

Article



How Physical Environment Impacts Visitors' Behavior in Learning-Based Tourism—The Example of Technology Museum

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Abstract: Visiting a museum is a popular activity in the tourism industry, especially in cultural and learning-based tourism. To help plan museums effectively, this study investigated the underlying motivations and constraints and their impact on the perceived physical environment and visitor satisfaction toward a museum. The results suggest that the physical environment of museums serves as an axial mediator among motivations, constraints and visitor satisfaction. Six essential factors of physical environment are affected by motivations and constraints, further affecting visitor satisfaction in various patterns, in which architectural planning, exhibition, external environment, and entrance are clearly affected by basic motivations and constraints. Under motivations, family education and self-development are the most two profound influences on enhancing visitor satisfaction through the physical environment. Shops and café are worth special attention in meeting motivation of attractiveness, occasion and social interaction. The results could support the planning and design of a satisfactory museum.

Keywords: learning-based tourism; science museum; motivation; constraint; museum planning; physical environment (PhE); visitor behavior; visitor satisfaction

1. Introduction

In recent years, the role of the modern museum has transformed from the traditional functions of collection, exhibition and research into an emphasis on leisure, education, aesthetic experiences and entertainment [1–3]. On the other hand, a museum may have something different to offer from other leisure and tourism products, through unique features such as outdoor exhibitions or cultural learning experiences [4]. Economic, cultural and social demands also push museums to deal with the issues of visitor experience and profitability [3]. To create a pleasant museum experience, museum planners and managers must pay considerable attention to visitor satisfaction and service quality [5]. The latter has always been regarded as key to gaining a competitive edge in the service industry [6]. However, it is impractical to use the conventional generic assessment scale for service quality to evaluate individual satisfaction and quality of physical environment in a modern museum [7].

As museum managers tackle challenges emerging from limited resources and budget, they have to develop effective strategies to improve the museum's performance and visitor satisfaction in order to compete with other museums and leisure activities [8]. Tourists' choice of destination is driven by a variety of factors, such as the potential to learn, the diversity of facilities, the aesthetic experience, and the quality of environment [9]. Hence, to improve the museum services, it is important to understand the market responses [1,2,10,11], namely, what affects visitors' decision to visit or not and how they evaluate the services delivered by the museum. Visitors' interest (e.g., motivation and perception) as well as the information provided by the museum (e.g., collection, exhibition and events) are key topics in the performance of a museum [12].

With this background, this study set out to meet three objectives: (1) identify the motivations and constraints that influence the decision to visit a museum; (2) suggest a demand-based list of physical environment which affect visitor satisfaction; and (3) construct a causal relationship among visitors' interests, physical environment, and visitor satisfaction as a whole.

2. Literature Review

2.1. Motivations to Visit a Museum

Understanding the motivation behind museum visits is essential for the planning, promotion, and pricing of the attractions [13]. Motivation has been characterized as a goal- and value-driven behavior, which can be grounded in biology, or a complex interaction with external stimuli that trigger various individual activities to accomplish a specific goal [14,15]. Derived from different orientations of human psychology theory, two distinct types of motivations have been identified to determine an individual's cognitive and affective responses, namely intrinsic and extrinsic motivations [16,17]. The former involves one's internal feelings, such as feeling interested or enjoyable, while the latter involves external incentives and interactions. Similar to intrinsic and extrinsic motivations, another taxonomy applied to travel choices is push and pull motivations [18–21]. Push motivations are driven by personal and internal psychological forces such as emotion and cognition, while pull motivations are associated with the features of the destination choices [21]. Previous studies indicate that motivations that drive visitors to museums include education, leisure, friends, work, physical facilities, and escapism [22–25], within which visitors seek to satisfy not only one objective but a variety of leisure incentives [26]. To regular visitors, experiencing the entire museum environment is more appealing than the collections within the museum [27]. Here, motivation is guided by neither internal nor external forces and is mostly self-oriented. Widely-used scales for quality of service may exclude some critical factors that also influence one's choice of destination, such as the reputation of attractions, perceived entertainment, and the cultural experience [28].

Researchers have not reached a consensus on how to classify the motivations to visit a formal or informal place [29–31], but they continue in the efforts to understand the reasons behind an individual's decision on whether to visit a museum [32].

2.2. Constraints to Visiting a Museum

From the socio-psychological perspective, motivations can be divided into factors of seeking and avoidance [33]. Hence, it is also essential to pay attention to the negative aspect of human psychology. Constraints, as opposed to motivations, hinder people's decision to visit a place, and have been the subject of another stream of research [34–39] which explores intrapersonal (lack of interest), interpersonal (lack of company) and structural factors (lack of time, high cost, crowding, dissatisfaction with or unattractiveness of the destination environment) [40–42]. Among them, intrapersonal and structural constraints affect visitors' intention significantly, while interpersonal ones do not [41].

Constraints are not necessarily barriers to leisure participation because people negotiate them [43–46] using various strategies [47,48]. Self-efficacy [49], social capital and motivation are factors affecting the negotiation and relative strategies [50].

Constraints that influence people's decision to visit a museum may comprise psychological and situational factors, as well as those attributed to the museum itself. Factors such as individual psychological status, preference, socioeconomic status, and interpersonal relationship are not dictated or controlled by the museum environment or staff. Other factors, such as promotion, image of the museum, the quality of service, and physical facilities can be manipulated and controlled

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by the museum, which should have been addressed through planning or management to reduce constraints during the visitors' museum experience. Although much research has been dedicated to the investigation of leisure constraints, few studies concurrently probe the effect of leisure constraints and motivation factors. To obtain a holistic view of the human decision-making process, researchers should not eliminate the constraining factors as determinants of human behavior.

2.3. Museum Physical Environment (PhE) and Service Quality

Physical environment (PhE) of a museum have not been widely discussed in marketing research. Researchers initially defined and identified the distinct features of service quality [51,52], followed by either verifying the measurement of service quality [52–57] or extending its relationship with antecedent and subsequent constructs, such as motivation [18,19,21,58,59], value [54,60–62], and satisfaction [63–67].

