Comparison of walkability in transit-oriented development (TOD) and non-transit-oriented development in Hong Kong

Submitted by

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DECLARATION

I, *Chan Cin Yee* declare that this research report represents my own work under the supervision of *Dr. Chow Sin Yin, Alice*, and that it has not been submitted previously for examination to any tertiary institution.

Signed

Chan Cin Yee 24/4/2023

ABSTRACT

Transit-oriented development (TOD) is a type of sustainable development that has a high-density, mixed-use, and pedestrian-friendly design in a radius of 800 meters centered at the transit service. The function of TOD is to encourage people to live near transit services and decrease their dependence on driving while increasing on walking. It is believed that TOD areas are more walkable than non-TOD areas as their designs focus on pedestrians. In order to analyze the walkability of TOD and non-TOD areas, three sites in Hong Kong are chosen to study. Sha Tin and Tsuen Wan, which are part of the new town development in the 1970s, are representatives of TOD. Mong Kok, which has a long development history in the old urban area, represents the non-TOD area.

In this study, both subjective and objective research methods have been used. A questionnaire targeting pedestrians in the three study areas shows the subjectively perceived walkability. While field observation and map analysis using QGIS and online open spatial data show the objective walkability in the areas. The score and data collected will be compared based on walkability indicators according to the four principles for pedestrian planning in Hong Kong.

The result indicates that TOD areas are more walkable than non-TOD areas. Sha Tin is the most walkable among the three sites. Yet, the difference is ambiguous due to the size and relief of Hong Kong. Besides, objective environmental factors are unequal to pedestrians' perceived walkability. Objectively, Mong Kok has the highest linkage and accessibility, but pedestrians disagreed based on their subjectively walking experience. Recommendations for each area have been proposed at the end of this paper.

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LIST OF ABBREVIATIONS

AQI	Air Quality Index
ESRI	Environmental Systems Research Institute
HKMS 2.0	Hong Kong Map Service 2.0
KCR	Kowloon-Canton Railway Corporation
MTR	Mass transit railway
NO2	Nitrogen dioxide
$PM_{2.5}$	Particulate matter 2.5
PM_{10}	Particulate matter 10
QGIS	Quantum Geographic Information System
‘R+P’ model	‘Rail + Property’ model
TOD	Transit-oriented development

CHAPTER 1: INTRODUCTION

1.1 Study background

Hong Kong is a densely populated city with 7.4 million residents packed in a 1 thousand square kilometer territory (Census and Statistics Department, 2023). In order to efficiently maximize land use and minimize urban sprawl simultaneously, most of the areas are developed vertically by skyrocketing buildings and compacted with different types of land use around the MTR stations. Citizens rely heavily on MTR and other public transport rather than automobiles for commuting. MTR is the backbone of transportation in Hong Kong and carries 4.7 million passengers every day (MTR, 2023). Therefore, Hong Kong is well known as a the top three benchmarking transit-oriented development city and acts as a role model for the international (The World Bank, 2019).

One of the main goals of transit-oriented development is to promote walking activities around MTR stations by developing a walkable area. As Hong Kong is small and has high-density development, there are lots of walking activities everywhere. Hence, this paper wants to investigate whether TOD can attract people to walk more compared to non-TOD.

1.2 Research questions & hypothesis

Two research questions are as follow:

1) What are the differences of walkability in TOD and non-TOD areas in Hong Kong?
2) How can the walkability in TOD and non-TOD be improved?

It is hypothesized that TOD areas are more walkable than non-TOD areas. Walkability is very subjective and differs for each person. However, the environmental indicators, such as density, air quality and crime rate, are objective. Non-TOD areas are usually old established areas that have a poorer image. Thus, it is predicted that TOD areas have higher walkability scores than non-TOD areas in Hong Kong.

CHAPTER 2: LITERATURE REVIEW

2.1 Transit-oriented development

Peter Calthorpe first suggested transit-oriented development as a neo-traditional guide to sustainable community design and he defined TOD as a mixed-use community that encourages people to live near transit services and to decrease their dependence on driving (Carlton, 2009). The function of TOD is not only to encourage people to walk more by increasing the convenience of walking but also to reintegrate the separated age and social groups by sharing common spaces and local stores in the tight mix of housing and open space design, so as to create a rebirth of the lost sense of community and place (Calthorpe, 1989).

In Hong Kong, studies have defined TOD as an area centered at the MTR stations and have high-density, mixed-use, pedestrian-friendly urban areas in a radius of 800 m or within 10 minutes of walking time (Lu & Gou & Xiao & Sarkar & Zacharias, 2018). One of the successful reasons for Hong Kong TOD is due to the 'Rail + Property' model. The MTR company has the development right to design the top and adjacent areas of the stations. According to the 'R+P' model, TOD can divide into five types, which are high-rise office (HO), high-rise residential (HR), mid-rise residential (MR), large-scale residential (LR), and large-mixed use (LM) (Cervero & Murakami, 2009).

However, there is no standardized assessment tool for distinguishing a TOD. Scholars usually distinguish TODs by their characteristics using different indicators, such as the '5Ds' criteria, including density, diversity, design, destination accessibility, and the distance to transit (Ewing & Cervero, 2001). When places match the characteristics or measurements, they are TODs. Vice versa, the others are non-TODs. So, due to this unstandardized differentiation of TOD and non-TOD, there are lots of differences between existing oversea studies and local studies. Lots of existing overseas studies have defined areas centered at the MTR stations are TOD in Hong Kong. But for Hong Kong studies, not all areas around the MTR stations are defined as TOD. It is because of the limited size and relief of Hong Kong, most of the areas have high-density development and accidentally match the characteristics of TOD. In fact, some of the places are already developed before the completion of the MTR station which coincidentally is placed at the center of that area. To fill this research gap, TOD is defined as a place that started to develop or re-designed after the construction of the MTR station in this paper.

2.2 Walkability

Pedestrian-friendly is fundamental to transit-friendly (Gori & Nigro & Petrelli, 2014). To quantify and qualify the extent of pedestrian-friendly, walkability is used to

measure how inviting or un-inviting an area is to pedestrians (Forsyth, 2015). Scholars used different walkability indices and methodologies to show the walkability of a place. Gori, Nigro, and Petrelli (2014) used three indicators, connectivity, quality and proximity, to measure walkability. In 'Comparing Transit Oriented Developments Based on Walkability Indicators' by Marc Schlossberg and Nathaniel Brown (2004). They visualized the urban form and utilized the Geographic Information System (GIS) to compare the walkability in TODs by assessing street networks, intersections, and pedestrian catchment areas. In 'Measuring pedestrians' satisfaction of urban environment under transit-oriented development (TOD): A case study of Bangkok Metropolitan, Thailand' by Iamtrakul and Zhang, they used a questionnaire survey and site survey to study four factors: personal characteristics, psychosocial variables, the built environment, and natural environment. In addition, they used GIS to integrate spatial data to reflect the dimensions of the built environment. After that, nine factors are evaluated according to users' experiences and expectations including, sidewalks and walkways, tree and planter strips, connectivity, traffic management, urban density, street qualities, and mixed-use and diversity (Iamtrakul & Zhang, 2014). For Hong Kong local studies, Civic Exchange (2016) utilized two walkability assessment checklists, one for general users and one for professionals, as methodology. They developed a 4-criterion framework for good walkability, which

are possible to walk, efficient to walk, comfortable to walk, and interesting to walk. Inside the checklist, there are 10 types of indicators, including accessibility and connectivity, physical and visual permeability, public realm amenities, scale and density, variety and diversity, legibility and orientation, streetscape and visual quality, microclimate and environment, safety and security, and transit and pedestrian friendliness (Civic Exchange, 2016).

From these examples, the wide variations of the walkability index can be seen. In this study, the four principles for pedestrian planning: linkage, safety, accessibility and comfort, and attractiveness and vibrancy, suggested by the Planning Department (2021) will be used. Firstly, linkage refers to having clear and direct signs, barrier-free facilities, and mechanized pedestrian facilities such as lifts and escalators, which can facilitate pedestrians to walk efficiently and overcome level differences. Secondly, safety refers to preventing pedestrian and vehicular conflicts and enhancing pedestrians' personal safety. Thirdly, accessibility and comfort refer to accessible and rationalized street furniture, such as benches and rain shelters. Fourthly, attractiveness and vibrancy refer to creating an attractive, vibrant, and identifiable area through activities.

In terms of methodology in walkability studies, most of the above studies only focus on either objective or subjective aspects but seldom combine both of them. Thus, both the objective environmental factor and pedestrians' subjective perceived walkability will be investigated in this study.

Criteria	Indicator
Possible to walk	• Width of pedestrian sidewalks and paved pathways • Evenness of paved surfaces • Universal access to paved pedestrian areas • Safety from road traffic • Feeling of security and personal safety from danger
Efficient to walk	• Ease of crossing roads with traffic signals • Ease of crossing roads without traffic signals • Provision of street-level connections where there is a footbridge or subway • Convenience of footbridges/subways location • Clear and useful pedestrian signs and directions • Directness of routes to main destinations in the neighbourhood • Ease of transferring between public transport modes
Comfortable to walk	• Weather protection of the area (rain, sun, excessive wind) • General quality, cleanliness and hygiene of the area • Roadside air and noise pollution • Provision of seating space and rest areas • Landscaping and greenery of paved pedestrian areas • Provision of public toilet and other amenities • Crowdedness of the area • Amount of street obstructions in walking paths
Interesting to walk	• Visually attractive streetscape and pleasant environment (e.g. public art, street furniture, landscaping, paving, lighting etc.) • The area's appeal for staying and walking around • Variety of shops and restaurants • Variety of leisure and recreational activities • Overall quality and flexible use of public open spaces • Diverse range of activities, but not too crowded • The area is appealing to a wide cross section of people

Figure 1: User checklist and indicators (Civic Exchange, 2016)

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Study area

As mentioned in the above part, TOD in this paper is defined as a place that started to develop or re-designed after the construction of the MTR station. Sha Tin and Tsuen Wan will represent TOD, while Mong Kok represents non-TOD. The areas in the radius of 800 meters around the MTR stations are the study areas.

