

## Article

# Evaluation and Optimization of Restorative Environmental Perception of Treetop Trails: The Case of the Mountains-to-Sea Trail, Xiamen, China

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**Abstract:** A treetop trail is an elevated linear green open space that plays a key role in forming a scientifically rational urban space and meeting the growing leisure needs of the people. Taking the Mountains-to-Sea Trail in Xiamen, China as a case, and through 426 questionnaires, this study explores the dimensions of the perceived restorative environment components of greenway recreationists and impacts on behavioral intentions. The demographic factors lead us to the following three conclusions. First, from an age perspective, restorative environmental perceptions are strongest among those aged 60 and above and weakest among those aged 18–30. Second, in terms of place of permanent residence, local visitors have stronger restorative environmental perceptions than other city users. Third, in relation to the number of accompanying travelers, individuals who embark on solo journeys experience the most robust perception, while that diminishes as the count reaches three or more companions. A structural equation model (SEM) is used to present the quantitative relationship among avoidance motivation, treetop trail environmental quality, restorative environmental perception, place attachment, and loyalty. The results showed that users' escape motivation has a direct and indirect positive correlation with restorative environmental perceptions, and environmental perceptions have a significant positive correlation with restorative environmental perceptions. Furthermore, their place attachment to the restorative nature of the treetop trails positively affected their loyalty. This study provides essential factors to consider when constructing treetop trails in high-density cities.

**Keywords:** treetop trails; restorative environmental perception; greenway; Mountains-to-Sea Trail; structural equation modeling



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## 1. Introduction

As urbanization accelerates, negative emotions such as stress, fatigue and irritability have emerged as significant issues for people. Therefore, addressing these psychological problems and finding ways to eliminate them have become urgent social concerns [1]. In such times, changing the usual environment, especially to a natural setting, offers a good solution to mitigate negative emotions and can promote the recovery of the individual's mental and physical health [2]. Several scholarly investigations have indicated that urban green spaces have the potential to enhance both physical and mental wellness [3,4], foster social cohesion [5], facilitate recuperation from fatigue, provide enjoyment, and alleviate the stress arising from daily life and work [6]. There, spaces have been often described as restorative environments [7,8] that relieve mental fatigue and stress, and even shift emotions from negative to positive. Restorative environments are also beneficial in reducing

anxiety [9], restoring concentration [10], promoting self-identity [11] and reducing the probability of physical illness [12]. As a result, the challenge lies in creating more places that promote mental health and wellbeing within the constraints of scarce urban land [13,14], and restorative environments have become an important part of urban landscaping [15].

As an essential type of urban green space, greenways are linear open areas specifically designed for scenic roads, mountain ranges, riverbanks and other artificial and natural pathways [16]. Urban greenways connect tourism resources such as natural and human landscapes, wetlands, green spaces and contemporary urban agriculture, providing places for recreation and fitness, creating a quiet, relaxing and stress-free environment for recreationists to have a restorative experience [17–19]. As rapid outward growth of urban areas, treetop walks have come to the attention of urban planners as elevated greenways. Although initially mainly used for scientific research [20,21], in the 21st century, they have been used in urban spaces in Australia, the UK, Singapore, China and other countries, linking ecological patches such as urban hills and green spaces and parks, providing users with places for daily leisure life and recreation and fitness [22–24]. These elevated linear green open spaces play an important role in forming a scientific and rational urban space, a continuous and complete landscape pattern and a healthy and well-ordered ecosystem [22,25].

Given the theoretical importance of green space, it is somewhat unexpected that although certain studies have demonstrated a positive correlation between the utilization of green space and health, there persist issues pertaining to the measurement of green space utilization and the examination of pathways that influence the wellbeing of inhabitants. Primarily, the majority of these studies commence from the perspective of green space provision, employing indicators such as green view rate, quantity of green spaces and the normalized difference vegetation index (NDVI) to gauge green spaces [26,27], thereby disregarding user health behavior preferences and the actual utilization characteristics of green spaces [28]. Secondly, research on greenways has focused on the classification [16], historical evolution [29], urban planning [30,31] and satisfaction [32] of greenway systems, while research on the perceived recreation of greenway users is relatively homogeneous. Given the evidence of the potential health value of greenways, some scholars have progressively refined this deficiency through research. Lachowycz et al. summarized the relationship between green space and user health through socioecological theory and classified the factors involved. These include green space exposure factors (e.g., distance to green space), potential moderators (e.g., demographic characteristics, life context, green space characteristics and quality), moderating mechanisms (e.g., motivation to use green space, conditions), potential mediators (e.g., improving personal perceptions, achieving aesthetic pleasure, attaining relaxation), and outcomes (e.g., physical health and mental health) [33]. Po-Ju Chang studied the physical (e.g., paths, seating, open spaces, natural elements, facilities, water and aesthetics) and social environments (e.g., neighborhood social capital, neighborhood social cohesion and neighborhood residential self-selection) of greenways, building a multilevel model through a combination of expert evaluation and questionnaires [34]. However, while research continues to accumulate regarding users' motivations, greenway activity type [35] and trail type [36] for trail use, an understanding of how and why people choose treetop trails remains extremely limited. In order to accurately assess visitor preferences for environmental settings and the impact of health benefits, it is crucial to consider the underlying motivations for engaging in recreational activities, both at an individual and societal level. By investigating these motivations and preferences, planners and managers can gain valuable insights into the perceived restorative qualities of treetop trails.

