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Sustainability biophilic design in retail environments: Enhancing consumer experience and sustainability practices

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Abstract

This research examines the impact of biophilic design as a stimulus on consumer experiences in retail settings. Biophilic design aspects have been examined from the perspective of both the fields of environmental psychology and marketing. This research uses the concepts of the Stimulus-Organism-Response paradigm (SOR), the attention restoration theory (ART), the temporal engagement theory (TET), and signaling theory. This effort examines the relationship between the impact of biophilic designs and customer perceptions regarding the satisfaction and sustainability of brands. The methodology used has been the administration of a cross-sectional survey in both Jordan and Palestine. This has allowed the empirical verification of the structural mode of the experiment. This experiment proposes that the factor of biophilic designs has positive effects related to customer satisfaction and the perceptions related to the sustainability of brands, because the in-store time factor acts as the mediator. This effort highlights the fact that biophilic designs have positive effects because the related store environments can stimulate positive experiences related to the extended duration of the positive experiences. This outcome has positive effects because the effect related to biophilic designs can influence the effect related to customer satisfaction.

Keywords: Biophilic design, Customer experience, Retail marketing, Sustainability perception, Dwell time, Experiential store design

1. Introduction

The retail industry today also has a paradigm shift concerning the definition of the store. Instead of the store being considered a passive sales point, the store is designed as a space that has the potential to influence the customer emotionally and cognitively at the point of physical interaction [1]. The store as a retail experience has been considered as an active service environment that creates immersed experiences outside of the product offerings rather than physical price [2]. This perspective has been based on the classic stimulus, organism, response paradigm, where the store environment can stimulate the customer internally to produce experiential reactions like satisfaction and behavior rather than physical purchase as a stimulus, since the physical store environment can influence the customer's behavior rather than physical designs [3].

In this paradigm, biophilic design has emerged as a specific type of strategic language in retail design. Biophilic design can be described as the intentional integration of natural elements such as daylight, plants, water, organic materials, and visual/spatial pointers towards nature indoors as a means of achieving the stimulation of psychological comfort and cognitive ease [4]. Research conducted in the area of environmental psychology has identified the role of exposure to biophilic elements as beneficial in restoring directed attention, reducing mental fatigue, and triggering positive states of arousal at lower levels corresponding to the intensities linked to stress relief and cognitive clarity [5]. Nonetheless, the preponderance of this paradigm has been couched in the rhetoric and language of the health field and office spaces for the "healing" and "restorative" functions [6].

In contrast, retailing as a symbolic-transactional space encompasses the visitor as both the 'buyer' as well as the interpreter of the 'meaning' at the same time as being the 'subject' of the intentional experiential narration [2]. Thus, the question being investigated here is whether biophilic design, as used in retail, should merely remain as a comfortable option or whether biophilic design should instead be conceived as the 'instrument' that influences attitudes towards the brand as well as the cognizance of the attendant behaviors linked to the specific brand [7].

However, the existing body of knowledge has a weakness when biophilic retail environments are considered in immediate affective experience: "it feels calm," "it feels enjoyable," rather than breaking down the relationship between the experiential outcome of this feeling and the specific behavior-related outcome measures of retail experience satisfaction and the willingness for sustained involvement in the store brand [7], [8]. This overlooks two considerations. Firstly, retail experience has been argued as a layered, cumulative process over time as the customer stays in the store and engages the spatial environment during their physical traversal of the store space [1], [9].

Secondly, staying longer in the store has specific significance. When the customer stays longer in the store simply because the retail environment has facilitated comfort experiences related to reduced cognitive and psychological effort, the customer experiences more than the feeling of enjoyment; rather, the customer embarks upon the journey of experiential transition when the attention paradigm shifts from being defensive to exploratory [9]. Staying longer in the store, under such circumstances, has more significance than simply being a befriending factor. Rather, staying longer in the store serves as a mediator between spatial experience influences and downstream consequences related to experiential store satisfaction and the customer's attachment to the store as a spatial location [10].

Despite this dominant perspective, the current state of the literature leaves open the question of how, as a temporal factor, the bioenvironment present in the store contributes to something beyond a merely instantaneously pleasing visual trigger. Whether the length of consumer presence in the store serves as a determinate mediating route that yields a measured consumption outcome from bioenvironmental design features, or simply as an afterthought of the overall experience, remains unclear. Furthermore, this interpretive relationship connecting biosigns present in the store, such as natural light, plants, and living materials, and consumer perceptions of sustainability, continues to remain unclear, as these features could be seen to denote some tokenistic commitment to true sustainability, versus some kind of potential atmospheric trigger open to interpenetration by the consumer, as it does in the Middle Eastern markets, where the meanings of these two concepts remain determined by culture.

The other unresolved issue arising from the aforementioned topic relates to the view of sustainability. Sustainable retailing can quite accurately be considered as a form of communication that involves signs and messages pointing towards greater concern for the environment [11]. This form of communication supposes that the credible aspect of sustainability can only be given through discourse: in other words, the firm has to convince the customer of the virtues of sustainability. This positioning can, however, be contested through signaling theory. According to this theory, the prediction that customers will view the firm as credible in retailing sustainable products relies not on discourse but rather on visible signs and signals that highlight the firm's commitment to positive environmental actions [12]. Such signs can therefore include the inclusion of

biophilic features such as the use of reclaimed wood materials in store designs, plants present in the store's interior design environment, the use of natural light sources as compared to strong man-made sources of light that can create discomfort among customers, as well as water features as biophilic components that uniformly signal to the customer the firm's commitment to the environment both at the discourse level as well as at the spatial level [12], [13]. In this case, the cues can increase the customer's view and assessment of the firm as credible towards sustainable retailing practices. Such cues can increase the firm's trustworthy status as related to the customer. This status forms the basis for the tangible aspects of customer satisfaction related to the firm's retailing as sustainable [8].

Building on these gaps, this study presents an integrated explanatory model that connects biophilic design, time spent in the store, experiential satisfaction, and sustainability perception in a single causal structure. By doing so, the paper extends current research by integrating the S-O-R model, attribution theory (ART), and signaling theory into a single testable model and validating it using a cross-country approach and data from Jordan and Palestine. The model sees biophilic design as the environmental stimulus that triggers psychological and emotional states in the consumer, following the stimulus, organism, response tradition [4]. It views time spent in the store as a way to engage rather than just a passive outcome. The argument is that spending more time in a calming environment enhances immersion and helps process and internalize symbolic and ethical cues [9]. It defines satisfaction as an emotional and relational assessment of the retail experience, not just a judgment of service quality [1], [2].

Finally, it presents sustainability perception as an interpretation of the brand's ecological credibility, influenced by both symbolic understanding and actual exposure to design choices that seem eco-friendly [13]. By connecting these aspects, the model shifts the discussion from "Do natural elements make the store nicer?" to "Through what pathway does nature-infused retail space create measurable strategic value?" [8], [11].