3.1.1 Sha Tin

Sha Tin Station was first established in 1910 by Kowloon-Canton Railway Corporation (KCR). In 1956, 'Sha Tin New Market' was developed next to the KCR station. It was an area of 150,000 square feet with 125 temporary sheds, different kinds of shops and businesses, and even a cinema (Hulu Culture, 2023). Unluckily, typhoon Wanda, the most destructive typhoon in the history of Hong Kong, destroyed the Sha Tin Market. In the 1970s, the government commenced to develop Sha Tin into a new town after the establishment of the Lion Rock Tunnel (Hills & Yeh, 1983). A basic plan for the Sha Tin New Town had been drawn up by the Government's Planning Department and the aim was to produce a balanced and self-contained development that could provide more housing and residents did not have far to travel to find work (Garrett, 2015). During the new town

development, the KCR station was renovated and the original ‘Sha Tin New Market’ area was developed into the town centre, providing comprehensive facilities, including a public library, a town hall, and a large-scale shopping mall ‘New Town Plaza’ (Tan & QL Xue, 2014). By looking at the development history of Sha Tin, it is obvious that Sha Tin is a well-planned area centered at the MTR station with high-density, mixed-use, pedestrian-friendly characteristics. In 2021, the population in Sha Tin City Centre has achieved 18 thousands (Population Census, 2022). So, Sha Tin is chosen to study as a TOD in this research.

3.1.2 Tsuen Wan

After the second world war, Tsuen Wan was the largest industrial district and played a significant role in industries. In the 1950s, about 20% of Hong Kong’s labor was concentrated in Tsuen Wan factories (Hulu Culture, 2023). ‘Tsuen Wan Satellite Town’ is part of the new town development and the planning started in 1959, was announced in 1961, and developed officially in 1973 (Hulu Culture, 2023). In 1982, Tsuen Wan Line and Tsuen Wan MTR station started to service (Planning Department, 2019). During the new town development, there are lots of transformations in the area. For example, vacant industrial buildings have changed into other uses, such as hotels, office buildings, and shopping malls (Planning

Department, 2019). Furthermore, more community facilities, such as a town hall, hospital, recreation, and open space were constructed to support a balanced and self-contained development. One of the most iconic features of Tsuen Wan is the footbridges. The footbridges started to develop after the completion of the Tsuen Wan MTR station and expanded farther to link other buildings. It shows that Tsuen Wan is well-planned and redeveloped with the center at MTR station. In 2021, the population in Tsuen Wan around the MTR station has achieved 59 thousands (Population Census, 2022). Hence, Tsuen Wan is one of the representatives for TOD in this study.

3.1.3 Mong Kok

In 1924, a new pier opened on Shantung Street and attracted different types of businesses such as goldsmiths, banks, and mahjong parlors accumulated in Shantung Street (Hulu Culture, 2023). As people heavily relied on boats to travel between Kowloon and Hong Kong in the past, Mong Kok became a commercial and residential area after the completion of the pier. Due to the pier closing in 1972 and the completion of the Mong Kok station in 1979, some of the shops moved from Shantung Street to Nathan Road which is more accessible. And Mong Kok becomes one of the most famous tourist spots and shopping area in Hong Kong. In

2021, the population in Mong Kok has achieved 63 thousands (Population Census, 2022). In short, Mong Kok has been developed long before the completion of Mong Kok Station. Mong Kok Station was coincidentally put in an area which is near the centre of the developed area – Shantung Street. Thus, Mong Kok has the characteristics of high density and mixed land use, but it was not planned to be a TOD initially. So, Mong Kok is chosen as a non-TOD in this study.

3.2 Research method

This paper will investigate both objective environmental factors and pedestrians' subjective perceived walkability. Three methodologies are set, including questionnaire, field observation and map analysis.

3.2.1 Questionnaire

Firstly, a questionnaire survey will be conducted. It is used for analyzing the pedestrians' subjective perceived walkability. This research targets pedestrians in Sha Tin, Tsuen Wan, and Mong Kok and aims to receive at least 50 sets of data in each area. Voluntary sampling and convenience sampling will be applied. The questionnaire will be divided into three parts. In the first part, it is about the pedestrian's characteristics, such as age, gender, education level, and any physical

disability. In the second part, respondents need to give walk scores to different indicators. The indicators are set according to the four pedestrian planning principles, linkage, safety, accessibility and comfort, and attractiveness and vibrancy (Planning Department, 2021). The place with the highest walk score means it is the most walkable among the three study areas. In the last part, respondents can give open-ended comments or suggestions on how to improve the walkability in that area.

3.2.2 Field observation

Secondly, field observation will be conducted. Field observation is an objective methodology. The observer will visit the three sites and observe items that cannot be seen on the map. For example, cleanness of the street, activities and performances on street, and festive decorations and music. During observation, the numbers and data will be recorded and photos will be taken as evidence. In order to be fair, the field observation will be carried on within the same week, at the same time, and in similar weather conditions.

3.2.3 Map analysis

Thirdly, map analysis by Quantum Geographical Information System (QGIS) will be utilized. This is an objective methodology to quantify the environmental factors affecting walkability. Different online spatial data are used for analysis. The first website is HKMS 2.0. Digital topographic map iB5000 was used for producing the base map, road polygons, and building polygons. Furthermore, it can show the crossing facilities' polygons, such as footbridges and subways. Digital topographic map iB10000 was used for displaying the MTR stations and drawing the buffer from the center of the MTR stations. GeoCommunity Database (iGeoCom) was used to show the MTR exits and points of interest. Lastly, aerial photos provided by the HKMS 2.0 are used to compare the greenery in the three areas. The second website is DATA.GOV.HK. The 3D pedestrian network is used to show both indoor and outdoor 3D pedestrian routes. Besides, it can also reveal the number of road crossings on ground level. The third website is ESRI China. It is used to indicate the locations of the air quality monitoring network. The last website is Hong Kong Traffic Injuries Collision Database. It shows the traffic injuries with pedestrians and traffic injuries hot zones. By inputting the above data sets into the QGIS, the walkability of the three areas can be quantified on the map and compared easily.

Figure 2: Sha Tin Buffer.

Figure 3: Tsuen Wan Buffer

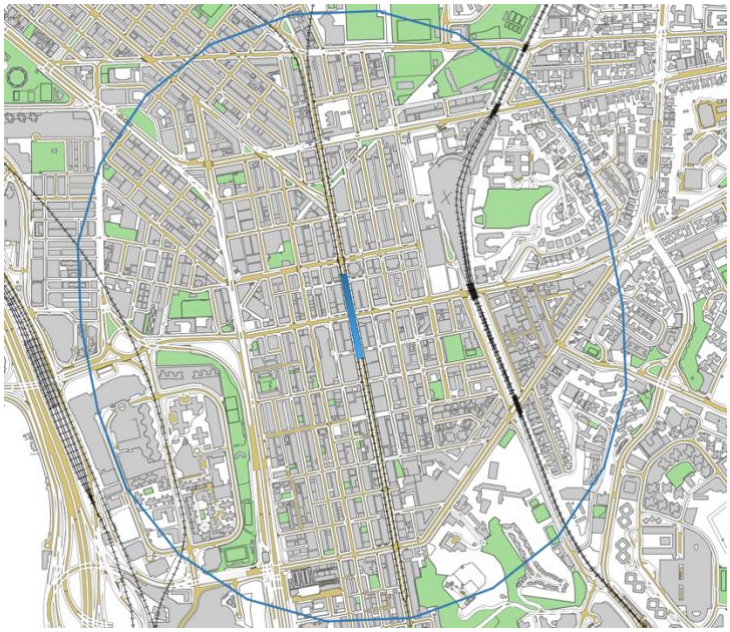

Figure 4: Mong Kok Buffer

CHAPTER 4: FINDINGS

4.1 Linkage

4.1.1 Number of MTR exits

Figures 5, 6, and 7 show the MTR station and MTR exits in Sha Tin, Tsuen Wan, and Mong Kok respectively. The blue polygons represent the MTR stations, and the size of the polygons illustrates the size of the stations. The blue dots are the location and number of the MTR exit.

In Sha Tin, there are 5 MTR exits. Two of them are connected to the shopping mall – New Town Plaza. Two of them are linked to the public transport interchange. One of them is linked to the Pai Tau Village.

In Tsuen Wan, there are 11 MTR exits. The exits are separated into ground level and upper level. There are two exits on the ground level and nine exits on the upper level. The nine exits are linked to the footbridges and buildings, such as Nan Fung Centre.

In Mong Kok, there are 15 MTR exits. They are distributed along Nathan Road, Argyle Street, and Fife Street. The exits are also connected to two shopping malls, including This is Our Place (T.O.P) and Langham Place.

By comparing the total number of MTR exits in the three areas, Mong Kok has the highest number of MTR exits. It shows that Mong Kok is better in linkage as the catchment area is larger and pedestrian can go different destinations easier.