In today's world of humanism, it is crucial to concentrate on the experience and place attachment of recreationists [37], which allows people to stay in familiar surroundings for perceptual recovery. Research has confirmed that perceptions of experience correlate with both place attachment and behavioral intentions of recreationists [38]. While previous studies have explored the association between urban green space and activity, few

have focused on physical and social characteristics in a single study [39], and even fewer have discussed the relationship between green space, place attachment and loyalty [40]. Therefore, this study answers the following questions: (1) Does the treetop trail as a type of elevated greenway also positively affect perceived recovery? (2) Does user motivation affect perceived recovery? (3) Which trail characteristics influence perceived recovery? (4) How do users' perceptions of the restorative environment on the treetop trail affect their loyalty to the trail? The findings of this research provide valuable insights for the planning and adaptation of greenways in densely populated coastal urban areas.

## 2. Theoretical Background and Hypothesis

In this section, the discussion centers on the causes of and results brought about by treetop trails promoting perceptual recovery, establishing the research hypotheses between several key constructs mentioned in the above context. Firstly, the improvement in tourists' perceived image of a destination is significantly influenced by both internal and external escape motives [41]. Perceived environmental quality of treetop trail environments has a positive effect on perceptions of restorative environments [42]. However, there is no research that demonstrates the relationship between tourist escape motivation, trail environment perception and restorative environment perception. Therefore, the hypotheses are proposed by linking users' escape motivation, perceived quality of trail environment and perceived restorative quality. Secondly, the change in urban destination perception has a positive impact on place attachment [43], but it remains to be demonstrated whether this plays an equally positive role for treetop trails. Therefore, hypotheses linking restorative environmental perception and place attachment are proposed. Thirdly, loyalty is a result of place attachment [44], but whether this works equally well for treetop walks is unknown. Consequently, this study aims to propose hypotheses that establish a link between users' escape motivation, perceived quality of trail environment, perceived restorative quality, place attachment and loyalty.

### 2.1. Linking Escape Motivation, Trail Quality Perception and Restorative Environmental Perception

The study of restorative perception was first developed by environmental psychologists Kaplan R and Kaplan S. Attention restoration theory (ART) suggests that an environment that promotes attention restoration is a restorative environment, and that the restorative experience of attention in a restorative environment is restorative perception [45]. The characteristics of a destination that visitors perceive as restorative in terms of psychological, physical and social capabilities are known as visitor perceptions of restorative environments [46]. Numerous experiments have demonstrated that restorative perception is primarily associated with five dimensions: fascination, novelty, escape, congruence and compatibility [47–49]. In contemporary society, people live in a variety of artificially constructed environments that are increasingly distant from real, natural life, allowing for people's instinct for escape to be triggered [50]. Iso-Ahola's model of escape-seeking motivation contains two motivational forces, where escape refers to the desire to leave everyday life and seeking refers to the desire to gain intrinsic psychological rewards through tourism in a relative context. The psychological benefits of tourists' desire to escape from their personal and interpersonal worlds as well as their everyday environment arise from the interaction of these two motivational forces [51]. In escape motivation theory, tourism positively affects tourists' image perceptions [52], and the perceived image of tourist locations is significantly improved by both inner and extrinsic escape incentives [41]. Therefore, the following research hypotheses are proposed:

**Hypothesis 1 (H1):** *Avoidance motivation positively influences environmental quality perception.*

**Hypothesis 2 (H2):** *Avoidance motivation positively influences perceived restorative qualities.*

Outdoor natural environments have more restorative elements than urban built environments, and nature tourism sites provide visitors strong sensory resonance through their rich natural and human landscapes, enabling them to have a better restorative experience [53]. It has been demonstrated that an individual's environmental preferences can enhance the restoration potential of the environment [54]. The length, width, surface, amenities, accessibility and surroundings of a greenway can affect the perception of access [55–57]. Factors such as sky openness, green visibility, visual complexity, skyline complexity and plant color richness can affect the perception of trail vision [58,59]. Essential green space features also include the presence of amenities [60] and aesthetic qualities [61]. The following research hypothesis is therefore proposed:

**Hypothesis 3 (H3):** *Environmental quality perception positively influences perceived restorative qualities.*

## 2.2. The Relationship between Perceived Restorative Qualities and Place Attachment

Place attachment, which is made up of place identification and place reliance [62], expresses an individual's emotional and practical ties to a specific location or setting through their interactions with it [63,64]. Place attachment explains the positive effects of the environment on people's physical and mental health, expressed as a sense of emotional and functional access, which in turn strengthens the bond between people and their environment. Restorative perception explains the positive effect of the environment on people's perception of health, as shown by the restoration of intentional attention through the intervention of unintentional attention [65]. Natural resources provide the conditions for recreational activities to take place and create functional attachments to them; for example, respondents relied on the natural environment of metropolitan parks for health-related benefits such as stress reduction and relaxation [66]. For tourism destinations, promoting restorative intuition can be effective in enhancing visitors' sense of attachment and identification with the destination. Hence, the following hypothesis is proposed:

**Hypothesis 4 (H4):** *Perceived restorative qualities positively influence place attachment.*

## 2.3. Place Attachment and Loyalty

If people visit the same place several times because of place dependence, they are likely to develop emotional attachment and a sense of belonging to it, which in turn leads to place identity. Loyalty between visitors and destinations, i.e., recommendations and intention to revisit a destination, has been shown to be closely related to the level of attachment [67,68]. Loyalty is the result of place attachment [44]. Loyalty affects visitors' willingness to return to a destination and to promote it to others [69]. However, whether this also applies to urban treetop trails has been less studied. The following hypothesis is proposed to test this relationship:

**Hypothesis 5 (H5):** *Place attachment makes a positive contribution to loyalty.*

# 3. Materials and Methods

## 3.1. Case Study

The study site is located in Xiamen, Fujian Province, off the southeast coast of China, a highly urbanized island city with a geographical area of approximately 158 km<sup>2</sup> and a population of approximately 1.2481 million, which is the political, commercial, cultural and residential center of the region [70]. The construction of the Mountains-to-Sea Trail (MST) was completed against the backdrop of the need to address land constraints in the city, to expand the vertical space of the city, to ensure rapid urban development while allowing the public to see the mountains and water, to have more green leisure space and to enhance the livability of the city. The design and construction of the MST is based on the successful experience of many domestic and international treetop trails such as the

