

Responsive Street and Walkability Open Space

Xiangsi Li^{1*}, Zhengyang Zhu^{2*}

¹Guangdong Urban & Rural Planning and Design Institute CO. LTD., Guangzhou, China

²College of Horticulture and Landscape Architecture, Zhongkai University of Agriculture and Engineering, Guangzhou, China

Email: xiangsili0525@foxmail.com

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Abstract

Urbanization's gradual acceleration has become the main trend. Thus, it is obvious that the urban landscape become more important compare with before. There are many previous researchers find out a strong relationship between the walkability environment and human health. This research aims to increase walkability quality in the urban space, particularly, on streets. This study will focus on the four streets connected to Cathy Freeman Park related to the walkability design.

Keywords

Walkability, Urban Open Space, Pedestrian Behaviors, Urban Landscape Design, Interaction

1. Introduction

In the 1930s, with the development of car production industries, the car cost reduced, and driving by car became the main mode of transportation instead of walking (Hendee, 2014). In the first city development progression stage, urban planning pays attention to the design of the motor vehicle. In recent 40 years, urban planning starts to turn back to the design for rideability and walkability. There are many benefits that could be brought by walkability including economic, ecological, and human health. According to the Bureau of Transportation Statistics, the motor vehicle travel rate is much higher than walking. Motorized travel walking represents about 15 times while motorized travel is 50 times. However, these researchers ignore short trips, nonwork travel, and recreational travel. The cities which have a high level of motorized vehicle use require large amounts of land paved for parking and land paved. The improved walkability could reduce these costs by reducing the amount of land required for transport

*Xiangsi Li and Zhengyang Zhu contributed equally to this work.

(Litman, 2004). Moreover, there are still some other benefits of land-use efficiency, economy, and health. In this paper, the “walking” and “walkability” not only include walking on foot but also mean “nonmotorized travel” and “non-motorized travel conditions”. Thus, the aim of this paper is to assess pedestrians’ comfort with reference to street space and street facilitation of the places. These aspects have been identified as the leading indicators to present the level of the walkability street.

2. Background

• What Is Walkability?

Walkability can be different meanings depending on different groups. Many factors could impact the feeling of pedestrians and it is hard to measure case this is a feeling of comfort. Besides, walkability is not only related to the outside environment, but it can also depend on the personal space requirements for different pedestrian facilities such to different groups such as children, women, and elders. The previous standard and cognition of comfort for pedestrians is the width of the sidewalk. On the contrary, there are many other factors also important to pedestrians. Actually, some cities have already adjusted the new standard of walkability. The new standard concludes the personal characteristics such as group size, age, and gender.

• The Benefit of Walkability

Land use Efficiency

The low-density development requires plenty of land use which is the road used for the motorized vehicle and car parking. Thus, the space used for walking is much less compared with motorized vehicle. Besides, the traffic noise could be reduced by walking. Moreover, walkability communities have less space for car parking. The extra space could provide for other development patterns. (Figure 1)

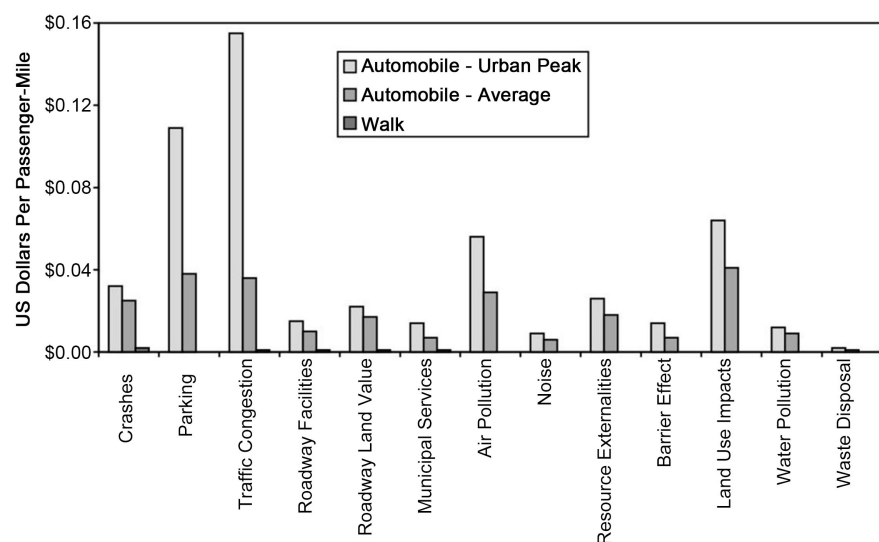


Figure 1. The comparison between automobile travel and walking (figure from Litman, 2004).

