National Cheng Kung University

Department of Transportation and

Communication Management Science

Master Thesis

評估以推動渡輪運輸導向發展達致永續運輸之可行性

-以香港為例

Accessing feasibility of promoting Ferry-based Transit-Oriented Development to achieve sustainable mobility: Case of Hong Kong

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中文摘要

渡輪運輸在沿岸城市中重新崛起，成為應對擁擠道路交通系統的可行替代方案，而大眾運輸導向發展則成為解決都市交通問題和促進永續發展的重要舉措。本研究旨在探討在香港推動以渡輪為基礎的大眾運輸導向發展（Ferry-based Transit-Oriented Development, FTOD）的市場和技術可行性，並利用其廣泛的渡輪網絡來增強大眾運輸的永續性。本研究的目的是評估渡輪航線的效率，評估碼頭周邊地區的永續發展表現，以及了解公眾對 FTOD 的看法和建議。

本研究採用資料包絡分析來進行航線效率分析，並使用永續 FTOD 指數來評估碼頭社區的永續性。此外，通過問卷調查收集居民對渡輪航線使用情況和對 FTOD 的看法，並對經常和不經常搭乘渡輪的乘客進行進一步分析。

航線效率結果顯示，大多數渡輪航線的營運效率達到最大值。此外，商業和混合發展社區在 FTOD 地點發展的永續性方面表現更佳。問卷結果顯示，在考慮搭乘渡輪時，班次頻率和服務時間是民眾的主要考慮因素。受訪者亦更傾向於改善碼頭社區的連接性和設計方面。本研究亦揭示 FTOD 對出行和經濟利益的顯著影響。本研究最後提出了改進渡輪航線、碼頭和提升碼頭周邊社區整體發展的建議。

關鍵字：永續運輸、渡輪交通、大眾運輸導向發展

Abstract

Ferry transport has seen a resurgence in coastal cities as a viable alternative to congested road transportation systems. At the same time, transit-oriented development (TOD) has emerged as a strategic approach to tackle urban mobility challenges and promote sustainability. This study investigates the market and technical feasibility of promoting Ferry-based Transit-Oriented Development (FTOD) in Hong Kong, leveraging its extensive ferry network to enhance sustainable mobility. This study aims to evaluate the efficiency of ferry routes, assess the development performance of the surrounding area of piers as well as identify perceptions and suggestions on FTOD from the public.

Data Envelopment Analysis (DEA) is employed for route efficiency analysis, while the Sustainable FTOD Index is employed for assessing sustainability of pier communities. Additionally, a survey is conducted to collect data on ferry route usage and perceptions of FTOD among residents, with additional analysis on the perception between regular and non-regular riders.

Efficiency results indicate that most ferry routes operate at maximum efficiency. Moreover, commercial and mixed development communities exhibit better performance regarding FTOD site development on sustainability. Survey findings reveal that concerns are raised regarding the frequency and service hours when considering ferry usage. Respondents are more inclined towards improving connectivity and design aspects of pier communities. The study reveals a notable perception of the impact of FTOD on mobility and economic benefits. The study concludes with suggestions for improving performance of ferry routes, and piers and enhancing the overall development of surrounding pier communities.

Key Word: Sustainable Mobility, Ferry Transportation, Transit-Oriented Development

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June 2024

Content

List of abbreviation

AHP - Analytic Hierarchy Process

AIS - Automatic Identification System

ANOVA - Analysis of Variance

BCC – Banker-Charnes-Cooper Model

CBD - Central Business District

CCR – Charnes-Cooper-Rhodes Model

DEA - Data Envelopment Analysis

DMU – Decision Making Unit

FTOD - Ferry-Based Transit-Oriented Development/ Ferry-Oriented Development

GIS – Geographic Information System

HKSAR - Hong Kong Special Administrative Region

HKKF - Hong Kong and Kowloon Ferry

HYF – Hong Kong and Yaumatei Ferry (known as Yaumatei Ferry)

MTR - Mass Transit Railway (metro system of Hong Kong)

NDA – New Development Area (evolved from New Town)

NWFF – New World First Ferry (nowadays Sun Ferry)

OZP – Outline Zoning Plan

TD – Transport Department

TOD - Transit-Oriented Development

TPU – Tertiary Planning Unit (in Population Census)

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Chapter 1 Introduction

This section serves to provide a comprehensive overview of the study's purposes. Firstly, the basic background of this study will be explained to emphasise the importance of the study. Following this, the research objectives and research flow of this study to explain the scope of this work.

1.1 Background

Hong Kong's skyline is renowned for its dense skyscrapers set against a stunning harbour, and taking a ferry across the harbour is a well-known tourist experience. As a waterfront city, Hong Kong historically relied on ferries as a primary transportation mode for both passengers and freight. Prior to the 1980s, ferries played a pivotal role in Hong Kong's transportation system, with piers strategically located along the coast in close proximity to urban settlements and economic centres. However, with the advancement of modern transportation network, including the completion of three cross-harbour tunnels and 8 metro (MTR) lines in the urban area in recent decades, the significance of ferries as a key urban transportation option declined, which Figure 1.1 displays the declining mode share of ferry comparing to other major modes of public transportation. This led to the closure of some ferry piers and reduced frequency for other routes, diminishing the appeal of ferries for daily commuters and contributing to the decline in the viability of some coastal areas.

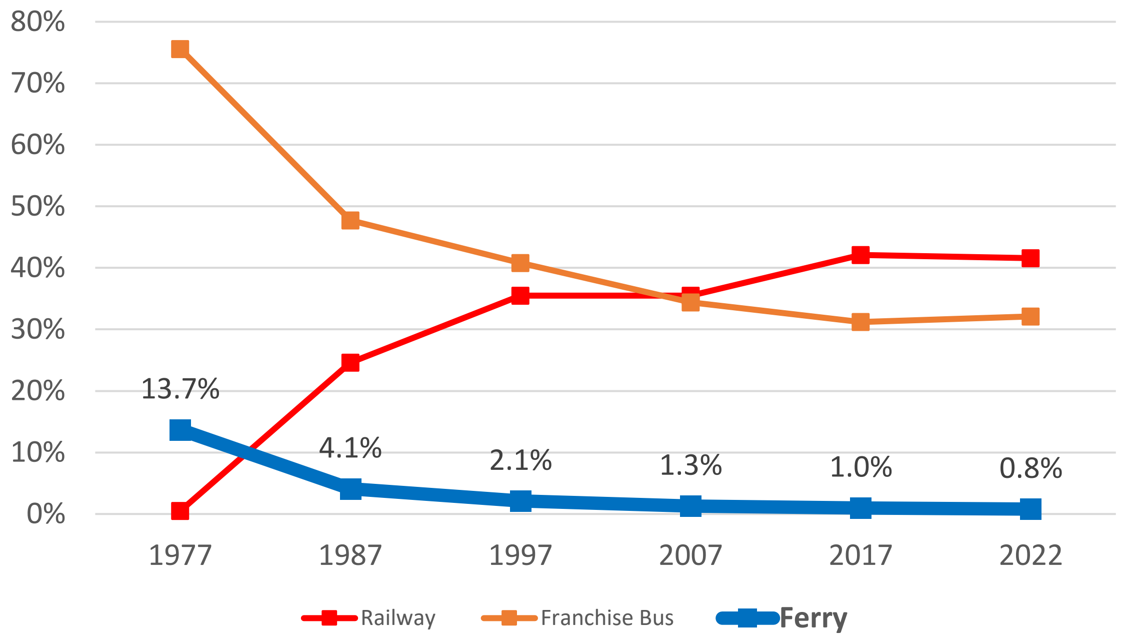


Figure 1.1 Mode share of ferry, railway and franchise bus

(Transport Department) (1977-2022)

In recent decades, the widespread congestion issues on road and rail transport networks have led to significant delays and inefficiencies, impacting the daily lives of commuters and the overall productivity of the city, thus becomes a critical issue for policymakers and the public to reconsider how to transform the entire public transportation system into a more sustainable and resilient form. On the other hand, ferries have been an integral part of the city's heritage and have shaped its urban and economic landscapes. Revitalising ferry routes and nodes, and integrating them into a modern, multi-modal transportation network could help preserve this heritage while adapting it to contemporary needs. These have opened the door for a revival of ferry transportation for re-engaging existing bus and railway passengers to adopt ferry as an alternative, or even as their daily transportation mode. Indeed, in recent years, the government's attempts in setting up new routes and destinations, as well as restrengthening existing routes have shown the focus of transportation policy shifts from railway domination to multi-modal transportation. However, some of the new destinations of these new routes lacks proper connection to the nearby development while the service quality of these routes are yet to compete with the existing public transportation, thus limiting the effectiveness of adopting ferry as a sustainable mode of transportation.

The concept of Ferry-based Transit-Oriented Development (FTOD) builds on conventional Transit-Oriented Development (TOD) principles, focusing on creating multi-modal transport hubs around ferry piers. Unlike extensive road or rail networks, ferry routes have minimal land use and can be quickly adapted to changing demand patterns. This makes ferries an appealing option for sustainable urban mobility. FTOD aims to facilitate seamless transfers between ferry and other transportation modes while encouraging balanced residential and commercial development in the community around the pier while all stakeholders can enjoy the benefit of high accessibility and inclusive environment (Tanko et al., 2018). In such way, FTOD would be a propellant to increase the efficiency of ferry transport, but also foster the revitalisation and sustainability of waterfront communities.

1.2 Research objective and framework

This study explores the technical and market feasibility of how sustainable mobility can be achieved through the promotion of FTOD in the coastal communities. There are four research objectives to achieve the research goal, as shown:

1. Evaluation of the performance and efficiency of ferry routes.
2. Evaluation of development performance of ferry piers and its surrounding area.
3. Identify perceptions of FTOD from the perspective of public.
4. Develop strategies and recommendations for policymakers and planners to effectively promote FTOD in existing and future sites.

The framework of this research is shown in Figure 1.2

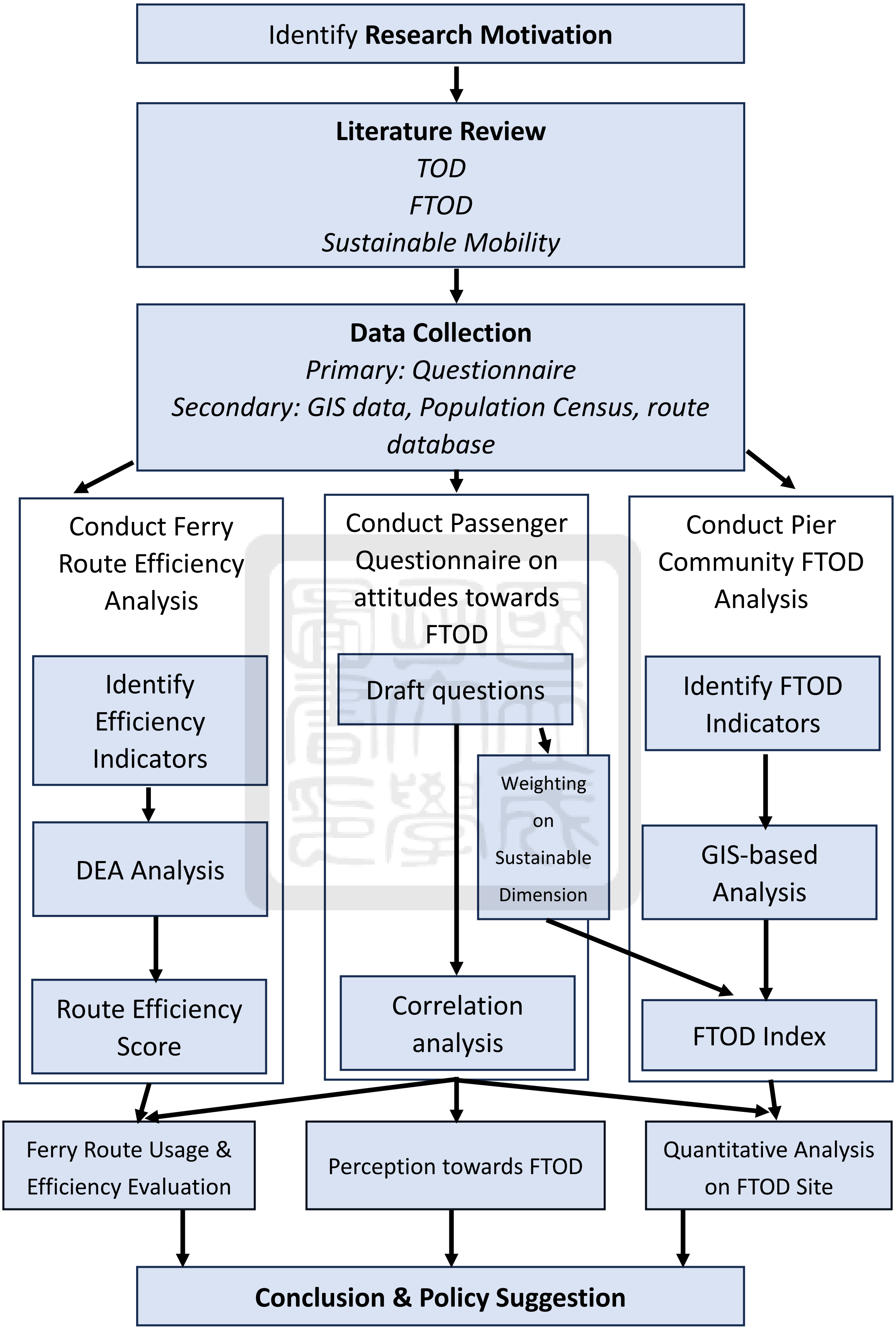


Figure 1.2 Research framework

Chapter 2 Literature Review

To understand the concept of Ferry-Based Transit-Oriented Development and its examples of application to be adopted, in the following chapter, three aspects of interrelated topics will be reviewed, namely Sustainable Transit-Oriented Development and its benefits, Ferry-Based Transit-Oriented Development, its features and application, as well as Sustainable Mobility and application to Ferry Transportation.

2.1 Sustainable Transit-Oriented Development and its benefits

Transit-Oriented Development (TOD) can be conceptualised as the integration of housing, retail, and commercial development within a walkable distance from a transport hub, typically within a 500-meter radius, to facilitate sustainable development and the smart growth of urban communities (Yap et al., 2013). This model aims to reduce reliance on automobiles, promote public transit usage, and create vibrant, pedestrian-friendly environments.