Singapore Forest Trail and Fuzhou Fudao. The MST consists of the “Linhai Line” and the “Yunhai Line”. The Yunhai line officially opened in January 2020, is approximately 23 km, of which over 10 km is elevated, linking the eight mountains and three waters, including Foxtail Mountain and Xianyu Mountain, etc. Part of the Linhai line opened in January 2022 and the rest of the trail completed development in January 2023, totaling approximately 31 km, running through the entire Dongping Mountain, and is currently the longest treetop walkway in the world (Figure 1). The coherent footpath system connects several natural mountain parks and water areas on Xiamen Island, with treatments of varying heights forming nodes on the path. As a link between the various viewpoints, this trail is meant to be a beautiful manmade landscape. Therefore, the design of the greenway surface pays much attention to accessibility, naturalness and a sense of landscape. The trail width is set at 2.8 m, with a partial width of 2.4 m. This is sufficient to meet the needs of smooth passage and enhance the visitor experience. The trail comprises both ground-hugging and elevated segments. The ground-hugging portion is surfaced with permeable concrete, which serves the purposes of permeability, heat dissipation and ecological balance adjustment. Conversely, the elevated section is constructed using steel box structures and paved with composite bamboo or aluminum grids. In summary, the meticulous planning and design of the trail notably augment the visual appeal of the surrounding environment, all the while upholding ecological preservation principles and affording visitors the opportunity to relish the splendor of the verdant landscape and water bodies during their fitness walks.

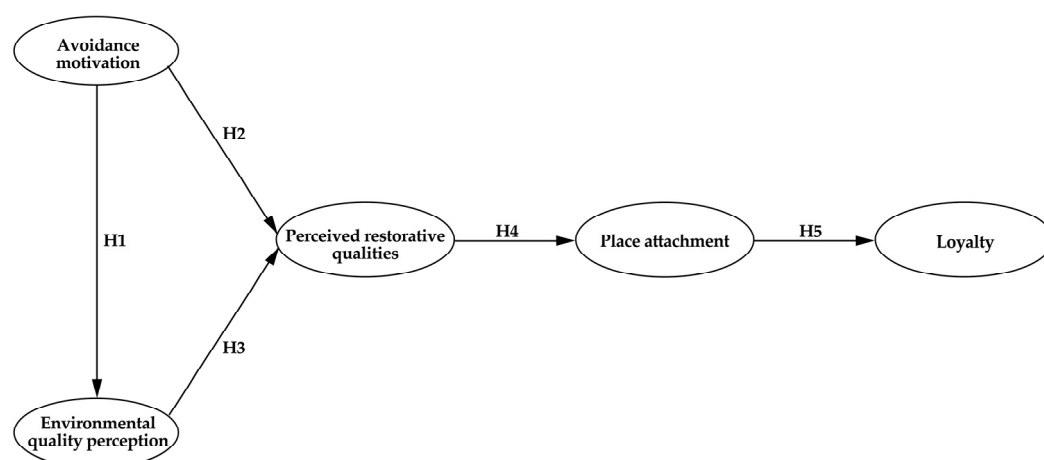


**Figure 1.** Mountains-to-Sea Trail routes, representative images of significant locations, and questionnaire distribution locations.

### 3.2. Structural Equation Modeling

To examine how restorative perceptions are acquired by recreationists on treetop trails, this study analyses the paradigm of “escape motivation–perceived restorative quality–place attachment–loyalty”. Escape motivation, perceived environmental quality and perceived restorative quality are the three key factors of interest in this study. Structural equation

models, a type of multivariate statistical model, are capable of addressing intricate relationships among multiple variables and offer solutions for variables that are challenging to observe directly [71]. This model has gained widespread application in the social sciences and other domains, enabling measurement errors in both independent and dependent variables to be accounted for—in contrast to conventional statistical techniques—which is not possible in traditional regression approaches [72]. In conclusion, employing structural equation modeling was deemed suitable for testing the five hypotheses outlined above (Figure 2). The data were imported into SPSS 26.0 for parameter estimation and, initially, validation factor analysis was conducted to estimate and test the measurement model. Subsequently, path analysis was performed using AMOS 26.0 to estimate and test the structural model. Additionally, the obtained results were evaluated to determine if the indicator values satisfied the predetermined fitness criteria of the model. In the event of inadequate fit, a meticulous revision was undertaken.



**Figure 2.** Structural equation modeling.

### 3.3. Questionnaire Design

From January to March 2023, the research team conducted eight field visits along the MST to gain a preliminary understanding of the overall design of the trail and to conduct in-depth interviews with users. The preliminary findings showed that most of the users' concerns focused on the stylistic presentation of the treetop trail, access and viewing experience on the trail, and that they came mainly to relax, walk and take photos.