Community Livability

Livability is an important characteristic of a high-quality community. A safe environment could provide comfort social environment for the communities. In addition, streets are the main factor to consist of the communities. This means walkability is the main factor to achieve a safe environment. The livability community should have attractive, safe, and walkable streets. The high motor vehicle street may reduce the interest of the communities to know about their neighbors.

Health

The lacking of physical activity is one of the main reasons leading to health problems such as heart disease, hypertension, stroke, and obesity (Killingsworth & Lamming, 2001). Some mental issues such as depression could become worse while lacking enough physical exercise. In some developed countries, cardiovascular diseases are the major reason which brought premature death.

In addition, motorized transport has a high level of traffic death compared with nonmotorized transport. For instance, the Netherlands has a low level of traffic deaths and a cyclist death rate per million kilometers which holds a high level of nonmotorized transport (Pucher & Dijkstra, 2000).

Economic Development

Walkability is one of the important factors which could impact the retail and employment center. Some commercial industries, particularly, can be affected by walkabilities such as retail sales related to employment and satisfaction. The improvement of walkability could improve the competitiveness of a shopping center.

3. Research Question

There is a requirement for a better understanding of the factor constraints in the comfort of walking on the street and a structured approach to identifying how these factors work on the street system. More specifically, the following research questions need to be addressed: **How can landscape design help increase walkability level and facilitate interaction between pedestrians and urban environment?**

Besides, there are some sub-questions are concluded in the following study:

- 1) How can the urban streets and urban open green space make pedestrians stay for a longer time?
- 2) How can the urban open space create more different types of activities?
- 3) How can connect the streets and urban open space?

4. Aims

This research will focus on the high quality of the walkability environment in urban streets and urban open spaces. The overall aim is to increase the walkability quality level and facilities the interaction of the citizens and the urban environment. Besides, change the urban landscape design structure in order to

change the behaviors of citizens. Thus, to support this aim, three objectives are drawn up as follows:

- 1) To provide different features to arouse the different senses of users in order to lead outdoor activities happened.
- 2) Use permeable features and enough shade to ensure comfortable walking and relax spaces.
- 3) To create privacy and connection space which require establishing a physical separation among different functions spaces and meanwhile use hardscape and soft-scape for visual connection.

5. Literature Review

• Landscape Environmental Setting for Pedestrians (LESP) Framework

The definition of the LESP is the elements that pedestrians can see in the walkway surrounding within a 3.0 m radius that could impact the comfort and behaviors of pedestrians (Kasim, Shahidan, & Yusof, 2018). Ng and Cheng (2012)'s study shows that three meters (3 meters) are the largest distance that could impact behaviors and thermal comfort.

The element in the LESP includes the mad-made shade, pedestrian walkway, seats, and trees. The quality of walkability can be measured through these elements. These elements in **Figure 2** and some subcategories are also shown in **Figure 3**.



Figure 2. An example of LESP (by author, 2020).

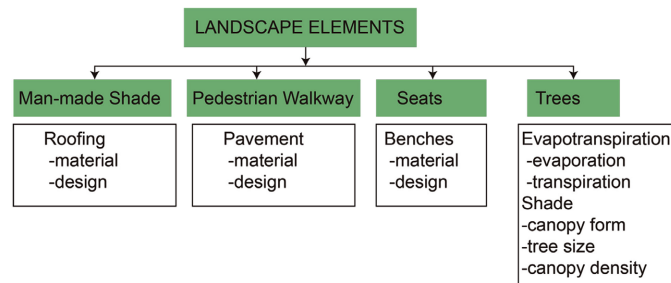


Figure 3. LESP framework (by author, 2020).

For the materials used in the pavement, the colors have been confirmed as having important effects on reducing the temperature by several researchers. In addition, the albedo is another element that affects the comfort of the walking experience. Although many studies show that high-albedo materials can help to reduce the temperature. Some studies also show that even the high-albedo materials used in canyon surfaces could reduce the air temperature but they cannot offset the discomfort due to the glare in the sunny weather (Kasim, Shahidan, & Yusof, 2018).