In marketing practice, service quality has been affirmed as an influencing factor to customers' evaluation and intention to maintain a relationship with business vendors [68]. Through the attainment of customer satisfaction and repeat purchase, companies obtain sustainable advantages over their competitors [51]. Zeithaml [62] defined perceived quality as "the consumer's judgment about a product's overall excellence or superiority." Researchers argue service quality is largely dependent upon the cognitive gap between expected and perceived performance [69]. The measurement of service quality is thus assessed by the difference between the two and mostly relies on customers' subjective and cognitive judgment [70]. Service quality is also evaluated by the level of service fulfillment between customers' expectation and perceived service delivery [71].

Due to difficulties in obtaining objective data on the standard of service and making a comparison between expectation and performance at the same time, most studies apply perceived service quality as the major determinants of behavioral consequences in their frameworks [72,73]. Referring to Swan and Combs's performance-based model [74], people may perceive both technical quality and functional quality during the delivery of service and consequently form an overall evaluation of service quality [72]. Besides, using only a performance scale to measure the construct of service quality yielded better analytical results than a comparative measurement of expectation versus perceived performance [55]. In studying leisure and tourism, researchers argue it is not precise enough to rely on only service quality scales [52] to study individual perception of service quality. Instead, it is necessary to evaluate the overall experience [7,73,75–77]. Acknowledging inconsistent results from different service quality measures, researchers engaged in leisure and tourism studies are inclined to develop their own quality constructs based on perception of service features and emotional experiences [75].

Physical environment (PhE) can be a constraint as well as an attraction for visitors. Hence, to better predict visitors' decision on whether to visit a museum, the service quality of the museum in this study is measured by using visitors' evaluation and perception of the quality of a museum's PhE. To probe the service factors of a museum, the construct "physical environment (PhE)" herein is defined as the service functions embedded in the museum's facilities, including both internal/external environment and information/exhibition, which can be perceived and evaluated by visitors.

2.4. Visitor Satisfaction

Cardozo [78] first introduced the concept of customer satisfaction into marketing research and concluded high customer satisfaction increases people's purchase intention, possibly extending it to other similar products or contributing to enhanced reputation through word-of-mouth. Consequently, marketing researchers have devoted efforts to formulate definitions of customer satisfaction [70,79–81].

Satisfaction may be represented by different models, such as individual psychological expectation-disconfirmation [82] (CS/D), expectation-desire congruency [83], equity [84], norm [85], and performance [86]. Satisfaction can be generally divided into feature satisfaction and information satisfaction [66]. Feature satisfaction refers to the consumer's subjective judgment based on the performance of the product features [87]. Information satisfaction, on the other hand, refers to the

consumer's subjective judgment of information in choosing a product, which is outside the focus of this study.

Customer satisfaction can be established through a series of customer evaluations and comparison between their expectation and perceived performance in their use of a product or service. The service quality can be perceived differently based on the quality of product features or psychological outcome. Leisure satisfaction can be measured by how well leisure activities are perceived to fulfill the basic needs and motives that stimulated the desire to participate in an activity [76]. In the museum context, satisfaction can be evaluated via a visitor's experience in and perception of the museum environment within a certain period, e.g., during the museum visit. Museum visitors perceiving high quality and full satisfaction with the physical environment are more likely to recommend the museum to their friends or disseminate favorable comments to others [28]. Based on these notions, customers' satisfaction in museum services should be derived from their experience of a museum's facilities, functional services, and surroundings. Hence, the study concentrates on visitors' satisfaction with the performance of physical environment.

2.5. Links between Motivation, Constraint, Physical Environment, and Visitor Satisfaction

In the research of service marketing, especially in tourism, customer satisfaction is critical to both business practice and academic interest. Researchers have agreed visitor satisfaction is affected by his or her motivations [88]. Established motivations include seeking variety from the daily routine, recreational opportunities, and leisure experiences [88]. Tourists may share similar patterns of motivation and satisfaction, such as knowledge seeking, social interaction, and escape [89]. Such similarity between motivation and satisfaction may lead to high overall satisfaction [21,90]. Contrary to motivations, visit constraints have not been a major focus of investigation in marketing and management studies [32]. As a negative influence on the willingness to visit a museum, we can expect constraints to influence satisfaction negatively. A combination of various determinants of visitor satisfaction, including motivations and constraints, works together to influence the decision to visit a destination. Aside from museums, prior research on other destinations has also favored an approach that combines motivations and constraints because it provides a holistic view of individual decisions [91]. However, the causal relationship between the role of physical environment, motivations, constraints and satisfaction have been rarely explored. While past discussions focus on the linear relationship between service quality and individual satisfaction, the objective of this study was to delineate multiple factors of motivations, constraints and physical environment that influence one's satisfaction after a museum visit.

2.6. The Hypothetical Model

Previous studies reveal individual satisfaction is affected by one's motivations [21,88,89] and is mediated by performance-based service quality [65–67,72,75,92]. Researchers have focused on either verifying the causal relationship between service quality and customer satisfaction or confirming the link between individual motivations and satisfaction. Little has been done that postulates a causal relationship between individual motivations, constraints, facility features and satisfaction in a museum context. In this study, motivations and constraints are hypothesized to influence visitor satisfaction in their visit as mediated through their perception of the museum physical environment (Figure 1).



Figure 1. Proposed model on the relationship among motivations, constraints, physical environment of a museum and satisfaction.

3. Methods

3.1. Design of Questionnaire

A survey questionnaire was used as the instrument of study. The questions were designed based on literature review and were pre-tested to ensure satisfactory content validity [93]. The questionnaire comprised four sections, each measuring one of the four study constructs. All constructs were measured on a five-point Likert scale ranging from strongly disagree (=1) to strongly agree (=5). Demographic variables, i.e., age, gender, education, income, and marital status, were also investigated at the end of the questionnaire.

3.2. Measurement of the Study Constructs

Visitors' motivations were examined as factors that drive individuals' decision to visit a museum, with five sub-constructs: learning, leisure/entertainment, environment, social interaction, and promotion [23,94]; there is a total of 24 items (Appendix A, A1–A24). Constraints, on the other hand, were treated as negative influences that hinder individuals' decision to visit a museum. The constraints comprise 21 items (Appendix A, B1–B21).