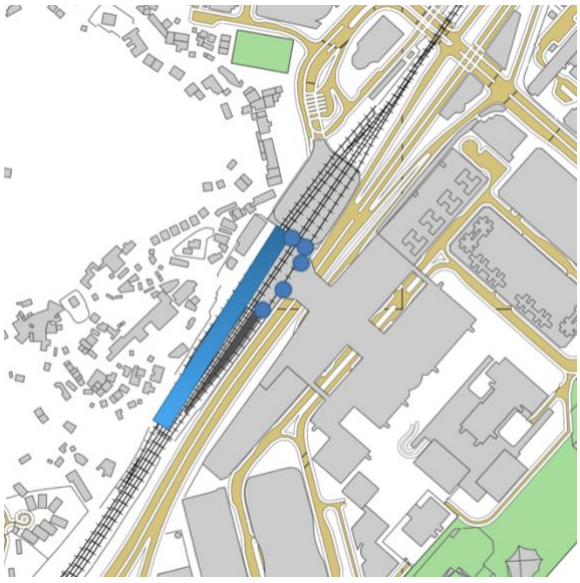

Figure 5: Sha Tin MTR exits

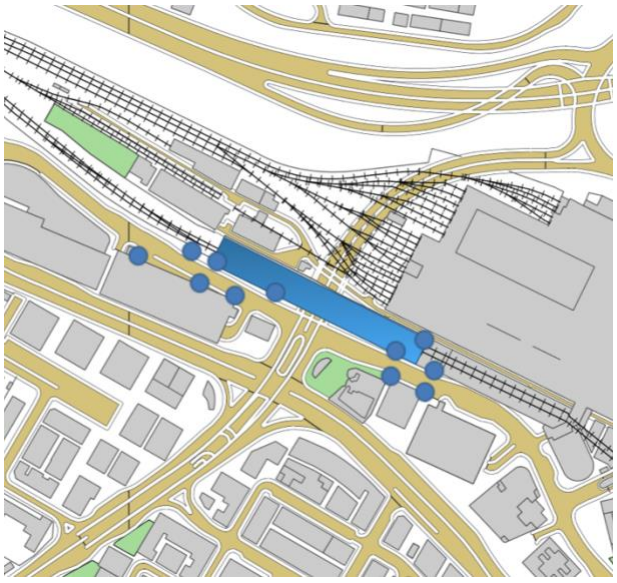

Figure 6: Tsuen Wan MTR exits

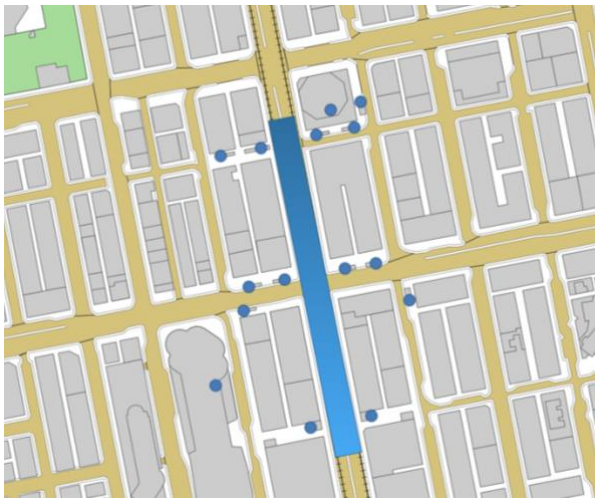

Figure 7: Mong Kok MTR exits

4.1.2 Density of pedestrian route

Figures 8, 9, and 10 show the density of the pedestrian route. The black line indicates the indoor and outdoor 3D pedestrian routes. The higher density of pedestrian route, pedestrians will have more possibilities and choices to walk. Besides, when the pedestrian route is denser, it means more road is near to each other or overlaying. So, the connectivity and linkage are higher.

In Sha Tin, the total length of the pedestrian route is 82811 meters. In Tsuen Wan, the total length is 124157 meters. In Mong Kok, the total length is 137152 meters. To calculate the density, the area needs to be calculated by $A=\pi r^2$. The area of the three areas is $\pi \times 800^2 = 2010619$ m2. After that, the density can be calculated by $D = \ell / A$. Finally, the density of the pedestrian route in Sha Tin is 0.0412, Tsuen Wan is 0.0618, and Mong Kok is 0.0682. Hence, Mong Kok has the highest density of pedestrian routes and the best linkage.

Figure 8: Sha Tin pedestrian route

Figure 9: Tsuen Wan pedestrian route

Figure 10: Mong Kok pedestrian route

4.1.3 Crossing facilities (ground level)

The orange polygons in Figures 11, 12, and 13 are crossing facilities on the ground level, including all cautionary crossings and signalized crossings. The importance of crossing facilities on the ground level is to connect two separate pedestrian routes. Without sufficient crossing facilities, it is difficult for pedestrians to walk and may even cause traffic accidents when they are crossing the road.

In Sha Tin, there are 241 crossing facilities. In Tsuen Wan, there are 430 crossing facilities. In Mong Kok, there are 951 crossing facilities. From the comparison, Mong Kok has the greatest number of crossing facilities on the ground level. In Figure 13, the block design of Mong Kok can be observed. This design created lots of crossroads and favors the existence of crossing facilities on ground level. Therefore, this examines Mong Kok has the best linkage.

Figure 11: Sha Tin crossing facilities (ground level)

Figure 12: Tsuen Wan crossing facilities. (ground level)

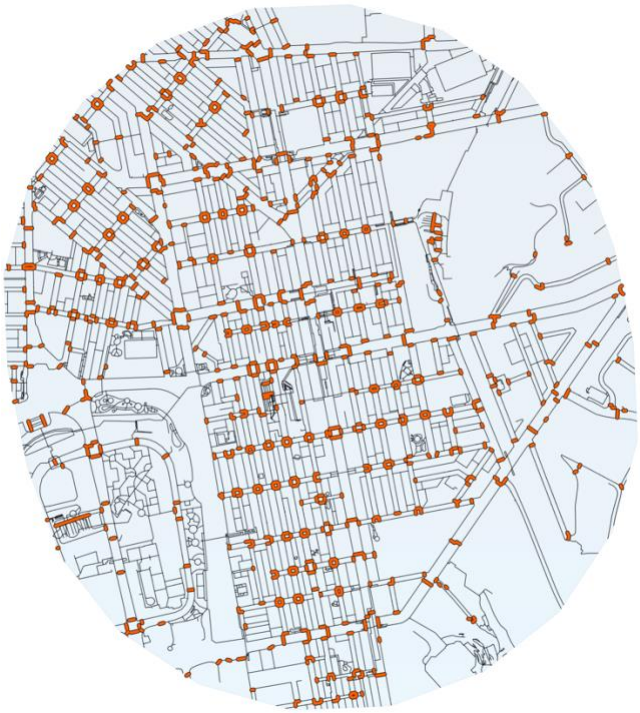

Figure 13: Mong Kok crossing facilities (ground level)

4.1.4 Crossing facilities (upper and underground level)

Some of the places are not suitable to have ground-level crossing. So, crossing facilities in upper and underground levels are the alternatives to increase the linkage of a place. The red polygons in Figures 14, 15, and 16 represents crossing facilities in the upper and underground level, such as footbridge, bridge, and subway.

In Sha Tin, there are overall 71 crossing facilities on upper and underground levels. 39 of them are footbridges, 14 of them are bridges over water, and 18 of them are subways. And the total area for all crossing facilities in the upper and underground levels is 18490 m^2.

In Tsuen Wan, there is a total of 93 crossing facilities on the upper and underground levels. 71 of them are footbridges, 13 of them are bridges over water, and 9 of them are subways. And the total area for all crossing facilities in the upper and underground levels is 37715 m^2.

In Mong Kok, there are overall 37 crossing facilities on the upper and underground levels. 33 of them are footbridges, 1 of them are bridges over water, and 3 of them

are subways. And the total area for all crossing facilities in the upper and underground level is 16381 m^2.

From the comparison, Tsuen Wan has the most footbridges, while Sha Tin has the most bridges over water and subways. Yet, Tsuen Wan still has the most number and largest overall area of upper and underground crossing facilities.

	Sha Tin	**Tsuen Wan**	**Mong Kok**
Footbridge	39	71	33
Bridge (Footbridge over water)	14	13	1
Subway	18	9	3
Total number	71	93	37
Total area (m^2)	18490	37715	16381

Table 1: Crossing facilities (upper and underground level)

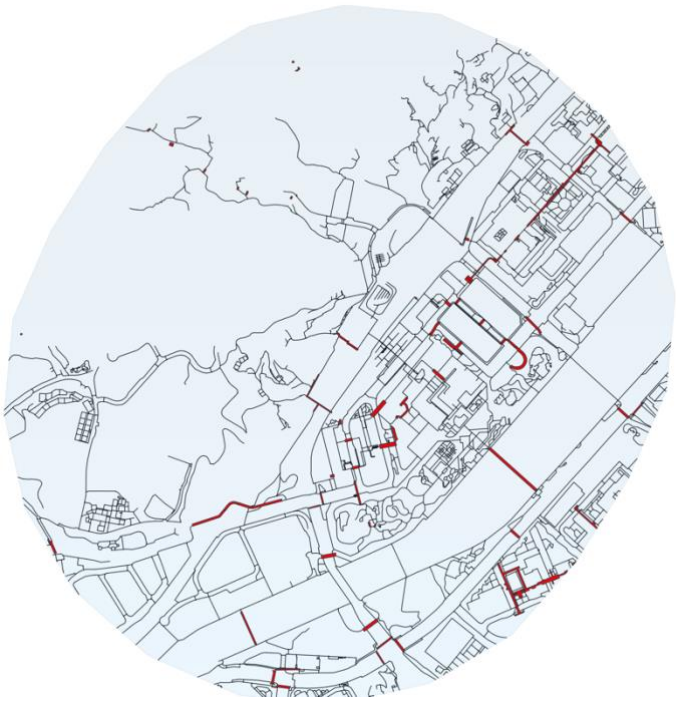

Figure 14: Sha Tin crossing facilities (upper and underground level)

Figure 15: Tsuen Wan crossing facilities (upper and underground level)

Figure 16: Mong Kok crossing facilities (upper and underground level)

4.1.5Pedestrian perceived linkage

In the questionnaire, respondents need to give scores to five indicators in terms of linkage. They are ease of transferring between public transport modes, amount of clear and useful directions and signs, amount of crossing facilities, amount of machined pedestrian facilities, and the number of barrier-free facilities.

Subjectively, Sha Tin has the highest walk score in linkage, which is 17.6. The second is Mong Kok with 16.75. The last is Tsuen Wan with 16.44.

