The Research of Environmental Behaviors and Usage Patterns based on Triangulation Analysis: A case study of 29-3 Park in Da Nang City, Vietnam

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Abstract— Although the development of open space in developed countries has been effectively researched and developed, so far, Viet Nam has not yet developed any specific policy or research for developing public space being appropriate to Vietnamese needs, social context and culture. The development of these spaces is either mainly based on the subjective ideas of the designer or reproduced from the foreign design; therefore, there is a doubt about this project's effectiveness in Vietnam. This study took a 29-3 park in Danang city as a case study, applying the triangulation method that exams 3 different dimensions included human perception, use pattern, and spatial structure to explore the quality of this open space. In accordance with qualitative and quantitative data that were collected in a semi-structured interview, activities mapping, questionnaires and spatial structure analysis, findings indicated that this place is mainly occupied for human recreation and health-related needs with 87.5% and 12.5 % respectively. Despite the diversity of activities there, the majority of which are such common recreational activities as sightseeing, relaxation, group activities, fishing, jogging and children playing. Although lots of concerns are given to physical settings, environment, management and maintenance, and function services of the space, 63.27% of the measured variables received positive feedback from the user, while 24.49% of the variables rated negative and 12.24% were in the neutral response. Some prominent factors that are deemed as causes of attraction or obstacle to people's visit would be specified in this paper.

*Index Terms— **Da Nang, 29-3 Park, usage pattern, space syntax, behavior mapping***

I. INTRODUCTION

Under pressure of urbanization and population growth, developing countries have been confronting a host of environmental problems, especially the shortage of green spaces negatively affecting the life quality of city dwellers.

Da Nang city was originally under the French colonial planning rules; it later became a military centre in the Vietnam war, yet less developing during the subsidy period. After the 1980s, the "opening up" policy was launched, and cities in Vietnam developed strongly; Da Nang was no exception. However, the urban planning was actually given attention right after Da Nang became a municipality. This period was divided into two stages: the first one focused on splitting plots in order to exploit property, and the other one paid more attention to urban landscape and amenities; therefore, the rapid decline and significance of natural areas and urban sprawl have been unprecedented [1]. With potential economic development, the population is predicted to double (about 2 million) by 2030 [2]. Those led to the environmental problems that caused the lack of green space in the metropolitan area [3].

Due to the irrefragable benefit of open space, the local government launches the campaigns of improving existed open spaces, utilizing the small space inner the city and riverbank, coastline to be outdoor open spaces to balance the rate between construction and urban open space. These types of open space were classified based on natural characteristics such as Riverside, Lakeside, coastal open space, and other open space according to historical or political features such as square. While a few of these places have been frequently used, the rest was rarely occupied by dwellers, which raises the question of whether these places can be considered as a successful place, and understands how can evaluate the open space.

In the study results of the relationship between human and the urban spatial environment, scholars have filled the gaps in knowledge and contributed to the design of many benefits. Rahman (2015) determines the factors that make people use the street open space and asserts that the attributes that make up these factors are different depending on various social contexts [4]. Jaehyeong Nam (2016) investigates the use of management and supply systems in the parks where services

have not been clearly defined [5]. The findings identified the hierarchy of the park for the management scheme and policies. Neto (2016) is involved in determining the physical element along the street open space that has an impact on human impressions [6]. In addition, many research focuses more specifically on a particular element or object or depend on different methods to understand the relationship between humans and the open-space environment such as DonghoonLee (2015), Ming-Shih Chen (2016), Shu-Ying Tsai (2016) [7], [8], [9]. The studies mentioned above focus on certain aspects of the relationship between people and the environment. And so, it cannot evaluate as well as provide a whole view of the success of an open space in the city. Moreover, due to the different socio-cultural conditions, the existed knowledge cannot be applied in Vietnam

This research is a serious academic study in an attempt to find out about demands and assessment of users to public open spaces in the social context of Vietnam, assisting planners, designers and policymakers in the more effective construction and renovation of urban public spaces. Taking 29-3 Park in Da Nang city as a research case, this study pays attention to three respects simultaneously as the analysis of human needs, the analysis of behaviours, activities and spatial structure. This place with an area of over 20 hectares was expanded and upgraded in 2015, is located in Thanh Khe district of Da Nang city, this space is divided into various sections of recreational, cultural and sports activities; besides, it is the largest and oldest public open space in Da Nang city.