Such an approach has obvious managerial implications. If biophilic design influences dwell time positively, as it affects perceptions of comfort and cognitive effort, and subsequently leads to greater satisfaction with the visit experience, design goes beyond mere ambiance and represents a resource-driving factor [14]. If the same design principles influence perceptions of credible commitment to the environment and the belief that the retailer pursues its goals responsibly rather than simply claiming to do so in advertisements, biophilic design transcends a mere stylistic solution and represents a sustainable competitive advantage in resorting to the positioning of the store as a trustworthy steward of the environment [15]. This suggests that the physical store provides a basis for the simultaneous creation of competitive advantage based on both experiential attachment and perceptions of the store as a trustworthy entity guided by principles of integrity [16].

In this regard, the present study introduces biophilic design concepts as a functional tool influencing the extent to which consumers feel differently, stay longer in the physical store, and believe more strongly in the retailer's commitment to the environment, placing spatial designs at the forefront as functional factors in the sustainable retailing strategy rather than at the end of the strategy as a purely stylistic aspect.

2. Literature review and hypothesis development

2.1. Biophilic design and consumer satisfaction

Biophilic design improves customer satisfaction through the creation of a retail environment that mitigates stress, restores attention, and provides a feeling of ease rather than pressure [17]. Nature-based elements like plants, sunlight, natural wood and rock textures, and water features can promote calm, counteract cognitive fatigue, and produce positive affect during the shopping event [5]. This supports the SOR paradigm, whereby the physical environment of the retail store serves as a stimulus influencing the shopper's subjective internality, the shopper's feeling state. This feeling state can predict satisfaction and behavior [3], [18].

In biophilic environments, shoppers perceive greater safety, greater welcome, and reduced cognitive overload. These internal perceptions become the antecedent to more positive evaluations of the store and the shopping

event [12], [16]. From empirical studies based in retailing environments, the effect of interacting with nature-like environments promotes greater self-reported customer satisfaction and positive attitudes toward the store and the brand compared to traditional store designs incorporating nature-like elements [14], [19]. This provides clear evidence that biophilic design has commercial outcomes because of its role as an effective regulator of customer feeling states [16].

Satisfaction can also be anticipated as a consequence of multisensory immersion and psychological need satisfaction, both of which drive how the consumer experiences the store as a space rather than as a purchasing occasion [20]. Biophilic spaces stimulate the senses in a gentle manner: visual softness, organic touch, and gentle natural sounds. This multisensory congruity facilitates orientation, reduces alertness, and enables decision-making as a more fluent and less defensive process [21]. Self-determination theory proposes that enabling autonomy, competence, and relatedness in environments will increase the indices of well-being because the person feels free to operate effortlessly rather than struggling [2]. Such a biophilic retail environment can meet the requirements for autonomy, reduced strain through perceptual overload, and freedom of exploration as the customer feels neither pushed nor observed [22]. As long as the customer feels intellectually facilitated and emotionally recognized, the desire to remain and become involved and evaluate the brand as a positive option follows logically, assuming satisfaction as a relationship rather than a passing event [14], [19]. On this basis, we hypothesize:

H1: Biophilic design has a positive effect on customer satisfaction.

2.2. Biophilic design and sustainability perception

Biophilic design influences the way the consumer ascribes environmental authenticity to the retailer because biophilic design serves as a non-verbal form of sustainability communication within the retail environment rather than merely being used as ornamentation [23]. Signaling theory states that individuals draw inferences based upon visible and expensive signals present in the environment because these signals reveal non-obvious attributes of the firm, such as a lack of ecology, the opposite of the signal a firm wishes to convey [11]. Light from the sun, live plants, wood, water features, and other materials derived from nature are considered signals because they represent the investment made towards actualizing the firm's self-proclaimed commitment to the environment as more than merely superficial [19]. This type of signal towards the customer influences the ascription of green motives towards the firm as more trustworthy because the firm appears more credible when, in fact, making assertions towards the customer about its role as a sustainable brand, when in actuality the firm has merely included green materials as biophilic design components [12].

This perceptual outcome can also be strengthened psychologically. Attention restoration theory argues that exposure to natural stimulation will recondition depleted cognitive resources and counteract cognitive overload, allowing individuals to attain a relaxed and more reflective mindset [5], [24]. In a commercial context, this relaxed mindset means greater acceptance of the retail environment's messaging and greater malleability for seeing the store as authenticating organizational commitments to ethics and the environment [11]. This effect can only be multiplied by multisensory immersion.

As the soothing sounds of nature, organic textures, and the visual greenery of plants deliver the “greening” retail experiential strategy in multisensory immersion experiences, the shopping environment immerses the customer in their “own” green story,” as the physical retail space communicates the store's authenticity as affirming values related to the customer's sustainability ideals [20], [21]. Just as anticipated, when customers believe the retail space communicates their sustainability ideals at their unique values approached differently by the store strategy, the customer indicates greater attachment to the retail business or concern store as related to their customers' greater adherence to store sustainability ideals [14]. On this basis, we hypothesize:

H2: The incorporation of biophilic design principles enhances consumers’ sustainability perception of the retail environment.

2.3. Biophilic design and time spent in store

Dwell time in the store is also very important to the business as more time in the store correlates to greater exploration, unplanned product try-out activities, and brand attachment [25]. This provides the retail environment with the challenge of slowing customers down and encouraging meandering behavior rather than merely facilitating business-based pass-through behavior [14], [26]. Biophilic design continues this effort by emphasizing the store as a positive, rewarding environment where customers feel safe and comfortable enough to remain rather than feeling cognitively drained or irritable [27]. Nature-based elements such as live plants, simulated sunlight effects, water effects, and organic materials communicate soft, protected environments that reduce alertness and perceived threat to time [25]. This indicates that when the shopping environment provides relief rather than stressful stimulation, customers will become comfortable, allowing time to pass at their leisure rather than merely trying to escape the store as quickly as possible [28]. Research studies based on the service-scape suggest that comfortable shopping surroundings that stimulate enjoyable shopping moods cause customers to remain longer and meander unpredictably through the store, allowing them to view more products and increasing opportunities for unplanned impulse buying [27].

ART explains how biophilic design positively influences dwell time, as the stimulation of natural elements restores people's directed attention and counteracts the effects of fatigue [29]. The use of trees as indoor micro-destination components to signify the soothing aspects of nature replenishes shoppers' depleted attention resources [30]. Thus, the shopper stays alert and composed rather than adopting the behavior of someone tired and looking for the quickest way out of the shopping destination. This has important behavior-related effects as relaxed customers remain longer in the shopping space and let their curiosity rather than their impulse to exit drive their behavior [31]. This multisensory destination environment both calms and engages customers because being visually immersed in greenery and physically interacting with natural materials as the ambient environment provides a self-satisfying and functional experience [20], [32]. Thus, the shopping destination uses the more relaxed visitor as a channel through which the biophilic elements translate the shopper's relief and relaxation into profit. On this basis, we hypothesize:

H3: Biophilic design positively affects the amount of time customers spend in the store.