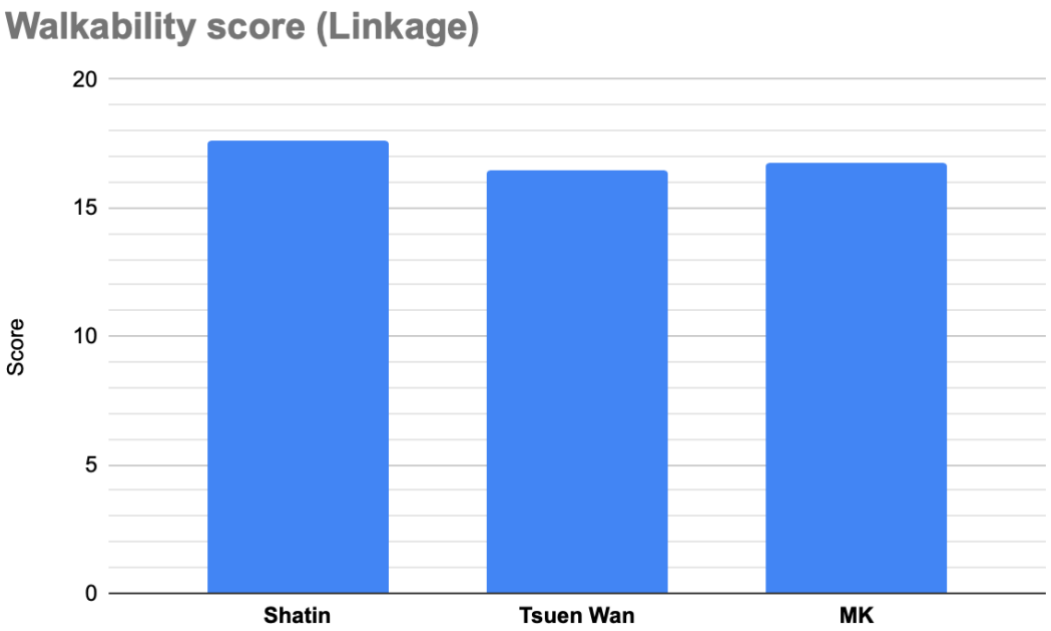

Figure 17: Pedestrians' perceived linkage score

4.2 Safety

4.2.1 Traffic injuries with pedestrians

Figures 18, 19, and 20 show traffic injuries involving pedestrians from 2014 to 2019. The yellow dots mean slight accidents, the orange dots are serious accidents, and the red dots represent fatal accidents. By comparing the figures, Mong Kok has the most traffic accidents and fatal collisions with pedestrians. The second is Tsuen Wan, with lots of traffic accidents but less seriousness. Sha Tin has the least traffic injuries affecting pedestrians.

On the other hand, Tsuen Wan and Mong Kok have lots of traffic hot zones. For Tsuen Wan, two of the areas are the top ten traffic hot zones in Hong Kong. The first area is Market Streets near Yeung Uk Road Market, such as Chuen Lung Street, Ho Pa Street, and San Tusen Street, in Figure 21. This area has 99 collisions from 2015 to 2019 and the collision density is 132.5 collisions per kilometer (Hong Kong District Info, 2023). Another area in Tsuen Wan is Tsuen Kwai Street at the Junction of Tsuen Fu Street in Figure 22. There were 18 traffic accidents involving pedestrians from 2015 to 2019. The collision density is 108.6 collisions per kilometer (Hong Kong District Info, 2023). For Mong Kok, the area around Nathan Road, Dundas Street, Portland Street, Hamilton Street, and Fa Yuen Street in Figure 23 has 94 collisions from 2015 to 2019. As it involves a

larger area, the collision density is lower than the two in Tsuen Wan, which is 106.3 collisions per kilometer (Hong Kong District Info, 2023). These data show that although Tsuen Wan does not have the most traffic collision with pedestrians among the three areas, traffic safety is still remarkably low. Hence, Sha Tin has the highest traffic safety among the areas.

Figure 18: Sha Tin traffic injuries

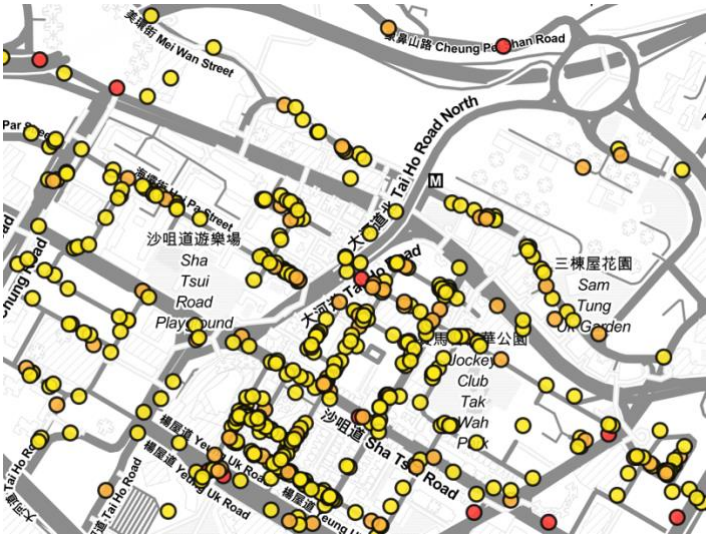

Figure 19: Tsuen Wan traffic injuries

Figure 20: Tsuen Wan traffic injuries

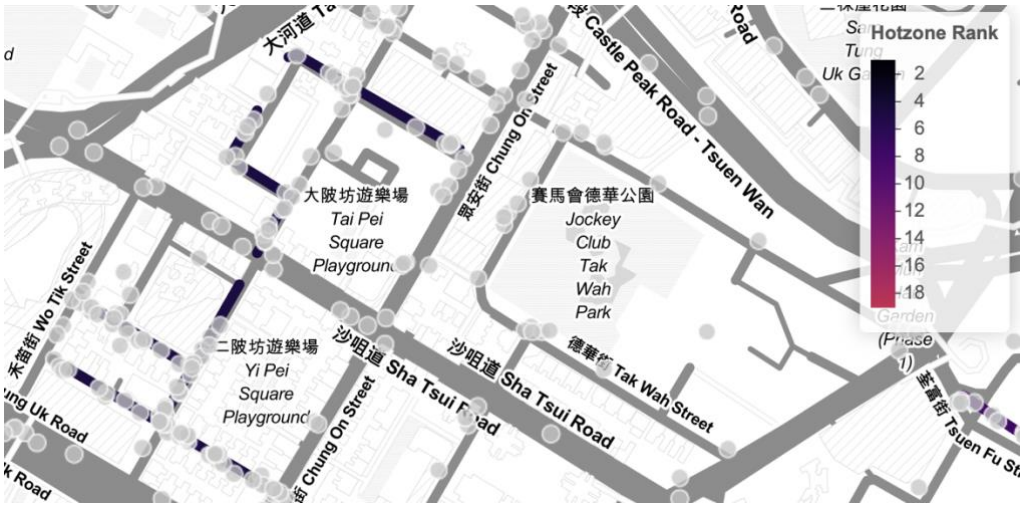

Figure 21:Tsuen Wan traffic hot zone (Market Streets near Yeung Uk Road Market)

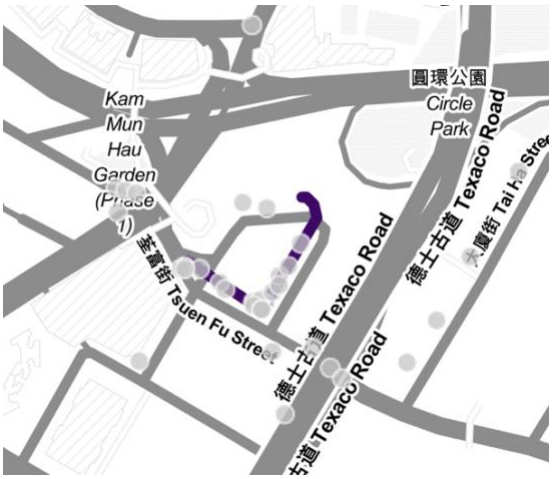

Figure 22: Tsuen Wan traffic hot zone (Tsuen Kwai Street at the Junction of Tsuen Fu Street)

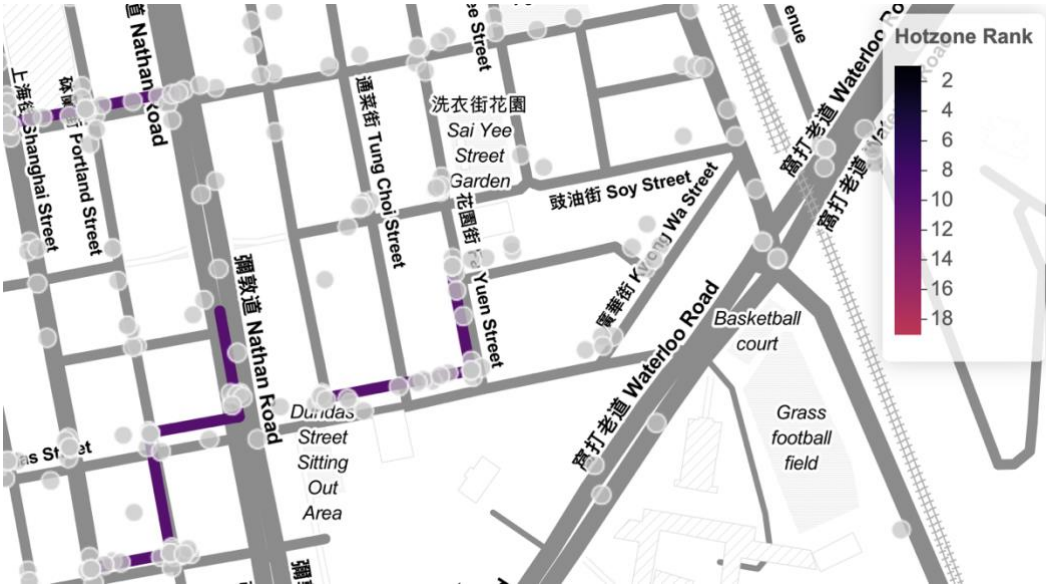

Figure 23: Mong Kok traafic hot zones

4.2.2 Pedestrian perceived safety

Pedestrians subjectively agreed that Sha Tin has the highest degree of safety among the three areas. Respondents are required to answer seven questions related to their perceived safety in that area, such as separation from vehicles, amount of abandoned shops, and pedestrian flow volume. Sha Tin gained 23.3, Tsuen Wan has 21.88, and Mong Kok obtained 19.24.

