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EVALUATION OF WALKABILITY ON GULANGYU BASED ON RESIDENTS' PERCEPTIONS

Summary. As a heritage site, Gulangyu has a unique character and importance in its community function. Most heritage sites in China are car-free destinations where walking is the primary mode of transport and a medium of interaction in residents' daily lives. This study investigates residents' perceived evaluations of the landscape environment and residents' walking behaviour using descriptive statistics, correlation and logistic regression analysis to derive relationship between landscape and walking behaviour. The aim is to derive the landscape factors that influence walking behaviour and improve the basis for enhancing the walkability of Gulangyu. The results show that function is most strongly correlated with purposeful walking. And the recreational walkers are influenced by a combination of function, safety, comfort, aesthetics and pleasantness.

1. INTRODUCTION

Heritage sites encompass sites and historic buildings, as well as more complex areas, landscape settings, and the cultural heritage inherited by local inhabitants. Heritage sites are communities in which local people live. Their perceptions of the community environment affect their quality of life, living experience, and sense of belonging.

In China, many heritage sites are car-free destinations where walking is the primary mode of transport. Walking has a transport function and is an essential part of daily social interactions. There is a close relationship between walking and the landscape environment. Walkers are more aware of their environment than motor vehicle and public transport users, and they can hear, see, and smell the environment while walking [1]. The city's aesthetic value is reflected in the combined experience of multiple senses, especially for walkers [2]. Therefore, enhancing the pedestrian environment is a powerful way to shape a high-quality habitat. The pedestrian experience and landscape environmental factors in heritage sites should be better understood as car-free destinations. The study of pedestrian perceptions and landscape environmental factors affecting walking in heritage sites has implications for improving residents' quality of life and preserving cultural spaces in heritage sites.

The landscape elements are divided into hardscape and softscape elements. Hardscape elements are related to the environment constructed by artificial materials, such as road paving, facilities, and open spaces. Softscape elements are delicate, organic, and growing materials like plants, flowers, trees, and water. The selection of landscape factors was based on the urban characteristics of Gulangyu. All landscape factors that may affect the perceptions of walking are considered. These include functional factors such as the material, width, facilities and slope of the sidewalks; safety factors such as traffic and night-time lighting during walking; natural and artificially created comfort landscape factors such as weather, shade, street furniture and cleanliness; aesthetic factors such as trees, building heights and

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colours, public art, and water features that visually affect pedestrians; recreational places such as public spaces, parks, and beaches; and a psychological sense of belonging. All these factors add to the pleasure of walking.

Many studies have confirmed the correlation between walking and the landscape environment. However, the conclusions based on research and general urban design may not apply to heritage cities. Currently, the research on heritage cities in China mainly focuses on the protection and restoration of heritage buildings, the cultural value of historical buildings, the commercial and tourism development of historical blocks, the protection and utilisation of historical culture, and so on. There is still room to improve the walking environments in heritage areas, according to the few studies available. In a survey of the walking environment of Gulangyu residents, it was found that satisfaction with road connectivity is the lowest, followed by shade facilities and crowding, and it was concluded that comfort and connectivity have the most significant impacts on overall satisfaction [3]. In addition, some sections have problems such as congestion, excessive commerce, and dirty road surfaces [4]. Another study showed that the garden greening, street greening, and public parks in Gulangyu are lacking in ornamental value and that the planting of plants was monotonous and disordered [5]. Although some relevant research findings on the pedestrian environment in Gulangyu are available, current studies are one-dimensional and only look at aspects such as road functionality, the commercial environment, or the green environment. Similar studies have not been conducted for other heritage areas, namely Lijiang, Xidi, Hongcun, and Pingyao. Since walking is the main means of transportation, the walking experience is important for both residents and visitors.

The questions addressed in this study are as follows:

- a. What are residents' walking attitudes and behaviours in Gulangyu?
- b. What is the relationship between landscape factors and residents' walking behaviour in Gulangyu?
- c. What landscape elements can be effective in promoting residents' walking behaviour in Gulangyu?

The objectives of this study are as follows:

- a. To understand the attitudes of Gulangyu residents towards walking and their walking behaviour.
- b. To verify which landscape factors are associated with walking behaviour in Gulangyu.
- c. To find landscape factors that can promote walking behaviour in Gulangyu.

2. LITERATURE REVIEW

2.1. Walkability and the Landscape Environment

Walkability is a characteristic describing whether a particular area is suitable for walking and is closely related to environmental factors. Understanding how to create a walkable environment is the goal of many researchers. However, most existing studies have focused on the neighbourhood and community scale and the urban scale, while little attention has been paid to the pedestrian environment within heritage sites [3].

Walking is seen as an unconscious way of optimising an urban space. Walking is emphasised to promote the optimisation of the public realm and is seen as part of urban regeneration and upgrading the local environment [6]. Erna and Amin analysed the walkability of roads through obstructions, cleanliness and maintenance, amenities (street lighting, seats, canopy/trees, rubbish bins), disabled supports, and the importance of shade based on the actual number of walkers on the road [7]. Factors related to the weather, particularly temperature and precipitation, also affect walking [8, 9]. Walking paths and crime are other factors affecting walking [8]. Moreover, micro-scale variables such as pavement quality and obstacles on the pavement are relevant factors in promoting walkability [10]. Pedestrian mobility, safety, interest, and comfort can increase the attractiveness of walking. These factors can be divided into two main categories: perceived factors affecting ease of movement and logical good ownership factors [11]. Handy suggests possible ways to encourage people to walk. They are to improve the quality of the built environment by enhancing amenities (bike lanes, pavements, parks, public transportation), safety (quiet, low crime, low traffic, pedestrian safety, children's safety, street lighting), attractiveness (appearance, level of maintenance, variety of housing styles, large trees), and socialisation (diverse neighbours, neighbourhood interaction, similar economic levels) [12].