II. METHODOLOGY

A. Theoretical framework

In order to learn about public spaces, we firstly should understand how they are defined. Several definitions of public spaces are truly shown in different angles and levels. The most noticeable definition about public space is of the UK government; accordingly, that space is thought to be where the community can get free access to all parts including construction and natural environments such as street spaces, squares, paths for residential areas, shopping malls or civil community; open spaces and parks; semi-public spaces that allow unlimited access and also are an intersection of inside private spaces with outside ones entitling the community to have free access [10]. Another opinion of UK's Loard Rogers's Urban Task Force Report stated that public spaces should be conceived as an open room within a neighbourhood; a certain place for relaxing and enjoying urban experiences; an avenue with a range of different activities, from outside dining to street entertainment, from sports and entertainment areas to squares with political and municipal functions; and most importantly, a place for a seat and a walk [11]. Lynch suggested that those places are merely considered as open when they are accessible [12]; Cooper and Francis defined urban open spaces as publicly accessible ones encompassing

parks and shopping centres that are designed to serve human activities and entertainment [13].

The first dimension regards to satisfying human perception toward public space. In order to use a public open space the most effectively, three key elements as usage demands, physical setting quality and spatial structure need satisfying [14, 15]. Indeed, in terms of usage and design, characteristics of public open spaces are divided into three main categories as "meaningful", "democratic" and "responsive" that aim to serve needs of users [10]. Similarly, research of Francis is inclined to describe such feelings of users as comfort, relaxation, passive, engagement, active engagement, discovery and fun [15], while other studies focus on human needs of caring physical characters of open spaces like accessibility, activities, sociability, high-quality, functionality and safety [16].

The second dimension is the activity and physical patterns of public spaces. Whyte believed that a primary factor assessing the success of a space is used, whereas Appleyard supposed "liveability" to be a measure of the success of urban space [17, 18]. It can be said that activity patterns are a key factor for the success of public spaces, which relates to various physical settings [12]. Gehl classified outside activities into three different categories as necessary, optional and social activities that correspond to the physical quality of spaces from low to high [16].

The third dimension is related to spatial configuration, which interests scholars and initially appeared under a quite broad and abstract concept applied to an entire city. Not until Hillier's book, "Space is the machine" was published, from an angle of architecture theory, the nature of spatial structure has been revealed. He thought spatial structure is an inherent characteristic of urban areas, which is the linking value of sociocultural and material properties. Hence, to learn objectively in mathematical aspect of spatial structure which contains the relationship between physical structure and social structure of a space, especially in urban open spaces, Hillier's theory helps to expose potential spaces so that people can become closer by discovering the operation mechanism of the overlapping between observation fields in spaces and human movements [19].
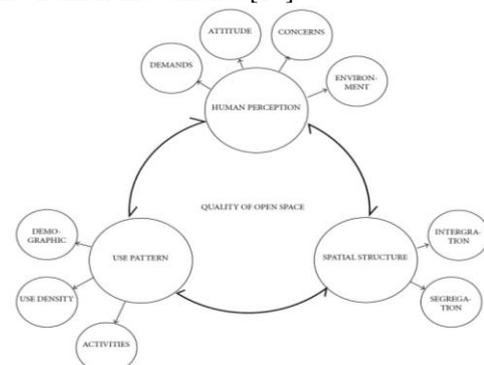

Fig.1: Three dimensions with related attributes affecting the quality of open space

In general, three dimensions mentioned above have the common relationship with space and human beings; also, it is an important measure in evaluating effectiveness/success of a public space (Fig. 1).

B. Methods

For a better understanding of a phenomenon, a triangulation method was applied. The triangulation is explained as a method, that exams the same issue in various aspects complement and verify each other. There are several different methods in triangulation included multiple theory, multiple method, multiple data and multiple research, though all of which is to verify the validity and capture different dimensions of the same phenomenon.