2.4. The mediating role of time spent in the store

In-store time represents both a desirable behavior outcome for the retailer and the channel through which biophilic design impacts the customer experience assessment and the brand relationship [14]. In fact, a biophilic environment can promote longer in-store time because the shopping space can become more cognitively restorative, sensorially soothing, and emotionally supportive rather than tiring or forceful [11]. According to the ART, exposure to natural stimulation can improve directed attention and prevent cognitive tiredness and overload because the visitor can get revitalized rather than feeling depleted [29]. This type of extended behavior has great significance since the longer the customer stays in the soothing and coherent area, the more opportunities the visitor has to examine the goods and commodities found in the store, as well as to get the gist of the information at their own convenient tempo [2]. After that, the customers tend to decipher the store as a spot not only of purchase but also as a space representing specific values and meanings and intentions of the store, like the “pro-sustainable” goals expressed through biophilic materials like plants as green elements visible in the store signage [32].

Moreover, longer exposure in the store also amplifies the affective-interpretive components. As the customer stays longer in the biophilic environment, the customer goes through the cyclical experience of relief from stress, sensory stimulation, and perceptual accommodation. This leads to the cumulative effect of a positive emotional state and easier decision-making [20]. This indicates that customer satisfaction can neither remain exclusively aligned with the relief-oriented response exerted by plants, sunlight, and natural materials [33]. Rather, as argued in the context of other studies [16, 32], the cumulative effect of the biophilic experience has been that the customer experiences the sustained positive effects of comfort. This enables the customer to

develop a positive and lasting impression of the shopping experience [14], thereby allowing the customer to form a positive biophilic attribute towards the shopping experience. Empirical studies have found that customers staying longer in nature-infused shopping stores tend to reveal higher customer satisfaction and attachment towards the store compared to customers who remain shorter in the store [19]. On this basis, we hypothesize:

H4: Time spent in the store mediates the relationship between biophilic design and customer satisfaction.

2.5. Mediation between biophilic design and sustainability perception

The time the customer spends in the store serves as the channel whereby biophilic design influences the consumer's perceptions towards the retailer's authenticity and credibility concerning the environment and their commitment to the continuity of sustainable practices [11], [14]. A biophilic design immerses the customer in an environment that can communicate information about sustainable practices through signs such as wood materials used in the store or the greenery viewed in the store.

Moreover, the immersions can communicate information related to resource cuts through signs such as natural light. This serves as the implicit sign that communicates information related to the values of the customer rather than as a slogan [34]. The longer the customer spends in the store, the more the customer can encode the information rather than get exposed to the information in passing [1], [29]. Moreover, the longer the customer stays in the immersions of the store environment, the more the customer can observe patterns like plants that have been cared for. In fact, the observations demonstrate that the customer can get information concerning the commitment of the store to sustainable services through signs like the use of recycled materials [35]. This serves to reinforce the fact that the store sells commodities but also adheres to the principles of sustainable practices.

Even longer visits can increase the positive congruity between “feeling good here” and “this brand is green,” and the stronger the congruity, the longer the customer stays [40, 41]. The attention restoration theory proposes that exposure to nature-like aspects restores the mind and diminishes the effects of cognitive fatigue, thereby placing the customer in a receptive rather than a defensive-hasty mode [1, 29]. In this mode, the customer can more feasibly absorb the retailer's signals about its green traits as credible rather than biased marketing communications [2], [11]. Research in nature-rich retail environments illustrates that customers staying longer in the nature-rich retail store felt more trustworthy towards the brand's green claims and more convinced that the firm cares about the green cause than customers staying shorter in the nature-rich retail store [19]. This empirical anecdote illustrates the indirect communication of the firm's green appeals through biophilic store designs that essentially keep customers longer in the store, long enough to incorporate the green appeal as the brand's essence [35]. Accordingly, we hypothesize:

H5: Time spent in the store mediates the relationship between biophilic design and sustainability perception.

These hypothesized causal relationships are presented visually in Figure 1.

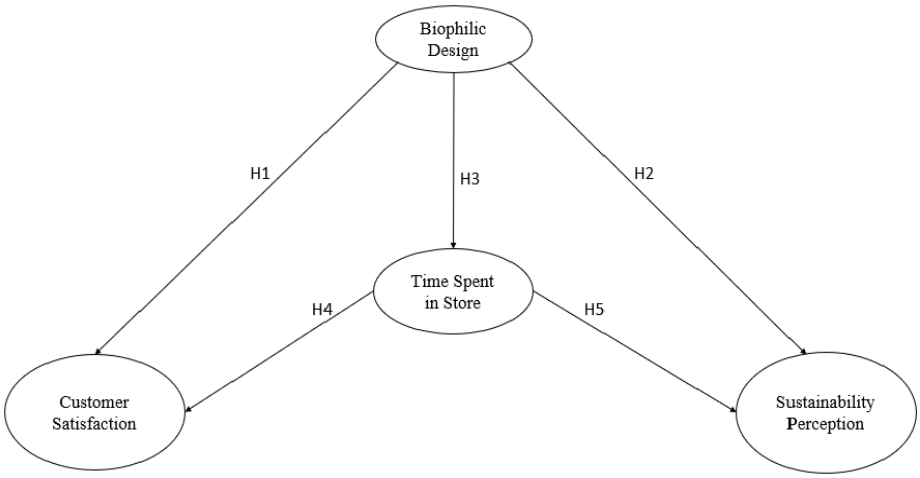

Figure 1. Hypothesized model

3. Materials and methods

3.1. Sampling

The research focused on adult consumers in Jordan and Palestine with experience of biophilic retail environments, that is, retail stores incorporating visible elements of nature like plants, sunlight, water features, and natural materials [12], [17]. These two markets were selected as the awareness of sustainability and green consumption story has been more prominently observed in both countries, making consumers more receptive to the cues and positioning of the retail store concerning the environment [1], [35]. This selection of markets also addresses the concern of generalizing findings from the West and analyzes how the biophilic designs infused in retail stores can become experiential comfort as well as a signal of sustainable consumption among consumers in the urban geography of the Middle East [15]. Analysis based on the two countries can reveal how the cultural context frames the reception of biophilic signals at the psychological level and how the reception of signals influences customer satisfaction and perceptions of sustainability.