2.2. Walking Perception

Environmental perception is one's subjective feelings and mental judgments about their surroundings and changes to their surroundings [13]. The physical environment influences human perceptions [14], and the decision to walk may be made after one has been influenced by the perception of walking. Most studies have concluded that pedestrians' perceptions of their environment affect walking travel behaviour [15, 16]. Cao concluded that respondents' perceptions of community characteristics significantly impacted walking frequency [17]. Some travel behaviour studies have verified that perceived walkability scores can predict future walking behaviour [18]. Researchers have also found that the relationship between perceptions of the built environment and pedestrian activity is a two-way relationship [19]. Thus, some articles use the concept of perception as a mediator between the objective environment and walking [20-22]. Environmental perception and walking behaviour are significant [23].

3. RESEARCH AREA AND METHODOLOGY

Taking Gulangyu as an example, this study analyses the landscape factors affecting walking based on a questionnaire survey of residents in the heritage community regarding their perceptions of the walking environment.

3.1. Research Area

Gulangyu is located in Xiamen, Fujian Province, which covers an area of 1.91 km² with a registered population of approximately 16,000 people. Named a World Heritage Site in 2017, Gulangyu is an international community with a rich history and culture, an urban community where residents live, and a tourist community that undertakes tourism functions. The complexity of Gulangyu's multiple community functions makes the residents' perceptions of walking different from those of residents of ordinary cities, making studying the pedestrian environment even more valuable in this setting. Gulangyu retains primitive ferry connections to the city of Xiamen, with cars and bicycles banned from the island; only a minimal number of environmentally friendly electric vehicles are used for public services, leaving walking as the only means of transport for residents. The pedestrian environment of Gulangyu makes it a representative area of heritage sites, which is essential for enhancing the quality of the pedestrian environment and improving the quality of life of the community's residents. The environment is also for developing and conserving Gulangyu's high-quality development needs and cultural heritage.

3.2. Questionnaire Design and Data Collection

The present questionnaire survey was conducted among residents who had lived in Gulangyu for more than six months. After data collection, the questionnaire data were collated and analysed through SPSS. Descriptive statistics and correlation analysis were carried out to derive the residents' perceptions of the walking environment on Gulangyu and the landscape and environmental factors associated with their walking behaviour. The five sections of the questionnaire asked residents to evaluate indicators related to function, safety, comfort, aesthetics, and pleasure. A 5-point Likert scale was used to assess the indicators, with the following response options: 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), and 1 (strongly disagree). In total, 385 questionnaires were distributed in January and June 2022, and 372 valid questionnaires were returned. The Cronbach's alpha value for the questionnaire is 0.974, indicating good internal consistency and reliability.

3.3. Study Methods

The study is divided into three parts to determine the landscape elements that affect residents' walking behaviours and the degree of influence of these factors (Fig. 1). The first part uses the literature review method to summarise and draw conclusions about the landscape factors influencing walkability. Based

on the summarised landscape factors and the environmental characteristics of Gulangyu, a synthesis was made to derive the landscape elements suitable for this study. In the second part, a correlation analysis was carried out between residents' evaluations of these landscape elements and their walking behaviour. The third part is a logistic regression analysis based on the results of the correlation analysis. This three-step research approach moves from screening landscape factors to selecting factors that are associated with walking and deriving the correlation between factors and walking behaviour through logistic regression analysis. This research system helps derive the landscape factors that influence the walking behaviour of Gulangyu residents.

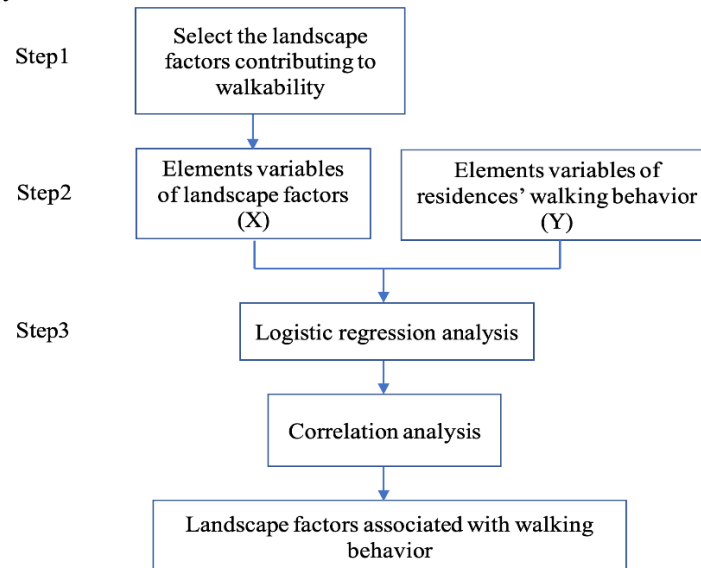


Fig. 1. Methodology

- Step 1: Select the landscape factors contributing to walkability.