The questionnaire was designed based on the preliminary findings of this study. The questionnaire included six target layers containing demographic data, avoidance motivation, environmental quality perception, perceived restorative qualities, place attachment and loyalty. There were 29 indicator layers, using a five-point Likert scale. Firstly, we conducted demographic data of the users to understand their basic characteristics such as gender, age, education level, permanent residence, number of companions, times of visits and channels used to learn about the trail. The second part used Iso-Ahola's user avoidance motives, both extrinsic and intrinsic avoidance motives [51]. This theory adequately responds to the desire of recreationists to leave their living environment and to gain intrinsic psychological rewards through destination tourism. Applying this theory to this study helped better explore the psychological expectations of users prior to visiting treetop trails. Thirdly, Lin et al. conducted a screening and weighting exercise based on the grey statistical method and hierarchical analysis of the perceived landscape environment evaluation indicators of the treetop trail, and arrived at the weights and ranking of the indicators [73]. The scale included trail quality perception, trail view perception, trail access perception and infrastructure perception. The fourth part used the perceptual recovery scale developed by Hartig et al. The scale has been widely used in a variety of situations including urban environments, indoor environments and natural environments [45,47,74,75]. Fifthly, the

place attachment component has been shown to be an important prerequisite for tourism loyalty [76] and the use of the place attachment scale has helped to shape tourists' interpretations of the travel environment [77]. This component draws on the place attachment scale developed by Williams et al. and includes place dependence and place identity [62]. The final section is loyalty, which includes recreationists' intention to revisit and intention to recommend [69,78]. When users make revisits or invite others to visit, this leads to a new round of perceived recovery, which is important for sustaining the long-term health-promoting benefits of the greenway.

### 3.4. Data Collection

In April 2023, the research team distributed pilot questionnaires for a presurvey in several sections of the MST and obtained 25 valid questionnaires, which were analyzed for reliability using SPSS 26 statistical software (IBM Corp., Armonk, NY, USA) with a Cronbach's alpha of 0.955 for the total scale and Cronbach's alphas for the subscales being all above 0.80, indicating good reliability. The original questionnaire has therefore been retained for official release. The offline survey was chosen for May 2023, with milder weather and moderate heat and cold. It is the peak tourist season in Xiamen. The survey period covered weekdays and weekends on sunny days. To ensure a broad representation of respondents, the research team chose to randomly distribute onsite questionnaires to trail users at four trailheads (Figure 1). All four sections were located in rest areas near the trail entrances and exits, allowing the surveyors direct access to potential respondents. Site A is located on the Yunhai line, a tree-lined and secluded area that is a great spot for walking and relaxing. This not only an important place for users crossing Huwei Mountain from Point 1 but also a way to enjoy cherry blossoms in spring. Sites B, C and D are all located on the Linhai line. Site B is an essential route for recreationists crossing Dongping Mountain from Dongshan Reservoir to the south. Situated centrally within the city, Dongping Mountain boasts an extensive forest cover exceeding 80%, rendering it as Xiamen's prominent "urban green lung". In this section, individuals have the opportunity to appreciate panoramic vistas of the city from an elevated position on the treetop trail, along with scenic views of the reservoir and the sea. Site B is equipped with seating arrangements in close proximity, serving as a designated area for leisurely activities and providing a suitable environment for conducting interviews and administering questionnaires. Site C is situated in close proximity to the viewing platform, which represents the southernmost point of Xiamen Island and is encompassed by the sea on three sides. This location not only offers a picturesque outlook of the sea and the southern region of Xiamen Island but also affords a glimpse of Kinmen Island. The site attracts a substantial influx of tourists, resulting in a significant volume of pedestrian activity, thereby rendering it conducive for research endeavors. Positioned within a sheltered region, Site D encompasses a multitude of seating arrangements, thus serving as a pivotal resting spot in close proximity to the entrance and exit. Following a stroll along the trail, visitors frequently halt at this location to relish the scenic oceanic vista, observe the sunset, and engage in conversations with fellow travelers, thereby fostering a profoundly tranquil ambiance. Consequently, Site D emerges as an exceptionally suitable locale for conducting questionnaires.

Before conducting the survey, the researchers obtained user consent to provide a comprehensive explanation and clarification of the survey content, thereby ensuring that the respondents comprehended the survey's purpose and questionnaire content. The distribution of 450 questionnaires resulted in the collection of 426 valid questionnaires, yielding an effective rate of 94.67%. The sample size was sufficient to meet the requirements for structural equation modelling.

## 4. Results

### 4.1. Demographic Characteristics

The results of the questionnaire survey (Table 1) show that among the respondents, there were more women (53.5%) than men (46.5%), mainly concentrated in the 18–30 age

group (52.1%), a predominance of people with college and undergraduate degrees (65.3%), more local permanent residents (50.9%), more visits with one peer (51.2%) than by themselves or more than two peers, more people visiting for the first time (55.6%), and the majority of people learned about MST from online sources (51.9%) (Supplementary Material).

**Table 1.** Description of the distribution of sample characteristics.

|                         | Variables                                                | Frequency | Cumulative Percentage |
|-------------------------|----------------------------------------------------------|-----------|-----------------------|
| Gender                  | Male                                                     | 198       | 46.50%                |
|                         | Female                                                   | 228       | 53.50%                |
| Age                     | <18 years old                                            | 22        | 5.20%                 |
|                         | 18–30 years old                                          | 222       | 52.10%                |
|                         | 31–40 years old                                          | 88        | 20.70%                |
|                         | 41–60 years old                                          | 66        | 15.5%                 |
|                         | Over 60 years old                                        | 28        | 6.60%                 |
| Academic qualifications | Junior High School and below                             | 33        | 7.70%                 |
|                         | High school/technical secondary school/vocational school | 60        | 14.10%                |
|                         | Junior college/college                                   | 278       | 65.30%                |
|                         | Postgraduate and above                                   | 55        | 12.90%                |
| Permanent residence     | Xiamen                                                   | 217       | 50.90%                |
|                         | Other cities                                             | 209       | 49.10%                |
| Number of peers         | Alone                                                    | 73        | 17.10%                |
|                         | With a friend/family/love                                | 218       | 51.20%                |
|                         | With two or more friends/family/lovers                   | 135       | 31.70%                |
| Number of visits        | Once                                                     | 237       | 55.60%                |
|                         | Two or three times                                       | 91        | 21.40%                |
|                         | More than three times                                    | 98        | 23.00%                |
| Method of discovery     | Newspapers or publications                               | 22        | 5.20%                 |
|                         | Network channels                                         | 221       | 51.90%                |
|                         | Introduction of friends and family                       | 103       | 24.20%                |
|                         | Others                                                   | 80        | 18.80%                |

#### 4.2. Effect of Demographic Characteristics on Perceived Restorative Qualities

##### 4.2.1. Permanent Residence Factor

The effect of permanent residence on perceived recovery quality was investigated using an independent sample *t*-test in SPSS 26.0. As shown in the table, perceived restorative quality was significantly influenced by the place of permanent residence, with local users in Xiamen having significantly higher levels of perceived recovery than visiting users in other cities (Table 2).