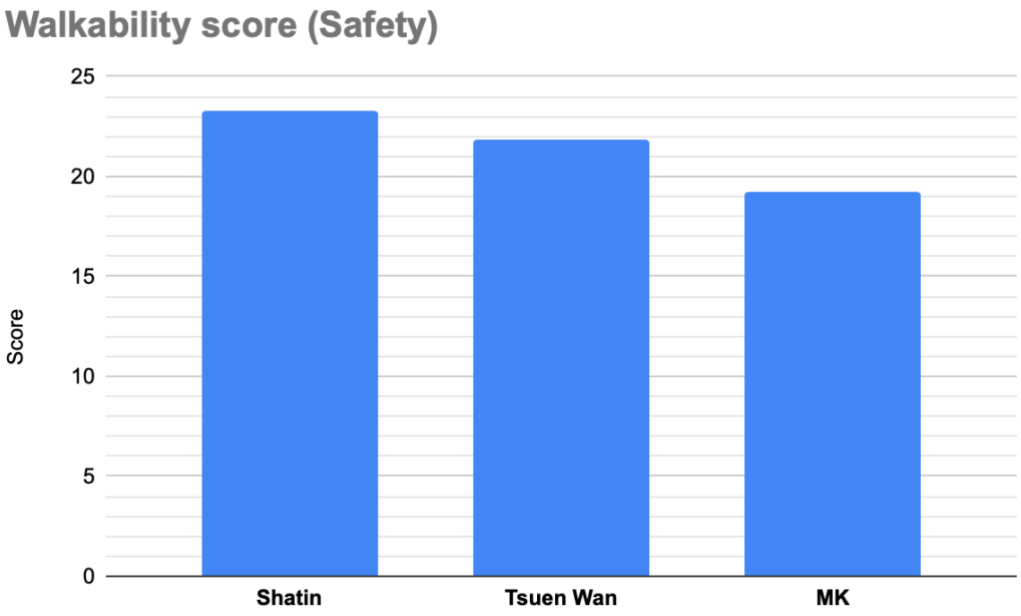

Figure 24: Pedestrians' perceived safety score

4.3 Accessibility & comfort

4.3.1 Accessibility to community facilities

Figures 25, 26, and 27 indicate the number of community facilities in the three areas. The green polygons represent parks, and the orange dots are community facilities. Community facilities are necessary for residents to improve their

quality of living in that area, such as town halls, libraries, children centers, supermarkets, malls, etc. The more community facilities, pedestrians are more convenient and accessible to the community. In Sha Tin, there are 85 community facilities. In Tsuen Wan, there are 218 community facilities. In Mong Kok, there are 244 community facilities. Therefore, Mong Kok's community facilities are the densest and perform better in accessibility.

Figure 25: Accessibility in Sha Tin

Figure 26: Accessibility in Tsuen Wan

Figure 27: Accessibility in Mong Kok

4.3.2 Greenery

Greenery is important in urban planning. Firstly, vegetation act as a carbon sink which can trap carbon dioxide and produce oxygen to better the air quality. In the long run, it can protect people's health by decreasing the chance of respiratory diseases. At the same time, greenery also benefits people's mental health as they beautify the urban landscape. Furthermore, it diversified the biodiversity in the city by providing habitats to animals, such as birds. Lastly, it can slightly decrease the temperature in the street as it acts as a shelter and avoid direct sunlight on the pedestrians.

Figures 28, 29, and 30 are aerial photos taken in April 2022. The colors of the photos are color-tuned for differentiating vegetation in an urban area. The red color represents vegetation. From the top angle, it can be compared that Sha Tin has the most greenery, the second is Tsuen Wan, and the least in Mong Kok. From the perspective of the street view in Figures 31, 32, and 33, it also proves that Sha Tin and Tsuen Wan have greenery along the streets, while there is no greenery along the street in Mong Kok at all.

Figure 28: Greenery in Sha Tin (Aerial photo)

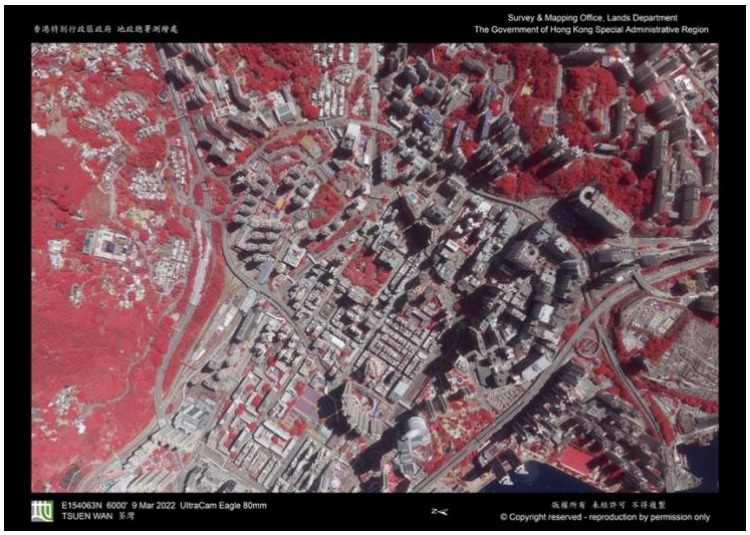

Figure 29: Greenery in Tsuen Wan (Aerial photo)

Figure 30: Greenery in Mong Kok (Aerial photo)

Figure 31: Greenery in Sha Tin (street-level)

Figure 32: Greenery in Tsuen Wan (street-level)

Figure 33: Greenery in Mong Kok (street-level)

4.3.3 Cleanness

Form the field observation, all three areas have rubbish in the street, such as cigarettes, construction waste, and waste from shops in Figures 34, 35, and 36. Yet, Sha Tin has the least amount of rubbish and have the minimal impact to the pedestrians.

Figure 34: Cleanness in Sha Tin

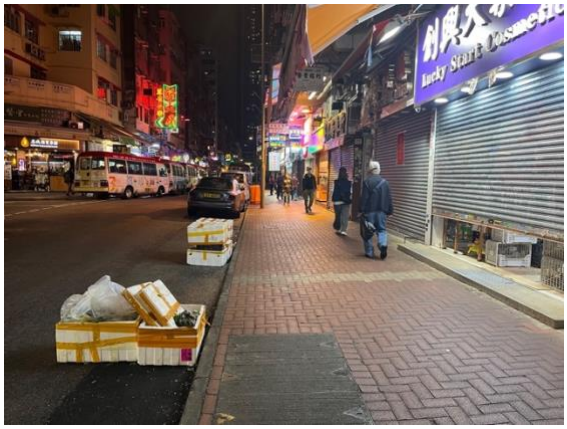

Figure 35: Cleanness in Tsuen Wan

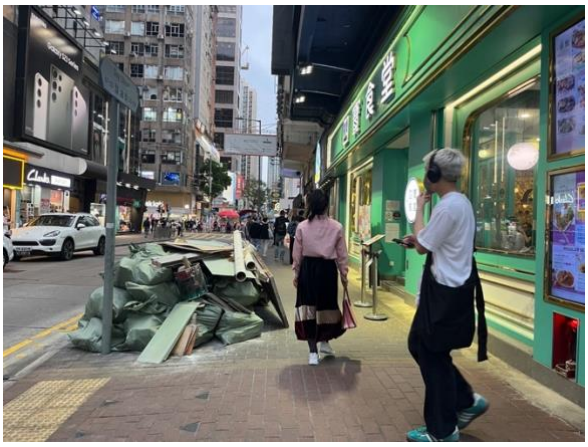

Figure 36: Cleaness in Mong Kok

4.3.4 Air quality

The better air quality will increase the willingness of pedestrians to stay longer in the area. Figures 34, 35, and 36 show the Air Quality Index (AQI) of the three areas. They show the concentration of different pollutants, NO2, PM10, and PM2.5. So, the higher the AQI, the higher the health risk (EPD, 2023). Mong Kok has the highest AQI among the three areas while ShaTin has the lowest. It

implies that Mong Kok has the worst air quality while Sha Tin has the best air quality. This result also echoes the amount of greenery in the three areas.

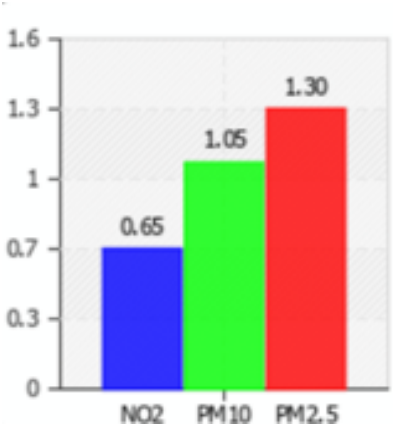

Figure 37: AQI in Sha Tin

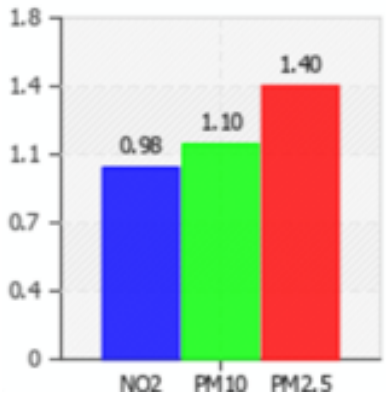

Figure 38: AQI in Tsuen Wan

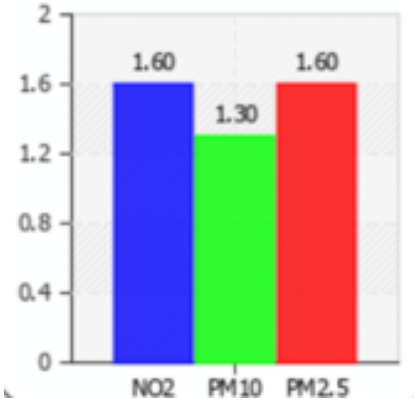

Figure 39: AQI in Mong Kok

4.3.5 Pedestrian perceived accessibility and comfortness

Pedestrians answered 10 questions related to accessibility and comfort in the questionnaire, such as the number of public toilets, cleanness, amount of benches, and noise pollution. The respondents give Sha Tin the highest score for accessibility and comfort, which is 33.9. The second is Tsuen Wan with a score of 25.88. The last is Mong Kok with a score of 19.28. Thus, Sha Tin performs the best in accessibility and comfort.