"A purposive (judgment) sampling method has been employed to ensure the sampled respondents were meaningfully pre-exposed to biophilic store environments. This type of sampling strategy can be considered appropriate when the outcome depends on the informed assessment rather than the naive assessment [2]. The respondents were approached directly through online dissemination (social and email), and only those pre-exposed to the nature-integrated stores were retained. This helps secure the validity of the respondents' judgments and assessment of the effects of biophilic design [16]. This gave the required 600 useful responses that were perfectly divided between Jordan (n=300) and Palestine (n=300), following the elimination of respondents considered unaware of nature-based design elements found in retail stores [14], [16], enhancing the constructs' relevance and the utility of the perceptual measures.

Data were collected through an online self-administered questionnaire, which allowed parallel data gathering in both countries with minimal interviewer bias and consistent presentation of items across regions [11], [36]. To ensure the experience was relevant, respondents were screened to confirm that they had visited retail environments incorporating nature-based elements such as plants, natural light, and natural materials within the last nine months. Online administration encouraged privacy and voluntary participation, which tends to lower social desirability pressure in sustainability-related judgments, where respondents may otherwise overstate pro-environmental concern to appear responsible [35]. All participants provided informed consent, and confidentiality was maintained, aligning the procedure with ethical standards for research with human subjects in marketing and services contexts [14]. In sum, the sampling approach, sample size, and data-collection mode were designed to isolate informed consumers of biophilic retail spaces, capture cross-cultural variation in emerging sustainable retail markets, and support robust multivariate testing of the proposed model relating biophilic design to satisfaction, dwell time, and sustainability perception.

3.2. Data analysis and measurement instrument

The picture shows a structural equation modeling (SEM) diagram that was designed using SmartPLS4, which is a partial least squares (PLS) analysis program. SEM is a powerful tool of statistics that can be used to study complex relationships between latent and observed variables.

For this research, to ensure terminological consistency, the term ‘sustainability perception’ is used to assess the retailer's ecological credibility, while ‘time spent in the store (dwell time)’ refers to in-store time as a behavioral engagement measure. Therefore, sustainability perception is denoted SP, and time spent in the store is denoted TS.

The measurement model focuses on the fit between the observed variables and the constructs. This also has to come before the analysis of the structural model [37]. For the current analysis, the constructs are considered reflectively. This indicates that the observed variables are expected to correlate because their content revolves around the same topic. Reliability can first be determined based on the consistency of the measures. For this

metric, the values should preferably be 0.70 or above. This shows the consistency of the items representing the constructs. However, excessively high values can also end up suggesting redundancy rather than excellence. Composite reliability assessment follows. This specific metric tends to perform more optimally when utilizing PLS-SEM. For this metric, the constructs should preferably have values between 0.70 and 0.90. This suggests the lack of inflation of the measures [37]. Moreover, the rho_A of the Dijkstra-Henseler correlation should exceed 0.70 [37]. On the other hand, very high reliability scores indicate strong internal consistency. While this indicates strong consistency, it may also indicate some overlap among the indicators, with future research assessing whether shorter subsets retain the constructs' explanatory power.

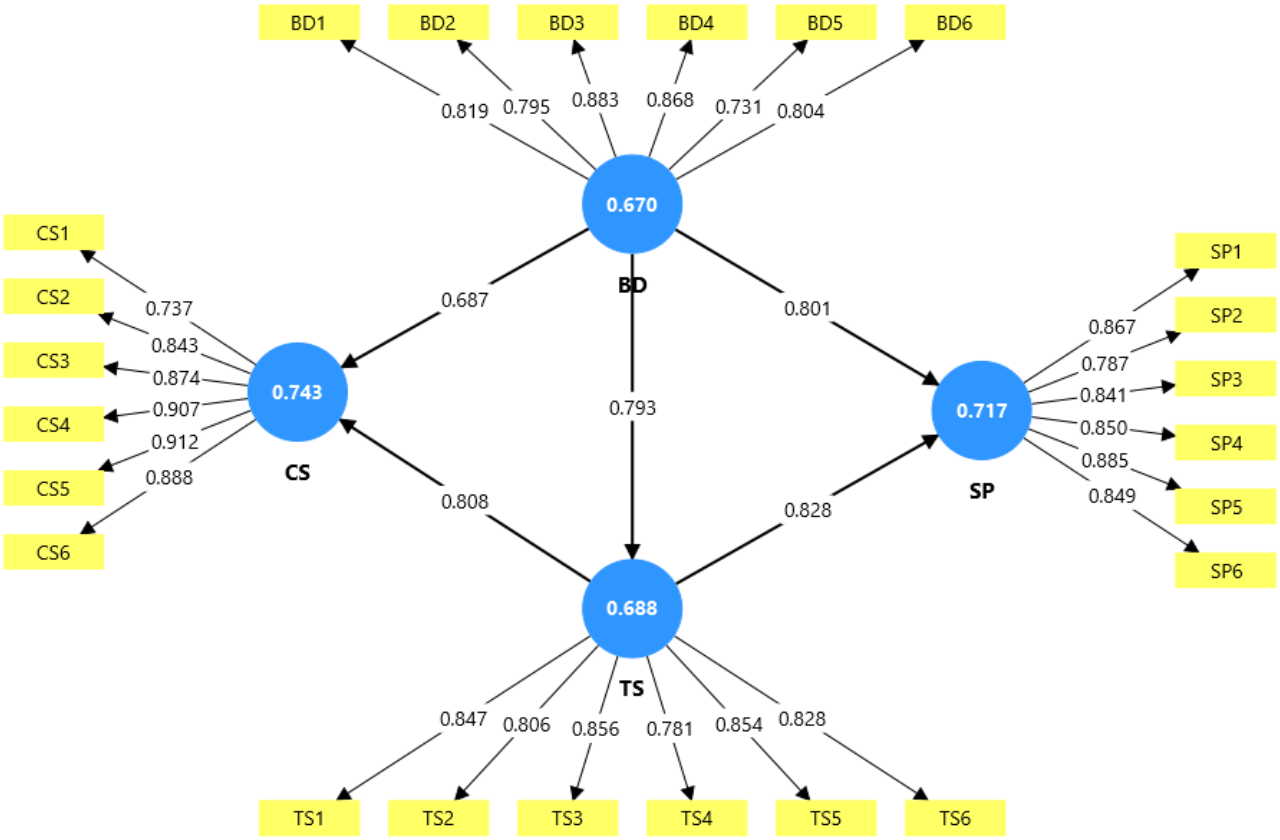

Figure 2. Biophilic Design (BD) model assesses Customer Satisfaction (CS), and the Sustainable Perception model measures the time spent by customers (TS)

Reliability of the indicators can be investigated on the basis of the outer loadings. Ideally, this should exceed 0.70 to demonstrate the strong loading of the observed indicators on their corresponding constructs. The strategy has recommended the deletion of those items whose loadings are below 0.70 unless strong theoretical reasons exist for their inclusion. Second, the average variance extracted (AVE) should demonstrate a minimum of 0.50. This implication indicates the ability of the proposed constructs to explain at least 50% of the total variation in their corresponding set of indicators [37].