Historically, in the context of urban transportation development, the enhancement of motor vehicle use, particularly automobiles, has symbolized modernization. Auto-oriented communities have emerged in suburban areas, with infrastructures and retail facilities strategically located along highway networks to cater to commuters. This setup necessitates that commuters drive from their homes through highway networks to their workplaces and leisure destinations, subsequently resulting in severe highway congestion (Noland et al., 2017). To mitigate suburbanisation and the escalating trend of private vehicle use, the construction of mass transit systems with population concentration along bus or rail corridors has been adopted as a viable solution by governments and private developers (Yap et al., 2013). Consequently, the application of TOD has become widespread in metropolitan areas, even extending to lower-tier cities, in both developing and developed countries.

To access the potential benefits of existing and proposed TOD sites, a set of indicators has been employed to measure how TOD can maximize the development scale. For this study, the emphasis will be on sustainability rather than the traditional indicators derived from the 3D (Density-Diversity-Design) model (Cervero & Kockelman, 1997). This shift in focus involves reorganising the conventional TOD indicators into three dimensions of sustainability: economic, social and environmental benefits. Since the conventional considerations of TOD would lead to intensification of gentrification of the existing site due to provision of integrated development and infrastructure around the node, which the underprivileged groups may be forced to leave the TOD site and seek for cheaper and remote suburban residential areas, which further worsening the social equity within the city (Kahn, 2007). To address this issue, the concept of sustainable TOD has been initiated, aiming to shift the focus of TOD from efficiency-oriented to incorporation of concepts of inclusiveness and eco-friendly, as well as adopting bottom-up approaches for public participation in designing their community (Chava & Newman, 2016).

From the perspective of economic efficiency, intensifying residential and commercial development around the transportation node can lead to an increase in public transportation system usage as the population density rises (Lin & Shin, 2008), This also contributes to the financial viability of the transportation system, which encouraging private operators to provide new and improved services (Lo et al., 2008). The application of TOD can bring benefits to the local society by fostering economic activities. According to Renne's research (2018), the urban areas around the port and railway stations with the application of TOD have a relatively higher proportion of job density and more professional jobs. Moreover, improved transportation services attract more residents and visitors, leading to rise of property value along the transportation hub (Tsai et al., 2017).

Regarding social equity, the development of TOD prioritises the importance of mixed land use and integrated development hub with provision of retail and welfare facilities proximate to the transport hub. This approach fosters community cohesion by encouraging greater interaction among residents, thereby strengthening social capital (Kamruzzaman et al., 2014). Furthermore, the provision of sufficient transportation services can enhance community accessibility, which can also facilitate citizen mobility, especially the underprivileged group like elderly and low-income population, thereby improving their social well-being (He et al., 2020).

From the perspective of environmental sustainability, integrating residential and commercial development into smaller plots of land reduces the pressure of urban sprawl, which commuters are more likely to choose public transport since the provision of public transportation would be sufficient with higher development density, which reduces the traffic congestion (Lo et al., 2008). Moreover, the shortened distance between residential areas and transportation hubs decreases travel distance and, consequently, carbon dioxide emissions (Gao et al., 2022).

2.2 Ferry-Based Transit-Oriented Development, its features and application

The primary focus of TOD typically centres around the integration of the transportation modes such as buses and railways. In the context of ferry, not all towns and metropolitans have either navigable waterway or harbour for ferry operation. Even for coastal or river cities with port infrastructure, patronage of ferry services may experience reduction due to the construction of bridges and tunnels. This trend has led to the abandonment of some routes by operators. To address this issue and enhance the operational performance of ferry services, the attractiveness of the ferry nodes—namely the piers and their surrounding environment—becomes increasingly important. This consideration has given rise to the concept of FTOD, an extension of the classical TOD concept.

Features of Ferry-Based Transit-Oriented Development include:

1. Enhancing land-use mix around ferry terminals, for instance, mixed residential, commercial and recreational land uses, in order to stimulate ferry ridership (Tanko et al., 2018).
2. By developing new ferry hub in the CBD, it can contribute not only to multimodal transfer but also integrate promenade activities (Tsoi & Loo, 2021).
3. The success of FTOD rested on an additional focus on terminal design and proving additional facilities, such as shelter and retail arrangements (Thompson et al., 2007).
4. The pre-requisite is to maintain a high-quality level of ferry service, in terms of frequency and travel time (Leung et al., 2017).

FTOD is a relatively novel concept, yet various case studies and conceptual illustrations can be found internationally. In both Sweden and Australia, major cities have ferries with a relatively low modal share of less than 5%, and these services were considered declining due to fierce competition from buses and subway systems. However, in the past decade, the municipal governments of Swedish cities like Gothenburg and Stockholm have launched initiatives for river renewal aimed at revitalizing land use along the riverfront. These initiatives included establishing new piers in areas with limited public transport coverage and integrating various transportation modes at ferry hubs. Despite these efforts, land use restriction policies along the river make it difficult to accommodate high-density development around ferry hubs.

In Australia, new ferry hubs have been established by developers to promote private housing development and enhance connectivity. However, this has also led to intensified income inequality, with more underprivileged populations being displaced due to gentrification (Tanko et al., 2018).

In the United States, the FTOD concept has been implemented in some metropolitan areas. For example, in New Jersey, the proximity to New York City, separated only by the Hudson River, has been capitalized on by land developers to build new housing developments along the river. Ferry services connecting these developments with the CBD of New York City have increased the attractiveness of ferry-connected communities among young professionals. Nonetheless, FTOD requires high population density and short distances to ferry hubs to support ferry patronage. While higher density development is beneficial for developers, it may also reduce the aesthetic value of the development of high-rise buildings obstruct river views. Developers, therefore, must balance higher density with maintaining scenic views when planning FTOD projects (Thompson et al., 2007).

These international examples illustrate the diverse applications and challenges of FTOD which highlight the need for careful planning and policy interventions to ensure that FTOD can effectively contribute to sustainable urban development and enhance the quality of life for residents.

2.3 Sustainable Mobility and application in ferry transportation

Sustainable Mobility, or Sustainable Transport, can be defined as "*ensure that environmental, social, and economic considerations are factored into decisions affecting transportation activity*" (Carey, 2004). It also aims to "*satisfy the needs of present without compromising the needs of future generations*" (World Commission on Environment and Development, 1987).

To explore this concept of sustainable transport in-depth, a framework of three principles for sustainable transport has been proposed by Ford et al. (2015) which includes economic development by facilitating the movement of people and goods, which is crucial for economic activities; achieving environmental goals by reducing greenhouse gas emissions and pollutants associated with various transport modes and their usage; and ensuring equitable access to essential services, like healthcare, for all socio-economic groups.

With the rapid growth of human activities in cities, the emission of greenhouse gases and air pollutants has increased, primarily due to energy combustion for fuel and electricity. To mitigate the scale of pollution and the greenhouse effect from the transportation sector, promoting the use of public and shared transportation, as well as active transportation, is a viable alternative to private transportation, which has a relatively low carrying capacity. Therefore, creating an urban environment that integrates various activities can encourage citizens to use public transportation (Papagiannakis & Yiannakou, 2022).

Ferry transportation, though not typically regarded as a major transportation mode in most cities, has been found to offer distinct advantages in enhancing the sustainability of urban transportation systems. The emission of greenhouse gases per passenger kilometre for ferries is 30% lower than that of usage of automobiles (Robinson et al., 2023). In Hong Kong, the adoption of diesel-electric propulsion (DEP) systems in 2018 by Star Ferry marked a significant step towards reducing emissions. According to government-subsidised reports in

Hong Kong, NOx emissions from DEP systems are reduced by 69%, and black smoke, previously emitted by conventional ferries, is no longer observed (Cheung, 2018).

Additionally, improved ferry services can play a crucial role in supporting offshore or remote regions by providing a reliable transportation lifeline, potentially leading to greater self-sufficiency. A study focusing on social change on Cheung Chau island, the largest outlying island of Hong Kong was conducted by Lau et al. (2022) in relation to ferry development. The study found that offering ferry freight services enabled residents to purchase daily necessities and medications without leaving the island. This helped sustain the social structure and traditional customs of Cheung Chau while reducing the rate of emigration from the island, thereby promoting a sense of community continuity.

2.4 Summary on literature findings

The literature review, indicates that the adoption of TOD would foster high patronage by promoting denser urban development, thus creating a positive cycle of growth. In addition, TOD also aligns with the principle of sustainable mobility by encouraging usage of public transport and minimising resource depletion and pollution. This makes transportation modes emphasised by TOD, such as railways and bus networks, more appealing to commuters and policymakers.

TOD demonstrates advantages towards the viability and sustainability of the local community. However, specifically for FTOD, there is limited research for reviewing and analysing its accessibility and sustainability. This research emphasises how the development of ferry routes and pier communities can be improved through FTOD to achieve sustainable mobility and what pre-requisites must be met to facilitate this process.

Chapter 3 Study Area

For this study, Hong Kong is chosen to be the major study area, which Hong Kong is a major coastal metropolitan with high population density, as well as a well-developed transportation system and infrastructure. Moreover, due to the coastal geography of Hong Kong which has plenty of populated islands and a long coastline, it favours the development of water transport. Therefore, Hong Kong is suitable for this research for FTOD.

3.1 Development of ferry transportation in Hong Kong

Hong Kong is a coastal city with 7.5 million population (Census and Statistics Department, 2023). It has been divided into 18 districts while each district consists of either urban area or new town. The two major urban regions of Hong Kong, namely Hong Kong Island and Kowloon Peninsula, are separated by the Victoria Harbour. Since colonised by the United Kingdom in 1840s, Victoria Harbour and its surrounding coastal area had been developed into trading port, which lead to the demand for cross harbour traffic. In 1898, the Star Ferry Company was set up, providing cross harbour ferry from Central in Hong Kong Island and Tsim Sha Tsui in Kowloon Peninsula (Mak, 2002). In 1924, the HYF was founded under the franchise by the government in order to control unregulated small ferry services, also known as the "*walla-walla*" (Pang, 2001). HYF extended its service to some large outlying islands and rural areas like Cheung Chau before Japanese occupation in 1941.

After the Chinese civil war in 1949, refugees' influx to Hong Kong and the population of Hong Kong expanded. Public Resettlement Estate were built along the new developed urban and suburb area of Hong Kong like Kwun Tong and Kwai Chung. At the same time, ferry piers were built along the Victoria Harbour, accompanied with bus terminus which residents from inland public housing estates or new town can take buses to pier and transfer ferry to the Hong Kong Island (Wong, 1998). Due to the franchise system set by the government, before late 1990s, ferry routes in Hong Kong were only operated by the HYF and Star Ferry, which had established a scale of economy and monopolised the market of passenger ferry in Hong Kong (Lai et al., 2012).

In 1972, the first cross-harbour vehicle tunnel in Victoria Harbour commenced its operations. Within two decades, one more cross-harbour vehicular tunnel and two MTR tunnels began to serve the residents of Hong Kong. On the other hand, reclamation projects along the Victoria Harbour and some new towns led to either relocation of the ferry pier to a more distant location away from residential or commercial areas, or even the demolition of the ferry pier, for instance, Tai Kok Tsui and Sham Shui Po Pier in the western Kowloon have been demolished in 1992 due to the West Kowloon Reclamation Project, and replaced by a cross-harbour bus route (Wong, 1998). This resulted in losing the attractiveness of ferry transport and patronage of ferry routes, especially inner-harbour routes declined rapidly (Li, 2010). Figure 3.1 and Table 3.1 show the patronage of the major inner-harbour route operator "Star" Ferry has dropped after the road and rail tunnels opened.

The route size of HYF shrunk since the 1980s, in the late 1990s, with the effect of the reclamation project mentioned above, some major inner harbour and new town routes suspended operations. At the same time, residents of outlying island were dissatisfied with the monopoly of the HYF and its poor services (Lau et al., 2022). In 2000, after the government reorganised the majority of ferry routes from franchise to tender-based license in 1999 while some routes were taken by other operators like HKKF, HYF handed over its remaining 8 ferry routes to the NWFF.

After the 2000s, the development of ferry services remained relatively stable with a slight reduction in ferry routes and patronages. In the mid-2010s, the government decided to launch new ferry routes to rural areas and relaunch cancelled routes in urban areas, with the adoption of smaller vessels and looser frequency. To enhance the usage of the inner harbour route and attract more tourists, the government had proposed a Water Taxi service, which would be a circular service between tourist spots and residential areas like West Kowloon Cultural District, Central, Tsim Sha Tsui East and Wan Chai (Transport Department, 2020). On the other hand, the government has also subsidised ferry companies for purchasing new environmentally friendly and electric vessels since 2024 (Transport Department, 2024).

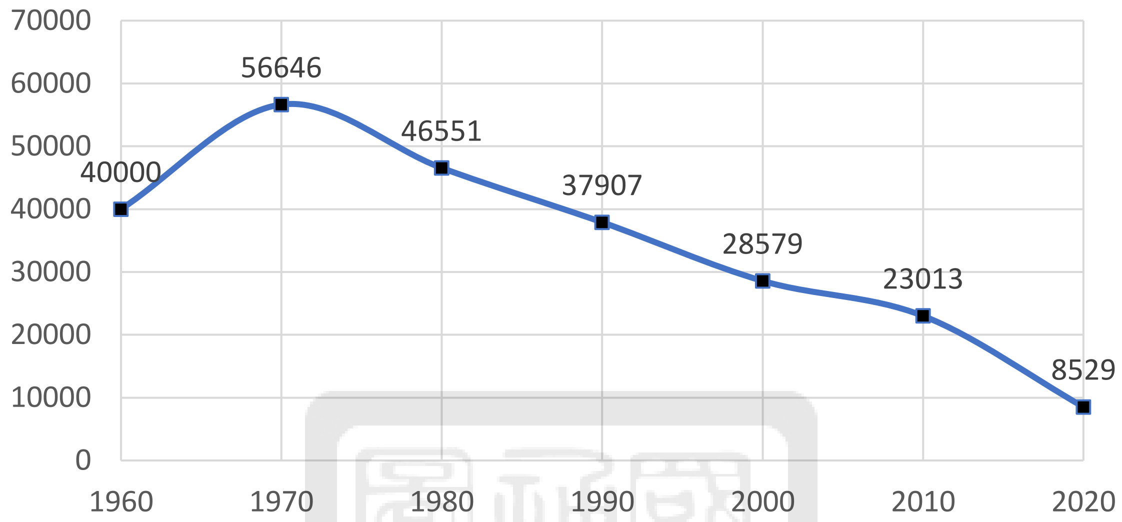


Figure 3.1 Average daily patronage of the Star Ferry Company (Transport Department) (1960-2020)

Table 3.1 Important event affecting cross-harbour transportation

Year	**Event**
1972	First Vehicle Cross Harbour Tunnel Commenced
1980	First MTR Cross Harbour Tunnel Commenced
1989	Second MTR & Vehicle Cross Harbour Tunnel Commenced
1997	Third MTR & Vehicle Cross Harbour Tunnel Commenced
2006	Relocation of Central Pier
2015	Relocation of Wan Chai Pier

3.2 Overview of ferry routes covered in the study

Ferry services in Hong Kong can be classified into two types, namely the Inner-Harbour ferry route and the Outlying Island ferry route. By the 31st December 2023, there are 23 ferry routes and 10 ferry operators in Hong Kong, while 9 routes are Inner-Harbour Routes and the rest are Outlying Island Routes. Differing from the 3 franchise bus operators which dominate the market, there are 4 ferry operators in the inner harbour route network, and each operator runs up 2-3 routes. Most of the ferry routes are run under the license system which a license will be renewed by the government for a certain year and there will be tender competition when the license ends. An exception is the 2 routes operated by the “Star” ferry which are under the franchise system which has no competition of tender but is subjected to stricter regulations, like discourse of financial information.