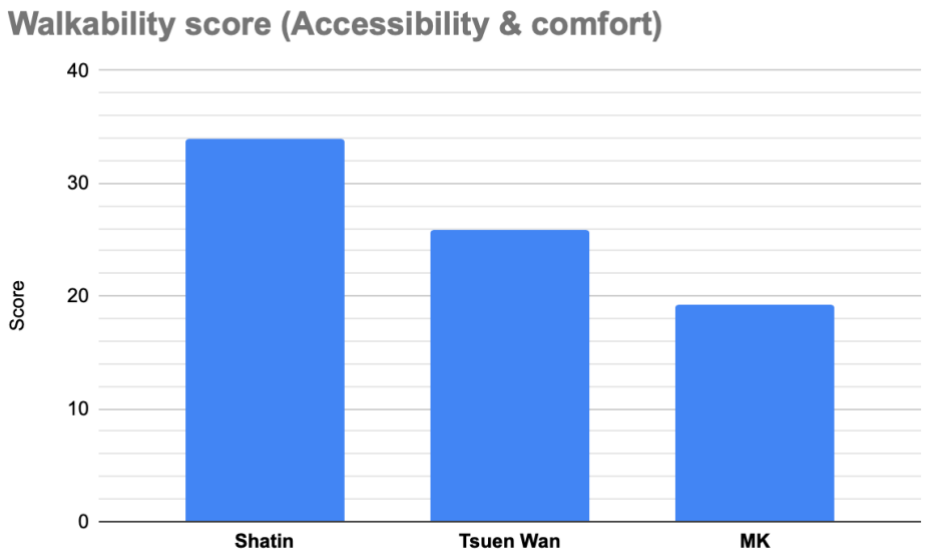

Figure 40: Pedestrians' perceived accessibility and comfort score

4.4 Attractiveness & vibrancy

4.4.1 Activities and performances

Different types of events are important for a walkable area as it is the reason people visit the place and increase their interest in staying in this area. Besides, activities and performances also make each place special, unique, and identifiable.

In Sha Tin, there are activities and performances organized voluntarily and by different organizations. In open spaces, such as the area next to the MTR exit in Figure 38, there are often busking and religious activities like singing carols. In parks, elderly people are gathering there for exercising and dancing together. In

shopping malls, there are various kinds of activities and decorations for every festival to attract people to visit and consume. In outdoor areas, there are areas for holding activities and performances, such as that in Figure 39, but it needs to be applied and booked beforehand. All in all, Sha Tin is an attractive place with various types of events around the MTR station.

In Tsuen Wan, there is less open space compared to Sha Tin. Only busking can be found on footbridges near the MTR exits and streets on ground level. In Figure 40, people are busking on the footbridge. From the field observation, most of the pedestrians walk by the performers quickly and no people stop and gather. This phenomenon is caused by the limited width of the footbridge as there is insufficient space for people to stop and watch the shows. So, it decreases people's willingness of staying there to enjoy the performance.

In Mong Kok, there are more locations for performers to choose from. For example, near MTR exits, outside Langham Place, and on Soy Street. Except for busking, there are more forms of performances, such as drawings and playing special musical instruments. Another thing that makes Mong Kok so special is the flea market and agglomeration. In Mong Kok, there are lots of souvenirs in

the Ladies Market, different brands of sneakers in Sneakers Street, which is Fa Yuen Street, and different species of fish in Goldfish Street. These unique streets attract many citizens and tourists. The number of performances and activities cannot be counted and used for comparison, but through the types of activities, Mong Kok is the most attractive and vibrant place among the three areas.

Figure 41: Busking in Sha Tin

Figure 42: Performances in Sha Tin

Figure 43: Busking in Tsuen Wan

Figure 44: Ladies Market in Mong Kok

4.4.2 Parks

Parks can also attract people to gather and improve the image of the area. The green polygons in Figures 42, 43, and 44 are parks. In Sha Tin, the total area of parks is 227639 m2. The largest green polygon in Figure 42 is Sha Tin Central Park, which is 100019 m2. There are different types of facilities provided for all ages of users. In Tsuen Wan, the total park area is 241330 m2. The largest park in Tsuen Wan is Shing Mun Valley Park which is 47156 m2. In Mong Kok, the overall area of parks is 300721 m2. Cherry Street Park, which is 41168 m2, is the largest park in Mong Kok. By comparing the total area, Mong Kok has the largest area to gather people.

Figure 45: Parks in Sha Tin

Figure 46: Parks in Tsuen Wan

Figure 47: Parks in Mong Kok

4.4.3 Malls

Hong Kong is renowned as a ‘shopping paradise’. Tourists are attracted by shopping malls and shopping is one of citizens’ recreational activities. In Figures 45, 46, and 47, the purple dots represent the locations and numbers of malls. In Sha Tin, there are 10 malls in total. In Tsuen Wan, there are 30 malls. In Mong Kok, there are 40 malls. Besides, shopping malls in Mong Kok are concentrated along Nathan Road. From these data, it shows that Mong Kok has the most attractiveness and vibrancy.

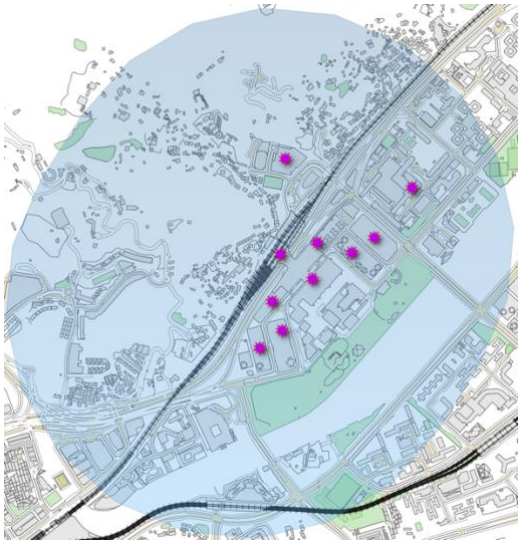

Figure 48: Malls in Sha Tin

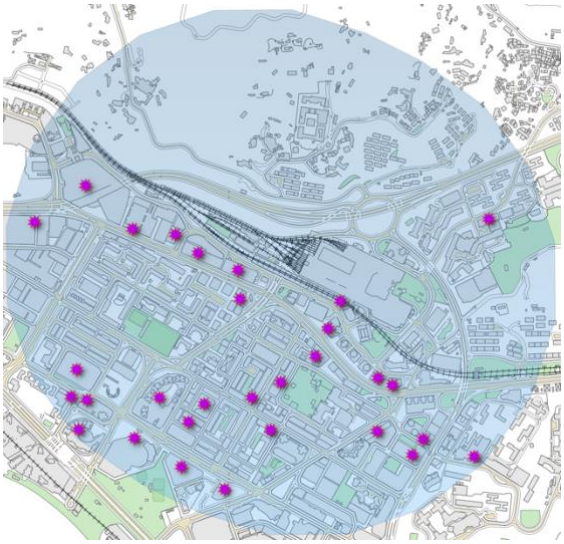

Figure 49: Malls in Tsuen Wan

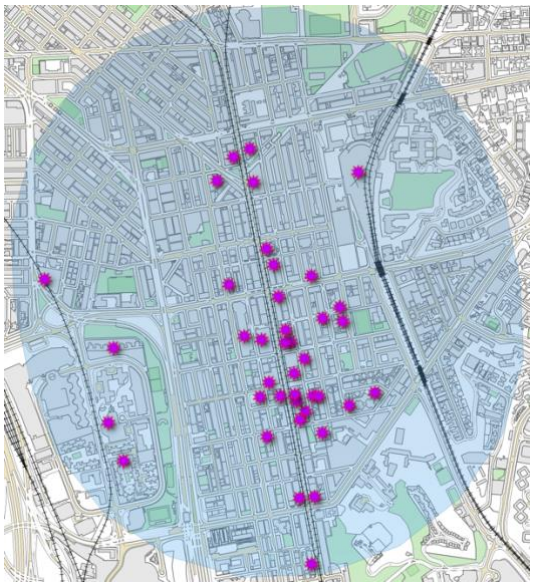

Figure 50: Malls in Mong Kok

4.4.4 Pedestrian perceived attractiveness and vibrancy

Pedestrians are required to give scores to five questions about attractiveness and vibrancy in the questionnaire. Sha Tin obtained 13.9 which is the highest score, Tsuen Wan has 12.14 and Mong Kok has 11.52. Surprisingly, Mong Kok got the lowest score which indicates that pedestrians' perceived attractiveness is different

from the objective environmental factors. The next chapter will explain it in detail.

On the other hand, in the questionnaire, respondents are also required to choose three things that most attract them to visit a place. In Figure 49, the factors are shopping malls, parks, flea markets, performances, artworks, and decorations. 141 out of 150 respondents think that the shopping mall is the most attractive factor. The second attractive factor is the park, with 72 votes. The third attractive are flea market and performances, which have both 67 votes. The fifth attractive thing is decorations with 53 votes. The least attractive thing is the artwork with 32 votes. This shows that Hong Kong people think that the attractiveness and vibrancy of a place refer to the existence of shopping malls.