The third element that influences the walking experience is seating which is one of the main street furniture. It could break the pedestrian's walking journey and increase social opportunities. The architectural students of the University of Melbourne made a survey of street activities in 1978 showed that the increased seat number could increase seat activities. Otherwise, the various requirement of various groups should also be attending. According to the Australian Disability Discrimination Act 1992 (DDA), the increasing requirement for accessible design by the aging population makes the accessible design necessary in order to ensure public space and help them to move through cities in comfort. Thus, the walkability street for various groups including age, size, disability, or ability should ensure the street furniture can offset the demand of the various group (Figure 4).

The third significant element is the trees. Basically, trees could play the function to reduce the radiant. Trees use not only use the shade to reduce the temperature but also use various ways to reduce temperature compared with man-made shade. According to the LESP, there are five categories of walkaways (Table 1).

• Outdoor Human Behaviors

Varies of social activities happened in different places depending on the public spaces. In general, daily activities could be divided into three types include necessary activities, optional activities, and "Resultant" activities (social activities). Necessary activities mainly belong to everyday tasks such as going to school or to work and waiting for a taxi. These activities are less required for people to participate. In addition, most of these activities required them to walk. All of these activities are necessary for daily life. Thus, the physical environment has the least impact on this kind of activity. Optional activities are the kind of activities that could be chosen whether to participate or not. These activities can be



Figure 4. Aria Seat, Classic Plaza DDA Seat and Park DDA Seat (image from Street Furniture Australia, 2020, <https://earthexplorer.usgs.gov/>).

Table 1. LESP Types 2 (Kasim, Shahidan, & Yusof, 2018).

Type of LESP	Description
Type 1	One landscape element, <i>i.e.</i> , pavement
Type 2	Two man-made landscape elements, <i>i.e.</i> , pavement and man-made shade
Type 3	Two landscape elements, <i>i.e.</i> , pavement and trees
Type 4	A combination of man-made landscape elements and nature, <i>i.e.</i> , pavement trees and man-made shade
Type 5	Pavement sandwiched between trees, <i>i.e.</i> , pavement and two rows of, trees

impacted most by a suitable time, place, and mood. Hand out with friends to get a breath of air, lying on the grass enjoy sunbathing are included in this category. This category of activities requires high-quality exterior physical conditions. This means only the necessary activities happened if the outdoor environment quality is poor. The third activity is Social activities which require two preconditions to conclude the people and public space. The broadest social activities include simply seeing, and hearing other people, and passive contacts.

The previous two types of activities are the reason lead the social activities happened. It is resulting in the moving of people and enters into the same spaces (Gehl, 2011). (Figure 5)

- **Different Groups and Walkability**

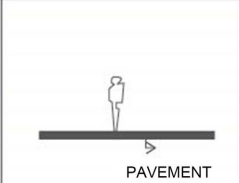

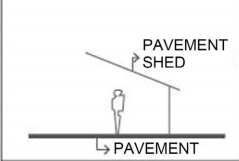

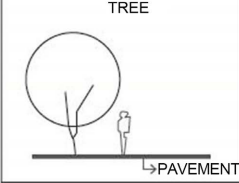

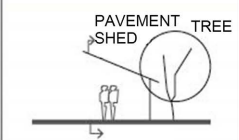

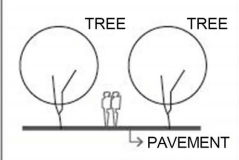

Different kinds of groups have different requirements in urban open spaces. According to La Rosa et al. (2018), different social groups demand accessibility to urban green spaces requires a planning framework to evaluate. The requirements from different groups should be observed and considered in the design progress. These groups could be divided by gender, age, and ethnicity (Carmona, de Magalhães, & Hammond, 2008). In addition, the different groups could be

impacted by walkability at different levels. For example, the safety of the street has a significant impact on females rather than men. Doyle, Kelly-Schwartz, Schlossberg, and Stockard (2016) use the ACES model to analyze the different implications brought by the walkable level to different genders.

This paper focuses on the differences in age group relationships with street walkability and trip generation (Liao, Berg, Wesemael, & Arentze, 2020). Accessibilities and resting furniture are the basic need of elder people (Table 2). Besides, the visual connection is an important element for adults with children.

Table 2. The presence of pedestrian infrastructure that promotes walkability (Atodaria, 2019).

Modes of Walkability	Presence of Existing Infrastructure	Possible Interventions/Improvisations
Sidewalks	Partial	Add Sidewalks to places where there is absence of sidewalks.
Pedestrian connectivity and infrastructure	Partial	Addition of street furniture, signals and trees. Addition of pedestrian path to improve more connectivity and accessibility.
Width of sidewalk	Inadequate size	Could provide adequate size of sidewalks so that it can be accessed efficiently even on wheelchair.