Under the transport policy of the Hong Kong government, public transportation services are not directly owned or operated by the government. Instead, all transportation services, including ferry are operated by private firms under the commercial framework, with government authorities serving as regulators. Subsidies are only provided to specific Outlying Island Ferry Routes since there is "*no alternative means of transportation*" than ferry for these outlying islands or remote rural areas (Transport Department, 2023). However, in some island rural residential area like Ma Wan and Mui Wo with road connection, there are bus service connecting to nearest MTR stations and indirectly compete with ferry service.

This study focuses on the inner-harbour ferry routes and their corresponding urban pier communities. These inner-harbour routes serve high-density locations and exhibit a higher potential for FTOD, with some routes already evolving into a form of integrated multimodal hub. On the other hand, since the operation mode and business model of Outlying Island routes is differed from Inner-Harbour Route, they are not included in this research.

Figure 3.2 shows the map of Inner Harbour Ferry Route, which operates within Victoria Harbour, providing service between Hong Kong Island and the Kowloon Peninsula. With cross-harbour tunnels and MTR serving as the backbone of cross-harbour transportation, the current service points of inner harbour ferry routes are usually situated at some distance from MTR stations and vehicular tunnel entrance, which provides opportunities for these ferry routes to survive. For instance, for the route H08 from Kwun Tong to Sai Wan Ho, though these two communities have the provision of MTR stations, the location of these piers are more than 500 meters away from the stations. Moreover, even though some piers are close to MTR stations, since the existing ferry routes provide a more direct service than MTR network which may refers multiple transfer, these routes can provide an alternative for commuters, like the route H04 connecting North Point and Hung Hom in only 8 minutes, which the MTR takes triple of travel time and requires transfer for twice.

Regarding fleet size and patronage, Star Ferry Company is the largest operator which runs routes connecting commercial area of Hong Kong. For other operators, Sun Ferry Company is also a major operator in both inner harbour and outlying island ferry. Fortune Ferry Company is considered a medium-sized operator due to its larger fleet, while Coral Sea Ferry Company has a smaller fleet and a limited staff complement. Table 3.2 lists the information on routes and fleets of the inner-harbour route operators.

Table 3.2 List of inner-harbour ferry company and its number of routes

Operator	**No. of Inner Harbour Route**
Sun Ferry	**2**
Star Ferry	**2**
Fortune Ferry	**3**
Coral Sea Ferry	**2**
Total	**9**

Source: Transport Department (2023).

Most inner-harbour ferry routes, except the Water Taxi route, commenced their operations before 1980s that the cross-harbour road network had yet to be well-established. Additionally, due to speed limit in the Victoria Harbour for maximum 28 km/h, high-speed vessels are less likely to be deployed on these routes. The routes connecting Tsim Sha Tsui to Central and Wan Chai are the only two with direct links to central business districts and tourist destinations, making them the inner-harbour routes with the highest patronage. The remaining routes primarily serve the eastern part of the Victoria Harbour which consists of residential and industrial areas, for instance, the route connecting North Point and Kowloon City (H05). Consequently, these routes have lower patronage and frequency, and most of these routes do not provide service beyond the evening peak hour. Table 3.3 lists the origin and destinations of the inner-harbour routes.

Table 3.3 List of inner-harbour ferry route

Destination	Operator	Sailing Time
H01. Central – Tsim Sha Tsui	Star Ferry	8 mins
H02. Central – Hung Hom	Fortune Ferry	16 mins
H03. Wan Chai – Tsim Sha Tsui	Star Ferry	8 mins
H04. North Point – Hung Hom	Sun Ferry	8 mins
H05. North Point – Kowloon City	Sun Ferry	14 mins
H06. North Point – Kwun Tong (– Kai Tak Cruise Terminal (Weekend and holiday only))	Fortune Ferry	12 mins
H07. Water Taxi (Central – Wan Chai – Tsim Sha Tsui East) (- West Kowloon Cultural District (Weekend and holiday only))	Fortune Ferry	25 mins
H08. Sai Wan Ho – Kwun Tong	Coral Sea Ferry	12 mins
H09. Sai Wan Ho – Sam Ka Tsuen	Coral Sea Ferry	10 mins

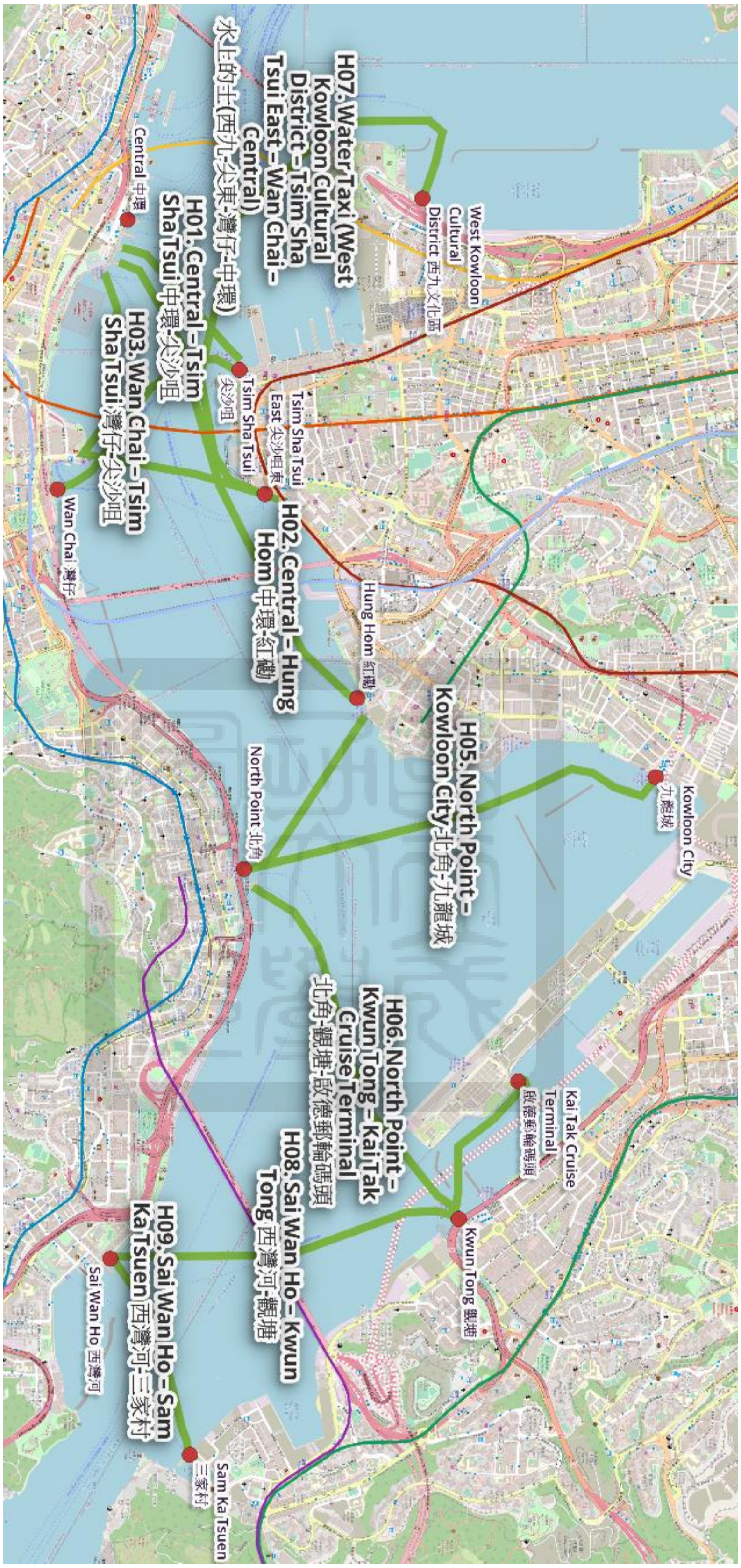


Figure 3.2 Map of inner-harbour ferry route

3.3 Characteristics and evolution of FTOD site

3.3.1 Characteristics and distribution of ferry piers

In Hong Kong, most coastal locations are equipped with piers or landing steps for vessels, including ferry piers typically located in urban areas and on large outlying islands. Table 3.4 lists the location distribution of ferry piers in Hong Kong. These urban ferry piers are characterised by substantial concrete structures that house indoor waiting rooms and offer a range of basic passenger services. These services include fare gates, customer service centres, convenience stores, and washrooms, ensuring a certain level of comfort and convenience for passengers.

Conversely, the piers located in new towns and rural areas, often referred to as public piers, lack such amenities. These public piers do not feature covered shelters or dedicated passenger services, such as exclusive waiting rooms and washrooms. Instead, they must share berthing space with other private boats, which can lead to congestion and a less organised boarding process. This disparity highlights a significant difference in the infrastructure and service provision between urban and rural ferry piers.

Urban ferry piers are typically well-integrated with interchange facilities and are situated in proximity to residential or commercial areas, facilitating easy access to other modes of transportation and essential services. This integration supports a seamless transition for commuters and enhances the overall efficiency of the public transport network. In contrast, the majority of public piers, especially in rural areas are surrounded by village settlements and lack external road access. This isolation not only limits the accessibility of these piers but also restricts the potential for integrating ferry services with other forms of transportation.

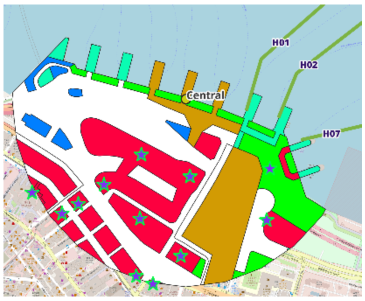
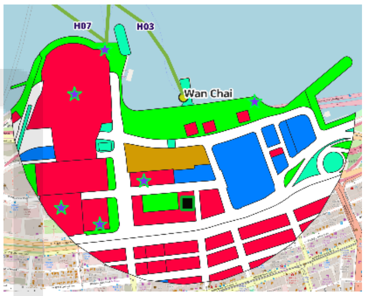
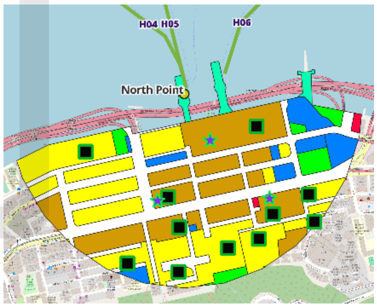
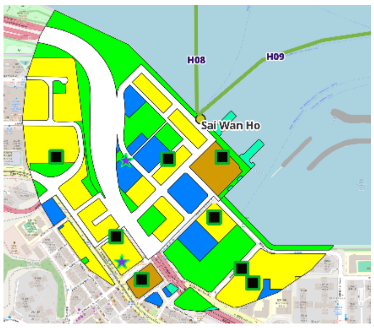
Table 3.4 Location of pier for ferry service and selected study site

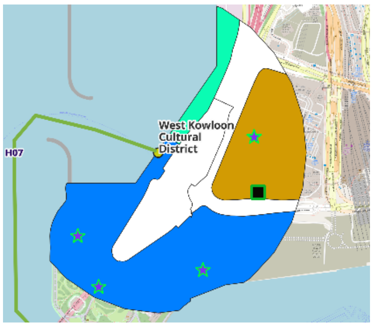
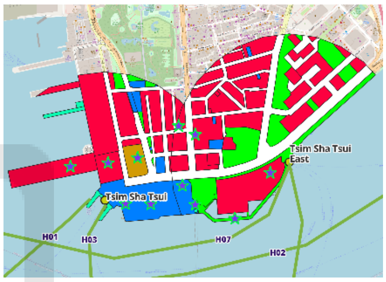
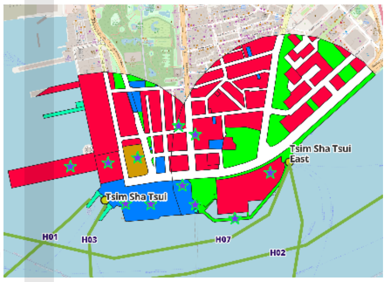
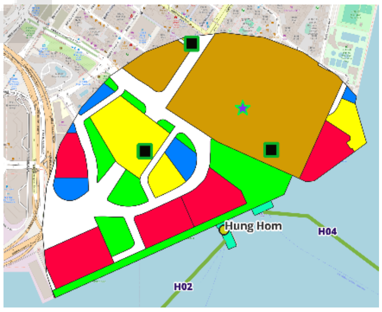
Location	Total No. of Ferry Pier	Selected Study Site
Urban - Hong Kong Island	6	4
Urban - Kowloon	8	8
New Town	5	Not Included in this research
Rural	20	
Isolated Island	15	
Total	**54**	**12**

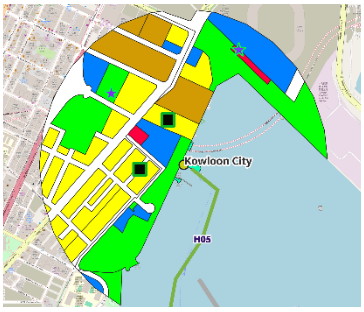
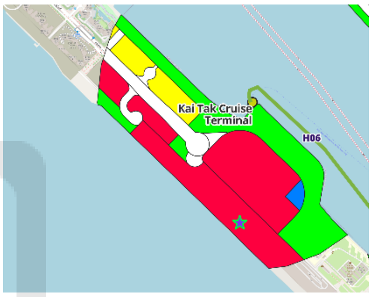
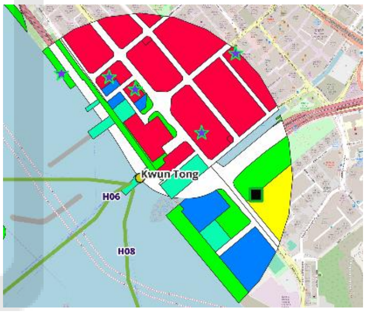
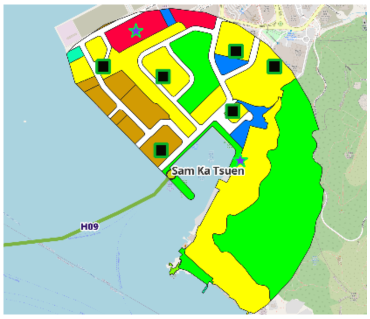
Table 3.5 displays the location and population of all piers with regular ferry service, and Figure 3.4 displays the land use zoning map of the pier communities within the study area, according to the OZP, which each developed urban area has a set of OZP, which consists of location and size of different categories of land, for instance, Residential, Commercial, Government/Institution or Community (G/IC), Comprehensive Development Area (CDA). The west side of the urban area along Victoria Harbour is typically concentrated with commercial land use, for instance, Central and Wan Chai on the Hong Kong Island are the hub of commercial centre.

