**, *36*, 1242–1251. [CrossRef]
69. Fornell, C.; Larcker, D.F. Evaluating structural equation models with unobservable variables and measurement error. *J. Mark. Res.* **1981**, *18*, 39–50. [CrossRef]
70. Menatti, L.; Casado da Rocha, A. Landscape and health: Connecting psychology, aesthetics and biophilic design. *J. Environ. Psychol.* **2022**, *79*, 101715. [CrossRef]
71. Vanhöfen, J.; Härtel, T.; Reichert, G.; Randler, C. The relationship between perception and landscape characteristics of recreational places with human mental well-being. *Sci. Rep.* **2025**, *15*, 4245. [CrossRef] [PubMed]
72. Schertz, K.E.; Sachdeva, S.; Kardan, O.; Kotabe, H.P.; Wolf, K.L.; Berman, M.G. A thought in the park: The influence of naturalness and low-level visual features on expressed thoughts. *Cognition* **2018**, *174*, 82–93. [CrossRef]
73. Molari, M.; Dominici, L.; Manso, M.; Silva, C.M.; Comino, E. A socio-ecological approach to investigate the perception of green walls in cities: A comparative analysis of case studies in Turin and Lisbon. *Nat.-Based Solut.* **2024**, *6*, 100175. [CrossRef]

74. Menninghaus, W.; Wagner, V.; Wassiliwizky, E.; Schindler, I.; Hanich, J.; Jacobsen, T.; Koelsch, S. What are aesthetic emotions. *Psychol. Rev.* **2019**, *126*, 171. [CrossRef] [PubMed]
75. Saini, S. Customer experience and sustainability in social, environmental and economic contexts. *Int. J. Innov. Sci.* **2025**, *17*, 824–839. [CrossRef]