Third, the test of the discriminant validity between the constructs can be confirmed if the correlation between each construct and its set of indicators shows stronger bonds than the correlation between the constructs. This indicates the distinct nature of the constructs. Third, multicollinearity can also be tested through the variance inflation factor (VIF), and VIF values should remain below 5. This indicates the avoidance of inflated variances among the set of indicators due to the biasing effects of paths among the constructs [37].

The given Fornell-Larcker table assists analysts in assessing the discriminant validity of Smart-PLS SEM analysis as a valuable evaluation measure of the study. Discriminant validity corroborates the ruthlessness that latent constructs based on the model are solely distinguished in all aspects related to other constructs in the study.

Table 1. Fornell-Larcker criterion

Fornell-Larcker	BD	CS	SP	TS
BD	0.818			
CS	0.687	0.862		
SP	0.801	0.638	0.847	
TS	0.793	0.808	0.828	0.829

Besides the Fornell-Larcker criterion, the heterotrait-monotrait ratio (HTMT) matrix was used to ensure that the variables were discriminated. It is a better procedure to evaluate the conceptual discrimination of the latent variables in the PLS-SEM model. It turned out that the values were less than the maximum tolerated level of 0.90 [37]. Although some ratios are close to the upper boundary (e.g., between time spent and perceived sustainability), this finding provides theoretical justification because satisfaction with purchase, perceived sustainability, and dwell time are conceptually similar variables with acceptable discriminant validity. This establishes that the discrimination between variables is adequate (Biophilic Design, Customer Satisfaction, Sustainable Perception, and the Time Spent by Customers). Consequently, the model can be stated to have high discrimination validity, which justifies the validity of the causal relationship of the proposed relationships among the variables in the structural model.

Table 2. Heterotrait-monotrait ratio (HTMT) matrix

	BD	CS	SP	TS
BD				
CS	0.749			
SP	0.873	0.673		
TS	0.871	0.875	0.888	

The four constructs of the measurement properties that are tested in this table are Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), and Customer Time Spend (TS) measure constructs that are tested using the outer loading, average variance extracted (AVE) analysis, the discriminant validity check of the constructs, and reliability index (RI) check.

Table 3. Measurement properties of Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), Customer's Time Spend (TS)

		Convergence validity		**Discriminant validity**	**Reliability**		
Construct	**Items**	**Outer loading**	**Average variance extracted (AVE)**	**Fornell-Larcker Criterion: Is the square root of AVE for each construct greater than its correlations with other constructs?**	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Cronbach's alpha**
BD	BD1	0.819	0.670	Yes	0.903	0.924	0.900
	BD2	0.795					
	BD3	0.883					
	BD4	0.868					
	BD5	0.731					
	BD6	0.804					

		Convergence validity		Discriminant validity	Reliability		
Construct	**Items**	**Outer loading**	**Average variance extracted (AVE)**	**Fornell-Larcker Criterion: Is the square root of AVE for each construct greater than its correlations with other constructs?**	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Cronbach's alpha**
CS	CS1	0.737	0.743	Yes	0.929	0.945	0.930
	CS2	0.843					
	CS3	0.874					
	CS4	0.907					
	CS5	0.912					
	CS6	0.888					
SP	SP1	0.867	0.717	Yes	0.927	0.938	0.921
	SP2	0.787					
	SP3	0.841					
	SP4	0.850					
	SP5	0.885					
	SP6	0.849					
TS	TS1	0.847	0.688	Yes	0.913	0.930	0.909
	TS2	0.806					
	TS3	0.856					
	TS4	0.781					
	TS5	0.854					
	TS6	0.828					

The present research points to several promising avenues of future research in the emerging area of biophilic retail design. The BD construct demonstrates adequate explanation of indicator variance through its outer loadings, which range from 0.731 to 0.883, and its AVE value of 0.670. Reliability tests show strong consistency between variables through composite reliability calculations and Cronbach's alpha results: rhoc equals 0.924 and rhoa equals 0.903, and Cronbach's alpha measures 0.900. The reliability indicators of CS and SP, and TS together exceeded 0.913, while Cronbach's alpha registered between 0.909 and 0.930, which satisfies all recommended thresholds for reliability evaluation.

The study results show that both reliability and validity levels measure strongly within the Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), Customer Time Spend (TS) research model. The study findings confirm the research recommendations, because these constructs provide critical knowledge about their mutual relationships. The existing relationships, Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), Customer's Time Spend (TS), should remain under investigative analysis while researchers investigate their practical significance for relevant domains.

Table 4 shows the variance inflation factor values for the measurement model variables Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), and Customer's Time Spend (TS). The assessment of multicollinearity through VIF values safeguards the structural model results from possible distortions that might

occur due to high indicator correlations [37]. Multicollinearity issues will not affect results when VIF stands below 5.

Table 4. Variance inflation factor (VIF) of Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), Customer's Time Spend (TS)

Item	VIF	Item	VIF
BD1	2.196	SP1	2.860
BD2	2.130	SP2	2.605
BD3	3.505	SP3	3.172
BD4	3.255	SP4	2.636
BD5	1.707	SP5	3.878
BD6	2.038	SP6	3.306
CS1	1.664	TS1	3.440
CS2	2.729	TS2	2.845
CS3	3.221	TS3	2.694
CS4	4.651	TS4	2.469
CS5	4.905	TS5	3.097
CS6	4.148	TS6	2.949

All VIF values in the measurement model fall below 5.0, thus reflecting low levels of multicollinearity, which does not affect the analysis significantly. The metrics Biophilic Design (BD), Sustainable Perception (SP), and Customer's Time Spend (TS) demonstrate low risk levels of multicollinearity because their VIF ranges between 1.707 and 3.878, whereas Customer Satisfaction (CS) exhibits moderate VIF, ranging from 1.664 to 4.905; this ensures unique indicators to their constructs remain intact. Results demonstrate that the measurement model fulfills the criteria for reliable and suitable use in SEM analysis.

Because data were collected from a single source through a self-administered questionnaire, standard method bias was evaluated for presence. As a diagnostic test, a review of variance inflation factors was conducted. In all cases, VIFs were below 5.0, indicating that no standard method bias systematically affected the relationship. In addition, care had been taken during the design and implementation of the questionnaire for increased emphasis on anonymity.

The developed PLS-SEM analysis includes Table 5, which shows the model fit indices between the saturated model and the estimated model. The observed data evaluation by these indices enables researchers to determine model validity for structural analysis according to Kono and Sato [37]. Standardized root mean square residual (SRMR) and $dULS$ (unweighted least squares discrepancy) and dG (geodesic discrepancy) Chi-square and normed fit index (NFI) represent the main indicators.