Conversely, the eastern part of Victoria Harbour primarily features residential communities. Areas such as Sai Wan Ho and North Point are largely dedicated to residential usage. Some communities exhibit mixed land use. For instance, Kwun Tong and Kowloon City were initially developed as industrial centres with residential areas in the 1960s. With the decline of industrial activities, these communities have transitioned to commercial land use in recent decades.

Table 3.5 Brief information on the existing pier listed in the study area

Pier Communities	District	Major Land Use	Type of Pier	Number of Destination	Land Use Zoning Map
Central	Central & Western	Commercial	Ferry & Public	4	
Wan Chai	Wan Chai	Commercial	Ferry & Public	3	
North Point	Eastern	Residential	Ferry	4	
Sai Wan Ho	Eastern	Residential	Ferry	2	

Pier Communities	District	Major Land Use	Type of Pier	Number of Destination	Land Use Zoning Map
West Kowloon Cultural District	Yau Tsim Mong	Residential & Institutional	Public	3	
Tsim Sha Tsui	Yau Tsim Mong	Commercial	Ferry	2	
Tsim Sha Tsui East	Yau Tsim Mong	Commercial	Public	3	
Hung Hom	Kowloon City	Residential & Commercial	Ferry	2	

Pier Communities	District	Major Land Use	Type of Pier	Number of Destination	Land Use Zoning Map
Kowloon City	Kowloon City	Industrial & Residential	Ferry	1	
Kai Tak Cruise Terminal	Kowloon City	Recreational	Public	2	
Kwun Tong	Kwun Tong	Commercial	Ferry	3	
Sam Ka Tsuen	Kwun Tong	Industrial & Residential	Ferry	1	

Legend

- Commercial and Scenic Spot
- Residential Development
- Study Pier

Land Use

- Commercial
- Residential
- Major Road and Junction
- Open Space, Green Belt
- Government, Institution or Community
- Comprehensive Development Area, Commercial / Residential
- Other Uses

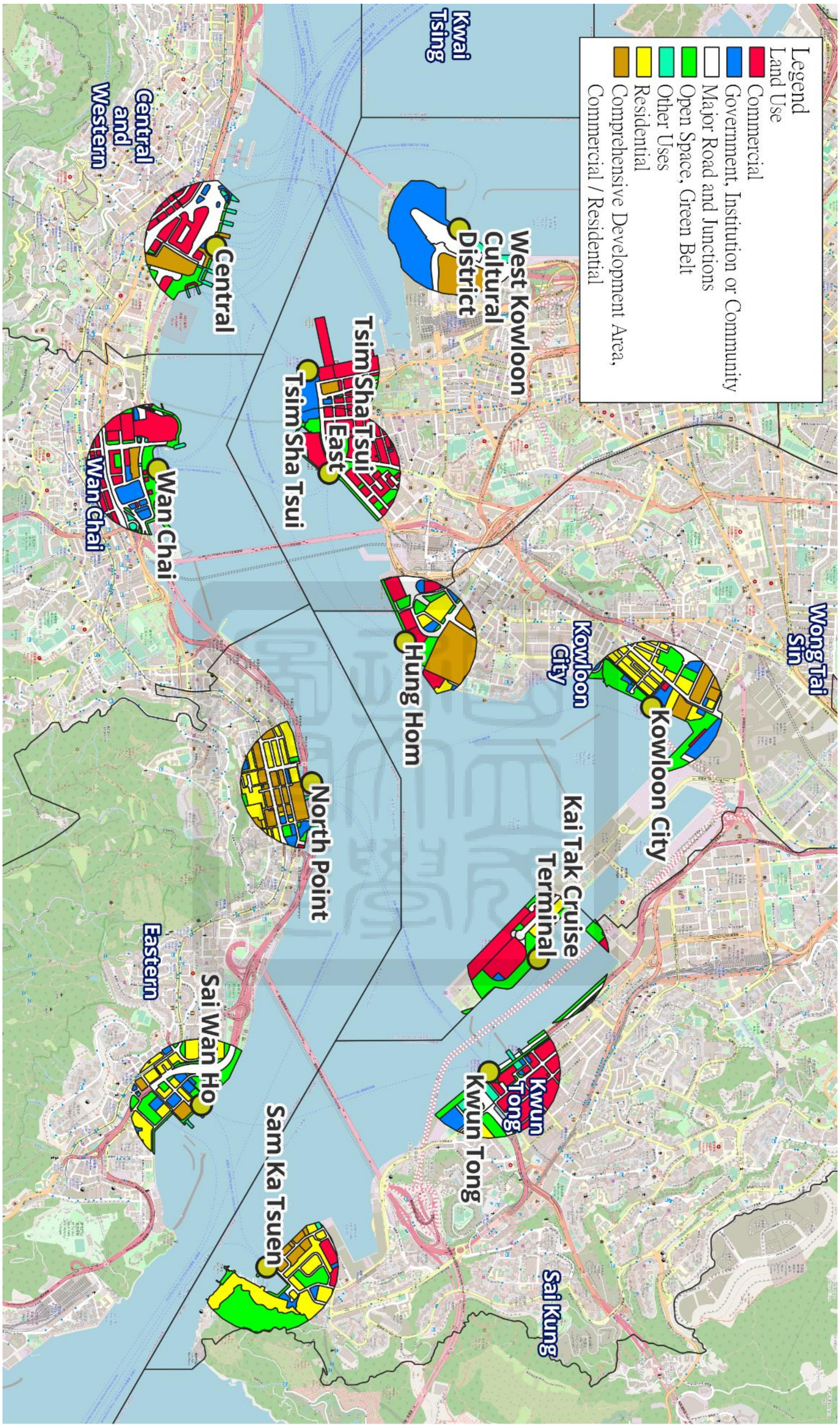


Figure 3.3 Map of selected study site piers and corresponding land use zoning

3.3.2 Evolution of FTOD in Hong Kong

In Hong Kong, the initial form of TOD followed the establishment of the MTR system after the 1970s, while the MTR Corporation also initiated property development projects along MTR stations, also known as the Rail-plus-Property (R+P) model (Cervero, 2010). Several large-scale private housing complexes have been constructed atop MTR depots. For example, Telford Garden, situated near the Kowloon Bay station in eastern Kowloon, comprises over 20 mid-rise private housing blocks, shopping malls, and office buildings, all located above the train depot. Additionally, there are footbridge network connecting the nearby Kowloon Bay business area and the Ngau Tau Kok public housing estates (Leung, 2005). In the later stages of urban development in new towns, plans incorporated both public and private housing, as well as retail facilities, within a walkable distance from MTR stations. Furthermore, some MTR stations feature their own bus interchanges, facilitating seamless transfers for rail passengers to their neighbourhood communities via bus and minibus. Therefore, the successful implementation of TOD in Hong Kong demonstrates the potential for integrating transportation and urban development to create sustainable, efficient, and liveable urban environments.

For ferry-based TOD, studies have explored the island topology and respective transportation patterns of outlying communities, as well as the effectiveness of FTOD. In Hong Kong's outlying islands, local business hubs are usually located near ferry piers (Leung et al., 2017). Although the concept of FTOD was not explicitly applied to waterfront areas during their design stage in urban areas, certain elements, such as transport interchanges next to piers, can be observed nowadays.

Moreover, some suburban private housing developments, such as Discovery Bay on Lantau Island, have been developed since the 1980s as ferry-based communities with a car-free design. The backbone of these communities' connectivity to urban areas is provided by ferry services, with residents transferring to their housing communities via buses at terminuses near the ferry piers. However, since the opening of the Discovery Bay Tunnel in 2000, which connected Discovery Bay to the external road network and led to the introduction of bus routes connecting to nearby MTR stations, the importance of the ferry has declined. Nevertheless, the ferry remains an important mode of transport for commuters to the CBD, offering travel times that are half as long as bus-MTR transfers (Loo, 2018).

Chapter 4 Methodology

In the context of this study, the market and technical feasibility of FTOD is to be accessed, which technical feasibility refers to the assessment of whether the proposed FTOD initiatives can be implemented using existing technology, infrastructure, and resources (Purwantono et al., 2021). It involves evaluating the practical aspects of ferry services, including vessel capabilities, pier facilities, and operational efficiency, to determine if they can support the proposed FTOD framework effectively.

Market feasibility, on the other hand, evaluates the acceptance and demand for the proposed FTOD initiatives from public. It considers factors such as market demand, consumer preferences and regulatory support to determine if the FTOD concept can attract sufficient ridership and support to sustain its operations and contribute positively to sustainable mobility objectives.

To conduct a comprehensive evaluation of the ferry route system and pier communities, this study employs various methodologies, each designed to address specific research objectives. Table 4.1 provides a concise summary of the proposed methodologies.

Table 4.1 Research objective and the corresponding proposed methodology

Research Objective	Type of Methodology
1. Evaluation of the performance and efficiency of existing ferry routes	Data Envelopment Analysis (DEA)
2. Evaluation of development performance of existing ferry piers and their surrounding area	FTOD Index with calculation and correlation of FTOD indicator
3. Identify perceptions and suggestions on FTOD from the perspective of local residents	Questionnaire with Likert scale question, analysed by correlation analysis
4. Develop strategies and recommendations for policymakers and planners to effectively implement FTOD	

4.1 Data collection

The study begins by collecting secondary data on Hong Kong's transportation system, ferry routes, piers and associated infrastructure and land use planning. This data is sourced from government reports and statistics, records from ferry operators, and previous studies on Hong Kong's public transport system. Most demographic and socio-economic data of the pier communities, for instance, employment population and rent-to-income ratio are collected from the 2021 Population Census conducted by the Census and Statistics Department. Additionally, the latest data from the Common Spatial Data Infrastructure from the Hong Kong government is utilised for GIS analysis. This includes information such as the distribution of bus routes within the pier coverage area, as well as the OZP which provides the distribution of land use of certain pier communities. Moreover, for the latest information regarding ferry route operation, most information, for instance, frequency and capacity of the ferry route, are gathered from the information provided by the Transportation Department. The secondary data serves as the foundation for understanding the current state of the ferry system in Hong Kong, the performance of ferry routes and ferry piers, and its connectivity with other modes of transportation.

Beyond secondary data, primary data will be obtained by conducting surveys with the public, and detailed information will be introduced in section 4.4. This will allow the collection of user-specific information, such as preferences for ferry route and pier service attributes, respondents' travel behaviours, and their perspectives on FTOD.

4.2 Ferry route performance evaluation

To maintain a reliable transportation system, it is essential to ensure adequate frequencies, fare structures, and service quality, which are pivotal in retaining current passengers and attracting new ones. Evaluating the current operational performance of the ferry route system by focusing solely on outputs like patronage and generated revenue is insufficient. Instead, operational efficiency, which is output divided by input, to achieve the minimum input for the maximum output (Giokas, 1997), serves as a more appropriate metric.

Pham et al. (2020) study evaluated the efficiency of ferry routes in South Korea by comparing the performance of subsidized ferry routes and general routes using the Principal Component Analysis-Data Envelopment Analysis (PCA-DEA) model. This study analysed routes using both the BCC and CCR models of DEA and subsequently reclassified the routes based on PCA results. The findings indicated that long-distance routes do not necessarily represent high efficiency, and subsidized ferry routes with more mid-stops can achieve higher efficiency compared to direct general routes. Yang's (2012) study focused on assessing the operating efficiency of the Taiwanese ferry routes, with the adoption of different DEA models and the comparison between the results generated from the different sets of models, which demonstrates the applicability of DEA in evaluating ferry route efficiency in diverse geographic and operational contexts.

DEA Models and Analysis

Data Envelopment Analysis (DEA) will be adopted to analyse the efficiency of current ferry routes, given its widespread use in assessing the efficiency of public transportation services. The analysis will utilise secondary data related to passenger demand, operational inputs, and other route-specific information to calculate the efficiency of each ferry route, defined as a Decision-Making Unit (DMU). The DEA model will determine the relative efficiency of each route, indicating whether a particular route is operating efficiently or if there is room for improvement.

DEA operates by specifying inputs (such as frequency) and outputs (such as passenger demand) for each ferry route. Efficiency scores will be calculated for each ferry route, with a score of 1 indicating optimal efficiency. Routes with scores below 1 may be considered relatively inefficient. The DEA results will identify areas where operational improvements can enhance the efficiency of ferry services.

The selection of the DEA model, i.e. the choice between the Charnes-Cooper-Rhodes (CCR) model and the Banker-Charnes-Cooper (BCC) model, will both be adopted and compared to the results generated in this research. The selected model will determine how input and output weights are assigned. For CCR model, it is based on the constant return to scale, while for BCC model, it is based on the variable return to scale. For this research, the DEA model would be input-oriented, and the weighting for each input and output will be the same.

The equation for each DMU under the CCR model is as equation 4.1

$$Max\ h_j = \frac{\sum_{r=1}^{s} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}} \tag{4.1}$$

$$s.t. \frac{\sum_{r=1}^{s} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}} \leq 1, j = 1,2 \ldots\ldots n$$

$$u_r, v_i \geq \varepsilon \geq 0, r = 1 \ldots s\ ;\ i = 1 \ldots m$$

In this equation, each DMU has the output of **s** and the input of **m**. Y_{rj} represents the r^th output of the j^th DMU, while X_{ij} represents the i^th input of the j^th DMU. U_r represents the weight of output and V_i represents the weight of input.