For the assessment of physical environment (PhE), we developed a questionnaire to evaluate people's perception and experience in a museum context, done by synthesizing characteristics from previous studies and common planning features (e.g., a museum's image, open space, environment, displays, activities and service facilities). Thirty-four items were utilized to measure the PhE of a museum (Appendix A, C1–C34).

Positive recommendation and revisit intention are considered as behavioral responses of visitor satisfaction. For satisfaction measurement, this study rated visitors' attitudinal and behavioral responses by overall perception of their experience encounters during the time spent within the museum environment. The intention to revisit is another behavioral response that is commonly used in leisure and tourism studies to describe a visitor's psychological commitment to and preference for a place (or product) [21]. This study measured visitor satisfaction with three items, i.e., overall satisfaction with the museum, possibility of a re-visit, and intention to recommend the museum to friends or acquaintances (Appendix A, D1–D3).

3.3. Survey Site and the Survey

The survey was conducted on the National Science and Technology Museum (NSTM) in Kaohsiung, Taiwan. Opened in 1997 and employing 133 staffs, the museum has a total floor area of 20,756 m² and a site area of 19.16 ha. It contains 18 permanents and 3 special exhibitions (Figure 2). Kaohsiung is a major industrial city in Taiwan, and NSTM is the first museum of applied science in Taiwan. Unlike most museums of art or history, the aim of NSTM is on industrial development and

daily applications of science and technology. The exhibition is tailored closely to people's lives. This study covers the whole of the museum's environment and facilities as well as services given by all staff members.



Figure 2. Site plan and major floor plans of the National Science and Technology Museum.

NSTM visitors were recruited for the survey. Data were collected through questionnaires conducted in the museum lobby while visitors complete their visits. Trained investigators explained to the participants the objective of the study, and the participants completed the questionnaire on a self-report basis. The investigators stayed in the lobby and responded to questions from the participants if they had any. When the questionnaire was completed, the participants would receive a small souvenir as requital for their participation. It took six days, which were mostly Saturdays or Sundays, to complete the survey. The questionnaires were distributed between 10:00 and 16:00 while the museum was open. To explore visitor behaviors, which are closer to actual tourism comparing to that of young pupils obligated to visit the museum for their homework, visitors younger than 15 were excluded from the survey, and 405 questionnaires were collected.

3.4. Analytical Process

Exploratory factor analysis (EFA) was used to identify the underlying factors of motivations, constraints, and the physical environment (PhE). Before EFA, item analysis was performed to raise the consistency and stability between multiple items of each construct. Barlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy were employed to determine the fitness of the factor analysis. Cronbach's alpha values were calculated to determine the reliability of each identified factor [95]. Factor analysis contributes to an understanding of the underlying latent construct and has been favored by researchers who wish to classify a mix of research items into groups of influential factors [21,32,96–98].

After EFA, the properties of the four research constructs—motivations, constraints, PhE and visitor satisfaction—were examined using structural equation modeling (SEM) [99] together with a two-stage testing process [100]. The validity of the measurement models was first tested to determine how measured variables logically and systematically represent the four constructs involved in the

proposed model [95]. Then, a series of structural equation modeling (SEM) tests were run to estimate the structural model [95].

Finally, multiple regression was conducted to find the motivated and constrained determinants of perceived PhE for each factor extracted by EFA.

4. Results and Discussion

4.1. Sample Profile

In total, 405 questionnaires were distributed at the information desk of the museum. Forty-four responses were incomplete (e.g., over 1/3 of the questions unanswered or the same answers repeated in an entire section) and were excluded from the sample data. The final sample contained 361 questionnaires on which data analysis was conducted.

The demographic results of the survey indicate slightly more female visitors than male. Most of the visitors were between the age of 20 and 44 (72.5%) and have a college degree (61.7%); students accounted for a large proportion (Table 1).

	Percentage		Percentage
Gender		Occupation	
Male	48.1	Self-employed	1.9
Female	51.9	Blue-collar worker	6.6
		White-collar worker	14.2
Age		Technical worker	16.1
15–19	13.3	Government worker	17.7
20-24	24.7	Student	35.8
25–34	20.3	Retiree	7.9
35–44	27.5	Others	1.9
45–54	10.1		
55-64	3.5	Monthly income	
65+	0.6	<ntd10,000< td=""><td>35.1</td></ntd10,000<>	35.1
		NTD10,000-30,000	22.2
Educational Level		NTD30,000-50,000	25.3
Junior high	0.9	NTD50,000-70,000	13
High school	19.6	NTD70,000-90,000	2.2
College	61.7	NTD90,000-110,000	1.3
Graduate	17.7	Above NTD110,000	0.9
Marital status			
Single	53.8		
Married with children	38.3		
Married without children	7.9		

Table 1. Demographic characteristics of the sam	ple
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Note: NTD is the abbreviation for New Taiwan Dollar.

4.2. Sample Profile

Both Kaiser–Meyer–Olkin measure of sampling adequacy (>0.8) and Bartlett Test of Sphericity (p < 0.05) were used to assess whether the sample data were appropriate for conducting factor analysis. The results show motivations, constraints, and PhEs satisfy the assumptions in the factor analysis. Factors were extracted if their eigenvalues (or latent roots) were larger than 1. Rotated items with low communality (factor loading < 0.40) or cross-loaded items were excluded. Finally, the factor structure for three constructs were confirmed and labeled (Appendix B, Table 2). Note that factor analysis was not performed for the construct "satisfaction" because it only has three items.

Construct Factor		Explained Variance (%)	Total Variance Explained (%)
	Mo1 Self-development	20.69	
	Mo2 Occasion and social interaction	14.48	
Motivation (Mo)	Mo3 Leisure and companionship	12.32	61.47
	Mo4 Family education	7.67	
	Mo5 Attractiveness or obligation	6.32	
	Con1 Poor museum image	28.66	
Constraint (Con)	Con2 Unappealing soft content	20.10	63.43
	Con3 Unattractive service and cost	14.67	
	PhE1 Architectural planning	15.44	
	PhE2 Exhibition and marketing	15.23	
Physical Environment (PhE)	PhE3 External environment and accessibility	12.02	(1)7
	PhE4 Entrance and ticketing	9.03	64.27
	PhE5 Site planning	6.99	
	PhE6 Shop and café	5.57	

Table 2. Factors under the motivation (Mo), constraint (Con), physical environment (PhE) and the explained variances of the three constructs.