Table 5. Model fit indices for both the saturated model and the estimated model

	Saturated model	Estimated model
SRMR	0.079	0.081
d_ULS	1.886	1.963
d_G	1.004	1.005
Chi-square	3145.605	3163.561
NFI	0.780	0.779

A combination of goodness-of-fit indices was applied to determine the structural and standard model fit as applicable to the framework of structural equation analysis, where the partial least squares (PLS-SEM) technique was employed. These indices were interpreted based on recent literature recommendations [37]. On

balance, the model's fitness can be considered acceptable to good for PLS-SEM modeling. At the same time, it must be acknowledged that there have been debates about the use of global fitness indices in PLS-SEM.

Therefore, these indices are viewed as indicative but not conclusive of model fitness. One of the most significant goodness-of-fit indices of PLS-SEM is the SRMR index, which determines the average difference between the correlation matrices, as they were and as they were estimated. An acceptable value: SRMR: to fit appropriately, SRMR is supposed to be 0.08 or less [38]. This research study shows that the SRMR of 0.081 (estimated model) is very near the acceptable range, which shows an acceptable fit. The d ULS index compares the real and the predicted matrices based on the ULS procedure of $dULS = 1.963$ which falls within the permissible range when drawn in comparison to d G.

dG qualifies the difference between matrices geometrically and can be taken as a secondary index; the value of 1 is regarded as acceptable and near it [38]. In the current analysis, dG = 1.005, and this is regarded to be a good fit. The NFI calculates how much better the fit is than the basic model. Such values (0.90 and above) are regarded as ideal, but values 0.80 and above are acceptable in PLS-SEM, particularly in complicated models. The NFI in the present research is 0.779, which is midway approaching the acceptable minimum of 0.75, which signifies a good fit. Lastly, given the applied fit measures ($SRMR, dULS, dG, NFI$), and per the recently provided methodological recommendations in the field of PLS-SEM analysis [37], the quality of the model can be discussed as acceptable. The vast majority of indices are set or near the recommended values.

3.3. Structural model

The procedure that should be used after establishing that the criteria of the measurement model are met is assessing the structural model with the help of confirmatory tetrad analysis (CTA) and the analysis of mediation analysis of path coefficients. Table 6 brings the CTA appraisals on the four constructs of Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), Customer's Time Spend (TS). CTA of close proportional to the SMSEM to develop reflective or formative construction modeling of the construct by researching the tetrads. The fact that the p-value (P > 0.05) is not statistically significant supports the appropriateness of the reflective measurement model for the analysis [37].

Table 6. Confirmatory Tetrad Analysis (CTA)

CTA	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	CI low	CI up
BD	0.009	0.009	0.006	1.482	0.139	-0.003	0.021
CS	-0.002	-0.002	0.006	0.330	0.741	-0.014	0.010
SP	-0.003	-0.003	0.005	0.636	0.525	-0.013	0.006
TS	0.000	0.000	0.004	0.012	0.990	-0.007	0.007

The following figure is the representation of the relationships between Biophilic Design (BD), Customer Satisfaction (CS) and Sustainable Perception (SP), and Customer Spend Time (TS) using PLS-SEM structural modeling. Path coefficients make the relationships between the variables visible, and the meaning of the R^2 values and respective p-values are shown in brackets.

The structural model shown in the image through PLS-SEM illustrates the directional connections between Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), and Customer's Time Spend (TS). The established relationships receive interpretation through path coefficients combined with R^2 statistics and p-values, which signify the magnitude and importance of the relationships.

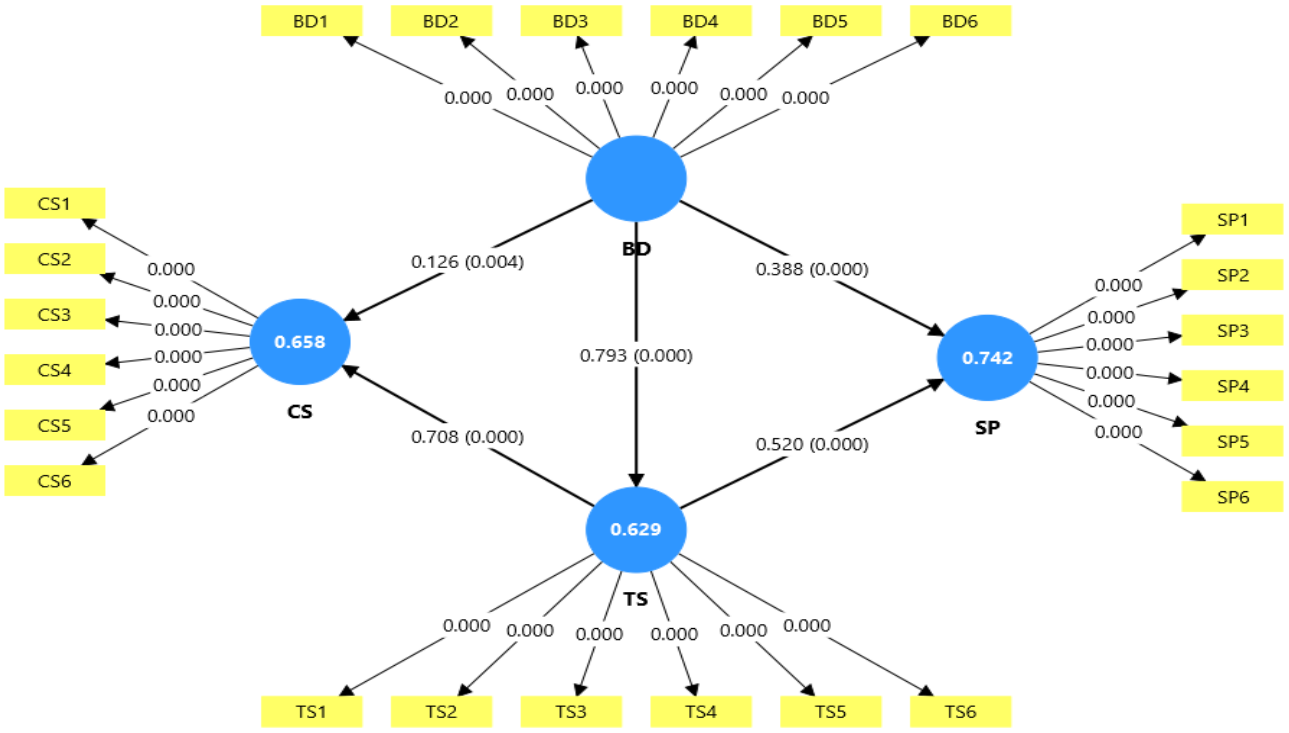

Figure 3. Structural model - Sustainable Perception (SP), Customer's Time Spent (TS), Biophilic Design (BD), Customer Satisfaction (CS)

Table 7 exhibits PLS-SEM results, which show that Biophilic Design (BD) directly affects Customer Satisfaction (CS), Sustainability Perception (SP), and Customers' Time Spent (TS). Both direct and indirect influences from BD reach the constructs because TS works as a mediating effect. In the structural model, the direct effect denotes the direct impact of biophilic design on the dependent variable. The indirect effect represents the mediated effect via the mediator variable (time spent in the store), while the total effect is a sum of the direct and indirect effects. As a result, the evaluation of the other five direct effects determines the degree of partial or near-complete mediation for the corresponding hypotheses H4 and H5, whereas the significance of the indirect effects assesses the support for these hypotheses.