		Hypothesis: very hot
		Hypothesis: very hot
		Hypothesis: slightly warm
		Hypothesis: slightly cool
		Hypothesis: cool

Quality of the physical environment	Poor	Good
Necessary activities	●	●
Optional activities	●	●●●
"Resultant" activities (Social activities)	●	●

Figure 5. The relationship between physical environment and activities (Gehl, 2011).

6. Methodology

6.1. Case Studies

6.1.1. High Line

The reason why to choose this case is that High Line has such a conflict location environment which is the city center part and it used to be a railroad. After the successful landscape design, High Line now has been transferred to an atypical public park base on the walking pedestrians. How to allow plant life to integral the site and develop the High Line to be bigger, better, brighter, and louder is the challenge and ambition of the High Line. The ideas of High Line come from the wild seeds that grow naturally on abandoned rail tracks. The High Line organized complexity factory to provide a natural and random feeling in contrast with the "hard" feelings of the vertical skyscraper of the urban environment. Some soft elements were used in benches, gardens, and lawns to represent the concept of "grow". From **Figure 6**, the variety of functions of the High Line also identified the High Line and makes it easier for pedestrians to remember. During the walking journey on the High Line, the benches with different characteristics and orientations give pedestrians various experiences.

6.1.2. Seoulo 7017

The reason why to choose this case is that Seoulo is a particular case that involved some special street facilities such as playground facilities and also organized many fun street exhibitions. The name of the Seoulo 7017 (**Figure 7**) comes from the first road created in 1970. The ambition of the Seoulo 7017 is to push the South Korean capital more pedestrian friendly and revitalize the neighborhoods around Seoul Station in the city center (Moffet, 2019). The 24,000 species of plants are one of the characteristics of Seoulo 7017. The pedestrians could have different visit experiences. The theme of plants changes every fifty or so meters to create different sections. In addition, the designer also designs



Figure 6. High Line Park (photos from HIGH LINE, 2020, <https://www.thehighline.org/photos/high-line-art/>). Designer: James Corner Field Operations, Diller Scofidio + Renfro, and Piet Oudolf; Location: Manhattan, New York City; Type: Urban liner park, public park; Size: 2.33 km; Completion year: 2009.