The researcher searched for studies published after 2000 using the keywords of “walking environment”, “walkability”, “walking landscape”, and “pedestrian”. After further screening and summarisation, 37 influential studies were listed. These 37 articles are relevant studies on the walking environment and walking behaviours and perceptions, and they allow us to draw reasonable conclusions regarding which environmental factors have an impact on walkers. Further, the findings of the studies were extracted concerning the factors in the landscape environment that influence walking decisions, behaviours, and perceptions, as well as the number of articles in which each landscape factor was mentioned (Fig. 2).

The selected landscape factors were summarised into five broad categories: function, safety, comfort, aesthetics, and pleasure. Function is the most commonly mentioned environmental factor affecting walking [24, 25]. The functionality of the walking path is often cited as the most important environmental factor. This factor includes the surface and accessibility of the walking path, which affects the route and walking quality. Security means that a person feels safe from the threat of crime, traffic, or chaos. Individuals may stop walking if they are unsatisfied with their safety [26]. The sense of security is the most frequently mentioned factor affecting walking, including personal safety feeling and traffic safety [27, 28]. The comfort of walking comes from the feeling of climate and the creation of artificial comfort. Compared to driving a motor vehicle, walking makes a person more exposed, is more physically demanding, and makes a person more sensitive to the environment. Therefore, weather, shade, and cleanliness may affect walking comfort [26]. Aesthetics have also been cited as important drivers of walking. This factor includes environmental appeal (e.g. natural scenery, public art, water features) and architectural features (e.g. the colour and height of buildings, sense of age) [27, 29, 30]. Several studies have found a direct relationship between walking and community attractiveness [30, 31]. Recreational facilities and pleasure are other factors affecting walking. Public recreational facilities, parks, squares, and green spaces are all related to walking [24, 32, 33].

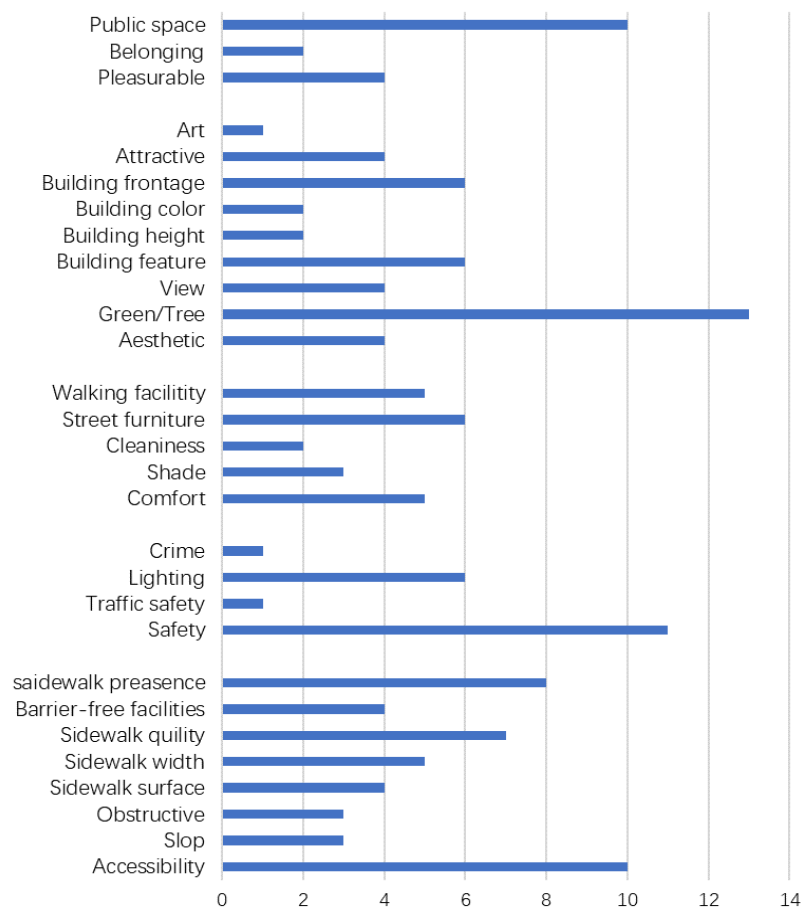


Fig. 2. Environmental factors associated with walkability and the number of times these factors were mentioned

Based on the literature and statistical results, it can be seen that in previous studies, accessibility, sidewalk quality, sidewalk presence, safety, lighting, street furniture, greenery and trees, building features, building frontage, and public spaces were the factors with relatively significant impacts on walking behaviour and perceptions. The researchers further classified the landscape factors mentioned often in previous studies and selected the ones that are suitable for this study based on the uniqueness of the landscape environment of Gulangyu. The five factors were assessed using 37 items (Fig. 3) that were developed into a questionnaire. Residents' walking behaviours were divided into purposeful and recreational walking. These two categories of walking behaviour may differ regarding their perceptions of the landscape factors.

- Step 2: Correlation analysis.

This study analysed the elements of the landscape environment that support walking behaviour based on the behaviours of residents travelling on foot, including travel time and distance. Descriptive statistics were used to obtain residents' attitudes towards walking and evaluate the importance of the five elements of function, safety, comfort, aesthetics, and pleasure. Through these data, the overall attitudes of Gulangyu residents towards walking and the landscape environment were examined. Correlation analysis was then used to analyse landscape elements (X) and residents' walking behaviours (Y). Correlation analysis is a test to measure the relationship between two or more variables. In this study, the environmental factors that influence residents' perceptions were examined by employing a bivariate correlation analysis (Kendall's tau-b correlation coefficient) to investigate the relationship between the landscape factors and walking behaviour (Fig. 1). Kendall's tau-b correlation coefficient is applicable when both variables are ordered variables.