This study extracted five factors from motivations to visit a museum, in which "self-development" (Mo1) is the strongest. Among them, "self-development" (Mo1), "occasion and social interaction" (Mo2), and "family education" (Mo4) are intrinsic, and "leisure and companionship" (Mo3) and "attractiveness or obligation" (Mo5) are extrinsic. "Leisure and companionship" (Mo3) and "occasion and social interaction" (Mo2) were established as motivations to visit a museum, which is consistent with prior research [10,94]. In recent years, the managerial philosophy of museums has undergone major changes, evolving from a historical role of collection and research into a competition for visitor attendance [5]. Visitors find it important to have a setting that makes them feel comfortable and at ease when deciding if a museum is where they want to spend their leisure time [101]. A museum's attractiveness (Mo5), such as its architecture and admission cost, was also found to be an effective motivation for visiting and crucial in meeting visitors' needs.

This study draws three factors from constraints which hinder people's willingness to visit the museum. All of them are structural constraints rather than personal or intrapersonal [35]. This suggests structural constraints are reasons hindering museum visits. Contrary to motivation, constraints toward visiting a museum are more extrinsic, while motivation to visit a museum is more intrinsic. What is noteworthy is "poor images of the museum" (Con1), rather than "unappealing soft content" (Con2), is the strongest factor hindering museum visits. That indicates the importance of the images in a museum. Another effective constraint to visiting a museum found in this study was "unattractive service and cost" (Con3), consisting of both admission charges and psychological efforts [102]. In line with prior assumptions, visitors weigh costs against the learning and recreational value they receive from the environment of a museum and the visit in general, and this assessment ultimately affects their level of satisfaction [103,104].

The study further suggests physical environment (PhE) possesses six main factors which affect visitors' satisfaction: "architectural planning" (PhE1), "exhibition and marketing" (PhE2), "external environment and accessibility" (PhE3), "entrance and ticketing" (PhE4), "site planning" (PhE5), and "shop and café" (PhE6). It is to be noted that "shop and café" (PhE6) stands for one of the crucial elements for visiting museum, and therefore it is extracted as an independent factor.

4.3. Structural Model of Proposed Visiting Behavior

After confirming the interrelationship between the observed indicators, a confirmatory factor analysis (CFA) was conducted to evaluate the reliability and validity, and the relationship between

the research constructs was redefined before the measurement and structural equation models were examined [100]. The reliability of the construct, which captures the degree to which a set of measures indicate the common latent construct, was tested by using the method proposed by Fornell and Larcker [105]. With CFA, the average variance extracted (AVE) of each construct (i.e., motivations, constraints, physical environment and satisfaction) was examined. The convergent validity is acceptable with the motivation value slightly under 0.50 [106], and the composite reliability (CR) for the four constructs are well within acceptable values for the criterion of reliability (>0.70) [107,108] (Table 3). The discriminant validity was also tested by comparing the average of variance extracted (AVE) and squared correlation (χ^2) among the constructs. The results show no correlation is larger than the average of variance, which confirms the discriminant validity [105] of the three constructs is also satisfactory (Table 4). After verifying different validity and reliability criteria, the construct validity for applying the research instrument in this study is determined acceptable.

Construct/Indicator	Factor Loading (λ)	Reliability Coefficient (λ ²)	Measurement Error $(1-\lambda^2)$	AVE	CR
Motivation (Mo)				0.416	0.778
Mo1	0.734 ^a	0.539	0.461		
Mo2	0.502 ***	0.252	0.748		
Mo3	0.635 ***	0.403	0.597		
Mo4	0.67 ***	0.449	0.551		
Mo5	0.661 ***	0.437	0.563		
Constraint (Con)				0.679	0.862
Con1	0.858 ^a	0.736	0.264		
Con2	0.923 ***	0.852	0.148		
Con3	0.671 ***	0.450	0.550		
Physical environment				0 557	0.001
(PhE)				0.557	0.881
PhE1	0.899 ^a	0.808	0.192		
PhE2	0.832 ***	0.692	0.308		
PhE3	0.644 ***	0.415	0.585		
PhE4	0.777 ***	0.604	0.396		
PhE5	0.706 ***	0.498	0.502		
PhE6	0.569 ***	0.324	0.676		
Satisfaction (S)				0.684	0.882
S1	0.662 ^a	0.438	0.562		
S2	0.891 ***	0.794	0.206		
S3	0.905 ***	0.819	0.181		

Table 3. Convergent validity of the measurement models.

Note: ^a Significance was not calculated because the unstandardized loading was set as 1.0 to fix construct variance. *** p < 0.001.

	Motivation (Mo)	Constraint (Con)	Physical Environment (PhE)	Satisfaction (S)
Motivation (Mo)	0.416 ^a	0.679 ^a		
Physical environment (PhE)	0.189 ^b	0.064 ^b	0.557 ^a	
Satisfaction (S)	0.142 ^b	0.027 ^b	0.333 ^b	0.684 ^a

Table 4. Discriminant validity of the measurement models.

Note: ^a Average variance extracted (AVE). ^b Squared correlation (γ^2).

The measurement model consists of two exogenous variables (i.e., motivations and constraints) and two endogenous variables (i.e., physical environment and visitor satisfaction). The proposed model revealed an acceptable data fit ($\chi^2 = 267.434$, df = 113, $\chi^2/df = 2.367$, CFI = 0.940, IFI = 0.940, NFI = 0.901, GFI = 0.910, RMSEA = 0.066), indicating the proposed model adequately explains the empirical relationship between the study variables. Though χ^2 is significant, which is sensitive to the sample size, the fit is deemed acceptable as χ^2/df is less than 3 [109], and incremental indices (over 0.90. RMSEA ranging from 0.6 to 0.8) also indicate the model fits the data well [110].