The equation for each DMU under the BCC model is as equation 4.2

$$Max\ h_j = \frac{\sum_{r=1}^{s} U_r Y_{rj} - u_0}{\sum_{i=1}^{m} V_i X_{ij}} \tag{4.2}$$

$$s.t. \frac{\sum_{r=1}^{s} U_r Y_{rj} - u_0}{\sum_{i=1}^{m} V_i X_{ij}} \leq 1, j = 1,2 \ldots \ldots n$$

$$u_r, v_i \geq \varepsilon \geq 0, r = 1 \ldots s\ ;\ i = 1 \ldots m$$

In this equation, based on the equation of CCR model, a variable u_0 is added, which represent the free variable allowing the model to handle variable return to scale.

Indicator adopted for ferry route analysis

The input and output indicators adopted for this ferry route analysis is shown in table 4.2. For the input factor, factors that directly affect the daily operation of the ferry route would be included.

To assess the number of daily trips, data provided by the Transport Department (TD) and ferry operators will be used to reflect passenger demand across both peak and non-peak hours. This data serves as a gauge of usage patterns and demand fluctuations throughout the day.

In addition, average speed of the ferry route, will be used to reflect the operational performance of the ferry routes, which is calculated from the distance of routes divided by the sailing time. Higher speeds can significantly reduce travel time, making ferry services more attractive to passengers compared to other modes of transportation, while also indicates more energy consumed.

Additionally, fleet size, indicated by the number of vessels operating on a specific ferry route, can be inferred from the service frequency during peak hours and validated by information from the AIS. For simplicity, the calculation involving spare vessels are excluded. This measure also indicates potential costs, as increased fleet size may correlate with higher fuel consumption and greater manpower requirements.

One of the output factors used in this study is the number of patronages, which is calculated from the average daily passenger numbers. This data, provided by TD and collected from ferry operators, serves as a key measure of ferry usage. However, since some routes have intermediate stops, but the patronage data only report the total count regardless of travel direction or the number of boardings at mid-stops, it is assumed that the patronage data for a given route applies uniformly to all piers along the route.

Moreover, load factor of the routes, which is calculated from the maximum carrying capacity divided by patronages, is adopted as another output factors to access the utilisation of carrying capacity of ferry vessels. A higher load factor indicates the vessel deployed is suitable for the operation of the ferry routes.

In addition to patronage, other public transportation efficiency studies often use revenue passenger kilometres (RPK) as an output factor. However, in the context of urban ferry systems like those in Hong Kong, where most inner-harbour ferry routes operate between opposite sides of the harbour at relatively direct distance, this metric is less relevant. Due to the fixed length of these routes, it is not feasible to improve efficiency by altering route distance.

Table 4.2 Indicator of ferry operation performance adopted

	Input	
Indicator	**Explanation**	**Reference**
Fleet size	Maximum No. of vessels deployed for each route	(Chung & Chiou, 2023; Hahn et al., 2017)
Speed	Average sailing speed for each route	(Li et al., 2017)
Trip	Total daily number of trips for each route	(Hahn et al., 2017; Pham et al., 2020)
	Output	
Indicator	**Explanation**	**Reference**
Patronage	Daily patronage for each route	(Hahn et al., 2017; Yen et al., 2023)
Load Factor	Average load factor for each route	(Yen et al., 2023)

4.3 FTOD Index

As established in the previous chapter, research on ferry pier communities and FTOD is relatively limited. To evaluate the developmental performance of existing ferry pier communities, a framework based on conventional TOD indicators will be employed and adapted. These indicators are crucial for understanding the extent to which a location can support FTOD principles, including mixed land uses, walkability, and public transport accessibility.

Selection of TOD indicators

TOD indicators will be selected based on the specific context of ferry pier communities. Commonly used TOD indicators such as population density, land use diversity, connectivity to public transport, and pedestrian-friendly infrastructure will be employed. These indicators will be detailed further in subsequent sections, providing a comprehensive framework for evaluating the TOD potential of ferry pier communities.

Spatial analysis using GIS tools

For spatial analysis, Geographic Information Systems (GIS) tools, specifically QGIS will be utilised to assess the selected TOD indicators. This software will be instrumental in analysing spatial data and creating maps to demonstrate the TOD potential of various ferry pier communities. The data sources used for these analyses will also be discussed in subsequent sections.

Study area selection criteria

The criteria for selecting the study areas are based on locations that already have regular ferry services. A 500-meter radius from each pier is designated as the catchment area for the pier community. This benchmark has been corroborated by multiple studies. For instance, research in Greece and Korea adopted a 500-meter radius as the buffer zone from metro stations (Roukouni et al., 2012) (Sung & Oh, 2011). Peng et.al (2019) concluded that 500 meters is the optimal walking distance for humans, taking approximately 6-8 minutes, therefore the radius of 500 meters from the node would be considered as the benchmark for analysing the coverage of the transportation hub. Additionally, according to the Hong Kong government survey, the average transiting time for passengers using ferries is approximately six minutes, which corresponds to a 500-meter walking distance (Transport Department, 2012).

In contrast to the traditional 3D model (Density, Diversity, Design), this study will emphasise sustainability by adopting a set of sustainable TOD indicators. These indicators, derived from the 3D model, are tailored to incorporate elements of sustainability as highlighted in the literature review. According to research by Wey et al. (2016), TODs are evaluated based on three aspects of sustainable development: economic efficiency, environmental sustainability, and social equity. Experts were consulted to weigh these indicators using the Analytic Network Process (ANP), resulting in social equity having the lowest proportion of weighting compared to the other two aspects.

Indicator adopted

Table 4.3 shows the economic, social and environmental indicators adopted for the sustainable TOD site analysis.

Economic efficiency

The population density for each pier community is derived from the latest 2021 census data, and the calculation of population within catchment area will be based on the subunit of Tertiary Planning Unit (TPU) covered in the 500 meter radius from the pier. In the 2021 population census, for the town planning purposes, the entire territory of Hong Kong is divided into 292 TPUs, and each TPU is divided into several subunits. This subunit represents a specific city block, providing greater accuracy in estimating the population within the catchment area.

The employment density of each pier community is derived from the number of employees working within the Tertiary Planning Unit (TPU) where the pier is situated, as employment statistics are only available at the TPU level. Employment density serves as a critical indicator of commuting demand, reflecting the concentration of workplaces and the corresponding need for transportation services.

Commercial density is determined based on the areas designated as commercial and business within the catchment area, as delineated in the OZP. This metric assesses the commercial intensity of the area and is cross-referenced with employment density, given that a significant portion of Hong Kong's workforce is engaged in the tertiary sector. This correlation helps to understand the interplay between commercial activities and workforce distribution.

Social Equity

The accessibility of bus routes is quantified by counting the number of bus routes serving the catchment area, excluding those that do not stop within it. A high number of bus routes within the pier community indicates robust connectivity and the potential for efficient transfer services to other destinations by bus. While the MTR is the dominant transportation service in Hong Kong, it is excluded from this evaluation since most piers have at least one MTR station within their catchment area.

The rent-to-income ratio represents the proportion of monthly household income allocated to rental expenses. Given that approximately 47.6% of Hong Kong households, particularly the underprivileged, live in rented flats in public or private housing (Census and Statistics Department, 2021), using rental expenses rather than housing prices provides a more accurate depiction of the housing situation. A lower ratio suggests that the majority of the community can afford housing more easily, whereas a higher ratio indicates greater financial strain due to housing costs, reflecting lower housing affordability. The rent-to-income statistics for each pier community are based on the ratios for the TPU where the pier is located.

Land use diversity within the catchment area is measured to understand the variety of land uses present. This diversity is calculated using Simpson's Diversity Index, which is commonly used in ecology and economics to measure the concentration of species and enterprises, respectively. A higher index value indicates a greater variety of land uses, suggesting a more balanced and potentially sustainable urban environment (Eck & Koomen, 2007).

The equation of the adapted Simpson's Diversity Index is shown as equation 4.3.

$$S = 1 - \sum_{i=1}^{n} \frac{n_i(n_i-1)}{N(N-1)} \tag{4.3}$$

n_i = number of categories of land use in the catchment area of its i^{th} classification

N = mixed land use index, which is the total number of land use categories included in the TOD study (commercial, residential, recreational, government and institutes, and others) (Loo & Lam, 2012)

0 indicates there is no diversity and all land is the same type, while 1 represents the maximum diversity, where land is equally distributed among all land use types.

Environmental Protection

Recycling facilities density is quantified by counting the number of recycling facilities, including recycling bins and recycling stations within the catchment area. The higher density of recycling facilities can encourage more citizens to recycle their daily waste and reduce the burden on the solid waste treatment system and the depletion on natural resources.

For green and open space, it refers to the area of the category of open space within the catchment area, as shown in the OZP. This measurement assesses the amount of recreational space available, which can enhance the social well-being of citizens and act as urban greening.

Finally, street pavement network density refers to the proportion of length of the street pavement within the catchment area. A denser street network implies better accessibility for pedestrians, promoting active mobility, since most inner-harbour ferry piers lack parking facilities for private vehicles, and the transport authorities discourage the use of bike in the urban area, thus most passengers access pier on foot or by public transport.

Table 4.3 Information of TOD indicator adopted

Indicator	Explanation	Reference
	Economic	
Pop: Population Density	Number of population within the catchment area	(Pezeshknejad et al., 2020)
Emp: Employment Density	Number of jobs within the catchment area	(Renne, 2018)
Com: Commercial Density	Area of Commercial Land Use within the catchment area	(Loo & Verle, 2017)
	Social	
Land: Land Use Diversity	Proportion of each type of land use within the catchment area	(Loo & Verle, 2017)
Bus: Accessible number of bus routes	Number of bus routes within the catchment area	(Nyunt & Wongchavalidkul, 2020)
Rent: Rent to Income Ratio	Proportion of household income paid on rent	(Kaniewska et al., 2024)
	Environmental	
Recycle: Recycle Facilities Density	Number of recycle facilities within the catchment area	(Cervero & Sullivan, 2011)
Street: Street Density	Total length of the street network within the catchment area	(Pezeshknejad et al., 2020)
Open: Green and Open Space	Area of open space within the catchment of pier	(Zhang et al., 2022)

4.3.2 Calculation of the TOD Index

After collecting data for individual TOD indicators, a TOD index for each pier community will be computed. This index will serve as the final product for this analysis, enabling comparison among all selected study sites. Each sub-indicator will be normalized, with the maximum value set to 1 and other values scaled between 0 and 1 based on their ratio to the maximum value (Singh et al., 2017), with the formula 4.4, while x represents the raw value of a certain community under the specific sub-indicator, except for rent-to-income ratio. This normalization process ensures that the indicators are comparable and can effectively highlight the relative performance of each ferry pier community in terms of TOD principles

$$X_{normalised} = \frac{X - X_{Min}}{X_{Max} - X_{Min}} \tag{4.4}$$

For rent to income ratio (which X shall be lower the better), shown as equation 4.5.

$$X_{normalised} = 1 - \frac{X - X_{Min}}{X_{Max} - X_{Min}} \tag{4.5}$$

For the weighting of the TOD index, the weighting for the three dimensions of sustainability, i.e. economic efficiency, social equity, and environmental protection, will be weighted by the respondents while they would rank the three dimensions in the questionnaire.

The formula of the FTOD Index is shown as equation 4.6.

$$FTOD = econ(pop + emp + com) + social(rent + land + bus) + enviro(recycle + street + open) \quad (4.6)$$

While *econ*, *social*, and *enviro* represent the weights that respondents assign to each category. In other words, respondents are required to compare between economic efficiency, social well-being and environmental benefits. For each individual indicator under the same dimension, their weighting will be calculated with the Principal Component Analysis (PCA) to determine the contribution of each sub-indicator within each dimension (Loo & Verle, 2017). Loading for each component is squared and normalised into weighting while all indicators under the same dimension will have the sum of 1 for weighting.

Moreover, a correlation analysis has been conducted for the individual indicator in order to identify the relationship between different factors within the sustainable FTOD framework.

4.4 Questionnaire

To accomplish the third research objective, “Identify perceptions on FTOD from the perspective of the public”, a questionnaire had been drafted for this study. Since evaluating the effectiveness of FTOD requires not only the adoption of spatial and socio-economic indicators for quantitative data collection, but also public input regarding satisfaction and perceptions. Although the general public may lack technical knowledge and expertise in urban design or sustainability, a bottom-up approach during the design and implementation stages of urban and transportation planning can help identify key stakeholders and their concerns. This approach can address the needs of a diverse society by allowing planners to consider a broader range of perspectives (Semeraro et al., 2020).

Regarding the perspective of public input in the TOD-related issue, people tend to appreciate the benefits that TOD brings to their communities. However, their views on TOD measures might differ from those of planners and professionals. Noland et al. (2017) examined public attitudes and viewpoints towards the TOD and found that residents generally support TOD elements that impact them directly. For instance, in commercial development around the transportation hub, developers often aim to establish office and entertainment hub to maximise the development potential, whereas local residents would tend to prefer more localised businesses like restaurants and small boutiques.

For the satisfaction of ferry service, Tanko et al. (2019) investigated the factors affecting passenger satisfaction with ferry services. They categorized 16 service attributes into three categories: service, comfort, and productivity, and analysed their correlation using Structural Equation Modelling (SEM). The results indicated that latent factors are more significant in explaining passenger satisfaction than the quality of performance. For the satisfaction of the transportation hub, Silva and Bazrafshan (2013) grouped and analysed the service attributes of bus interchanges into five categories, namely access, connection and reliability, information, amenity, and security and safety.

Moreover, Tsoi & Loo (2021) conducted a survey to investigate the individual perception towards the usage of ferry services in Hong Kong, with analysed by multinomial regression, revealed that the concerns of frequent and non-frequent users differ. Frequent passengers are more concerned with service frequency, while non-frequent users prioritise accessibility.

4.4.1 Structure of questionnaire

Given that the study area encompasses the entire urban region of Hong Kong, the questionnaire was distributed electronically for efficiency. This approach allowed the study to reach a broader audience, and members from the online forum of local communities and frequent ferry and transport users were invited to join this research. A pilot study was conducted in November 2023, with subsequent adjustments and removal of certain questions based on feedback, the formal study then took place from early January to mid-March 2024.

The questionnaire was hosted on Qualtrics, a widely-used professional online survey platform. A link to the questionnaire was distributed through electronic means. The majority of responses were gathered through over 10 local community groups on Facebook with primarily more than 5,000 members for each group, for instance, Facebook groups like Home of Yau-tongers and Friends of To Kwa Wan. List of local community groups are listed in the Appendix. Moreover, through targeted advertising of the survey for gaining reach rate and click rate on social media platform like Facebook and Instagram, responses were also gathered.