Firstly, this study adopted the data collection method by holding a semi-structured interview with open space users to find out about their needs and interests in this space. Then, an investigation questionnaire was sent out to collect data related to the attitudes of users and their satisfaction. The next step was activities mapping to learn about types of activities, behaviours of users and its distribution. Finally, an analysis of the spatial properties of the space was carried out by the following method of Bill Hillier to reveal the interaction of space structure and human behaviour.

Outline of Investigation

The authors of the accepted manuscripts will be given a copyright form and the form should accompany your final submission Data collection was done in 29-3 Park under two different forms. The first one is to collect data in the real environment and computing environment for spatial configuration analysis stage. In the real environment, the user interview, the survey of user behaviours, and activities mapping were conducted from September to November 2017. In the computer environment, surveying and redrawing the overall site plan of 29-3 Park were done through satellite image.

(i) The semi-structured interview was conducted with the total of 16 park users (details in Table 1). The interview was held by the writer to learn about interests and perspectives of users to this place. Every interview was done within roughly 15 – 20 minutes and recorded, greatly encouraging the expression of participants to activities, issues, physical quality and management.

(ii) Activities mapping was done within 7 days (3 weekdays, 2 Saturdays and 2 Sundays). Human behaviour is defined as the specific action that occurs within the Park. The observers recorded behaviours of park users and marked on the map. Owing to a large area and green coverage of the Park, and for better tracing the human behaviour within this space, the Park was divided into four different areas in which four observers did their work simultaneously (Fig. 2). A number of daily observations were 4 (in morning, noon, afternoon and evening) with the recording frequency of 2 for each observation. A group of users doing the same activity was counted as one activity.

(iii) Questionnaires were collected from a total of 40 participants (18 males and 22 females), aged between 17 and 66 years (M=23.3; SD=7.85) to measure users' satisfaction and attitudes on each specific issue within 29-3 Park including physical environment, management, activities, function.

(iv) 2D vector plan was prepared based on satellite image 2017. On the next steps, a grid for the visibility graph point locations was conducted.

Table1: Interviewed people outline

Adolescent	Young Adult	Single Adult	Adult with toddler or preschool	Elderly
4(2F, 2M)	4(2F,2M)	4(2F,2M)	4(2F,2M)	4(2F,2M)

III. RESEARCH FINDINGS

A. User's concerns

In order to find out about concerns of park users, the semi-structured interview has worked well; the writer was also in such a space at times and interviewed individuals who did activities. This helps to immediately collect unlimited amounts of information from interviewees in the real environment. Qualitative data were collected from the interview would be recorded and semantically analysed to prepare for the next survey.

Collected data showed that 87.5% of keywords related to the purpose of visiting the park are recreation, while 12.5% are for the health-related purpose. So, space plays a critical role in daily activities as well as recreational and social interactive activities of citizens. Activities recorded in the space are diverse, which are possibly split into representative categories as health-related activities, social interactive activities, recreational activities, trading activities and nature interactive activities.

Users are concerned about various existing problems in the space which can be classified into following groups as Physical setting, Environment, Management and maintenance, Function and service. The biggest concern of users that was indicated by data is about Environment, particularly a contaminated lake and air pollution due to dead fish and garbage; followed by Physical Quality consisting of poor quality of physical amenities such as benches, trash bin and public toilets; then, Management and Maintenance including Safety and finally, Function and service (Table 2).

Table 2: Summarizing main issues found based on interview's quantitative data

Visiting Purpose	Activities		Concerns	
-Recreation -Health-related purpose	Health-related activities	-Jogging -Walking -Public exercise -Taiji exercise	Physical setting	-Bench -Trash bin -Lighting -Refuge - Public Toilet

			Environment	-Water Environment -Smell -Cleanness -Greenery -Noise
Social interactive activities	-Camping - Group activities -Traditional cultural activities - Children's Interactive -Chatting		Management and maintenance	- Safety - Society's vices
Recreational activities	-Fishing activities - Sightseeing - Boating		Function and Services	-Vending - Children playground - Food Service - Zoo - Parking -Transportation/ public service connection
Trading activities	-Food trading			
Nature interactive activities	-Visiting zoo -Natural contact			

Interview results stated that the most preferred elements of users are the natural environment, scenery, wide view, freedom, big shading, free, liveness, wide pedestrian path, private space and greenery in order. By contrast, their unfavourable factors are pollution, love showing (graceless behaviours of the couples) in public, bad service maintaining, lack of seats, playing service and low quality of physical amenities, unsafety and lack of refuge.