Table 7. Structural model - Biophilic Design (BD), Customer Satisfaction (CS), Sustainable Perception (SP), Customer's Time Spend (TS)

Hypothesis	Path	Direct effect	Indirect effect	Specific indirect effect	Total effect	R2	T statistics (|O/STDEV|)	P values	Hypothesis decision
H1	BD -> CS	0.126	0.561		0.687	0.658	24.526	0.000	Supported
H2	BD -> SP	0.388	0.413		0.801	0.742	46.815	0.000	Supported
H3	BD -> TS	0.793			0.793	0.629	45.863	0.000	Supported
H4	BD -> TS -> CS		0.561	0.561			15.748	0.000	Supported Partial mediation
	BD -> CS	0.126							
	BD -> TS	0.793							
	TS -> CS	0.708							

Hypothesis	Path	Direct effect	Indirect effect	Specific indirect effect	Total effect	R2	T statistics (|O/STDEV|)	P values	Hypothesis decision
H5	BD -> TS -> SP		0.413	0.413			13.822	0.000	Supported Partial mediation
	BD -> SP	0.388							
	BD -> TS	0.793							
	TS -> SP	0.520							

The statistical significance can be strengthened by also determining the f^2 effect sizes for the endogenous variables. The f^2 values indicate how well biophilic design and in-store time contribute in terms of showing the substantive explanatory power for variance in satisfaction and sustainability perception, which can then be used to determine a magnitude interpretation for the p-values.

The total effect value of 0.687 shows that H1 has been proved because the BD has a significant positive effect on the CS, as the value of beta is 0.126 with a p-value of 0.000 and the t-statistic value of 24.526. According to the above-mentioned result, adding biophilic design elements can increase the allure and involvement of the environments as well as customer happiness significantly. The results, as shown above, validate H2. This demonstrates BD has a strong positive effect on sustainability perceptions ($\beta = 0.388$, $p = 0.000$, t-statistic: 46.815), and the total effect of the finding is 0.801. In fact, the observed relationship between BD and SP demonstrates the indirect effect between the factors, as BD affects TS to influence SP (indirect effect: 0.413), thereby indicating that consumers perceive the area designed based on biophilic design principles as sustainable.

Moreover, the effect created stays the same when the patrons spend more time in the area. As per H3 ($\beta = 0.793$, $p = 0.000$, t-statistic: 45.863), the effect of BD has the largest positive influence on the time customers spend in the area. This clearly indicates biophilic designs attract customers and motivate them to stay in the area longer. This could happen due to the positive effect biophilic designs produce as a whole. Customers staying longer in the area would exhibit greater involvement. They tend to purchase more and build stronger connections with their surroundings.

The results from mediation analysis demonstrate that BD relationships relate to CS through TS intermediation (indirect effect = 0.561, $p = 0.000$, $T = 15.748$). The customers' satisfaction levels with BD are strong, but extending their stay within natural-looking environments drives satisfaction levels even higher. To maximize customer satisfaction, businesses should adopt both biophilic design elements and strategies that promote extended customer duration in their facilities. The connection between BD and SP gets partially mediated by TS according to H5 results (indirect effect = 0.413, $p = 0.000$, $T = 13.822$). Sustainability perception shows direct improvement from BD exposure, but the duration of biophilic environmental stay strongly enhances those perceptions. Research findings relate strongly to green marketing and sustainable design strategies because they show that customer experiences alongside exposure control influence sustainability perception development [39].

The model analysis reveals a high predictive power because all variables demonstrate strong correlations: BD impacts customer satisfaction at 0.658, sustainability perception at 0.742, and customers' time spent at 0.629. The high value of R-squared in CS demonstrates that BD and TS directly affect customer satisfaction, along with producing mediation effects. SP shows BD plays a vital role in sustainability perception, where the mediator effect is partially mediated through TS. The high value of R^2 for TS confirms that BD plays an essential role as a driver of customer dwell time while showing its importance in user engagement and sustainability awareness promotion. Research evidence confirms that biophilic design structures customer experiences at both

retail and sustainable service settings. Customers gain direct satisfaction and develop better sustainability views from BD features that receive additional support from extended time spent surrounded by biophilic attributes. Research demonstrates why biophilic design must be implemented across commercial and public areas because it enhances customer engagement and satisfaction, together with sustainability awareness levels [40].

3.3 Analysis of differences between countries

The procedure of detecting the existence of statistically significant differences between the structural relationships of the primary variables in the (BREM) model between the countries of the study sample (Jordan and Palestine) was carried out based on the multigroup analysis developed with the PLS-MGA method. The results revealed that the effects of Customer Time Spend (TS) on Sustainable Perception (SP) and Biophilic Design (BD) on Customer Time Spend (TS) was higher both in Jordan and Palestine, or the effects of Biophilic Design (BD) and Customer Satisfaction (CS) and Sustainable Perception (SP) and the effects of Customer Time Spend (TS) on Customer Satisfaction (CS) was higher in Palestine compared to Jordan.

Nevertheless, according to the analysis of the comparative results of the two countries, even though there were some numerical differences in the values of the direct effect in the respective two countries, all these differences were not significant ($P > 0.05$). Therefore, this result indicates that the structural model maintains its consistency and interpretation across the sample countries, without any fundamental differences in how the Biophilic Design affects the sample countries. Therefore, the causal relationships within the (BREM) model are general and applicable across both countries, enhancing the model's validity in similar cultural environments.

Table 8. PLS-MGA comparison

Predictor	Target	Jordan	Palestine	Diff	p-value
BD	CS	-0.038	0.125	-0.163	0.536
BD	SP	0.206	0.533	-0.327	0.517
BD	TS	1.205	0.853	0.352	0.509
TS	CS	0.405	0.605	-0.199	0.508
TS	SP	0.664	0.496	0.168	0.545

4. Discussion

To enhance clarity, the following discussion will be structured around the hypothesized relationships and the three theoretical lenses. First, we will state the theoretical implications of each result for the S-O-R mechanism, the restoration-based interpretation, and the signaling-based inference, and thereafter the distinction between theoretical implications and managerial implications.