**Table 2.** Independent sample *t*-test for the effect of permanent residence on perceived restorative qualities ( $N = 426$ ).

| Dependent Variable              | Gender       | Mean | Standard Deviation | Mean Difference | t       | p-Value |
|---------------------------------|--------------|------|--------------------|-----------------|---------|---------|
| Perceived restorative qualities | Xiamen       | 4.48 | 0.509              | 0.13            | 2.117 * | 0.035   |
|                                 | Other cities | 4.34 | 0.758              |                 |         |         |

\*  $p < 0.05$ .

#### 4.2.2. Age Factor

The results of the one-way ANOVA test for the effect of age on perceived restorative qualities showed that age had a statistically significant effect on the variability of perceived restorative qualities. There is a clear difference in restorative environment perception between users aged 18–30 and over 60, with users over 60 years old having the strongest restorative environment perception and users aged 18 to 30 having the worst. Restorative environment perception from 41 to 60 is the second best (Table 3).

**Table 3.** One-way ANOVA test for the effect of age on perceived restorative qualities ( $N = 426$ ).

| Dependent Variable              | I/Year            | J/Year            | Mean Difference (I-J) | Standard Error | Significance |
|---------------------------------|-------------------|-------------------|-----------------------|----------------|--------------|
| Perceived Restorative Qualities | <18 years old     | 18–30 years old   | 0.017                 | 0.143          | 1            |
|                                 |                   | 31–40 years old   | −0.102                | 0.152          | 1            |
|                                 |                   | 41–60 years old   | −0.164                | 0.157          | 1            |
|                                 |                   | Over 60 years old | −0.412                | 0.182          | 0.242        |
|                                 | 18–30 years old   | <18 years old     | −0.017                | 0.143          | 1            |
|                                 |                   | 31–40 years old   | −0.119                | 0.080          | 1            |
|                                 |                   | 41–60 years old   | −0.180                | 0.090          | 0.448        |
|                                 |                   | Over 60 years old | −0.428 *              | 0.128          | 0.009        |
|                                 | 31–40 years old   | <18 years old     | 0.102                 | 0.152          | 1            |
|                                 |                   | 18–30 years old   | 0.119                 | 0.080          | 1            |
|                                 |                   | 41–60 years old   | −0.061                | 0.104          | 1            |
|                                 |                   | Over 60 years old | −0.309                | 0.139          | 0.261        |
|                                 | 41–60 years old   | <18 years old     | 0.164                 | 0.157          | 1            |
|                                 |                   | 18–30 years old   | 0.180                 | 0.090          | 0.448        |
|                                 |                   | 31–40 years old   | 0.061                 | 0.104          | 1            |
|                                 |                   | Over 60 years old | −0.248 *              | 0.144          | 0.858        |
|                                 | Over 60 years old | <18 years old     | 0.412                 | 0.182          | 0.242        |
|                                 |                   | 18–30 years old   | 0.428                 | 0.128          | 0.009        |
|                                 |                   | 31–40 years old   | 0.309                 | 0.139          | 0.261        |
|                                 |                   | 41–60 years old   | 0.248                 | 0.144          | 0.858        |

\*  $p < 0.05$

#### 4.2.3. Population Factor

The statistical analysis conducted using one-way ANOVA revealed a significant effect of the number of companions on the variability of perceived restorative qualities. The results indicated that there was a significant difference in the perception of the restorative environment between individuals arriving alone and those arriving with two or more companions. The strongest perceptions of the restorative environment were reported by individuals who arrived alone, while the weakest perceptions were reported by those arriving with two or more companions (Table 4).

**Table 4.** One-way ANOVA test for the effect of number of peers on perceived restorative qualities ( $N = 426$ ).

| Dependent Variable              | I/Number                               | J/Number                               | Mean Difference (I-J) | Standard Error | Significance |
|---------------------------------|----------------------------------------|----------------------------------------|-----------------------|----------------|--------------|
| Perceived restorative qualities | Alone                                  | With a friend/family/love              | 0.13                  | 0.087          | 0.369        |
|                                 |                                        | With two or more friends/family/lovers | 0.252 *               | 0.093          | 0.021        |
|                                 | With a friend/family/love              | Alone                                  | −0.013                | 0.087          | 0.369        |
|                                 |                                        | With two or more friends/family/lovers | 0.12                  | 0.070          | 0.281        |
|                                 | With two or more friends/family/lovers | Alone                                  | −0.252 *              | 0.093          | 0.021        |
|                                 |                                        | With a friend/family/love              | −0.12                 | 0.070          | 0.281        |

\*  $p < 0.05$ .

#### 4.3. Measurement Model Analysis

##### 4.3.1. Reliability and Validity Analysis

The consistency and reliability of the 426 questionnaires were assessed using SPSS 26.0. The findings revealed a high level of reliability for the questionnaire, with a Cronbach's coefficient of 0.946 ( $>0.700$ ) for the overall scale, and a decrease in the coefficient after the removal of certain questions. The results of the Bartlett's sphericity test and KMO analysis indicated a KMO sampling fitness number of 0.94 ( $>0.700$ ) and an approximate chi-square of 9106.804, and the significance probability value  $p = 0.000 < 0.001$  reached a significant level, confirming the validity of the results. To sum up, the sample data were suitable for exploratory factor analysis.