The goodness-of-fit was assessed to evaluate the validity of the structural model [95] The indices demonstrate a good fit for the structural model ($\chi^2 = 267.54$ with 114 degrees of freedom, CMIN/DF (CN; χ^2 /df) = 2.347. GFI = 0.909, AGFI = 0.879, RMR = 0.030, RMSEA = 0.065, NFI = 0.901, IFI = 0.941, CFI = 0.940, PNFI = 0.75, PNFI = 0.755). The path analysis of the structural model shows the relationship between visitors' motivations and constraints was insignificant ($\mathbf{r} = -0.12$ and p = 0.088). This result is reasonable as the two are counter but independent effects in determining visitors' experience and response. The causal link between determinants and physical environment is moderately strong and significant. The path coefficients from motivations and constraints to perceived quality of physical environment (PhEs) are 0.41 (t = 5.54, p < 0.000) and -0.21, respectively (t = -3.38, p < 0.000) (Figure 3). Therefore, the motivation effect is shown to overpower the constraint effect in determining the perception of physical environment after a visit. Furthermore, the path coefficient between PhEs and visitor satisfaction is 0.51 (t = 6.79, p < 0.000). Motivations also appear to have a direct effect on satisfaction with an impact of 0.16 (t = 2.39, p = 0.017), and an indirect effect of 0.21 through physical environment (Table 5). The two determinants, motivations and constraints, explain 23.1% variance in quality of physical environment and the three constructs explain 35.3% variance in visitor satisfaction.

Path	Direct Effect	Indirect Effect	Total Effect
Motivation \rightarrow Physical environment	0.411		0.411
Constraint \rightarrow Physical environment	-0.207		-0.207
Physical environment \rightarrow Satisfaction	0.509		0.509
Motivation \rightarrow Satisfaction	0.156	0.209	0.365
$Constraint \rightarrow Satisfaction$		-0.105	-0.105

Table 5. Direct and indirect effects among motivation, constraint, physical environment and satisfaction.



Figure 3. Estimated results of the study model. Physical environment forms a mediator among motivation, constraint and satisfaction. * p < 0.05, *** p < 0.001.

This study posits a structural model in which motivations and constraints have a mediating effect on visitor satisfaction through physical environment (PhE). The PhE partially mediate the path from motivations to satisfaction, in which the direct effect of motivations on satisfaction is 0.16 and the indirect effect mediated through PhE is 0.21, which is actually stronger than the direct one (Table 5). Therefore, the path mediated by physical environment may be deemed more important than the direct one.

The strong effect size of physical environment on visitor satisfaction (Table 5 and Figure 4) is consistent with previous theoretical results in which service quality is shown to be a vital determinant of individual satisfaction [21,28,66,67,111]. This result highlights the influence of physical environment on satisfaction. An individual's perception of a museum is derived from the evaluation of how well it performs on its various physical environment, such as exhibition environment, exhibition format, staff service and transportation, while the high level of satisfaction expressed by visitors who think the museum performed well in the quality of its physical environment confirms the theoretical assumption that the physical environment positively influence visitors' attitudinal and behavioral responses. The strength of the two explained variances in the model is also noteworthy. Motivations and constraints explain as high as 23.1% variance in the quality of physical environment, indicating careful consideration should be given to visitors' motivations and constraints in planning or managing a museum. As for visitor satisfaction, motivations, constraints and physical environment, they explain 35.3% of its variance. That is to say, over one third of visitor satisfaction can be achieved by paying more attention to motivations, constraint, and physical environment. In addition, though the effect of motivations on satisfaction is less than physical environment on satisfaction (0.51), motivations still have a relatively strong total effect (0.37) due to its compounded direct and indirect effects. Thus, to satisfy visitors, motivations of visit is another criterion to be considered besides physical environment. Compared to motivations, constraints have less effect on visitor satisfaction, and its influence is indirect. These results may fill the void in prior studies that are either dedicated to reveal the relationship between motivations and individual satisfaction [20,21,58] or verifying the relationship between service quality and individual satisfaction [66,112].



Figure 4. Interpretation of the structural model. Museum physical environment acts as an axial function in the model to transfer the impacts of motivation and constraint to visitor satisfaction. The indirect effect of motivation on satisfaction through physical environment is greater than its direct effect on satisfaction. Constraint has no direct effect on satisfaction.

4.4. Impacts of Motivation and Constraint on the Planning of Museum Physical Environment

To obtain the determinants of quality cognition towards a museum's physical environment, five factors in visiting motivations and three in visiting constraints were included and their relationships with six planning and management factors of physical environment for museum were tested. Multiple regression analysis with stepwise approach was conducted to select the most influential set of indicators in each factor of physical environment (Table 6) to generate appropriate planning and managing strategies.

Physical Environment (PhE)	Determinant	Beta	t-Value	Sig	VIF
	Mo4 Family education	0.251	4.307	0.000 ***	1.289
PhE1 Architectural planning	Con2 Unappealing soft content	-1.93	-3.747	0.000 ***	1.013
	Mo1 Self-development	0.163	2.780	0.000 ***	1.299
	Mo1 Self-development	0.174	2.892	0.004 **	1.299
PhE2 Exhibition and marketing	Con2 Unappealing soft content	-0.183	-3.456	0.001 **	1.013
	Mo4 Family education	0.170	2.836	0.005 **	1.289
PhE2 External environment and	Mo1 Self-development	0.161	2.606	0.010 *	1.301
accessibility	Mo4 Family education	0.140	2.277	0.023 *	1.290
	Con1 Poor museum image	-0.109	-2.001	0.046 *	1.017
	Mo4 Family education	0.191	3.154	0.002 **	1.289
PhE4 Entrance and ticketing	Con2 Unappealing soft content	-0.140	-2.614	0.009 **	1.013
	Mo1 Self-development	0.148	2.441	0.015 *	1.299
PhE5 Site planning	Mo4 Family education	0.294	5.524	0.000 ***	1.008
PhES Site planning	Con1 Poor museum image	-0.165	-3.095	0.002 **	1.008
	Mo5 Attractiveness or obligation	0.165	2.655	0.008 **	1.329
PhE6 Shop and café	Con3 Unattractive service and cost	-0.152	-2.803	0.005 **	1.006
	Mo2 Occasion and social interaction	0.145	2.328	0.021 *	1.331

Table 6. Relationship between motivation and constraint towards visiting a museum and perception of museum physical environment.