Problems related to recreational functions, facilities for children, fitness equipment, extra setting and proper arranging of seats, water environment, boating, public toilet, the appearance of more refuges, rearrangement of trees, place setting for food vending, the adding of tables, cleanness, and separate functional zones are expected to be addressed; also, management and maintenance will be improved.

B. User's assessment

The questionnaires with 64 statements were carried out based on qualitative data from the semi-structured interview. The descriptive statistics were described in Fig. 3.

In general, the attitude of the user toward this place at three different aspects included an assessment of place atmosphere, the importance of activities occupied in this place, and satisfaction toward environment elements and facilities is greatly polarized by 93.75% of the attributes have an average response value greater than 2.5 (neutral value) and only 6.25% attributes maintain asymptotically neutral value.
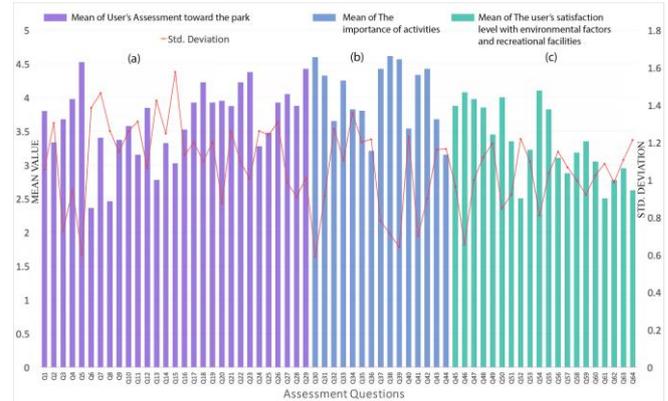
Fig. 3: User's responses toward the Park in three different dimensions (n=40) The questionnaires see appendix.

More specifically, in the first part of the questionnaires investigated users' overall evaluation of the park, which is presented in Fig. 3a. It can be classified into 3 categories: negative (12attributes), positive (14 attributes), and neutral responses (3 attributes). Notably, the majority of users think that this place has some problems such as dim lighting at night (Q18, M = 4.23), lack of seat and table (Q22, M = 4.23), and lack of diversity in greenery (Q23, M= 4.38). In contrast, they believe that healthy green foliage (Q5, M = 4.53), comfort children playground (Q27, M = 4.05), and Freely performing their activities (Q29, M = 4.29) are the elements positively affect to their impression. Among the clearly polarized attributes, there are still three factors that fall into the most neutral state, such as adequate public toilet and appropriately arranged (Q13, M = 2.78), unreasonable planned planting (Q6, M = 2.36), and feeling not private when someone is sitting nearby (Q8, M = 2.46).

In Fig. 3b, the results of the second part showed that most of the users' assessments on the importance of 15 activities collected from the interview were considered important for visitors (Mean >3). The activities, which considered as the most important ones of users, belong to Strolling (Q30, M=4.6), Sightseeing (Q31, M=4.33), Group Activities (Q33, M=4.25), health-related activities (Q37, M=4.43), Taiji Exercise (Q38, M=4.62), Children Playing activities (Q39, M=4.56), Gathering (Q41, M=4.33), and Relaxing (Q42, M=4.43). In contrast, there are two activities that are not necessarily needed in this place including Food trading activities (Q44, M=3.15), and Dating (Q36, M=3.21).

On the last part of questionnaires (Fig. 3c), the user's satisfaction in 20 environmental elements and recreational amenities was investigated. Whilst, most users are satisfied with the physical elements and amenities in this space, among them, air quality (Q46, M=4.08), walk path (Q50, M=4.00), and health supported equipment (Q54, M=4.1). Public Toilet (Q52, M=2.5), transportation/public service connection (Q61, M=2.5), and lighting (Q64, M=2.63) have neutral results.