The survey comprised 9 major questions, divided into 2 major components, namely ferry and pier usage experience and perception towards FTOD. Personal information and socioeconomic characteristics of respondent have also been collected. Figure 4.1 illustrates the structure of the questionnaire, and the appendix displays the sample of the questionnaire.

Four out of nine questions (Question 5, 6, 7, 9) used the 5-Interval Likert Scale in order to simplify scoring and create a metric for each service attribute. Respondents will than choose from least important/likely to most important/likely.

Ferry and pier usage experience

In the first section of the survey, information on the travel behaviour of adopting ferry by the respondents was gathered, including the major commuting mode across the Victoria Harbour and the frequency of using inner-harbour ferry service.

Additionally, respondents were asked to recall their previous experience of using ferry, including the route taken, purpose for travel and the time and transport modes used from their origin to pier and from the pier to destination. Furthermore, respondents were asked to rank the factors that influenced their use of ferry services based on the importance they attached to each, which included 9 service attributes that are grouped into two categories, namely service and comfort.

Respondents were also required to evaluate the satisfaction of the origin ferry pier from their last pier journey, which were categorised into 3 categories: service quality, node characteristics and sustainability.

Perception towards FTOD

The second part of the survey examined respondents' perceptions concerning the effectiveness of the possible FTOD measures. Respondents were asked to assign relative weights to economic, social, and environmental dimensions when considering the implementation of FTOD. At last, respondents also evaluated the prospect of FTOD in case of to be implemented in new development area (NDA) of urban areas (e.g. Kai Tak) and new town, focusing on the aspects of mobility, economic, social and environmental.

Figure 4.1 Structure of questionnaire

Demographic Information

Gender, Age, District of Residence, Income Range, Employment Status, Education Level

Section 1a: Ferry usage experience

1. What is your major mode crossing the Victoria Harbour?
2. How often do you take inner-harbour ferry in the past one year?

→ **Haven't taken inner-harbour ferry** → **To Q7**

Everyday/ Few Times A Week/ Once a week/
Few Times A Month/ Once a Month/ Few Times A Year

Section 1b: Ferry usage experience – Specific Route

3a. On your last inner-harbour ferry trip, where is the origin pier?

3b. As above, where is the destination pier?

4. For your last journey on ferry,

4a. What is your travelling purpose?

4b. Which type of transport mode you have adopted for connection from origin of the journey to ferry pier/ from ferry pier to destination of the journey?

4c. As above, how long is the time for the transport mode you have adopted for connection?

5. How would you rate the satisfaction of the origin pier according to the following factors?

6. How important are the following factors in influencing your decision to take inner-harbour ferry?

Section 2 View on Ferry-Based Transit-Oriented Development (FTOD)

7. For the following suggested measures, how would you evaluate the effectiveness to facilitate FTOD?

8. Please rank the 3 Major aspects of sustainable FTOD in terms of their importance.

9. If FTOD and new ferry service will be established in NDA of urban area or new town, do you agree with the following statements?

Completion

4.4.2 Analytical method

After the survey results were collected, all data were processed through SPSS and adopted descriptive statistics analysis to establish sample structure of the demographic and the socio-economic status of the respondents. Moreover, descriptive statistics analysis have also adopted to examine the frequency of taking ferry, major transport mode taken for crossing Victoria Harbour, purpose of taking ferry, as well as the time and transport mode taken for connection to and from pier.

In addition, t-test analysis has been adopted for the significance of difference between the regular and non-regular riders group, in terms of the perception on FTOD dimension, effectiveness on FTOD initiatives and factors on affecting usage of ferry service. Moreover, one-way ANOVA has been employed to assess the variability among pier communities and their impact on different aspects of user satisfaction.

Chapter 5 Results

This section aims to integrate the three primary methodologies—Data Envelopment Analysis (DEA), Sustainable FTOD Index, and questionnaires. Consequently, the results component is divided into three distinct parts: Ferry Route Usage and Efficiency Evaluation, Quantitative Analysis of FTOD Sites, and Perception Toward FTOD.

The following table 5.1 provides a brief outline of the content within each subsection of the results.

Table 5.1 Content of subsection in result and corresponding methodologies

Sub-chapter	Content	Corresponding Methodology
5.1 Descriptive Statistics	1. Ferry Route Performance Data 2. FTOD Site Data 3. Questionnaire - Demographic and Socio-Economic Status, Questions No. 1 (Major Cross-Harbour Mode), 2 (Frequency of taking ferry)	Data Collection, Initial Analysis
5.2 Ferry Route Usage and Efficiency Evaluation	1. Questionnaire - Questions No. 3 (Origin and Destination of last ferry trip), 4a (Trip Purpose), 6 (Factor affecting ferry usage) 2. DEA Analysis on Ferry Route	DEA, Questionnaire Analysis
5.3 Quantitative Analysis of FTOD Sites	1. Questionnaire - Questions No. 4b (Connection Time), 4c (Connection Transportation Mode), 5 (Pier Community Satisfaction), 8 (Sustainable FTOD Weighting) 2. Sustainable FTOD Index	FTOD Index Calculation, Questionnaire Analysis
5.4 Perception Toward FTOD	1. Questionnaire - Questions No. 7 (Effectiveness of FTOD Initiatives), 9 (Perception on future FTOD)	Questionnaire Analysis

5.1 Descriptive statistics

This subsection presents the foundational data necessary for subsequent analyses. It includes performance data of ferry routes, spatial and socio-economic information data on FTOD sites, and demographic and socio-economic information derived from the questionnaire. This initial statistical overview sets the stage for more detailed result illustrations in the following sections 5.2 to 5.4.

5.1.1 Ferry route efficiency analysis

From the 5 selected inputs and outputs, the descriptive statistics of the nine inner-harbour routes are listed as follows in Table 5.2.

Patronage and trip exhibits high variability with a wide range between the minimum and maximum values of routes. Vessel number variables show moderate variability.

Table 5.2 Descriptive statistics of input and output variables

Indicator	Variable (unit)	Mean	SD	Maximum	Minimum
Output	Patronage (per day)	3,557	6,168	19,429	115
	Load Factor	10.7	3.0	13.9	4.8
Input	Speed (km/h)	9.8	2.1	12.4	5.8
	Vessel (no. per route)	1.89	1.05	4	1
	Trip (per day)	88	97	322	14

Table 5.3 shows the correlation coefficient between input and output variables. Among the three input variables, number of trips show a higher correlation (0.976) with patronage that as the number of trips increases, there is a corresponding increase in daily patronage. Speed shows weak correlations with the other variables, including a weak negative correlation with patronage and number of daily trips, and a weak positive correlation with the load factor and number of vessels deployed.

Table 5.3 Correlation coefficient between input and output variables

	Patronage	**Load Factor**	Vessel	Trip	Speed
Patronage	1				
Load Factor	.493	1			
Vessel	.895**	.554	1		
Trip	.976**	.567	.914**	1	
Speed	-.168	.352	.039	-.087	1

**. Correlation is significant at the 0.01 level (2-tailed).

5.1.2 Sustainable FTOD site analysis

Table 5.4 displays the descriptive statistics of sustainable FTOD indicators. Within the 12 pier communities within the study area, the economic efficiency aspect presents the average population density as 40,819 people per square kilometre, with significant variability ranging from 1,942 to 112,367. Employment density is even higher, averaging 79,467 working population per square kilometre, exhibiting a high standard deviation of 84,230, indicating a substantial variation in workforce concentration. Commercial density, measured as the proportion of commercial land use on OZP, has an average of 0.248, reflecting the differing nature of the communities, with some being primarily residential with minimal commercial activities.

For social equity, the rent-to-income ratio is 0.28 on average, indicating a moderate level of housing affordability. The average number of bus lines serving these communities is 62, with a range from 5 to 177, highlighting the varying levels of public transportation accessibility. Land use diversity, as measured by the Simpson index, stands at an average of 0.67, indicating a relatively diverse mix of land uses in these pier communities.

Regarding environmental protection, the average street pavement density averages 0.047 metres of road per square kilometre with a range from 0.024 to 0.062, suggesting varying degrees of pavement network development. Recycling facilities density has an average of 39.4. Open space, assessed as the proportion of open space on the OZP, has an average of 0.197, indicating a moderate level of green space availability within these communities.

Table 5.4 Descriptive statistics of sustainable FTOD indicators

Dimension	Indicator	Mean	SD	Maximum	Minimum
Economic Efficiency	Population Density (population/km^2)	40,819	40,475	112,367	1,942
	Employment Density (population/km^2)	79,467	84,230	229,432	938
	Commercial Density (Proportion on OZP)	0.248	0.190	0.501	0
Social Equity	Rent-to-Income Ratio	0.28	0.07	0.35	0.13
	Accessible bus line (no.)	62	46	177	5
	Land Use Diversity (Simpson index)	0.67	0.06	0.772	0.579
Environmental Protection	Recycle facilities density (/km^2)	39.4	30.7	121.7	5.96
	Street density (m/km^2)	0.047	0.013	0.062	0.024
	Open space (Proportion on OZP)	0.197	0.131	0.455	0.032

Source: Census and Statistics Department (2021), Planning Department (2023)

Table 5.5 shows the correlation coefficient between input and output variables. Strong positive correlations have been shown for employment density with commercial density (.630), as well as the number of bus lines with employment density (.666). For a strong negative correlation, population density with commercial density (-0.740) is one of the examples. This suggests that areas with higher population densities tend to have lower employment and commercial densities.

Table 5.5 Correlation coefficient between input and output variables

	Pop	Employ	Com	Rent	Bus	Div	Recycle	Street	Open
Pop	1								
Employ	-.493	1							
Com	-.740**	.630*	1						
Rent	-.291	-.331	.146	1					
Bus	-.285	.666*	.165	-.620*	1				
Div	.430	-.152	-.375	.145	-.447	1			
Recycle	.601*	-.102	-.350	-.346	.119	-.262	1		
Street	.076	.546	.252	-.712**	.468	-.221	.361	1	
Open	-.138	-.287	-.165	.073	-.150	.219	-.532	-.496	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

5.1.3 Questionnaire

During the survey distribution phase from early January to mid-March 2024, a total of 322 responses were collected, with 301 responses deemed valid for analysis.

Gender and age

Table 5.6 displays the gender and age distribution of respondents. A significant portion of respondents (74%) were male, suggesting a potential gender imbalance in the sample. This disparity might reflect a general trend where male respondents exhibit greater interest in transportation issues compared to females. Additionally, over half of the respondents (75%) were aged 40 years or younger, with a substantial portion (20-30 age group) contributing to the majority of the responses. Nonetheless, individuals from mid-age and elderly demographics comprised approximately one-fourth of the total sample, providing a moderate representation of these age groups.

Table 5.6 Gender and age distribution of respondents

Age	**Gender**		**Total**
	Male	**Female**	
20 or below	32	5	37 (12%)
20-30	107	25	132 (44%)
31-40	40	17	57 (19%)
41-50	29	20	49 (16%)
51-60	7	8	15 (5%)
61 or above	9	2	11 (3%)
Total	224 (74%)	77 (26%)	301 (100%)

District of residence

More than half of the respondents are currently living in either the Hong Kong Island or the Kowloon Peninsula, while the districts with the most respondents are the Eastern district on Hong Kong Island and the Kwun Tong district in the Kowloon Peninsula. Table 5.7 displays the district of residence distribution of respondents.

Table 5.7 District of residence distribution of respondents

Region	District	No. of Respondents
Hong Kong Island	Central & Western	6
Hong Kong Island	Eastern	41
Hong Kong Island	Wan Chai	6
Hong Kong Island	Southern	11
Total: Hong Kong Island		64 (21.3%)
Kowloon	Kowloon City	24
Kowloon	Sham Shui Po	17
Kowloon	Yau Tsim Mong	10
Kowloon	Wong Tai Sin	24
Kowloon	Kwun Tong	40
Total: Kowloon		115 (38.2%)
New Territories	Kwai Ching	9
New Territories	Tsuen Wan	15
New Territories	Sai Kung	27
New Territories	Sha Tin	17
New Territories	Tai Po	10
New Territories	Tuen Mun	13
New Territories	Yuen Long	11
New Territories	North	8
New Territories	Islands	9
Total: New Territories		119 (39.5%)
Others		3 (1%)
Total		301

Income, employment status and education level

Table 5.8 shows the income, employment status and education level distribution of respondents.

From the results of the income range of respondents, there is a noticeable decrease in the number of respondents as income range increases, while half of respondents (59.5%) have a monthly income of less than 20,000 Hong Kong Dollar and only 8.3 % of respondents have a monthly income of 50,000 Hong Kong Dollar or above.

Half of the respondents (58.1%) are employed at full-time work, indicating a significant segment of working individuals, and one-fourth of respondents (25.6%) are students. Self-employed/employers, homemakers, and unemployed individuals constitute smaller proportions of the sample.

Respondents with a bachelor's degree or above comprise the largest group (65.1%). Only 21.3% of respondents received secondary education or below.

Table 5.8 Income, employment status and education level of respondents

Item	Option	No. of Respondents
Income Range	$0-10,000	92 (30.6%)
	$10,001-20,000	87 (28.9%)
	$20,001-30,000	44 (14.6%)
	$30,001-40,000	39 (13%)
	$40,001-50,000	14 (4.7%)
	$50,001 or above	25 (8.3%)
	Total	**301**
Employment Status	Full-Time Work	175 (58.1%)
	Part-Time Work	22 (7.3%)
	Self-employed/ Employer	8 (2.7%)
	Homemaker	7 (2.3%)
	Unemployed	4 (1.3%)
	Student	77 (25.6%)
	Retired	8 (2.7%)
	Total	**301**
Education Level	Senior Secondary (Form 7) or below	64 (21.3%)
	Sub-Degree	38 (12.6%)
	Bachelor	141 (46.8%)
	Postgraduate (Master or above)	58 (19.3%)
	Total	**301**

Frequency of taking inner-harbour ferry

Table 5.9 shows the frequency of respondents taking the inner-harbour ferry in the past year. Half of the respondents use inner-harbour ferries only a few times a year, and more than 10% have not used the inner-harbour ferry at all within the past year. This suggests that for the majority of respondents, ferry services are not a regular or preferred mode of transportation. In contrast, approximately 10% of respondents take the ferry once or more times a week.

In this research, to distinguish between regular and non-regular riders, respondents who take the ferry more than once a month are classified as regular riders, indicating that these individuals use the ferry as part of their daily lives rather than sporadically. The results show that 23.3% of respondents fall into the category of regular riders.