Note: * *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001

In motivations, "self-development" (Mo1) is conceived to be a fundamental factor that motivates people to visit a museum [22,30]. In this study, self-development is related to four of the six factors of PhE in a museum, including "exhibition and marketing" (PhE2)", "architectural planning" (PhE1), "External environment and accessibility" (PhE3), and "entrance and ticketing" (PhE4), at different strengths. "Family education" (Mo4) performed as the most profound motivation rather than self-development in relationship with the physical environment of a science museum. In the six factors of physical environment, family education affects five planning factors, even more than

self-development does. Consequently, museum planners or managers should pay extra attention to family education functions in planning or running a modern museum. Visitors motivated by family education were also found to cherish the educational and leisure value offered by the whole site of the museum, i.e., both interiors of the museum building and its outdoor areas.

In contrast with motivations, constraints hinder people from visiting a museum and should be cautiously avoided. The results show "Unappealing Soft Content" (Con2), which is connected with three of the physical environment factors, PhE1, PhE2, and PhE4, is the most influential constraint among the three towards perception of the physical environment. This is consistent with the previous study, which suggested that the quality of exhibition is vital to the decision of visiting a museum or not [101]. "Poor Museum Image" (Con1) is found to be a major constraint that keeps people from visiting, and its impact is concentrated in the external environment, i.e., PhE3 and PhE5. External environment is found to be especially sensitive to "poor image of the museum" (Con1). Planners and managers should make more efforts on the external environment when they intend to improve the museum image.

The study results yield some interesting patterns. The "architectural planning" (PhE1), "exhibition and marketing" (PhE2), and entrance and ticketing (PhE4) of a museum share the same determinants, namely "self-development" (Mo1), "unappealing soft content" (Con2), and "family education" (Mo4). The findings indicate self-development (Mo1), family education (Mo4), and soft content (Con2) are the basic determinants of museum physical environment. This pattern of visitor behavior is consistent with the main goal of a modern museum, which is to provide new knowledge, family education and an enjoyable experience to visitors. Other factors of physical environment show, in contrast, a heterogeneous pattern in their determinants. Site planning (PhE5) of a museum is affected by "family education" (Mo4) and hindered by "poor museum image" (Con1). In addition, the museum shop and café (PhE6), as ancillary services, reveals a distinct pattern compared to other physical environments. Visitors' drive from "attractiveness or obligation" (Mo5), "occasion and social interaction" (Mo2), and halt from "unattractive service and cost" (Con3) are critical to the evaluation of shops and café. Although "leisure and companionship" (Mo3) is one of the main motivations to visit the museum, it affects none of the planning features of the museum. This motivational demand can be satisfied when others are also satisfied.

5. Implications and Limitation

5.1. Practical Implications

Compared to other tourist attractions, visitors to a museum are seeking a dynamic and unique experience. They come with different experiences and expectations, such as seeking new information or acquiring enjoyable, aesthetic and recreational experiences. Some motivation, such as family education, being with others, and cost, are listed as benefits of visiting a museum versus other tourist destinations [101]. The findings of this study show family education (Mo4) and self-development (Mo1) influence visitors' perception towards physical environment of museum most profoundly. Hence, museum planners and managers should incorporate suitable physical environment and corresponding activities to serve the two motivations.

The findings about constraints also identify certain factors that may improve museum services when avoided. "Unappealing soft content" (Con2) and "poor images of the museum" (Con1) are shown to be constraints to visitors. In addition, "unattractive service and cost" (Con3), including monetary as well as psychological and physical, were perceived as constraints which could impede a visit. Hence, it is suggested that characteristics contrary to the constraints should be introduced to bring intriguing, novel, exciting and enjoyable experiences to visitors to repair the hindrance. A museum should increase the opportunities for visitors to physically interact through its exhibition content and format (e.g., using hands-on workshops or interactive technology). A well-designed physical environment both inside and around the museum buildings may reduce visitor dissatisfaction.

Enhancing the museum's general services and providing a flexible admission rate, such as discount for special events or rates varying according to age, visit timing, and frequency, could prove effective in encouraging attendance.

This study identifies six factors of physical environment that impact visitor satisfaction and deserve extra attention from museum managers and planners: Architectural Planning, Exhibition and Marketing, External Environment and Accessibility, Entrance and Ticketing, Site Planning, and Shop and Café. This examination of motivation and constraint as determinants of physical environment reveals distinct patterns, which equip planners and managers with tools to more precisely define the physical environment of a museum. The inherent planning issues of a museum, such as "architectural planning" (PhE1), "exhibition and marketing" (PhE2), as well as "entrance and ticketing" (PhE4) are related to motivations "self-development" (Mo1), "family education" (Mo4) and constraint "unappealing soft content" (Con2). While organizing these three factors of physical environment, planners and managers should pay extra attention to the functions of self-development (Mo1) and family education (Mo4) while specifically avoiding weak exhibition content (Con2).

Besides the interiors, the external environment of the museum is also found to have a significant impact on visitor satisfaction. Traditionally, planners and managers pay the most attention to the collection and visual elements of exhibitions and seldom note functions facilitating recreation and social interaction may also attract visitors. According to the study, the external environment of a museum should be designed specifically for family education (Mo4) and self-development (Mo1) while also emphasizing leisure functions. Enhanced external display areas in a natural environment can add to the museum experience. Facilitating walking and relaxing on the museum site and adding family-related facilities (e.g., family toilets and nursing room) will also be appreciated.

Additional services offered by a museum, such as catering, souvenir shops, barrier-free facilities, and special staff attention to seniors, as well as a comfortable environment all help create a warm and enjoyable experience for visitors. The study shows shop and café (PhE6), which have long been neglected, have a decisive influence on visitor satisfaction as well as meeting visitors' motivations including attractiveness and social interaction.