C. User's Behaviour within the park

Activities mapping recorded all behaviours/ activities mentioned from the last interview. The result revealed different uses of the park at various times.

In Fig. 4, almost a number of individuals involved in park activities on weekends are generally higher than that of weekdays. A number of people gathering for [Group activities] are found as the highest in the park on weekends, whilst participants in [Jogging] account for the majority in weekdays. Meanwhile, some activities such as [Sightseeing], [Relaxation] and [Fishing] have fewer participants but show a slight difference between weekdays and weekends. The rest like [Picnic], [Visiting the zoo], [Dating], [Playing sports], [Taiji zen], [Children playing], [Other] and [People with child] have much greater participation on weekends.

Observations stated that a park is a place for doing activities and engaging people in different recreational and relaxing activities, though this distribution is uneven. Residents get together for collective activities simply because the park is a free public space with a wide green coverage, appropriate for group activities of pupils, students, unions and religious groups. Similarly, some activities like [Strolling], [Putting feet up] and [Jogging] take place there as well; citizens come there for exposure to the natural environment, escape from the hustle and bustle of the city and do exercise. Due to benefits brought by a large lake in the middle of the park, fishing lovers often visit that place to find pleasures in fishing. Other remaining activities involve fewer individuals and are mainly weekend activities as residents have more leisure time. [Picnic], [Visiting the zoo], [Taiji zen] and [Other] have the lowest participation which proves the poor quality of physical settings and functions.

As a whole, this reflects how important the park plays a role in human life and that greenery and natural open space are essential factors drawing residents to the park. Nevertheless, some elements of physical settings, functions and low-quality environment stop people visiting that space.

D. Behaviours Distribution Analysis

To learn about the distribution of user behaviours in the spatial structure of this open space, behaviour mapping was applied to track specific actions of users when they stay in the park. A group of people performing a certain action jointly is considered a behavioural unit. The map of 720 and 433 behavioural units in weekends and weekdays respectively has been illustrated and recorded.
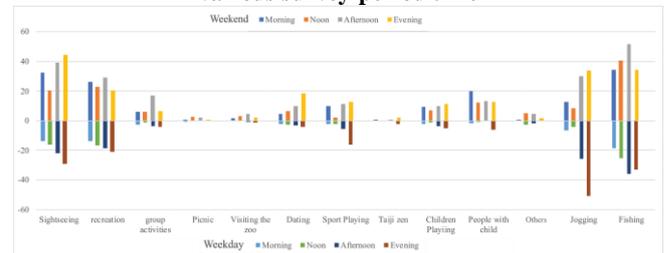
The distribution of behavioral units in the space reveals space-using characteristics of a certain activity, which is utterly dissimilar from the number of participants in a particular action or behavior (Fig.5).

Observation results of the distribution of user behaviours in 29-3 Park showed an uneven distribution of behavioral units, yet distribution patterns of weekdays and weekends are the same. Behavioral units as [Jogging], [Fishing],

[Relaxation] and [Sightseeing] have the highest distribution rate, while that of [Picnic], [Visiting the zoo], [Taiji zen] and [Other] is lowest (Fig. 5).

Fig. 4: Number of people / behaviours in the park at the various survey-period time

Fig. 5: Distribution of behavioural units

As can be seen on the behaviour map in Fig. 6, almost all spaces in the park are occupied for various behaviours; however, there is no sign of user activities near the entrance area of the park, whereas much more behaviours are recorded on the way to the lake and along internal walkways in the park.

E. Visibility Graph Analysis (VGA)

To quantify the physical spatial structure of internal walkways in the park, a VGA was conducted in accordance with the theory of Space Syntax that is a set of theories and techniques for the analysis of spatial configurations. For comprehending visibility relationships between spaces, we use Depthmap software for this analysis that only explains the degree of spatial integration in the studied section (internal walkways frequently occupied by user behaviours, apart from particular behaviours fixed in the space such as fishing around the lake or 'visiting the zoo' in the zoo).