The AMOS 24.0 analysis of the hypothetical model was subjected to validation factor analysis, which revealed that the standard factor loadings for each item ranged from 0.656 to 0.959. Construct reliability (CR) and average variance extracted (AVE) tests were run to examine the convergent validity of the variables, and both results were higher than the required threshold of 0.500. Additionally, the AVE value was higher than the standard value, demonstrating the excellent dependability of the survey (Table 5).

**Table 5.** Fitting factors for measurement scale problems.

| Structure Variables                 | Source of Observation Indicators                                             | Standardized Factor Loadings | AVE   | CR    | Cronbach's Alpha Value |
|-------------------------------------|------------------------------------------------------------------------------|------------------------------|-------|-------|------------------------|
| Intrinsic avoidance motivation (A1) | A11 Fast-paced life or stressful work                                        | 0.817                        | 0.673 | 0.858 | 0.849                  |
|                                     | A12 Poor mental state such as anxiety                                        | 0.959                        |       |       |                        |
|                                     | A13 Poor physical condition                                                  | 0.658                        |       |       |                        |
| Extrinsic avoidance motivation (A2) | A21 Located in a monotonous urban built environment                          | 0.789                        | 0.732 | 0.891 | 0.885                  |
|                                     | A22 Traffic congestion, noise and other problems in your city                | 0.957                        |       |       |                        |
|                                     | A23 Urban air pollution and poor environment and other problems in your city | 0.811                        |       |       |                        |
| Trail quality (B1)                  | B11 Formal aesthetics of exterior design                                     | 0.824                        | 0.749 | 0.899 | 0.899                  |
|                                     | B12 Feel safe in high places                                                 | 0.871                        |       |       |                        |
|                                     | B13 Friendliness of paving materials                                         | 0.899                        |       |       |                        |

Table 5. Cont.

| Structure Variables                 | Source of Observation Indicators                                            | Standardized Factor Loadings | AVE   | CR    | Cronbach's Alpha Value |
|-------------------------------------|-----------------------------------------------------------------------------|------------------------------|-------|-------|------------------------|
| View quality (B2)                   | B21 Variety of viewing angles                                               | 0.869                        | 0.67  | 0.89  | 0.888                  |
|                                     | B22 Visual openness                                                         | 0.858                        |       |       |                        |
|                                     | B23 Plants are colorful and varied                                          | 0.750                        |       |       |                        |
|                                     | B24 Water views worth seeing                                                | 0.792                        |       |       |                        |
| Passage perception (B3)             | B31 Plants are close and touchable                                          | 0.656                        | 0.504 | 0.752 | 0.745                  |
|                                     | B32 Away from the hustle and bustle of the city                             | 0.787                        |       |       |                        |
|                                     | B33 The ups and downs follow the terrain and are adapted                    | 0.680                        |       |       |                        |
| Facility Services (B4)              | B41 Entrance/exit points are easily accessible                              | 0.812                        | 0.621 | 0.867 | 0.864                  |
|                                     | B42 The layout of seating, lighting and other facilities is rational        | 0.757                        |       |       |                        |
|                                     | B43 Availability of accessibility facilities                                | 0.800                        |       |       |                        |
|                                     | B44 Reasonable layout for shade and shelter from the rain                   | 0.781                        |       |       |                        |
| Perceived restorative qualities (C) | C1 The trail traverses a coherent environment                               | 0.777                        | 0.631 | 0.895 | 0.921                  |
|                                     | C2 The form of the elevated trail is novel                                  | 0.797                        |       |       |                        |
|                                     | C3 The environment I felt on the trail lived up to my expectations          | 0.846                        |       |       |                        |
|                                     | C4 I was fascinated by the many interesting sights on the trail             | 0.786                        |       |       |                        |
|                                     | C5 On the trail I can relax from my daily life                              | 0.762                        |       |       |                        |
| Place attachment (D)                | D1 There is no better trail in my mind                                      | 0.890                        | 0.689 | 0.815 | 0.834                  |
|                                     | D2 Although I can do the activity on other trails, this one suits me better | 0.766                        |       |       |                        |
| Loyalty (E)                         | E1 Willing to revisit                                                       | 0.725                        | 0.623 | 0.767 | 0.783                  |
|                                     | E2 Willing to actively recommend this place                                 | 0.849                        |       |       |                        |

#### 4.3.2. Structural Equation Model Goodness-of-Fit Analysis

The present study utilized the large likelihood method of parameter estimation with AMOS 26.0 software to examine the structural relationships of the structural model. The outcomes were compared with the values of the conventional fitted coefficients in Table 6. The measurement model demonstrated a good fit, as evidenced by a root mean square error of approximation (RMSEA) of 0.063, a goodness of fit index (GFI) of 0.846 and a comparative fit index (CFI) of 0.931, along with other metrics falling within the good fit range. Additional support for the robust discriminant validity of the model is derived from the observation that the root value of each latent variable in the judgment matrix surpasses the correlation coefficient between the latent variable and other latent variables (Table 6).

Table 6. Table of overall fit coefficients.