Research on tourism has confirmed visitor satisfaction and loyalty are two critical components of competitive sustainability in the tourism market [21]. Prior studies also confirm visitor satisfaction is vital to building customer loyalty in the service industry [1,3,10,11]. Those who visit the same museum over and over again are inclined to have high intention to revisit and are more likely to spread positive words to others. The study found the physical environment of a museum has an effective influence on visitor satisfaction. The results inform the museum planning or management as to which physical environment helps enhance visitor satisfaction.

5.2. Limitations

This study was conducted on a group of visitors to the National Science and Technology Museum, which is located in southern Taiwan. The results might be different compared to studies conducted across different locations and different types of museums (e.g., art museums). The proposed framework herein may be applied in future research to test different contexts.

The data collected were cross-sectional and non-experimental. Although SEM analysis provides a robust method for validating the causal relationships, the results should be reported with caution. Longitudinal observation and comparison were not possible due to the constraint of time and location. Future research will benefit from the collection of longitudinal and experimental data to measure the interrelationships between the research variables and provide more precise results in validation.

Though physical environment is verified as a mediator in this study, it explains already 35.3% variance of visitor satisfaction. Other factors also considered important for satisfaction, such as perceived value, corporate image, and quality of learning, were not included in the study. Future research may include and verify more constructs and extend or refine the relationships tested in this research.

6. Conclusions

In tourism research, researchers have treated motivations and constraints as critical components of satisfaction. However, few studies incorporate constraints as inhibitors of perceived quality of physical environment and satisfaction in making a destination choice. Besides, no conceptual model has been established that explicitly examines the relationship among individuals' motivations, constraints, perceived quality and satisfaction toward the physical environment. This study conceptualizes the four as a whole.

Five factors are identified in motivations toward visiting a museum: "self-development", "occasion and social interaction", "leisure and companionship", "family education", and "attractiveness or obligation", in which "self-development" (Mo1) is the strongest motive to visit a museum. Three constraints tend to hinder visiting: "poor images of the museum", "unappealing soft content", and "unattractive services and cost", in which "poor images of the museum" (Con1) is found to be a major constraint that keeps people from visiting. Six essential factors in physical environment are found to influence visitor satisfaction: "Architectural Planning", "Exhibition and Marketing", "External Environment and Accessibility", "Entrance and Ticketing", "Site Planning", and "Shop and Café".

The structural model of the study suggests that physical environment serves an axial function among motivations, constraints and satisfaction. Physical environment has a strong effect (0.51) on the satisfaction of museum visitors, and, through the mediating effect, physical environment further transfers the influences of motivations and constraints on satisfaction. Although motivations have a direct effect on satisfaction, its indirect effect (0.21) is stronger than the direct one (0.16). That is to say, physical environment mediates prevailingly between motivations and satisfaction. The impact of motivations on visitor satisfaction (total 0.37) is much more than that of constraints (-0.11). The whole model can explain 35.3% of the satisfaction of museum visitors.

In motivations, self-development (Mo1) is the strongest motive for people to visit a museum, but it does not act as the most profound factor to affect physical environment of museum. Notably, family education (Mo4) does, followed by self-development. For constraints, poor museum image (Con1), which is the strongest constraint against visiting a museum, largely influences the external environment. When combining the impacts of motivation and constraints in planning a museum, planners and managers should pay attention to providing the functions under self-development (Mo1), family education (Mo4), and contain better soft content (Con2), through which the basic demands of museum visitors can be satisfied. Leisure and companionship (Mo3) has no significant effect on the physical environment of a museum. Shop and Café (PhE6) as ancillary facilities are shown to be important to attract visitors, especially those who come for attractiveness (Mo5) and social interaction (Mo2). The study carries practical implications on museum planning or management and helps define physical environment toward achieving better visitor satisfaction.

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Appendix A. Visitors' Questionnaire

This survey investigates visitors' motivation, constraint, and satisfaction toward physical environment in the National Science and Technology Museum (NSTM). Please rate each of the following statement using a scale from 1 to 5 (1 being "strongly disagree", 5 being "strongly agree" unless otherwise noted) by placing a " $\sqrt{"}$ in the corresponding box.

A. Motivation for visit

- A1. Improve my quality of life
- A2. Experience new things
- A3. Pursuit of interest
- A4. Engage in a worthy activity
- A5. Release stress and relax
- A6. For leisure
- A7. Attractive architecture
- A8. Improve parent-child relations
- A9. Work or school requirement
- A10. Learn something
- A11. Enhance social relations with accompanying person(s)
- A12. Special exhibition
- A13. Admission discount
- A14. Children's leisure and education
- A15. Make new friends
- A16. Just passing by and decided to come in
- A17. Kill time
- A18. Famous destination
- A19. Participate in a social activity
- A20. Participate in a parent-child activity
- A21. Invitation from the museum
- A22. Acquire new knowledge and information

B. Constraint from visit

- B1. Have bad impression about the museum
- B2. Transportation to/from museum inconvenient
- B3. Poor security around the museum
- B4. Unsafe environment
- B5. The museum environment is unclean
- B6. Insufficient leisure facilities on site
- B7. The museum site has too many barriers for moving around
- B8. The museum site is too hot and has no tree shade or shelter for rain
- B9. Must walk for a long line to enter the museum
- B10. Hard to get information on museum events
- B11. Opening hours not suitable for me
- B12. Admission too expensive
- B13. Poor restaurant service
- B14. Not enough stamina for such long visit
- B15. Exhibitions difficult to understand
- B16. Exhibitions unappealing
- B17. Not suitable for family
- B18. The museum's activities do not help me relax
- B19. Does not fulfill my social need
- B20. Crowded
- B21. Service quality unsatisfactory