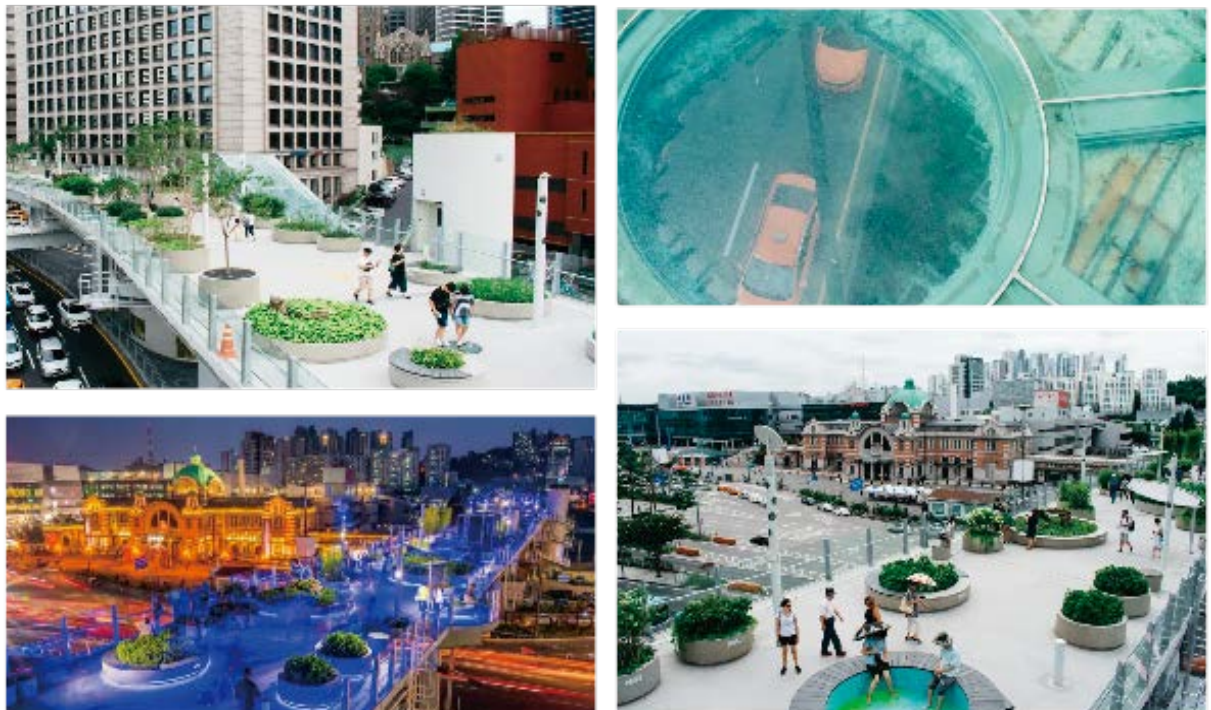


Figure 7. Seoulo 7017 (photos from Laura Maniglier, 2018, <https://theculturetrip.com/asia/south-korea/articles/15-beautiful-pictures-of-seoulo-7017-seouls-version-of-the-high-line>). Designer: Winy Maas; Location: Namdaemunno 5(o)-ga, Jung-gu, Seoul; Type: New York City Department of Parks and Recreation; Size: 1.024 km; Completion year: 2017.

the lighting of Seoulo 7017 at night in order to create different experiences at the night Skypark. Moreover, there are many fun street facilities in Seoulo 7017 such as the large exhibition Yunseul and BangBang Playground.

6.1.3. The Goods Line

The reason why to choose this case is that in that case, it uses a different street design strategy which blurs the boundaries of life. For example, it connects various life scenes such as study situations and exercise. The Good Line (**Figure 8**) is designed as a place with new social infrastructure in order to create opportunities for playing, gathering, and exchange of ideas. For example, outdoor movies and performances can be organized in the amphitheater at the Mary Ann Street stairs. The theme color of The Goods Line is brightly yellow which leaves an unforgettable memory to pedestrians. There are also plenty of detailed designs on the shape of benches and tables. During the pedestrians' walkway, some facilities are also used to create some social activities such as table tennis tables, study pods, outdoor workspaces, and playgrounds. Moreover, the preserved old train track and interlocking machine from the former Ultimo Street signal box could let remind pedestrians to think about the history of the industry's time in The Goods Line.



Figure 8. The Goods Line (ASPECT Studios, 2015, <https://www.aspect-studios.com/cn/projects/the-goods-line-2>). Designer: ASPECT Studio; Location: Ultimo, Sydney, NSW, Australia; Type: Urban liner park, public park; Size: 800 m; Completion year: 2015.

6.2. Research through Design

Location

The study site is in the center of Sydney Olympic Park which is located in the west-north of Sydney. The Sydney Olympic Park is supposed to become the new center between the Parramatta CBD and Sydney CBD. The lower level building type occurs the most land in the Sydney Olympic Park including the commercial area. The future development of Sydney Olympic Park may be impacted by the flooding resulting from the surrounding water areas.

Site Analysis-Site Selection

The site I selected is Cathy Freeman Park and the other four streets connected to Cathy Freeman Park included Grand Parade, Olympic Boulevard, showground road, and Dawn Fraser Avenue. In addition, some areas along the Grand Parade and Olympic Boulevard are also concluded in the study site (Figures 9-26).

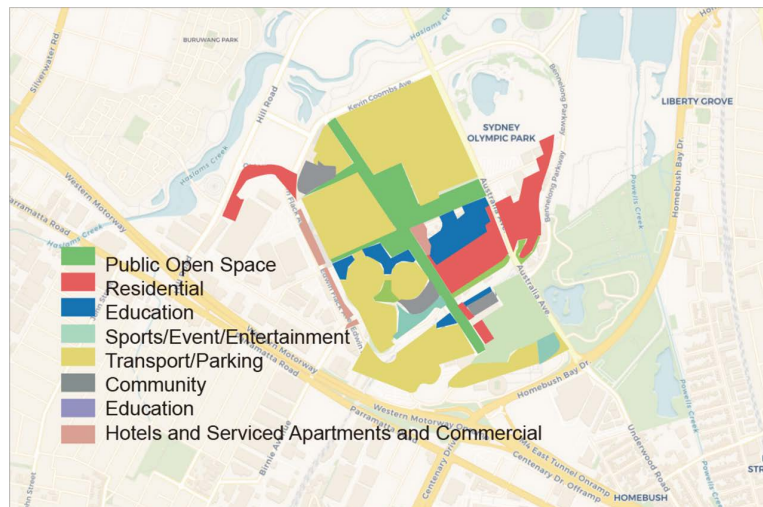


Figure 9. Uses for the town Centre (SOPA Master Plan, 2020).