As can be seen in Fig. 7, the spatial visibility relationships of this park are unevenly integrated between zones. The northern space network (main gate) has a higher integration coefficient than the southern one, which allows human movement density and activities in the north to be higher than in the south; red-marked spots imply the highest potentials of human movements and blue-marked ones show the lowest rate. The analysis of spatial structure (walkway network) of this green space indicates the low integration in the spatial visibility relationship, which affects the potential for human activities in the park.
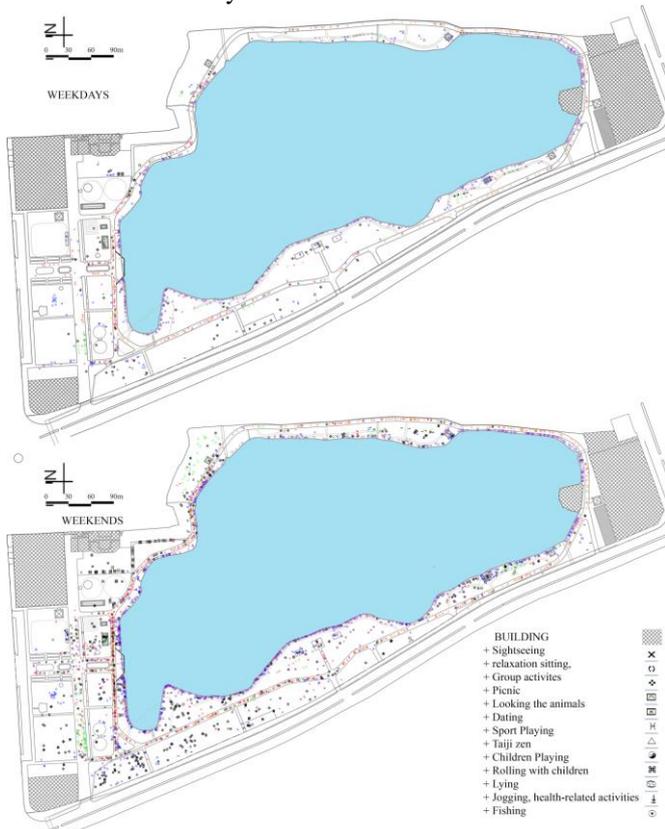
IV. DISCUSSION AND CONCLUSION

Open space is an important part of the urban area, and its quality affects life quality and social cohesion. Physical settings and spatial structure which are vital elements of open space have impacts on activities, level of satisfaction and the usage density. As the largest and oldest green open space in Da Nang city, 23-3 Park has been recently renovated yet the effectiveness of this place has been still unknown. This research aims to find out about needs, users' evaluation of the quality of this green open space, and also to learn how spatial and physical settings influence user behaviours. Findings produce the more effective design and renovation of this green open space to meet more usage needs of residents, thereby improving the life quality of city dwellers.

Research results in the case of 29-3 Park indicate that the visit purpose of users is primarily to entertain, while others choose the park for exercise. Activities in the park vary and are probably divided into five macro categories as health-related activities and nature interactive activities with total 15 activities. This proves that this space is really appealing and occupied for optional and social activities rather than necessary ones.

Fig. 6: User's behaviour distribution in 29-3 Park (this behavioural/ activities map shows the usage pattern of the space. We can understand which area is usually used by users)

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health-related activities and nature interactive activities with total 15 activities. This proves that this space is really appealing and occupied for optional and social activities rather than necessary ones. Analysis results of space-using patterns show that a number of participants in such activities as sightseeing, relaxation, group activities, fishing, jogging and children playing are superior to those of other activities. This means the environment setting or/and its quality are not encouraged or appealing to specialized activities like sports playing, Taiji zen, visiting the zoo, dating and picnic.

The interest of users is divided into four macro categories as physical setting, environment, management and maintenance, and function services with 20 elements. These issues need addressing before improving the park.

In their general evaluation of the park, users almost have the acceptable level of satisfaction in environment settings. Noticeably, the park has green foliage for shade and provides a space for residents to freely do what they want. However, the poverty of plant species, inappropriate planting and a loss of privacy are the most dissatisfied factors of users. In addition, public toilets and trash bins are inappropriately arranged and meet inadequate needs of users; similarly, unpleasant smell is a trigger for the negative evaluation of users.

Fig. 7: Visibility relationships between spaces in 29-3 Park.