C. Cognition of physical environment

- C1. Scenery on the museum site (include the surroundings)
- C2. Relaxing and comfortable landscape
- C3. Appealing environment
- C4. Convenient transportation access
- C5. Abundant parking
- C6. Easy to enter the museum
- C7. Bicycle parking provided
- C8. The museum site offers facilities for leisure and amusement
- C9. Beautiful and educational planting around the museum
- C10. Easy to find the entrance
- C11. Spacious and comfortable entrance
- C12. Simple ticket buying procedures
- C13. Reasonable admission price
- C14. Clear exhibition route and signage
- C15. Spacious and suitable environment for the exhibitions
- C16. Comfortable air-conditioning and ventilation in the exhibition space
- C17. Food service offered
- C18. Souvenir shop
- C19. Natural and artificial light utilized to create bright exhibition space
- C20. Visual display for the exhibition
- C21. Ample facilities to keep the place clean (e.g., trash bins)
- C22. Clear, accurate and sufficient interpretive boards
- C23. Clean and hygienic overall environment
- C24. Appropriate level of security
- C25. Secure indoor and outdoor spaces
- C26. Guided tour easy to understand
- C27. Ample information provided at the service desk
- C28. Personalized service for disabled persons
- C29. Information about museum easy to obtain
- C30. Appropriate museum opening hours
- C31. Interesting and vivid exhibition format
- C32. Educational exhibition content
- C33. Active promotion of activities and services
- C34. Adequate resting spaces along visiting route

Appendix B. Factor Analysis of Motivation, Constraint, and Physical Environment (PhE) of a Museum

A. Motivation:

	Mo1	Mo2	Mo3	Mo4	Mo5
Item	Self-Development	Occasion and Social Interaction	Leisure and Companionship	Family Education	Attractiveness or Obligation
A2. Experience new things	0.849				
A10. Learn something	0.784				
A4. Engage in a worthy activity	0.772				
A1. Improve my quality of life	0.756				
A3. Pursuit of interest	0.744				
A22. Acquire new knowledge and information	0.742				
A12. Special exhibition	0.660				
A16. Just passing by and decided to come in		0.781			
A17. Kill time		0.723			
A19. Participate in a social activity		0.691			
A21. Invitation from the museum		0.658			
A18. Famous destination		0.610			
A15. Make new friends		0.584			
A5. Release stress and relax			0.757		
A6. For leisure			0.753		
A11. Enhance social relations with accompanying person(s)			0.739		
A8. Improve parent-child relations			0.651		
A14. Children's leisure and education				0.788	
A20. Participate in a parent-child activity				0.782	
A13. Admission discount					0.612
A7. Attractive architecture					0.477
A9. Work or school requirement					0.437
Eigenvalue	4.552	3.184	2.709	1.688	1.389
Percent of variance explained	20.692	14.475	12.316	7.671	6.316
Percent of cumulative variance explained	20.692	35.167	47.483	55.154	61.470
KMO measure of sample adequacy			0.874		
Bartlett's test of sphericity			0.000		

B. Constraint:

Item	Con1	Con2	Con3	
	Poor Museum Image	Unappealing Soft Content	Unattractive Service and Cost	
B4. Unsafe facility	0.813			
B5. The museum environment is unclean	0.798			
B1. Have bad impression about the museum	0.776			
B3. Poor security around the museum	0.765			
B2. Transportation to/from museum inconvenient	0.711			
B7. The museum site has too many barriers for moving around	0.710			
B8. The museum site is too hot and has no tree shade or shelter for rain	0.665			
B9. Must walk for a long line to enter the museum	0.576			
B6. Insufficient leisure facilities on site	0.574			
B11. Opening hours not suitable for me	0.531			
B10. Hard to get information on museum events	0.492			
B18. The museum's activities do not help me relax		0.724		
B17. Not suitable for family		0.705		
B16. Exhibitions unappealing		0.705		
B15. Exhibitions difficult to understand		0.621		
B21. Service quality unsatisfactory		0.610		
B19. Does not fulfill my social need		0.594		
B20. Crowded		0.514		
B13. Poor restaurant service			0.742	
B14. Not enough stamina for such long visit			0.741	
B12. Admission too expensive			0.656	
Eigenvalue	6.018	4.220	3.081	
Percent of variance explained	28.656	20.096	14.673	
Percent of cumulative variance explained	28.656	48.753	63.426	
KMO measure of sample adequacy		0.953		
Bartlett's test of sphericity		0.000		

C. Physical Environment:

Item	PhE1	PhE2	PhE3	PhE4	PhE5	PhE6
	Architectural Planning	Exhibition and Marketing	External Environment and Accessibility	Entrance and Ticketing	Site Planning	Shop and Café
C21. Ample facilities to keep the place clean (e.g.,	0.673					
trash bins)						
C20. Visual display for the exhibition	0.673					
C24. Appropriate level of security	0.672					
C16. Comfortable air-conditioning and ventilation in the	0.632					
exhibition space						
C25. Secure indoor and outdoor spaces	0.626					
C15. Spacious and suitable environment for the exhibitions	0.618					
C23. Clean and hygienic overall environment	0.594					
C19. Natural and artificial light utilized to create bright	0.518					
exhibition space						
C14. Clear exhibition route and signage	0.509					
C34. Adequate resting spaces along visiting route	0.484					
C29. Information about museum easy to obtain		0.722				
C28. Personalized service for disabled persons		0.700				
C30. Appropriate museum opening hours		0.685				
C27. Ample information provided at the service desk		0.676				
C26. Guided tour easy to understand		0.667				
C32. Educational exhibition content		0.660				
C33. Active promotion of activities and services		0.619				
C31. Interesting and vivid exhibition format		0.583				
C22. Clear, accurate and sufficient interpretive boards		0.518				
C2. Relaxing and comfortable landscape			0.807			
C1. Scenery on the museum site (include the surroundings)			0.765			
C3. Appealing environment			0.762			
C5. Abundant parking			0.669			
C4. Convenient transportation access			0.659			

C6. Easy to enter the museum			0.632			
C12. Simple ticket buying procedures				0.692		
C10. Easy to find the entrance				0.683		
C11. Spacious and comfortable entrance				0.679		
C13. Reasonable admission price				0.592		
C7. Bicycle parking provided					0.732	
C8. The museum site offers facilities for leisure and					0.712	
amusement						
C9. Beautiful and educational planting around the					0.654	
museum						
C17. Food service offered						0.792
C18. Souvenir shop						0.697
Eigenvalue	5.249	5.148	4.086	3.070	2.377	1.894
Percent of variance explained	15.437	15.231	12.019	9.028	6.990	5.569
Percent of cumulative variance explained	15.437	30.668	42.687	51.715	58.705	64.274
KMO measure of sample adequacy			0.942			
Bartlett's test of sphericity			0.000			

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