- Step 3: Ordered logistic regression analysis.

In Step 2, relevant elements of walking behaviour and the landscape environment were selected. Ordered logistic regression analysis can be used for quantitative analysis and model-fitting equation calculations. The model need to be calculated using a cumulative probability formula; this is represented by Formulas (1)–(4). For some X variables that the formula calculation cannot calculate, an OR value can be used to judge their influence on the Y variables as in Formula (5).

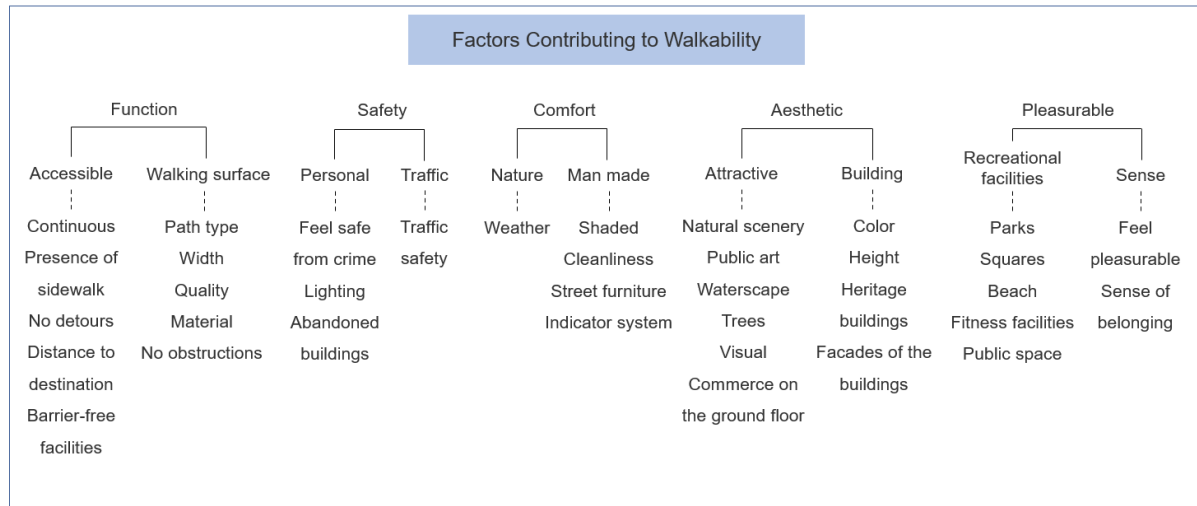


Fig. 3. Factors contributing to walkability

$$P(y \leq j|x) = P(y = 1|x) + \dots + P(y = j|x) \quad (1)$$

$$\text{Logit } P_j = \text{Logit}[P(y > j|x)] = \ln \frac{P(y > j|x)}{1 - P(y > j|x)} \quad (2)$$

$$\text{Logit } P_j = \text{Logit}[P(y > j|x)] = -\alpha_j + \sum_{i=1}^p \beta_i x_i \quad (3)$$

$$P(y \leq j|x) = \frac{1}{1 + \exp(-\alpha_j + \sum_{i=1}^p \beta_i x_i)} \quad (4)$$

$$OR = \exp(\beta_i) \quad (5)$$

3.4. Data Analysis

The data were analysed through on-site surveys and questionnaires assessing residents' perceptions of the environment and walking trips. The statistics are shown in Fig. 4 and Table 1.

In this survey, 171 respondents (45.97%) were male, and 201 (54.03%) were female. In Gulangyu, people aged 21-30 (29.03%) and 31-40 (36.29%) make up the majority, and middle-aged and young people account for a large proportion of the total population. In addition, 82 participants (22.04%) were engaged in commercial operations, and 83 (22.31%) were employed in private enterprises. As seen from the statistical data of age and occupation, there are more people between 21 and 40 years old in Gulangyu than in any other age group, and most of them are engaged in tourism services (e.g. they are waiters and waitresses in restaurants and hotels and shopping guides in stores). However, some young people who live in Gulangyu work outside the city of Xiamen and use boats as transportation. The duration of each walking trip was surveyed (Table 2), and the time of walking trips included the duration of purposeful and recreational walking trips. Each walk of less than one hour was given a value of 1, each walk of one to two hours was given a value of 2, and each walk of more than two hours was given a value of 3. It can be seen that the greatest proportion of purposeful walkers walk for less than an hour (49.32%), while recreational walkers tend to walk for one to two hours (46.24%). Walking distance refers to the approximate distance walked per day in km. If the walking distance was 0-3 km, it was given a value of 1, walking distances of 3-6 km were given a value of 2, walking distances of 6-9 km were given a value

of 3, walking distances of 9-12 km were given a value of 4, walking distances of 12-15 km were given a value of 5, and walking distances over 15 km were given a value of 6. Among these, 3-6 km was the most common distance, both for purposeful walking (42.12%) and recreational walking (46.59%). This was followed by the 0-3 km range (33.90% and 27.60%). Relatively few walkers travelled over 6 km per day. As seen from the table, the walking time and distance of Gulangyu residents are generally about one to two hours and 3-6 km.