From the findings, biophilic design appears to be more than a stylistic preference and functions rather as a tactical aspect influencing store satisfaction, perceptions of sustainability, and in-store time [1]. The positive relationship between biophilic design and satisfaction again supports the suggestion that the natural elements presented in the store influence stress reduction, attention restoration, and cognitive recovery effects in order to achieve a beneficial rather than effortful retailing experience [5]. This aligns well with the Stimulus-Organism-Response model, wherein the physical environment influences the person's psychical states rather than the states influencing the physical environment. This affects the visual perceptions eliciting evaluative responses like “I like being here” and “I want to come back” [1], [18]. The relationship between biophilic design and customer satisfaction bears relevance because the atmosphere can create satisfaction going beyond the array and price aspects [15], [16].

On the other hand, the positive relationship between biophilic design and customer satisfaction has been found to validate the fact that biophilic design serves as a credible signal for customers. They recognize the authenticity of the positive signal conveyed through plants, recycled materials, and soft natural light. This authentic signal proves the applicability of the signaling theory that visible and costly signals promote positive attitudes toward

the store's authenticity and the influence of biophilic design toward sustainability as proposed earlier [35]. Biophilic design has the capacity to boost the store's positive perspective towards sustainability, as proposed. This explains that sustainability can influence the store's positive outlook towards

In-store time proves to be a significant behavioral mediator between design and the experience-belief outcome. The positive influence of biophilic design on the former strongly indicates that nature-infused environments slow down the customer and promote unhurried rather than hurried consumption behavior [25]. Attention Restoration Theory explains the described slowing influence of biophilic design: the exposure to gentle Nature cues restores directed attention and adequately diminishes mental fatigue; the visitor stays alert and emotionally tempered longer [29]. This longer time in the shopping venue bears nontrivial consequences. The longer customers remain in biophilic shopping venues, the more their satisfaction amplifies because the longer the customers remain comfortable, the more the feeling settles internally as confidence in the venue and the corresponding brand, confirming H4 and recognizing satisfaction as a relational rather than immediate feeling driven by design [2], [9].

In fact, the results of the multi-group analysis reveal that the aforementioned structural links are similar between Jordan and Palestine. This indicates that the mechanism underlying the biophilic design effect has been robust across both markets despite their wider differences [14]. In theory and in practice, the finding has important implications. On the one hand, the fact that the aforementioned effect held across both Jordan and Palestine suggests that the psychological process triggered when the retail space integrates nature reaches beyond the realm of Western retailing, as documented in the biophilic theory. This effect has been shown to apply across the densely populated retail zones in the Middle East, where the discourse of sustainability has been less entrenched [35]. On the other hand, the finding has strong managerial implications. Essentially, biophilic design seems to represent a “tried and true” strategy for retail businesses. This strategy has been observed to have positive effects across multiple markets [19].

In essence, the above findings demonstrate that biophilic design can represent an “instrumental” factor that influences the retail store through how customers feel and how long they remain within the physical space. Moreover, the strategy has been observed to influence customers’ perceptions relative to the retailer's adherence to the principles of the environment. This appears to represent the core principles underpinning sustainable retail.

5. Conclusion

This project aimed at unlocking how biophilic design in retail environments influences the important aspects of customer satisfaction, perceptions of sustainability, and the time customers spend in the store. From the findings, biophilic design transcends the realms of aesthetics. Rather, it serves as a functional tool that regulates the customer’s affective experiences, slows the customers’ journey time, and conveys their moral stance. From the findings above, the interaction between the customers and the natural elements of the store, designed to reduce stress and cognitive overload, has a profound effect. This allows the customers to evaluate their experience in the store in a more positive and relaxed manner. For the customers' satisfaction based on this finding, satisfaction goes beyond the mere purchase experience.

The results also reveal that biophilic design serves as a signal of how responsible the retailer is towards the environment. Customers interpret the visible signs of biophilic design and sustainable materials as indications of the retailer’s concern for the environment, even when the retailer does not communicate this aspect clearly. In other words, customers recognize that the retailer demonstrates concern for the environment through the store rather than merely stating the concern in communication. This indicates that customers believe the store has the capacity to demonstrate aspects of concern for the environment.

In-store time appears as the mediator between spatial design and the two other factors. Biophilic spaces increase the customer in-store time as the shopping environment provides customers with mentally restorative

experiences rather than depleting ones. As customers spend more time in the store, their perceptions of satisfaction and sustainability increase. Customers get more opportunities to feel comfortable, get emotionally attached to the environment, and get used to the sustainable cues as a sign of the store's identity rather than the signification of the whole sustainability approach. This illustrates that design has consequences beyond the initial start.

Notably, the above patterns are observed across two national settings in the Middle East. The structural paths were stable for Jordan and Palestine. This indicates that the underlying process is not culturally unique. This has the advantage of being generalizable because biophilic retail design can be viewed as a strategic resource for transfer. In other words, the resource can be used due to the principles of psychological restoration, temporal involvement, and ethical credibility.

In the area of retail theory, the topic repositions store design as a form of behavioral technology. In biophilic design, the customer experience for feeling, staying time, and belief related to the integrity of the firm are determined. This issue makes a contribution to the area of sustainability studies in that the construction of environmental credibility can occur through the physical environment. In the area of retail practice, store atmosphere can play the role of a cost center or a differentiator. In general, the claim can be made that a retail environment that has a positive human, restorative, and ethical feel does more than gratify the visual.

Despite the strengths of this research, there are limitations that warrant mention. First, the data collected in this research comprise self-reported, cross-sectional data, which makes it difficult to conclude causation and may not accurately represent in-store behaviors. Second, this research uses data from a single source, although the risk of standard method variance is diminished because of the research design and the diagnostic tests conducted in the assessment of measures. Longitudinal studies in the future, perhaps examining how individual exposure to multiple biophilic stimuli over time affects satisfaction and perceptions of sustainability, and conducting studies in laboratory environments where identified biophilic design stimuli are manipulated, could help strengthen research on causation. Further inclusion of objective measures of behaviors, such as observational data, tracking, or sales data, and conducting the research within multiple other store locations in the Middle East could also improve the validity of this research.

Conflict of interest

The authors declare that they have no conflict of interest, and all of the authors agree to publish this paper under academic ethics.

Author contributions

Khaled Alshaketheep: Conceptualization, methodology, Writing, review & editing. Hind Al-Ahmed: Conceptualization, investigation, visualization. Omar Zraqat: Methodology, formal analysis, validation. Omar Megdadi: Project administration, resources, Data curation, writing - original draft.

Data availability statement

In accordance with Jordanian data privacy regulations and the Hashemite University Economic and Management Sciences Research Ethics Committee’s data access restrictions, the dataset used in this study is not publicly available. However, the corresponding author can provide the relevant data upon reasonable request, in compliance with the applicable legal and ethical guidelines.

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