Figure 10. site selection 1 (by author, 2020).

Site 1: Cathy Freeman Park

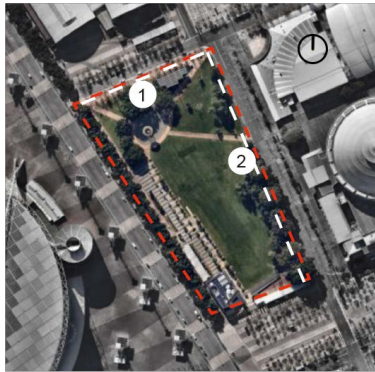


Figure 11. Site selection 1 (by author, 2020).

Context

- Size of site:
27,623 square meters
- Current Function
Urban park
- Topography

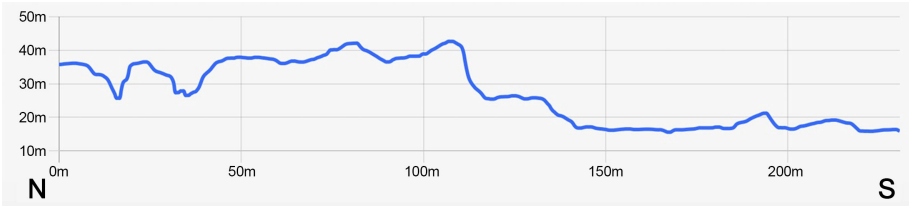
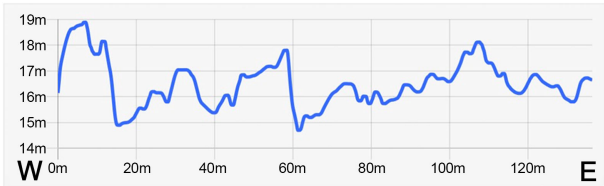


Figure 12. Cathy Freeman Park topography (nearmap, 2020).

- Walking scope: 2**
- Site 2: Olympic Boulevard**

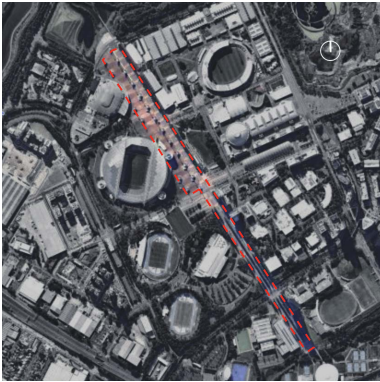


Figure 13. Site selection 1 (by author, 2020).

Context

-Size of site:

1544 meters

-Current Function

Necessary activities

-Topography

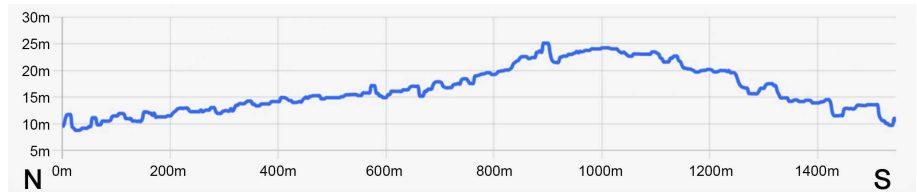


Figure 14. Olympic Boulevard topography (nearmap, 2020).

		<p>Hypothesis: slightly warm</p>
		<p>Hypothesis: very hot</p>

Figure 15. Site analysis (by author, 2020).

Walking scope: 1

Site 3: Grand Parade



Figure 16. Site selection 3 (by author, 2020).

Context

-Size of site:

530 meters

-Current Function

Necessary activities, Sydney Royal Easter Show

-Topography

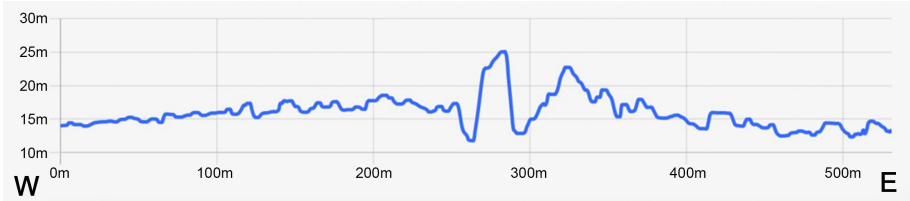


Figure 17. Grand Parade topography (nearmap, 2020).