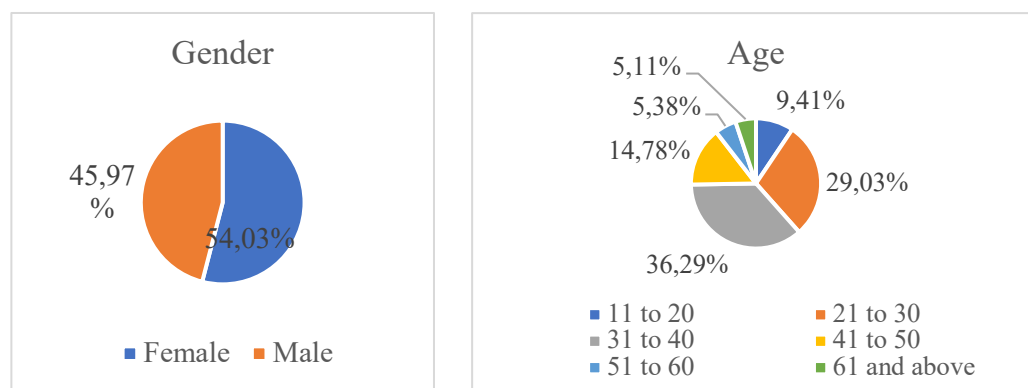


Fig. 4. Gender and age of questionnaire respondents

Table 1

Basic statistics of questionnaire respondents

Categories	Statistical Results								
Education background (%)	Primary school (3.23%)	Junior middle school (14.52%)	Senior middle school (25.81%)	Diploma (23.39%)	Bachelor's degree (26.34%)	Master's degree and above (6.72%)	-	-	-
Occupation (%)	Student (8.06%)	Teacher (2.15%)	Trade personnel (22.04%)	Government agencies staff (6.46%)	Enterprise staff (22.31%)	Tour guide (2.69%)	Freelancer (18.55%)	Retired (5.91%)	Other (11.83%)

Table 2

Classification of different elements of residents' walking behaviours

Activity Type	Questionnaire Item	Description of Value Assignment	Purposeful Walking (%)	Leisure Walking (%)
Walking time	Average time per walk in Gulangyu	Less than 1 hour – value “1”	49.32	34.05
		1 hour to 2 hours – value “2”	29.45	46.24
		More than 2 hours – value “3”	21.23	19.71
Walking Distance	General daily walking distance in Gulangyu	0-3 km – value “1”	33.90	27.60
		3-6 km – value “2”	42.12	46.59
		6-9 km – value “3”	11.64	12.90
		9-12 km – value “4”	5.82	6.09
		12-15 km – value “5”	2.74	1.79
		15 km and above – value “6”	3.77	5.02

4. RESULTS

4.1. Walking Purposes

First, walking purposes were categorised to understand whether the need for landscape elements differed between walking purposes. Purposeful walking is limited by destination and time. This type of

walking is a necessary activity. Purposeful walking locations include schools, homes, workplaces, supermarkets, and other locations associated with essential activities. Recreational walking is an activity that can be randomly chosen within an uncertain range, where the walking destination is not clear and is spatially selective. Residents may be roaming to and from places where they can socialise or exercise. Walking destinations and activities may be altered by factors such as the external environment, weather, and interference from other people. In this survey, 25% of residents chose walking as a purposeful activity in their daily lives, while 21.51% mainly walked for recreational purposes (Fig. 5). At the same time, about half of the residents (53.49%) said they performed both purposeful and recreational walking in their daily activities.

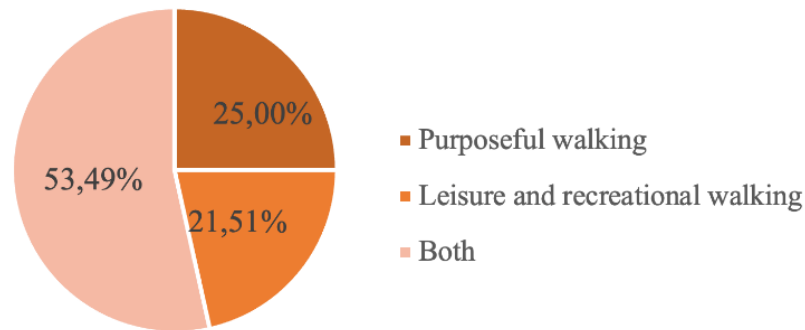


Fig. 5. Purpose of travel for residents

4.2. Correlation Analysis

Afterwards, the five main factors were divided into 37 items, and respondents scored the descriptions of the items. “Strongly agree” was assigned a score of 5, and “strongly disagree” was given a value of 1. The scores obtained for the landscape factor were (X), and the results for the walking behaviour were (Y) for correlation analysis. The significance level test was set at 0.05. The relevant analysis results are as follows. Improving the skid resistance of the roads is beneficial to the walking time and distance of recreational walkers (PF8) (Table 3). There was no significant correlation between other landscape factors and the necessary walking time and distance. The mean value of PF8 is shown in Fig. 6. It can be seen that the average value of PF8 is 3.72, which means that purposeful walkers do not recognise the anti-skid performance of the road.

Table 3
Methods of correlation analysis between landscape factors and purposeful walking behaviour

Walking Behavior	Landscape Factor			Correlation Coefficient	Significance Level
	Function	PF8	Description		
Walking Time (Y1)	Function	PF8	In extreme weather, the sidewalk material is not slippery.	0.145**	0.003
Walking Distance (Y2)	Function	PF8	In extreme weather, the sidewalk material is not slippery.	0.136**	0.007

** : p-values ≤ 0.01 indicate a high correlation between the two variables.

Landscape elements that affect residents' leisure walking time are as follows: barrier-free facilities (CF3), road anti-skid (CF6), enough light (CS2), weather (CC2), shaded (CC3), indicator system (CC6), commercial street-level buildings (CA7), fitness facilities (CP4), public places to be physically active (CP5), public space to socialise (CP6), and public space for all ages (CP7) (Table 4). Barrier-free facilities (CF3) is the only landscape factor likely to affect walking time of pedestrians (Table 4). Of these, CA7, CP4 and CP5 show a high degree of correlation with walking time.