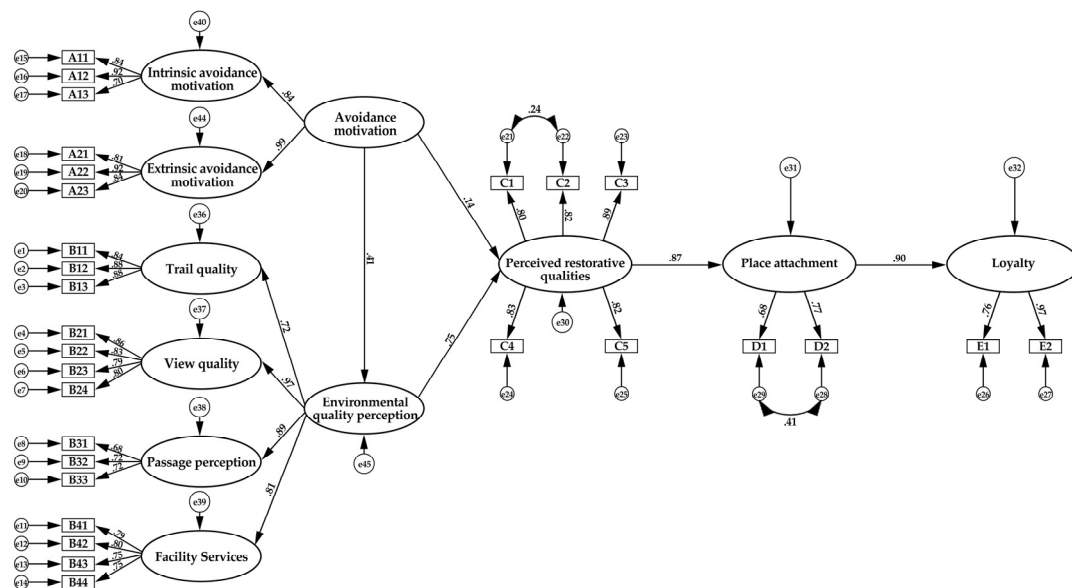
| Fitting Index        | X2/df  | GFI   | AGFI  | RMSEA | RMR   | IFI   | TLI   | CFI   |
|----------------------|--------|-------|-------|-------|-------|-------|-------|-------|
| Adaptation standards | [1, 3] | ≥0.8  | ≥0.8  | ≤0.10 | ≤0.10 | ≥0.9  | ≥0.9  | ≥0.9  |
| Fitted index value   | 2.599  | 0.858 | 0.830 | 0.061 | 0.05  | 0.935 | 0.927 | 0.935 |

#### 4.3.3. Structural Equation Model Goodness-of-Fit Analysis

In this study, the hypothetical paths were tested and analyzed at a significance level of  $p < 0.050$ , and the results of the path hypothesis tests were obtained (Table 7). The findings indicate that all five path coefficients ( $p$ -values) are statistically significant at a level of less than 0.05, thereby corroborating the validity of the path hypothesis. The final hypothesis model is depicted in Figure 3 (Figure 3).

**Table 7.** Results of path hypothesis testing.

| Assumptions                                                                                                | Standardized Path Coefficient | Standard Error | t-Value | p-Value | Hypothesis Testing |
|------------------------------------------------------------------------------------------------------------|-------------------------------|----------------|---------|---------|--------------------|
| Avoidance motivation has a significant positive effect on perceived restorative qualities (H1)             | 0.141                         | 0.038          | 3.474   | ***     | Established        |
| Avoidance motivation has a significant positive effect on environmental quality perception (H2)            | 0.408                         | 0.049          | 6.685   | ***     | Established        |
| Environmental quality perception has a significant positive effect on perceived restorative qualities (H3) | 0.749                         | 0.075          | 11.646  | ***     | Established        |
| Perceived restorative qualities have a significant positive effect on place attachment (H4)                | 0.873                         | 0.072          | 14.998  | ***     | Established        |
| Place attachment has a significant positive effect on loyalty (H5)                                         | 0.903                         | 0.053          | 15.386  | ***     | Established        |

\*\*\*  $p < 0.001$ .**Figure 3.** Standard estimates of the structural equation model path analysis.

## 5. Discussion

### 5.1. Implications of Major Findings

This study examined the relationship between user motivation, perceived environmental quality, perceived restorative environment, place attachment and loyalty. The hypothesis was that restorative environmental perception is influenced by user motivation and perceived environmental quality, which in turn influences place attachment and contributes to user loyalty. All hypotheses were confirmed, and some inferences can be drawn from them for urban green way planning.

The findings indicate several key points. Firstly, the standardized path coefficient of user avoidance motivation on the perception of trail quality is 0.41, showing a positive impact of avoidance motivation on the perception of restorative environments. Both intrinsic avoidance motivation, facilitated by intrinsic physiological or psychological factors, and extrinsic avoidance motivation, caused by the urban living environment, increase the likelihood that users come to treetop trails to relax and seek physical and mental pleasure. This helps to enhance a better understanding of the perceived quality of the trail.

Secondly, the standardized path coefficients of user escape motivation and trail environmental quality perception on perceived recovery quality were 0.14 and 0.75, respectively.

This suggests that both user motivation prior to recreation and environmental perception during recreation positively influence perceived recovery. However, directly obtaining visitors' perceptions of the restorative environment while on the treetop trail through escape motivation is challenging due to variations in user demographics such as age, status and education level. On the other hand, perceived environmental quality perception strongly promotes perceived recovery, with each unit increase in environmental quality perception corresponding to a 0.75 unit increase in perceived recovery quality. This finding aligns with existing research [42].

Thirdly, the standardized path coefficient from restorative environmental perception to place attachment is 0.87, indicating that the perceived restoration experienced by users on treetop trails significantly contributes to their place attachment, establishing a stronger connection with the destination. Lastly, for every unit increase in place attachment, loyalty increases by 0.93 units. These results highlight the significant impact of visitors' place attachment to treetop trails on their likelihood of revisiting and recommending them to others, consistent with previous studies [79,80].