		Hypothesis: very hot
		Hypothesis: cool

Figure 18. Walking scope: 2.

Site 4: Showground Road



Figure 19. Site selection 4 (by author, 2020).

Context

-Size of site:

427 meters

-Current Function

Necessary activities,

-Topography

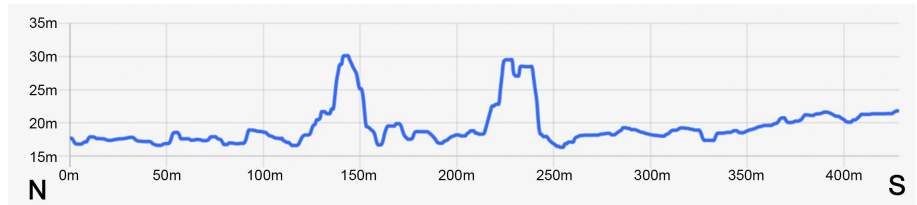


Figure 20. Showground Road topography (nearmap, 2020).

		<p>Hypothesis: slightly</p>
		<p>Hypothesis: cool</p>

Figure 21. Site analysis (by author, 2020).

Walking scope: 3

Site 5: Dawn Fraser Avenue

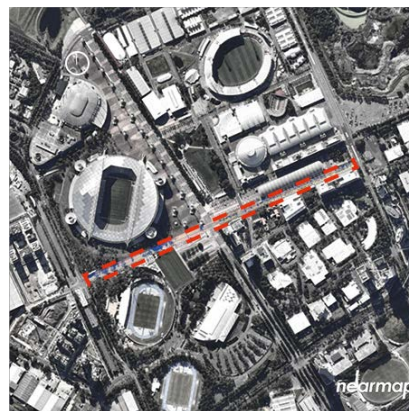


Figure 22. Site selection 4 (by author, 2020).

Context

-Size of site:

948 meters

-Current Function

Necessary activities,

-Topography

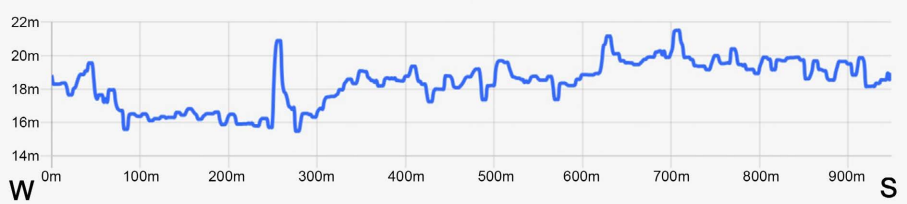


Figure 23. Dawn Fraser Avenue (nearmap, 2020).

<p>MANMADE SHED TREE PAVEMENT</p>		<p>Hypothesis: slightly</p>
<p>TREE TREE PAVEMENT</p>		<p>Hypothesis: cool</p>

Figure 24. Site analysis (by author, 2020).