Table 5.9 Frequency of taking the inner-harbour ferry in the past year

Frequency	No. of Respondents
Everyday	6 (2%)
A few times a week	17 (5.6%)
Once a week	11 (3.7%)
A few times a month	36 (12%)
Once a month	44 (14.6%)
A few times a year	153 (50.8%)
Haven't taken inner-harbour ferry	34 (11.3%)
Total	**301**
Regular Users (>1 times a month)	**70 (23.3%)**
Non-Regular Users	**231 (76.7%)**

Table 5.10 presents the results of ANOVA conducted to examine the variation in the frequency of taking inner-harbour ferry routes among different demographic group. Only income and employment status show significant difference in the frequency of taking ferry.

Table 5.10 ANOVA of frequency of taking ferry between demographic groups

Item		Sum of Square	*df*	Mean Square	*F* value	*p* value
Gender	Between Groups	1.226	6	.204	1.071	.380
	Within Groups	56.077	294	.191		
Age	Between Groups	12.210	6	2.035	1.318	.249
	Within Groups	454.056	294	1.544		
Region	Between Groups	6.394	6	1.066	1.863	.087
	Within Groups	166.455	291	.572		
Income	Between Groups	42.445	6	7.074	3.071	.006
	Within Groups	677.269	294	2.304		
Employment Status	Between Groups	75.937	6	12.656	2.547	.020
	Within Groups	1460.708	294	4.968		
Education Level	Between Groups	3.339	6	.556	.528	.787
	Within Groups	309.910	294	1.054		

Table 5.11 presents the distribution of ferry usage frequency among various income and employment status groups with more significant variation. Higher income groups and certain employment categories, such as self-employed individuals and full-time workers exhibit a more varied usage pattern, including some daily and frequent weekly usage. Lower income groups and part-time workers, along with homemakers and retired individuals, tend to use the ferry less frequently, with a substantial portion not taking it at all.

Table 5.11 Distribution of frequency of taking ferry across selected demographic groups

Categories	Item	Everyday	Few times a week	Once a week	Few times a month	Once a month	Few times a year	Haven't taken inner-harbour ferry
Income	$0-10,000	1%	5%	4%	15%	11%	43%	20%
	$10,001-20,000	1%	9%	5%	11%	15%	51%	8%
	$20,001-30,000	0%	5%	7%	14%	11%	55%	9%
	$30,001-40,000	5%	3%	0%	5%	13%	69%	5%
	$40,001-50,000	0%	7%	0%	14%	21%	50%	7%
	$50,001 or above	8%	0%	0%	8%	32%	44%	8%
Employment Status	Full-Time Work	3%	6%	1%	10%	16%	57%	7%
	Part-Time Work	0%	5%	5%	14%	14%	41%	23%
	Self-employed/ Employer	0%	13%	13%	13%	13%	50%	0%
	Homemaker	0%	0%	14%	14%	57%	14%	0%
	Unemployed	0%	0%	25%	25%	0%	50%	0%
	Student	1%	6%	5%	16%	9%	44%	18%
	Retired	0%	0%	13%	0%	13%	50%	25%

Major cross-harbour transportation mode

Table 5.12 shows the major transportation modes across Victoria Harbour. Most respondents adopt either the MTR or bus as their primary mode of crossing Victoria Harbour. The MTR emerges as the most popular mode of transportation, with 55.1% of total respondents preferring it. Non-regular riders show a higher preference (60.2%) for the MTR compared to regular riders (38.6%). The bus is also a dominant cross-harbour mode, with over 30% usage among both regular and non-regular riders.

Although the overall preference for ferries is only 8.6%, which is significantly lower than other major transportation modes, the preference among regular riders is notably higher (25.7%) compared to non-regular riders (3.5%). This indicates that regular ferry riders tend to use ferries more frequently.

The use of private vehicles (including cars and motorcycles) is low since vehicle ownership is considered expensive in Hong Kong, leading most commuters to opt for public transport, as displayed in this survey. Minibuses have limited popularity due to the restricted availability of demand-responsive routes for crossing the harbour and their limited coverage within the inner-city area. Moreover, walking or cycling are excluded, since pedestrian and cyclists is forbidden to enter any road or railway cross-harbour tunnel.

Table 5.12 Major transportation mode across Victoria Harbour

Cross-Harbour Transport Mode	No. of Respondents	Non-Regular Rider	Regular Rider
Bus	101 (33.6%)	78 (33.8%)	23 (32.9%)
Ferry	26 (8.6%)	8 (3.5%)	18 (25.7%)
MTR	166 (55.1%)	139 (60.2%)	27 (38.6%)
Private Vehicle	7 (2.3%)	6 (2.6%)	1 (1.4%)
Minibus	1 (0.3%)	0 (0%)	1 (1.4%)
Total	**301**	**231**	**70**

Table 5.13 presents the results of ANOVA conducted to examine the variation in the choice of major cross-harbour transportation modes among different demographic group. Only income shows a significant difference in the choice of major cross-harbour transportation modes.

Table 5.13 ANOVA of major cross-harbour mode between demographic groups

Item		Sum of Square	*df*	Mean Square	*F* value	*p* value
Gender	Between Groups	1.074	4	.268	1.413	.230
	Within Groups	56.229	296	.190		
Age	Between Groups	2.509	4	.627	.400	.808
	Within Groups	463.757	296	1.567		
Region	Between Groups	2.791	4	.698	1.202	.310
	Within Groups	170.058	293	.580		
Income	Between Groups	50.230	4	12.557	5.552	.000
	Within Groups	669.485	296	2.262		
Employment Status	Between Groups	16.921	4	4.230	.824	.511
	Within Groups	1519.723	296	5.134		
Education Level	Between Groups	9.338	4	2.335	2.274	.061
	Within Groups	303.911	296	1.027		

Table 5.14 presents the distribution of major cross-harbour transportation modes used by respondents across different income groups. The data indicates that lower-income groups heavily rely on the MTR and buses for cross-harbour travel. As income increases, there is a gradual shift towards greater use of the MTR.

Table 5.14 Distribution of major cross-harbour mode across selected demographic group

Income	Bus	Ferry	MTR	Private Vehicle	Minibus
$0-10,000	42%	8%	48%	1%	1%
$10,001-20,000	40%	8%	52%	0%	0%
$20,001-30,000	25%	11%	64%	0%	0%
$30,001-40,000	21%	5%	69%	5%	0%
$40,001-50,000	14%	7%	71%	7%	0%
$50,001 or above	24%	16%	48%	12%	0%

5.2 Inner-harbour ferry route usage and efficiency evaluation

This section presents a comprehensive evaluation of utilisation patterns and operational efficiency of the Inner-Harbour ferry routes. The evaluation is based on multipronged approach, incorporating insights from surveys conducted to measure ferry usage and perceptions, alongside with accessing route efficiency with the employment of the Data Envelopment Analysis (DEA) method.

By merging insights from passenger usage patterns with efficiency evaluations, this section provides a holistic understanding of the Inner-Harbour ferry system's performance and operational effectiveness. The findings could be instrumental for stakeholders aiming to optimise ferry services to meet the changing demands of commuters and to enhance urban mobility in the harbour region.

5.2.1 Usage evaluation

This section explores the usage dynamics of the Inner-Harbour ferry network, examining the frequency and purpose of ferry trips undertaken by commuters and travellers. Through survey data, pattern of preference for specific routes and the primary motivations behind ferry usage are examined.

According to table 5.15, the most visited piers for respondents are located in Central and Tsim Sha Tsui, which are within the service area of the route H01, the inner-harbour ferry route with the highest patronage. However, for other piers located in residential areas like Sai Wan Ho, fewer respondents reporting taking ferry there. Detailed analysis on pier site will be provided in section 5.3.

Table 5.15 Origin and destination pier of respondents on their last ferry trip

Pier	Origin	Destination	**Total**
Central	92 (35.5%)	49 (18.9%)	**141 (27.2%)**
Wan Chai	21 (8.1%)	24 (9.3%)	**45 (8.7%)**
North Point	18 (6.9%)	31 (12%)	**49 (9.5%)**
Sai Wan Ho	11 (4.2%)	15 (5.8%)	**26 (5.0%)**
West Kowloon Cultural District	1 (0.4%)	0 (0%)	**1 (0.2%)**
Tsim Sha Tsui	62 (%)	99 (38.2%)	**161 (31.1%)**
Tsim Sha Tsui East	0 (0%)	5 (1.9%)	**5 (1.0%)**
Hung Hom	14 (5.4%)	15 (5.8%)	**29 (5.6%)**
Kowloon City	13 (5%)	1 (0.4%)	**14 (2.7%)**
Kai Tak Cruise Terminal	1 (0.4%)	3 (1.2%)	**4 (0.8%)**
Kwun Tong	16 (6.2%)	13 (5%)	**29 (5.6%)**
Sam Ka Tsuen	10 (3.9%)	4 (1.5%)	**14 (2.7%)**

Table 5.16 illustrates ferry route taken by respondents on their last ferry trip. Unsurprisingly, most taken routes for both non-regular and regular riders are the route connecting commercial district (e.g. H01, H03). A closer examination reveals that more than half of the non-regular riders have utilized route H01. For regular riders, the distribution of routes taken is more evenly spread, indicating that regular riders may rely on less popular routes for their commuting needs.

Table 5.16 Ferry route taken by respondents on their last ferry trip

Route	**Total**	Non-Regular Rider	Regular Rider
H01 (Central-Tsim Sha Tsui)	**122 (47.1%)**	101 (53.2%)	21 (30.4%)
H02 (Central-Hung Hom)	**11 (4.2%)**	6 (3.2%)	5 (7.2%)
H03 (Wan Chai-Tsim Sha Tsui)	**39 (15.1%)**	31 (16.3%)	8 (11.6%)
H04 (North Point-Hung Hom)	**18 (6.9%)**	10 (5.3%)	8 (11.6%)
H05 (North Point-Kowloon City)	**14 (5.4%)**	10 (5.3%)	4 (5.8%)
H06 (North Point-Kwun Tong)	**19 (7.3%)**	9 (4.7%)	10 (14.5%)
H07 (Water Taxi)	**10 (3.9%)**	6 (3.2%)	4 (5.8%)
H08 (Sai Wan Ho-Kwun Tong)	**12 (4.6%)**	7 (3.7%)	5 (7.2%)
H09 (Sai Wan Ho-Sam Ka Tsuen)	**14 (5.4%)**	10 (5.3%)	4 (5.8%)
Total	**259**	190	69

Purpose of taking ferry

Table 5.17 shows the purpose of taking ferry on the respondent's last trip. Among all respondents, 17.9% reported using the inner-harbour ferry for commuting to school or workplace. Regular riders are more likely to use the ferry for commuting purposes, with 35.4% of them indicating this as their last trip purpose, compared to 11.8% of non-regular riders. Recreation and sport emerge as the most common purpose for taking the ferry for non-regular and regular riders, with 42.6% of respondents indicating this as their last trip purpose, that riders will take ferry in their own free time.

Table 5.17 Purpose of taking ferry on the respondent's last trip

Purpose of taking ferry	**No. of Respondents**	**Non-Regular Rider**	**Regular Rider**
Commuting to school/workplace	45 (17.9%)	22 (11.8%)	23 (35.4%)
Perform essential tasks, e.g. medical check	12 (4.8%)	8 (4.3%)	4 (6.2%)
Recreation and Sport	107 (42.6%)	85 (45.7%)	22 (33.8%)
Shopping	19 (7.6%)	17 (9.1%)	2 (3.1%)
Excursion, e.g. going to scenic spots or taking ferry as sightseeing	58 (23.1%)	46 (24.7%)	12 (18.5%)
Others	10 (4%)	8 (4.3%)	2 (3.1%)
Total	**251**	**186**	**65**

Table 5.18 illustrates the breakdown of ferry usage purposes across various routes. Notably, the most common purpose across all routes is recreation and sports, with percentages ranging from 25% to 60%. Routes H05, H07, and H08 exhibit particularly high percentages for recreation and sports, suggesting a stronger preference for these activities among passengers using these routes. Conversely, commuting to school or the workplace varies significantly across routes, with percentages ranging from 0% to 50%. Routes H06 and H09 have a higher proportion of commuting purposes compared to other routes.

Table 5.18 Distribution of purposes for taking ferry across different routes

Purpose of taking ferry	**H01**	**H02**	**H03**	**H04**	**H05**	**H06**	**H07**	**H08**	**H09**
Commuting to school/ workplace	18%	13%	17%	20%	23%	33%	0%	10%	50%
Perform essential task	7%	0%	3%	0%	8%	7%	0%	0%	0%
Recreation and Sport	43%	25%	38%	50%	54%	40%	57%	60%	25%
Shopping	3%	25%	14%	20%	8%	0%	14%	10%	0%
Excursion	23%	38%	24%	10%	8%	20%	29%	20%	13%
Others	5%	0%	3%	0%	0%	0%	0%	0%	13%

Table 5.19 presents the results of ANOVA conducted to examine the differences in the purpose of taking ferry across various demographic groups. Specifically, the region in which respondents reside, their income levels, and their employment status appear to be significant determinants of their ferry usage purposes.

Table 5.19 ANOVA of purpose for taking ferry between demographic groups

Item		Sum of Square	*df*	Mean Square	*F* value	*p* value
Gender	Between Groups	.766	5	.153	.818	.538
	Within Groups	45.919	245	.187		
Age	Between Groups	9.690	5	1.938	1.338	.249
	Within Groups	354.812	245	1.448		
Region	Between Groups	7.364	5	1.473	2.638	.024
	Within Groups	136.240	244	.558		
Income	Between Groups	34.042	5	6.808	2.964	.013
	Within Groups	562.754	245	2.297		
Employment Status	Between Groups	56.125	5	11.225	2.416	.037
	Within Groups	1138.098	245	4.645		
Education Level	Between Groups	11.092	5	2.218	2.174	.058
	Within Groups	250.055	245	1.021		

Table 5.20 presents the distribution of ferry usage purposes across selected demographic groups with higher variation. Recreational and sport and excursion dominate ferry usage across most categories, especially among those from Hong Kong Island, lower-income population, and part-time workers. Commuting to school or work is notably higher among those with higher incomes and self-employed individuals. The unemployed and retirees use ferries predominantly for recreational purposes and excursions.