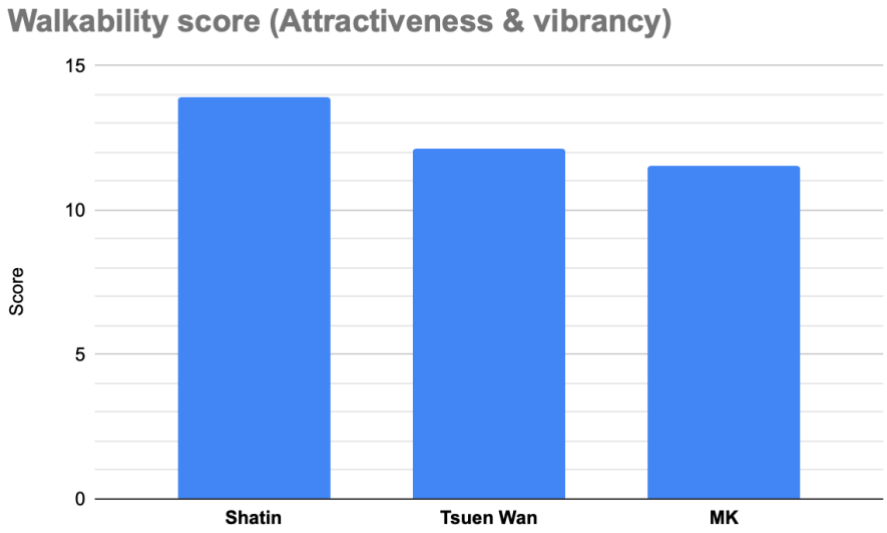

Figure 51: Pedestrians' perceived attractiveness and vibrancy score

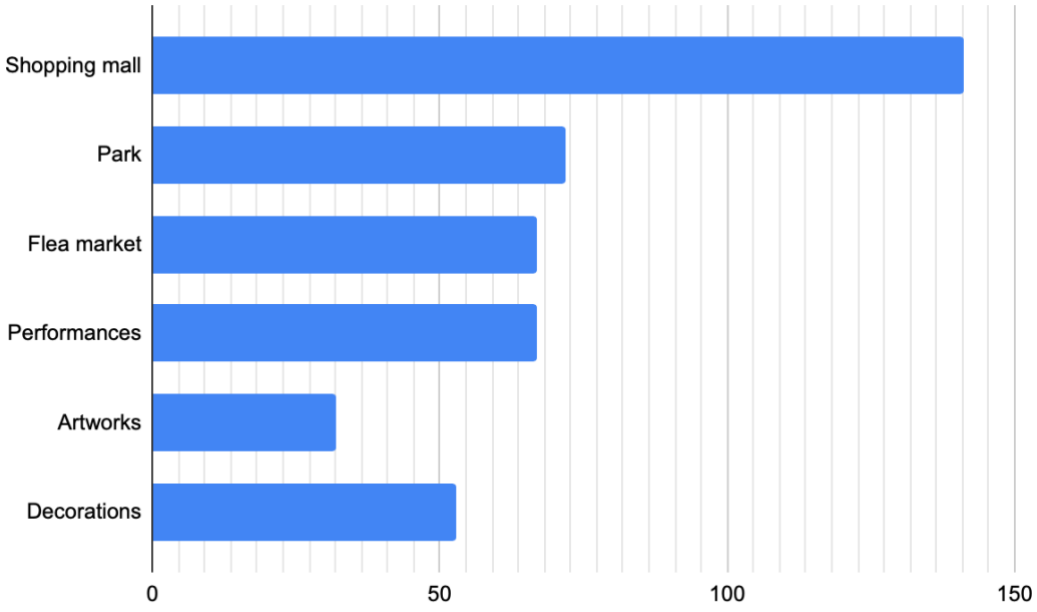

Figure 52: Top three attractive things in the street

CHAPTER 5: DISCUSSION

5.1 Difference between TOD and non-TOD

Table 2 summarized and compared the findings in the previous chapter. Sha Tin performs the best in 8 measurements, Tsuen Wan performs the best in 1 measurement, and Mong Kok performs the best in 7 measurements. From the result, Sha Tin is the most walkable area among the selected study sites. This shows that TOD is more walkable than non-TOD. Nevertheless, only a negligible difference can be observed. Two causes will be used to explain this phenomenon. Firstly, the small size and hilly relief of Hong Kong caused both TOD and non-TOD to have similar building characteristics, such as high density with mixed land use. It is convenient for citizens to walk in such places as the pedestrians' destinations are concentrated together. Secondly, the location of non-TOD will affect the extent of disparity between TOD and non-TOD. This study picked Mong Kok as the representative of non-TOD. As Mong Kok is located in the city center, it has a long developmental history and is well-linked to other places. In Figure 53, it shows the mapping of Mong Kok in 1963. At that time, when there is no MTR station, the streets were already designed and developed into small blocks. So, there will be a certain level of walkability in terms of linkage and accessibility in Mong Kok. If the chosen study site of non-TOD is not located in the city center, but in the suburb, the resulting differences between TOD

and non-TOD will be more prominent. To conclude, TOD areas are slightly more walkable than non-TOD areas in Hong Kong.

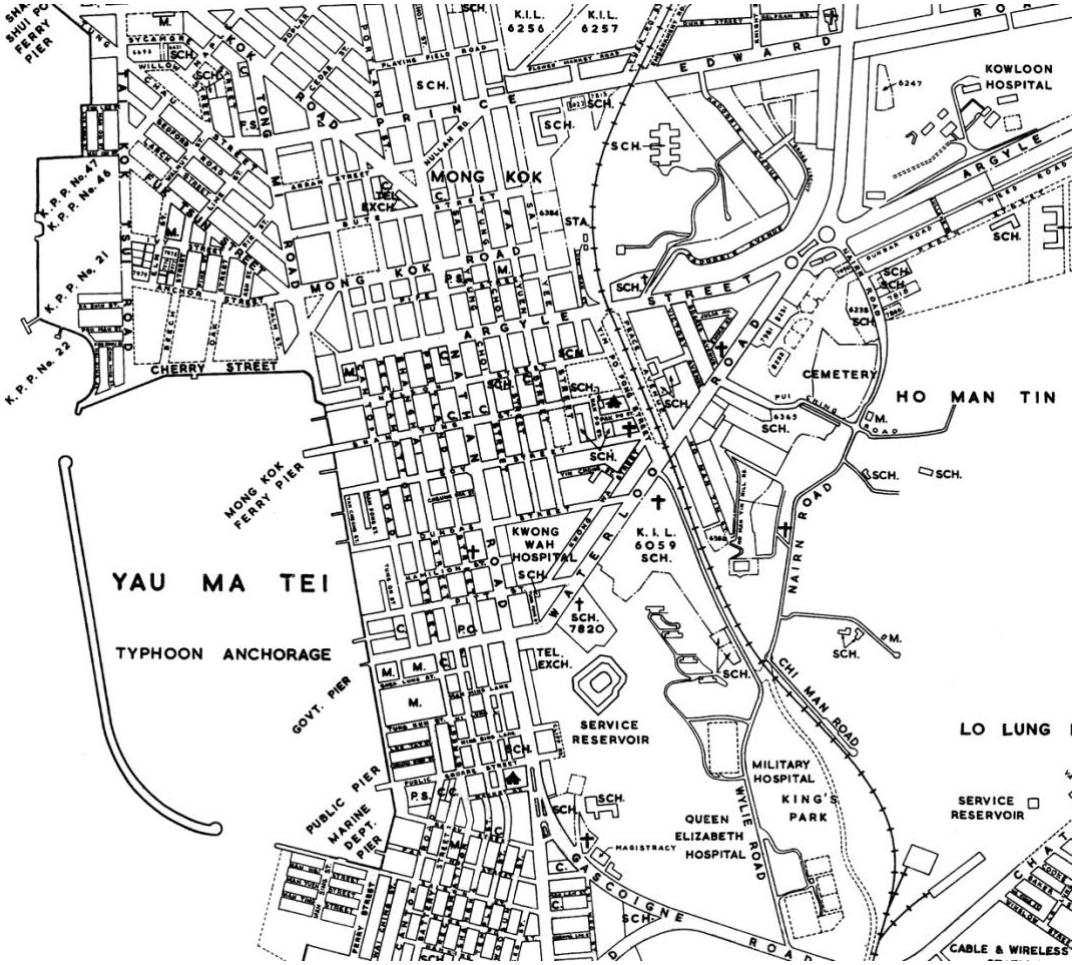

Figure 53: Mong Kok in 1963 (Lands Department, 2023)

		ShaTin	Tsuen Wan	Mong Kok
Linkage	MTR exit			✓
	Pedestrian route			✓
	Crossing facilities (Ground level)			✓
	Crossing facilities (Upper and underground level)		✓	
	Pedestrian score	✓		
Safety	Traffic injuries	✓		
	Pedestrian	✓		
Accessibility & comfort	Accessibility (Community facilities)			✓
	Greenery	✓		
	Cleanness	✓		
	Air quality	✓		
	Pedestrian score	✓		
Attractiveness & vibrancy	Activities and performances			✓
	Number of parks			✓
	Number of malls			✓
	Pedestrian score	✓		

Table 2: Comparison of Sha Tin, Tsuen Wan, and Mong Kok

5.2 Difference between objective and subjective walkability

From the previous findings, the difference between objective and subjective walkability can be seen.

Firstly, in terms of linkage, Mong Kok performs the best in objective environmental factors. Yet, pedestrians think that Sha Tin has the best linkage. This can be explained by the design of Sha Tin. As two of the MTR exits connected to the New Town Plaza, the shopping mall became an extension of the exits and created the multilevel pedestrian skywalk network in Sha Tin (Tan & QL Xue, 2014). The function of the multilevel pedestrian skywalk is similar to the footbridge. Pedestrians can travel to most of the places in Sha Tin Town Centre without walking on the ground level and are protected from rain and heat. Therefore, although the counted number of crossing facilities is less than Mong Kok, pedestrians will have a better walking experience in Sha Tin.

Secondly, in terms of attractiveness and vibrancy, Mong Kok has the greatest number of attractions, such as malls, parks, and flea markets. So, it is supposed to be the most attractive and vibrant area, but pedestrians subjectively think Sha Tin is better. Compare with linkage, attractiveness is more subjective and differs for each person.

According to the findings in the previous part, Hong Kong citizens think the shopping mall is the most attractive element in the street. However, the shopping malls in Sha Tin and Mong Kok target differently. In Mong Kok, there is a total of 40 malls, but most of them are small-scale and not targeted to all public. Some of them target teenagers and some of them target people who love to buy electronic equipment. Only a few numbers of malls, such as Langham Place and MOKO, target all types of people. In Sha Tin, although there is less number of malls, most of them are large-scale and suitable for all ages. Thus, in pedestrians' opinion, the quality of the mall is more important than the quantity of the mall.