Walking scope: 4

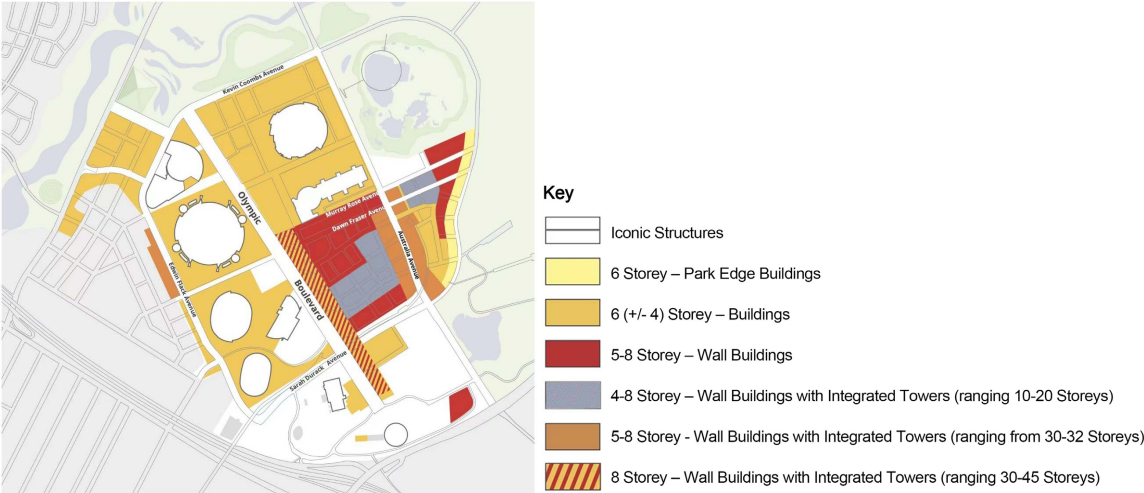


Figure 25. Illustrative Building Heights (SOPA Master Plan, 2018).



Figure 26. Population Density (AURIN, 2020).

The surrounding building in the future plan is supposed to develop into 4 to 8-story. In addition, the population density also shows a slight population growth in Sydney Olympic Park. Thus, the living population in the future Sydney Olympic Park is pretty high.

Site Analysis-Current Site Conditions-Cathy Freeman Park

The current Cathy Freeman Park is the main urban park located in the heart of Sydney Olympic Park. However, it has a low level of use. More than 80 percent of this park is an uncovered area. The main installation is Olympic Cauldron which can splash water at some specific time during the day. Moreover, according to the author's observation of the site, most users gather in the surrounding areas of the Olympic Cauldron because of the low temperature and shaded.

Advantages:

- 1) The site occupies the heart of Sydney Olympic Park
- 2) The Olympic Cauldron could attract users and reduce the temperature
- 3) It has a short distance from the train station and nearby the stadium.

Disadvantages:

- 1) This site does not have private space for the user to rest.

- 2) Most of these parks do not have shade.
- 3) Park infrastructures are not enough.

Site Analysis-Current Site Conditions—Grand Parade, Olympic Boulevard, Showground Road and Dawn Fraser Avenue

Advantages

- 1) Most of the sidewalks have a row of trees to provide shaded.
- 2) The trees located on Dawn Fraser Avenue could provide ornamental value to pedestrians.
- 3) Olympic Boulevard has enough space which could provide opportunities for future development.
- 4) Showground Road and Dawn Fraser Avenue have chairs that can be used to rest.

Disadvantages

- 1) Some parts of the Grand Parade and Olympic Boulevard do not have man-made shaded and trees shaded.
- 2) The species of trees in Dawn Fraser Avenue have little canopy which cannot provide enough shaded.
- 3) Most of the roads lack identity to make pedestrians to memory.
- 4) Most of the roads have a single function with low efficient use.
- 5) Olympic Boulevard and Grand Parade do not have chairs that can be used to rest.

Design Principles

According to the precedents study and sit analysis, there are some design principles proposed by me.

INTERACTION STREET

- Designing social infrastructure to provide opportunities for pedestrians to interact with the street.
- Designing some art installations connect with the history of the site to remind people of the history.
- Use bright colors to attract pedestrians to interact with the site facilities.

CHARACTERISTIC STREET

- Use some specific bright colors to create different themes for different streets in order to deepen memory.
- Use different plant species in different streets to create different characters.

SOCIAL STREET

- Increase some street furniture to create some social activities.
- Create different scales of rest areas in order to allow different scales of social groups.

CONNECT STREET

- Creating some interests places to connect the street.
- Create access between the open space and the street.

DIVERSITY STREET

- Creating different kinds of street furniture such as benches to meet the requirement of different groups of people.

- Creating a vision that connects the urban open spaces with the street in order to increase pedestrians' interest.

Propose Suggestions for Future Design

All in all, the walkability of streets cannot be generalized, and every street should not be designed with the same standard. In order to improve the walkability of streets and create a new picture of street life in the future, a set of highly targeted evaluation systems should be set up for streets in different regions according to the proportion requirements of different types of street pedestrians and different surrounding land use attributes. This paper, suggests that it is necessary to score different street functional spaces, street facilities, and street accessibility and make a detailed score system in order to make targeted recommendations for street improvement directions and spaces based on the evaluation results from this system. Furthermore, with the development of the city, the functions of the street and surrounding properties will keep changing, and this street evaluation system should be updated periodically.

7. Research Scope and Limitations

The main limitation of this research is the lack of observation of two precedents. Besides, the observation of the site in Sydney Olympic Park is also not adequate. There may have other issues on the site and cannot collect the whole day's volume of pedestrians.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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