An analysis of the means of the above factors (Fig. 6) shows that shade on the street received the highest rating. Indicating systems, weather, and public spaces where socialising can occur are also highly recognised factors. These are followed by public spaces where physical activity can take place and lighting at night. Barrier-free facilities, public spaces for all ages, and slip resistance of paths

received the lowest scores. Overall, the comfort factor of walking received the highest score, and the functionality of roads received the lowest score.

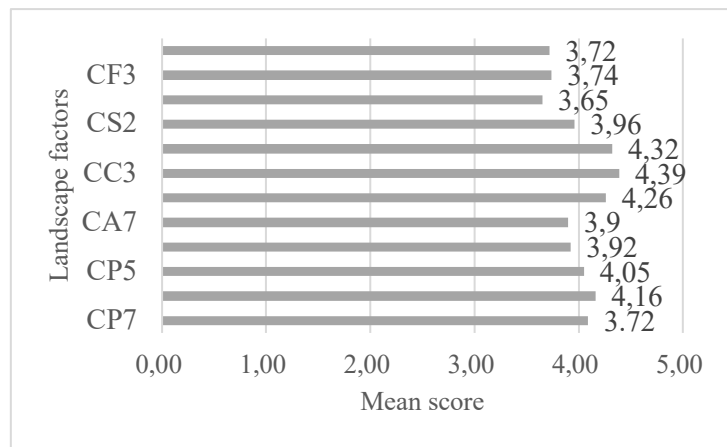


Fig. 6. Mean scores of landscape factors associated with purposeful and leisurely walking

The following conclusions were drawn. Road function influences the time and distance of purposeful walking. At the same time, all five factors influence the duration of recreational walking, and function influences the distance of recreational walking.

Table 4

Methods of correlation analysis between landscape factors and leisure walking behaviour

Walking Behaviour	Landscape Factor			Correlation Coefficient	Significance Level
Walking Time (Y3)	Function	CF3	Barrier-free facilities are complete.	0.117*	0.024
		CF6	In extreme weather, the sidewalk material is not slippery.	0.106*	0.040
	Safety	CS2	There is enough light to make people feel safe at night.	0.107*	0.041
	Comfort	CC2	The weather is walkable.	0.107*	0.046
		CC3	The sidewalks are shaded.	0.107*	0.049
		CC6	Indicator system, the map can indicate the sidewalks.	0.132*	0.014
	Aesthetics	CA7	Commercial street-level buildings make the road more attractive.	0.148**	0.005
	Pleasure	CP4	There are fitness facilities.	0.177**	0.001
		CP5	There are many public places to be physically active.	0.141**	0.007
		CP6	There is enough public space to socialise (e.g. chatting, playing chess).	0.133*	0.012
CP7		The public space is suitable for people of all ages.	0.133*	0.012	
Walking Distance (Y4)	Function	CF3	Barrier-free facilities are complete.	0.115*	0.023

Note. *: 0.01 < p-values < 0.05 indicate a certain correlation between the two variables; **: p-values ≤ 0.01 indicate a high correlation between the two variables.

4.3. Logistic Regression Analysis

An ordered logistic regression analysis was conducted in order to test the influence of landscape factors on walking behaviour. The significance level test for the ordered logistic regression analysis

results was set at 0.05, with walking behaviour serving as the dependent variable and landscape factors acting as the independent variable. An ordered logistic regression analysis led to the following conclusions. The skid resistance of the road (PF8) can increase the purposeful walking time (Y1) and purposeful walking distance (Y2) of residents (Table 5). The higher the road skid resistance rating, the higher the probability that the purposeful walking time will increase from less than one hour to one to two hours. In addition, an increase in road skid resistance may increase residents' purposeful walking distance from less than 3 km to 3-6 km, 6-9 km, 9-12 km, and 12-15 km, with the probability of an increase in walking distance being 1.25 times higher than the probability of an increase in skid resistance. During the modelling process for the ordered logistic regression between walking behaviour for recreational walking and landscape factors, a significance value of $p < 0.05$ was used for the parallelism test. The parallelism hypothesis did not hold and could not be analysed using the ordered logistic process. Therefore, the logistic regression relationship between residents' recreational walking and landscape factors was insignificant.

Table 5

Ordered logistic regression analysis for purposeful walking

Landscape Element Promoting Residents' Walking Behaviour			β	Significance Level	"OR" value	Category
Purposeful walking time (Y1)	Constant term	Y1="1"	0.794	0.037	-	-
		Y1="2"	2.151	0.000	-	-
	PF8	0,220	0.023	1.25	Function	
Purposeful walking distance (Y2)	Constant term	Y2="1"	0.260	0.475	-	-
		Y2="2"	2.113	0.000	-	-
		Y2="3"	2.928	0.000	-	-
		Y2="4"	3.638	0.000	-	-
		Y2="5"	4.217	0.000	-	-
	PF8	0.253	0.007	1.29	Function	

5. DISCUSSION

5.1. Residents' Attitudes towards the Walking Environment in Gulangyu

Gulangyu residents have a largely positive attitude towards walking. Items were presented to evaluate the impact of walking on the body and mood, walking to keep family and friends company, walking to experience the cultural and natural features of Gulangyu, and walking to interact with others. Respondents rated their agreement with the items on a scale of 1 to 5, with 5 indicating complete agreement (Fig. 7). It is clear from the data that most residents agree with the items "time spent with family while walking" and "time spent with friends while walking", as they gave high scores for these three related items. Participants were slightly less likely to agree with the items of "walking makes people feel happy" and "walking is good for the company" than the other items. In general, Gulangyu residents agree that walking benefits them in terms of physical health, experiencing the environment, spending time with family, and social interaction.