The satisfaction of users in environmental factors and recreational facilities is revealed. Public toilets, lighting, lake water and the connection between public services in this

space are the least dissatisfied factors of users. Quantitative indicators show that recorded types of behaviours are mostly seen important for users in this open space. Nevertheless, dating and food trading activities are considered the least important in this space.

The distribution of behaviours in the space states that activities occur almost everywhere in the space, and the highest density is in internal walkways/ roadways. Behavioural unit groups of sightseeing, relaxation, jogging and fishing are more often organized and take place in the park than the rest. Remarkably, some behavioural unit groups such as group activities have the high level of participation, yet low distribution density. This proves that users tend to get together in some particular places in the space.

To quantify the spatial structure of routes in which the density of behavioural units occurs, findings indicate that a whole space has the low integration, which implies that this structure less attracts human activities, especially when advancing towards the South. Except for place-based activities such as fishing in the lake, real observations show that some parts of the park are not seemingly frequented by users; this is possible due to low-quality and unclean environment. Therefore, apart from the spatial structure, several factors of physical settings, environmental quality and management affect the space use as well. Thus, in order to attract movements and activities of users, it is necessary to consider adjusting the internal roadway network to strengthen the connection between a whole park and Southern vicinity, for example building a walkway across the lake. The improvement of the environmental quality of the lake water and the atmosphere, as well as the disposition and diversification of trees, are needed. Amenities for the open space are necessarily enhanced by appropriately placing extra public toilets, trash bins and increasing the connectivity between public services and lighting.

Limitations of this study are not to take accounts of cultural characteristics, population and a limited number of participants in the space, so it is impossible to facilitate other features of the space to appear. Furthermore, limits in time also only allow the research to be carried out at a certain time; as a result, climate characteristic was abandoned. Future research should identify these shortcomings and be extended to other types of space in Da Nang city in order to further discover space-using features and widen horizon about the context of Vietnamese cultures.

ACKNOWLEDGMENT

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APPENDIX

Q1: Parking area is reasonable, Q2: It is safe when walking after the sunset, Q3: This space is clean, Q4: The water in the lake is polluted, Q5: Healthy green foliage, Q6: Tree planting is unreasonable, Q7: It is not safe to walk by the lake, Q8: I feel not private when someone is sitting near me in this space, Q9: The positive attitude of the motorcycle keeper, Q10: Feeling safe to join the games in the park, Q11: Food and drink vending services are sufficient, Q12: Having adequate seating and appropriately arranged, Q13: Having adequate public toilet and appropriately arranged, Q14: Having adequate refuges and appropriately arranged, Q15: Trash bin is not fit properly and inappropriately arranged, Q16: Full range of entertainment amenities, Q17: The kid games service with fee are not opened frequently, Q18: Lighting is not enough at night, Q19: Full range of sports facilities, Q20: The zoo is poor on animal species, Q21: The lake is monotonous, boring, Q22: I want to add more seat and table, Q23: I want to see diversity greenery and flower, Q24: Stench/ Bad smell is the main problem in this space, Q25: The smell from the zoo is the cause of my separation from its vicinity, Q26: Public toilet is not clean, Q27: Children play area is comfortable, Q28: Children play area is safe and clean, Q29: I feel that this space allows me to freely perform / do outdoor activities that I like, Q30: Strolling, Q31: Sightseeing, Q32: Looking other people's activities, Q33: Group activities, Q34: Camping, Q35: Visiting the zoo, Q36: Dating, Q37: Health-related activities, Q38:Taiji Zen's activities, Q39: Free-game service for children, Q40: Paid-game for children, Q41: Gathering, Q42: Relax, Q43: Fishing, Q44: Food trading activities, Q45: Tree, flower and greenery, Q46: Air quality, Q47: Children playground, Q48: Playground, Q49: Parking, Q50: walkways, Q51: Bench/seat, Q52: Public Toilet, Q53: Refuge, Q54: Equipment supports Health-related activities, Q55: Children Play facilities, Q56: The zoo, Q57: Lake water, Q58: Visual view, Q59: Cleanness, Q60: Entrance gate, Q61: Public service connection, Q62; Maintenance, Q63: Trashbin, Q64: Lighting.