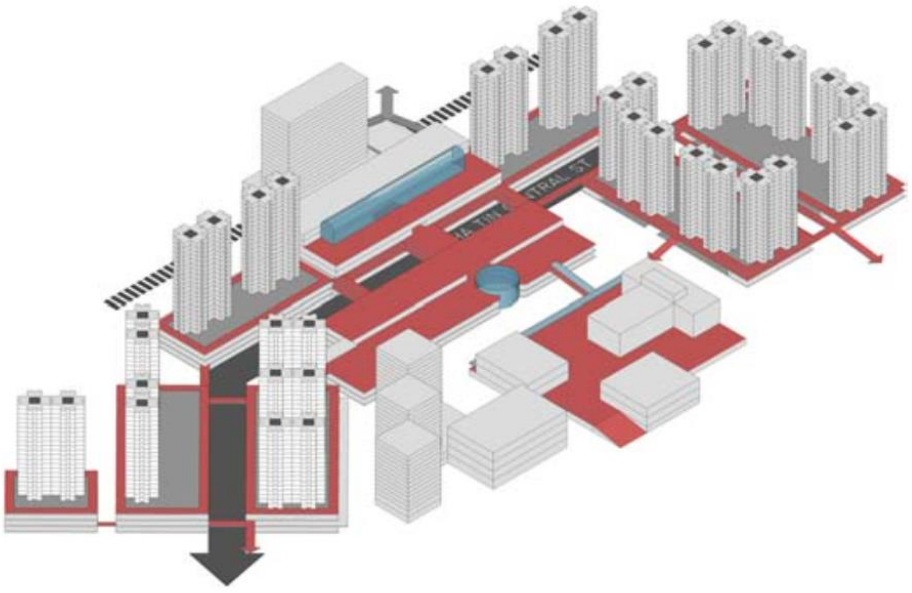

Figure 54: Pedestrian network of Sha Tin (Tan & QL Xue, 2014)

CHAPTER 6: SUGGESSTIONS

6.1 Sha Tin

From the questionnaire, respondents suggested some recommendations to Sha Tin. The recommendations can be divided into two main types after categorization. The first type is about accessibility and comfort, which is to improve the water quality of Shing Mun River. People love to walk along the Shing Mun River, but the smell of the Shing Mun River decreased pedestrians' willingness to stay longer on the riverside. The second type of recommendation is about attractiveness and vibrancy. Respondents hope Sha Tin can have more unique and authentic shops as most of the shops are franchise stores and luxury brands in the shopping malls. So, to improve the walkability in Sha Tin, it is suggested to protect the authenticity and increase the element of uniqueness. Actually, there are still lots of historical places in Sha Tin. For example, Lek Yuen Estate is one of the oldest public estates in Hong Kong. Due to the new town development, lots of shops that were originally located in the 'Sha Tin New Market' was placed in Lek Yuen Estate to continue their businesses. There are still lots of traditional old shops operating there, such as stores (辦館) and restaurants in Figure 55. On the other hand, Lung Wah Hotel in Figure 56, was a traditional hotel and famous film shooting location in the past. Now, it transforms into a restaurant and cultural village which host various cultural exhibitions. However, due to the rising rent, it is difficult for these traditional local shops to survive. So, the government

should try to protect and promote these local shops more as these shops are the embodiment of Sha Tin's history and culture.

Figure 55: Shing Kee Noodles in Sha Tin

Figure 56: Lung Wah Hotel in Sha Tin

6.2 Tsuen Wan

From the received suggestions for Tsuen Wan, the respondents are concerned about safety the most. They reflected that lots of shops occupy the street with their sundries and make the road very narrow. Some of them need to walk on the roadway next to the cars which is very dangerous. This echoes the objective findings that there are lots of traffic accidents and hot zones in Tsuen Wan. To improve this situation, the road needs to be re-designed considering the pedestrians. Firstly, the streets need to be widened and the government needs to strictly monitor whether the shops have occupied the streets. Secondly, the speed limit or flow of traffic on high-risk streets should be decreased. Through these two measures, it can minimize the conflict between pedestrians and vehicles.

6.3 Mong Kok

For Mong Kok, the pedestrians comment on two aspects, accessibility and comfort, and attractiveness and vibrancy. In terms of accessibility and comfort, pedestrians hope Mong Kok can have more greenery and benches for them to rest. In terms of attractiveness and vibrancy, they hope there is more space for outdoor activities or exhibitions. The pedestrian corridor suggested by the Urban Renewal Authority in Figure 57 can improve these concerns. This suggestion is similar to the Mong Kok Pedestrian Zone in the past. The pedestrian can use the road as a performance area from 4 pm to 10 pm on Monday to Saturday, and from 12 pm to 10 pm on Sunday and public holidays. For the new suggested pedestrian corridor, the building blocks will amalgamate together, and the road will change into an open space with greenery. Inside the open space, people can rest, perform, and gather. Thus, this open space can increase the greenery in Mong Kok and provide a place for outdoor activities and exhibitions.

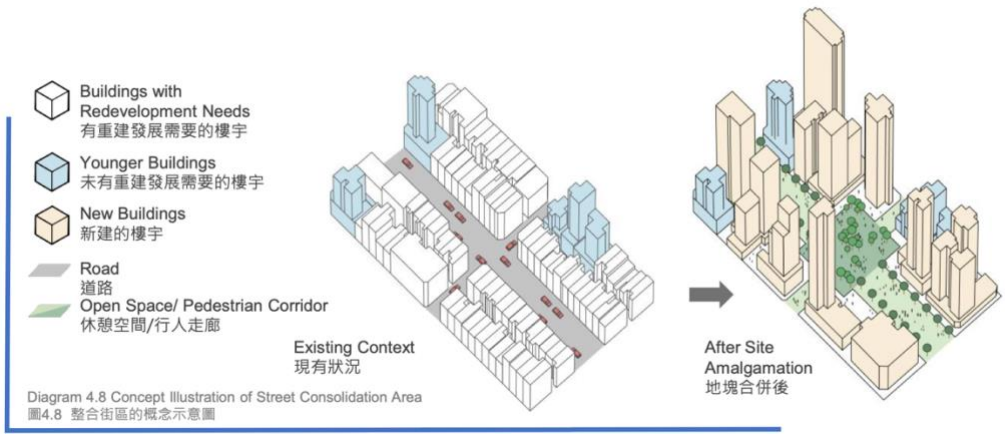

Figure 57: Pedestrian Corridor in Mong Kok (URA, 2022)

CHAPTER 7: CONCLUSION

7.1 Summary

This study examines that the TOD area is slightly more walkable than non-TOD areas in Hong Kong by comparing the walkability in four aspects: linkage, safety, accessibility and comfort, and attractiveness and vibrancy. On the other hand, the objective environmental factors are not equal to pedestrians' perceived walking experience. Walkability is very complex as it is affected by diverse environmental factors, personal walking experience, and numerous other factors. The three selected areas have their own strengths and weaknesses. Recommendations are made according to the comments of pedestrians. However, consultations with the public before the implementation and monitoring during the processes of these measures are crucial. Or else, the new suggested pedestrian corridor will face the same fate as the Mong Kok Pedestrian Zone.

7.2 Limitations

The limitations of this study are related to the data. Firstly, some of the data might have errors due to the limitation of QGIS. For example, the counted footbridge number is more than the exact number. This is because the data source used polygons to show the footbridges and the QGIS split one footbridge into a few segments. Thus,

there is a duplication of the number of footbridges. Secondly, the traffic injuries and hot zones data are not up to date, which is only from 2014 to 2019.

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APPENDIX

Interview area 受訪地點

- ☐ ShaTin 沙田
- ☐ Mongkok 旺角
- ☐ Tsuen Wan 荃灣

Part 1 - Personal information 個人資料

Age 年齡

- ☐ Under 18
- ☐ 18 – 59
- ☐ Above 60

Gender 性別

- ☐ Male 男性
- ☐ Female 女性

Education level 教育程度

- ☐ Primary school or below 小學程度或以下
- ☐ Secondary School 中學程度
- ☐ Post secondary school/ Associate degree/ Diploma 證書或文憑或副學位
- ☐ University or above 大學或以上

Do you own a private car?
請問閣下是否擁有私家車？

- ☐ Yes 是
- ☐ No 否

Do you have any physical disability?
請問閣下有身體殘疾嗎？

- ☐ Yes (Please answer the next question) 有 (請回答下一條問題)
- ☐ No 沒有

What kinds of physical disability do you have?
請問閣下有 哪種身體殘疾？

Part 2 - Walkability in designated area 指定區域的可步行性

A) Linkage 妥善連接

Ease of transferring between public transport modes
公共交通方式之間的轉換

Difficult 困難 0 1 2 3 4 5 Easy 容易

Amount of clear and useful directions and signs
清晰有用的指示和標誌的數量

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Amount of crossing facilities (e.g. crossing, footbridge, subway)
過馬路設施的數量（例如: 斑馬線、行人天橋、行人隧道）

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Amount of machinased pedestrian facilities (e.g. escalator, lift)
機械化行人設施的數量（例如: 自動扶梯、升降機）

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Amount of barrier-free facilities
無障礙設施的數量

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

B) Safety 安全

Separation from vehicles
行人與車輛的距離

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Vehicle speed
車速

High 高 0 1 2 3 4 5 Low 低

Amount of on-street parking
路邊停車的數量

Many 多 0 1 2 3 4 5 Little 少

Amount of bikes occupying sidewalk
佔用人行道的單車數量

Many 多 0 1 2 3 4 5 Little 少

Amount of abandoned houses or shops
廢棄房屋或商舖的數量

Many 多 0 1 2 3 4 5 Little 少

Pedestrian flow volume
行人流量

Little 少 0 1 2 3 4 5 Many 多

Perceived security level
感知安全程度

Low 低 0 1 2 3 4 5 High 高

C) Accessibility & comfort 舒適暢達

Street width
街道寬度

Narrow 窄 0 1 2 3 4 5 Wide 寬

Pavement smoothness
路面平整度

Rough 粗糙 0 1 2 3 4 5 Smooth 光滑

Cleaness
清潔度

Dirty 骯髒 0 1 2 3 4 5 Clean 乾淨

Amount of street obstructions
街道障礙物的數量

Many 多 0 1 2 3 4 5 Little 少

Amount of public toilets
公廁的數量

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Amount of lighting
燈光的數量

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Amount of benches
長椅的數量

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Amount of greenery (e.g. trees, plants)
綠化的數量（例如: 樹木、植物）

Insufficient 不足 0 1 2 3 4 5 Sufficient 足夠

Air quality
空氣質數

Poor 差 0 1 2 3 4 5 Good 好

Noise
噪音

Many 多 0 1 2 3 4 5 Little 少

D) Attractiveness & vibrancy 富吸引力和活力

Variety of shops & restaurants
商店和餐廳的種類

Little 少 0 1 2 3 4 5 Many 多

Variety of leisure and recreational activities
休閒娛樂活動的種類

Little 少 0 1 2 3 4 5 Many 多

Amount of open spaces
公共空間的數量

Little 少 0 1 2 3 4 5 Many 多

Amount of decorations (e.g. artworks, festive decorations, music)
裝飾品的數量（例如藝術品、節日裝飾品、音樂）

Little 少 0 1 2 3 4 5 Many 多

Choose **THREE** things that most attract you to a place
選擇**三個**最吸引您去某個地方的原因

☐ Shopping mall 商場

☐ Park 公園

☐ Flea market (e.g. Ladies' Market) 跳蚤市場 (女人街)

☐ Performances 表演

☐ Artworks 藝術品

☐ Decorations 裝飾品

Part 3 Suggestions and comments 建議和意見

Do you have any suggestions or comments of this location?
您對這個位置（沙田 / 旺角 / 荃灣）有什麼建議或意見嗎？