Respondents were asked to select the factors they consider essential in their daily walking in order to understand their overall perceptions and evaluations of the top five landscape factors (Fig. 8). Aesthetic factors were considered important for walking by 77.15% of respondents, followed by the comfort of the walking path (74.46%), safety (63.71%), functionality (54.03%), and the pleasure of walking (47.85%). The results show that the residents surveyed cared the most about the visual beauty and psychological comfort of walking, especially the aesthetic features of the path, while the physical features of the walking path and the emotions felt while walking were the least important.

5.2. Discussion of Relevant Analysis Results

- Purposeful walking behaviour is associated with functional factors.

Residents' purposeful walking behaviour correlates with walking time and distance and the functional factor of road skid resistance. The scores given by residents for the factor of road slip resistance were

low. Therefore, the skid resistance of road paving on Gulangyu needs further improvement. In particular, paving in the central park and the square in front of the residents' dock is a safety hazard when it rains.

- Recreational walking time is linked to all five factors.

Recreational walking time was correlated with all five investigated factors: functionality, safety, comfort, aesthetics, and pleasure. Of these, the aesthetics of ground floor businesses, public spaces suitable for physical activity, and exercise facilities were strongly correlated with recreational walking time. Barrier-free facilities, slip resistance, weather, shade, signage, and age-appropriate public spaces were also correlated with recreational walking time. Of these factors, the walking factors related to comfort (shade, weather, signage systems) scored the highest. This indicates that residents are satisfied with the comfort of the environment in Gulangyu. In contrast, the lowest-rated items were road slip resistance, public spaces suitable for all ages, barrier-free facilities, and the aesthetics of low-rise businesses and exercise facilities. These factors should be considered in future planning and renovation projects to increase the leisure walking time of residents.

- Recreational walking distances are related to functional factors.

The recreational walking distances of residents of Gulangyu are linked to barrier-free facilities. The barrier-free facilities of walking paths are an aspect of Gulangyu that needs to be improved. Currently, only the main walking paths have barrier-free facilities, and some secondary paths and areas outside the core area are not fully barrier-free. Since Gulangyu is an ageing area, complete barrier-free facilities may promote recreational walking.

- A high number of functional, pleasure, and comfort factors are associated with walking behaviour.

The correlation analysis indicated that the highest proportion of functional, pleasure, and comfort landscape factors was related to walking behaviour. The functional factors of barrier-free facilities and road slip resistance influence the distance between purposeful and recreational walking. However, the functional factors generally scored low, and residents were dissatisfied with the functionality of the roads on Gulangyu. Improvements in road functionality may foster purposeful and recreational walking. The pleasantness factor influences leisure walking time. Residents are satisfied with public spaces where they can socialise and be physically active. Street green spaces such as central parks, beaches, and piers provide open spaces for residents to socialise and exercise. However, exercise facilities are inadequate, and the current public space is rather homogeneous and unsuitable for residents of all ages. Comfort factors (shade, weather, and signage systems) influence leisure walking time, with all comfort factors scoring high.

5.3. Discussion of the Results of the Ordered Logistic Regression Analysis

The results of the ordered regression model show that adjustments to the Gulangyu walking path could promote purposeful walking behaviour. Purposeful walking time was increased from under one hour to one to two hours, while walking distance was increased from 0-3 km to 12-15 km.

6. FURTHER RESEARCH

Future research should be dedicated to finding pedestrian environment characteristics that affect walking behaviour and perceptions on Gulangyu and other heritage cities in China and suggesting specific solutions. Such solutions need to be tested by further household surveys and observations. Moreover, surveys of not only residents but also tourists are important in heritage cities.

7. CONCLUSIONS

The results show that various landscape and environmental factors influence walking behaviour by surveying residents' perceptions of walking. Gulangyu residents have a high level of recognition of the benefits of walking for physical and mental health and social activities. Therefore, enhancing the landscape environment may improve the quality of walking and promote walking behaviour [34]. Regarding the analysis of the correlation between the landscape environment and walking behaviour,

several functional, safety, comfort, aesthetic, and pleasure factors are correlated with walking behaviour in Gulangyu. Functionality showed an especially significant correlation with purposeful walking, while all five factors influenced recreational walking. Of these, public spaces where physical activity can take place, exercise facilities, and the aesthetics of ground-floor businesses are most significantly correlated with recreational walking. According to an ordered logic analysis, as the skid resistance of the road increased, more time and greater distances were spent on purposeful walking.