### *5.2. Treetop Trails and Perceived Restoration of Quality*

This study expands our understanding of the perceived health benefits associated with treetop trails, specifically regarding trail quality, view quality, access perception and facility services. Firstly, different from the findings in Fuzhou, China [42], existing studies have concluded that trail design is the most important factor in enhancing perceived restoration. In our study, viewing quality was the factor that played the most important role in this segment, probably because higher visibility of blue space (mainly the ocean) reduces psychological distress among residents [81], as well as the special topography of Xiamen Island and the meandering aerial corridors combining to bring about a multivariable visual impact effect, bringing multiple experiences of both long-distance and close-up views. While the trail in Fuzhou is in a forest park, the surrounding forest shades the view, perhaps leading to a restricted field of vision and a shortened viewing distance.

Secondly, trail access perception plays the second most important role. The unique form of the treetop walkway elevation makes it different from other urban greenways, and recreationists are therefore more concerned with the comfort level of the walkway as it undulates with the terrain. The experience of treetop trails crossing urban green spaces and waters makes users more concerned about whether it can meet the demand of getting away from the hustle and bustle of the city. Thirdly, trail facility services and trail quality are also important determinants. Reasonable and user-friendly arrangement of public service facilities such as seating, lighting and signage enhance users' recreational experience. Abundant access points provide convenience for users. Additionally, the elevated form of the trail also makes users more concerned about the safety of its guardrails and overall structure.

Interestingly, our observations revealed that some trails perceived as more restorative had fewer users compared to others, both on weekdays and weekends. However, users exhibited stronger attachment and loyalty to uniquely designed nodes or locations ideal for photography. While relaxation ranked highest in terms of users' willingness to revisit venues, they were more inclined to recommend friends to visit distinctive nodes or picturesque spots. On the other hand, when seeking solitary relaxation, users preferred trails perceived as more restorative.

### *5.3. Implications*

This study shows the significant effects of user avoidance motivation and treetop trail environmental characteristics on people's perceived recovery, as well as the contribution of people's perceived recovery from treetop trails to place attachment and loyalty. Based on the findings, the results have several policy implications that can facilitate greenway planning, especially the type of treetop trails, and help optimize the construction of urban greenways along high-density coasts.

Firstly, during the design and planning stages of new green way projects, prioritizing visual perception is crucial. The perceived quality of treetop trails has a direct impact on various aspects of perceived restoration. For instance, the trails offer diverse visual experiences, connecting urban wetlands, forests, parks and other green spaces, while providing views of lakes, oceans and other bodies of water. The presence of blue and green elements positively influences residents' perception of recovery. Policymakers should also address concerns regarding the comfort and safety of accessing elevated structures to alleviate psychological fears. Secondly, careful consideration should be given to the street networks that connect residential areas and greenways. Planning these networks effectively can reduce travel distances, promote walking and encourage greater use of greenways. Additionally, policymakers should focus on providing well-designed and user-friendly facility services, ensuring they are reasonable and tailored to human needs.

## 6. Conclusions

In the face of increasing urban land scarcity, the effective planning and utilization of nature to create healthier and more livable urban environments is a significant concern. Large-scale greenway construction is taking place in cities, but inappropriate locations or other problems with greenway construction are an important source of obstacles that prevent residents from realizing the expected health benefits [82]. In this study, based on the case of a treetop trail in Xiamen, China, an exploration of potential variables and their relationships suggests that, first, treetop trails as a type of elevated greenway have a positive impact on perceived recovery. Second, treetop trails have a key impact on the promotion of residents' wellbeing benefits in green spaces in high-density cities, as they influence users' motivation to escape and their perceptions of environmental quality. Further, among trail quality perceptions, view perception was the most important factor influencing perceived recovery, with access perception, facility services and trail quality as other important factor components. Finally, in user motivation, extrinsic avoidance motivation is the most important factor affecting perceptual recovery. In other words, the problems brought by the urban environment are restored perceptually to a certain extent after visiting treetop trails. Meanwhile, physical or psychological problems brought by life and work are other important factors.

In this paper, we proposed and estimated a model in order to understand the antecedents of treetop trails on the restoration of recreationist perceptions. Many significant antecedents were consistent with previous studies, such as access perception [42,73], landscape perception [42,73,83], trail perception [42,73] and amenity perception [42,73]. In addition, the results of loyalty as place attachment confirmed previous findings [44,69]. Notably, this model integrated multiple factors into a comprehensive framework, mitigating the issue of omitted variables [84]. Furthermore, this study explored the impact of tourist motivation on the perceived environmental quality and restoration of treetop trails, offering valuable insights for theories in this field.

Beyond its theoretical contributions, this study provides practical insights for the planning and management of densely populated coastal cities. Urban planners, policymakers or landscape architects have the ability and responsibility to make a significant contribution to our experience of a place by shaping the physical spatial environment of a city. Understanding people's perceptions of places can inform planning and management efforts by capturing the relationship between user characteristics and the value of a place. Considering users' perceived restoration quality as a vital mediating variable in greenway development planning can help decision-makers make more informed choices based on the value of treetop trails.

While this empirical study examined the relationship between avoidance motivation, environmental perception, place attachment, restorative environmental perception and loyalty, certain aspects were not extensively explored due to time and scope limitations. Factors such as the number of visits and gender did not yield significant differences in users' restorative environmental perceptions. Further categorization of users and investiga-

tion into the association between the distance users walk on treetop trails, their walking routes and their restorative environmental perceptions would be of research interest. Additionally, this study established a connection between avoidance motivation and negative emotions, albeit with a limited range of emotions. Moreover, the contribution of sound to environmental resilience was not inferred, as the presence of acoustic information was not manipulated. It is important to note that the constraints specific to Xiamen's urban space may limit the generalizability of the results to other geographical areas and seasons. Lastly, while the questionnaire and content analysis provide subjective measures, future studies could consider combining them with objective experiments, such as eye-tracking and brainwave measurements, to comprehensively analyze changes in users' perceived recovery and further elucidate the underlying mechanisms of influence.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/land12071472/s1>, Table S1: Data from questionnaire; Table S2: Female's data; Table S3: Male's data.

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