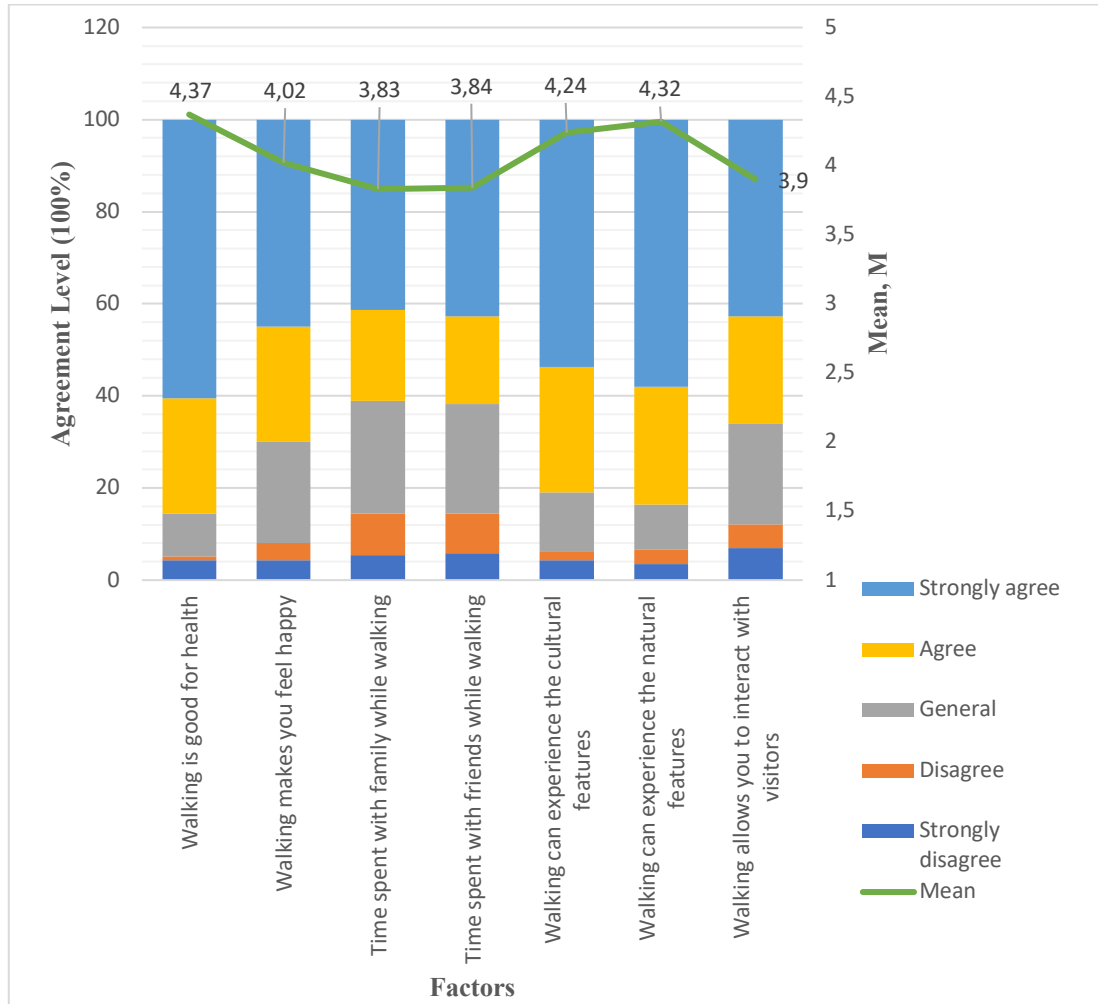


Fig. 7. Residents' attitudes toward walking

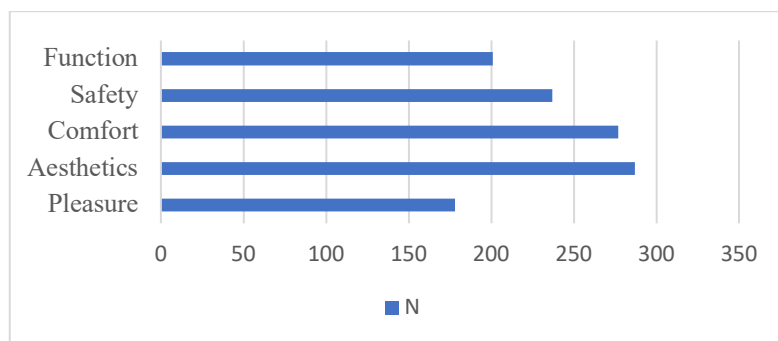


Fig. 8. Residents' views on the importance of walking landscape factors

It can be surmised from the above findings that promoting the walking behaviour of Gulangyu residents and enhancing the walking environment requires a focus on the functionality, pleasantness,

and aesthetics of the Gulangyu walking environment. In particular, improving road facilities and public spaces can increase the time residents spend walking recreationally, and improving the skid resistance of roads can increase the time residents spend walking purposefully and the distance covered.

There may be discrepancies between the present findings and findings from studies on other walking environments. In previous studies, factors such as public space, greenery, safety, accessibility, the presence of pavements, and road quality have been mentioned as influencing walking behaviour (Fig. 2) [7, 26, 35]. The main difference between Gulangyu and an ordinary city is that Gulangyu is a heritage city and popular tourist destination in China in which walking is the only mode of transport, and the quality and accessibility of pavements are satisfactory. Visitors of Gulangyu are subject to security checks, and criminal behaviour is rare on Gulangyu. Moreover, Gulangyu is rich in greenery and trees. The difference between Gulangyu's pedestrian environment and that of a normal city means that this aspect of the area is special. Moreover, as heritage cities are important residential communities and tourist attractions, the living environment and environmental perceptions of the residents, who are the protectors and holders of cultural heritage, need to be taken into account. Therefore, further research is needed to examine the pedestrian environment of Gulangyu and other heritage cities in China.

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