Table 5.20 Distribution of purposes for taking ferry across selected demographic groups

Categories	Item	Commuting to school/ workplace	Perform essential task	Recreation and Sport	Shopping	Excursion	Others
Region	Hong Kong Island	26%	2%	50%	13%	6%	4%
	Kowloon	18%	4%	40%	4%	27%	6%
	New Territories	13%	7%	41%	8%	28%	2%
Income	$0-10,000	13%	4%	43%	3%	36%	1%
	$10,001-20,000	16%	4%	42%	11%	24%	4%
	$20,001-30,000	21%	8%	47%	11%	13%	0%
	$30,001-40,000	21%	3%	44%	12%	15%	6%
	$40,001-50,000	18%	0%	36%	9%	18%	18%
	$50,001 or above	32%	9%	36%	0%	14%	9%
Employment Status	Full-Time Work	20%	4%	41%	10%	20%	6%
	Part-Time Work	19%	6%	63%	6%	6%	0%
	Self-employed/ Employer	38%	13%	25%	13%	13%	0%
	Homemaker	0%	14%	14%	14%	57%	0%
	Unemployed	0%	0%	50%	0%	25%	25%
	Student	15%	3%	46%	0%	36%	0%
	Retired	0%	25%	50%	25%	0%	0%

5.2.2 Factor influencing usage of ferry

Among the nine factors examined in this study that influence the usage of inner-harbour ferry service, according to Table 5.21, Frequency (4.12) and Service Hour (4.08) emerged as the most important factors. When considering the major dimensions that encompass these factors, namely "Route" and "Vessel," the "Route" factors are rated more highly (3.86) than "Vessel" factors (3.58). Notably, "Capacity of vessels" was identified as the least influential factor in affecting ferry usage.

Table 5.21 Factor influencing the usage of inner-harbour ferry service

Factor	Overall		
	Mean	Rank	SD
a.) Speed of route	**3.54**	6	0.983
b.) Frequency of route	**4.12**	1	0.822
c.) Punctuality of route	**3.97**	4	0.899
d.) Service Hour of route	**4.08**	2	0.806
e.) Fare of route	**3.60**	5	1.102
Route-related Factors	***3.86***	/	/
f.) Comfort on Vessel Environment	**3.52**	7	0.844
g.) Scenic View from vessel	**3.46**	8	1.072
h.) Safety on vessel	**4.04**	3	0.967
i.) Capacity of vessel	**3.32**	9	1.050
Vessel-relate Factors	***3.58***	/	/
Overall	**3.74**	/	/

Table 5.22 displays the correlation matrix on the factor affecting the usage of ferry. Correlation coefficient between speed and frequency is 0.485, indicating a moderate positive relationship, which is also the highest correlation in this model. This suggests that higher ferry speeds tend to be associated with higher frequencies of service, while respondents may take references from the outlying islands routes which some routes provide high-speed vessels with frequent headway during holiday peak hours. Additionally, a moderate positive correlation is observed between "Frequency" and "Punctuality" (0.436), as well as between "Frequency" and "Service Hour" (0.406).

Table 5.22 Correlation matrix on the factor affecting the usage of ferry

	Speed	**Frequ-ency**	**Punct-uality**	**Hour**	**Fare**	**Comfort**	**View**	**Safety**	**Capa-city**
Speed	1								
Frequency	.485**	1							
Punctuality	.355**	.436**	1						
Hour	.250**	.406**	.322**	1					
Fare	.138*	.206**	.166**	.177**	1				
Comfort	.206**	.132*	.145*	.153*	.219**	1			
View	-.101	-.159*	-.111	.016	.093	.256**	1		
Safety	.051	.049	.258**	.154*	.151*	.280**	.158*	1	
Capacity	.197**	.161*	.136*	.115	.112	.312**	.133*	.351**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Comparative analysis of factors influencing the usage of inner-harbour ferry between two rider groups

When analysing the differences in perception between regular and non-regular riders concerning factors that impact inner-harbour ferry service usage, most differences were not statistically significant ($p > 0.05$), as shown in Table 5.23. However, the "Capacity of vessels" factor showed a statistically significant difference (t-value: -2.18, $p < 0.05$), with regular riders perceiving this factor more positively compared to non-regular riders.

Table 5.23 Factors influencing the usage of inner-harbour ferry service between two rider groups

Initiatives	Category	N	Mean	Rank	SD	t-value
a.) Speed of route	Non-regular Rider	193	3.49	7	.95	-1.27
	Regular Rider	59	3.68	6	1.07	
b.) Frequency of route	Non-regular Rider	193	4.08	1	.82	-1.31
	Regular Rider	59	4.24	2	.82	
c.) Punctuality of route	Non-regular Rider	193	3.98	4	.85	.23
	Regular Rider	59	3.95	4	1.06	
d.) Service Hour of route	Non-regular Rider	193	4.03	3	.84	-1.87
	Regular Rider	59	4.25	1	.69	
e.) Fare of route	Non-regular Rider	193	3.56	5	1.06	-.93
	Regular Rider	59	3.71	5	1.22	
f.) Comfort on Vessel Environment	Non-regular Rider	193	3.53	6	.84	.29
	Regular Rider	59	3.49	9	.86	
g.) Scenic View from vessel	Non-regular Rider	193	3.41	8	1.06	-1.12
	Regular Rider	59	3.59	7	1.10	
h.) Safety on vessel	Non-regular Rider	193	4.04	2	.91	-.07
	Regular Rider	59	4.05	3	1.15	
i.) Capacity of vessel	Non-regular Rider	193	3.24	9	1.03	-2.18*
	Regular Rider	59	3.58	8	1.07	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

5.2.3 Efficiency evaluation

A DEA approach was used to evaluate the operational performance of ferry routes, considering key input-output metrics such as passenger patronage and trip frequency. This analysis helps identify routes that demonstrate optimal performance in terms of resource utilisation to maximize service provision. Peer analysis was also conducted to identify routes (DMUs) that exhibit similar operational characteristics, thereby facilitating mutual learning and performance enhancement. Additionally, slack variable analysis was employed to determine the extent of input reduction required for inefficient routes to achieve full efficiency, focusing on metrics such as the number of trips.

Table 5.24 illustrates the DEA Result of the Inner-Harbour Ferry Route under the CCR & BCC Model. The DEA results under the CCR model indicate the technical efficiency scores for each ferry route, with scores ranging from 0.551 to 1. The mean efficiency score across routes under the CCR model is 0.925, indicating an average efficiency level of 92.5%. 6 routes achieves full efficiency with a score of 1 under the CCR model.

H03 (Wan Chai-Tsim Sha Tsui) and Route H07 (Water Taxi) exhibited moderate efficiency scores ranging from 0.826 to 0.947. Routes H05 (North Point-Kowloon City) showed efficiency scores below 0.6, indicating that these routes could improve input-output utilization.

Under the Variable Returns to Scale (BCC) model, pure technical efficiency scores ranged from 0.668 to 1. Routes with a score of 1 under this model achieve full efficiency even with variable scale, demonstrating high performance in resource utilization. The mean efficiency score across routes under the BCC model is higher at 0.944, indicating an average efficiency level of 94.4%, since the BCC model offers a more flexible approach by creating a peer group of similar-sized DMUs, making it easier to identify where a DMU might need to adjust its scale or structure to improve efficiency. More than two-thirds of the routes have achieved the full efficiency of 1, while only routes H03 and H05 have a moderate efficiency score ranging from 0.668 to 0.827.

Table 5.24 DEA result of inner-harbour ferry route under CCR & BCC model

Route	**Constant Return to Scale (CCR Model)**	**Variable Return to Scale (BCC Model)**
H01 (Central-Tsim Sha Tsui)	1	1
H02 (Central-Hung Hom)	1	1
H03 (Wan Chai-Tsim Sha Tsui)	0.826	0.827
H04 (North Point-Hung Hom)	1	1
H05 (North Point-Kowloon City)	0.551	0.668
H06 (North Point-Kwun Tong)	1	1
H07 (Water Taxi)	0.947	1
H08 (Sai Wan Ho-Kwun Tong)	1	1
H09 (Sai Wan Ho-Sam Ka Tsuen)	1	1
Mean	**0.925**	**0.944**

Peer set analysis of ferry routes

Each row in below table 5.25 represents a ferry route (Decision-Making Unit or DMU), and the corresponding columns list the peer routes identified for each DMU. For example, Route H03 shares similarities with Routes H09, H01, and H04 in terms of operational characteristics or performance metrics, suggesting that these routes could learn from each other to enhance efficiency. Conversely, DMUs without identified peers, such as Route H06, indicate that these routes have reached maximum efficiency and require no further learning to improve operational performance.

Table 5.25 Peer set for DMUs

DMU	Peer 1	Peer 2	Peer 3	Peer 4
H01	H01			
H02	H02			
H03	H09	H01	H04	
H04	H04			
H05	H04	H01	H07	H06
H06	H06			
H07	H07			
H08	H08			
H09	H09			

Table 5.26 below outlines the number of identified peers for each ferry route (DMU), which indicates the number of times an efficient unit acts as a reference for other less efficient units. For example, DMUs H01 (Central - Tsim Sha Tsui) has two identified peers, indicating that this route shares similarities with two other routes. DMUs with a peer count of zero have no identified peers, suggesting a lack of significant similarities with other routes in the dataset.

Table 5.26 Peer count for DMUs

DMU	Peer Count
H01	2
H02	0
H03	0
H04	2
H05	0
H06	1
H07	1
H08	0
H09	1

Slack analysis of inefficient ferry routes

To understand the degree of improvement required for the inefficient routes as shown in the DEA analysis, a slack variable analysis was conducted. This analysis excluded those routes which had reached full efficiency. Given that the DEA method used in this context is input-oriented, the slack variable analysis considered only the input metrics.

The results shown in Table 5.27 indicate all inefficient routes need to reduce their vessel size by more than 40%. For instance, in Routes H05, this reduction implies that one out of three vessels may not be deployed to service. In addition to vessel size, Route H05 requires a reduction of more than 25% across all input variables to attain full efficiency, while Route H03 has a relatively smaller reduction in input variables required to meet efficiency targets.

Table 5.27 Slack variable analysis for inefficient DMU (ferry route)

Inefficient Route	Speed	No. of Trip	Vessel Size
H03	-17.3%	-22.2%	-17.3%
H05	-41.0%	-33.2%	-33.3%

5.3 Quantitative analysis on FTOD site

This section presents an in-depth analysis of FTOD sites focusing on three main aspects that have been done, i.e. the public satisfaction of pier communities, quantitative analysis on sustainability of FTOD sites and the connection time and mode adopted. Survey data on stakeholders' satisfaction with pier communities, as well as insights into connection times and modes to and from the pier have been reviewed. Additionally, it incorporates spatial and socio-economic data of the pier communities to compute a Sustainable FTOD Index.

5.3.1 Satisfaction of ferry pier and its surrounding area

Understanding the public's satisfaction is crucial for ensuring that FTOD initiatives align with the needs and preferences of the community. To gauge this, feedback on stakeholders' satisfaction with various aspects of the pier communities has been gathered. This feedback covered elements like pier facilities, accessibility, service quality, and the sustainability of the surrounding areas. The gathered insights provide a comprehensive view of the current state of FTOD infrastructure and highlight areas for improvement.

For this component, respondents were asked to evaluate their satisfaction with the origin pier from their most recent ferry trip, as displayed in Table 5.28. The mean score for each indicator provides an overview of the overall satisfaction with urban ferry piers. The highest satisfaction is the choice of ferry destination, with a mean score of 3.71 and a relatively low standard deviation of 0.841, indicating consistent satisfaction across respondents.

Table 5.28 Overall satisfaction of all ferry piers and their surrounding area

Satisfaction Indicator	Mean	SD
a.) Choice of ferry destination	3.71	0.841
b.) Sufficiency of pier facilities	3.36	0.876
c.) Easy access to route information	3.58	0.903
d.) Comfort of pier waiting area	3.22	0.873
e.) Service attitude of operator staff	3.61	0.708
f.) Multi-modal connectivity of pier	3.50	1.037
g.) Walking accessibility to/from the pier	3.69	0.933
h.) Diversity of (economic, leisure, social etc.) activities around the pier communities	3.55	0.924
i.) Sufficiency of greenery and open space	3.36	0.905
j.) Density of businesses and services around the pier communities	3.37	0.892

Satisfaction for each pier community

Two-thirds of the pier communities obtain a mean satisfaction score of higher than 3.5, except for North Point (3.29), Kwun Tong (3.29) and Sam Ka Tsuen (3.06). The pier community with the best satisfaction score is Hung Hom (3.67), which most aspects are kept at a relatively high score. Moreover, the 9 pier communities have also been classified as three types of communities according to their land use characteristics, namely commercial, residential and mixed communities. For the satisfaction sub-score between these three categories, residential communities have a lower score than mixed and commercial communities in most aspects, except the service attitude of staff. Table 5.29 shows the respondents' satisfaction with each pier and surrounding community.

Since the questionnaire sample sizes from West Kowloon Cultural District, Tsim Sha Tsui East and Kai Tak Cruise Terminal are insufficient, as ferry services to these areas are limited to a few times on weekends, they are included in the evaluation on satisfaction of ferry pier.

Table 5.29 Respondents satisfaction for each pier and surrounding community

Indicator	Pier									Type of Community		
	CEN	WAC	NOP	SWH	TST	HUH	KOC	KWT	SKT	C	R	M
a.) Choice of ferry destination	3.8	3.8	3.4	3.8	3.8	3.6	3.3	3.5	3.3	3.8	3.5	3.5
b.) Sufficiency of pier facilities	3.5	3.6	2.9	3.3	3.3	3.9	3.3	2.9	3.0	3.5	3.1	3.4
c.) Easy access to route Information	3.6	3.6	3.4	3.6	3.6	3.8	4.2	3.3	3.3	3.6	3.6	3.5
d.) Comfort of pier waiting area	3.3	2.9	2.8	3.3	3.4	3.3	3.1	3.1	2.8	3.2	3.0	3.2
e.) Service attitude of operator Staff	3.7	3.2	3.3	3.8	3.5	3.8	4.0	3.6	4.2	3.5	3.8	3.7
f.) Multi-modal connectivity of pier	3.5	3.6	3.1	3.4	3.7	3.6	4.0	3.4	2.5	3.6	3.2	3.5
g.) Walking accessibility to/from pier	3.7	4.0	3.9	4.0	3.8	3.9	3.6	3.3	2.5	3.8	3.5	3.6
h.) Diversity of activities around pier communities	3.5	3.7	3.3	3.6	3.7	3.6	3.4	3.5	3.0	3.6	3.3	3.6
i.) Sufficiency of greenery & open space	3.2	3.7	3.4	3.4	3.3	3.9	3.3	3.3	3.2	3.4	3.3	3.6
j.) Density of businesses & services around pier communities	3.4	3.5	3.5	3.2	3.6	3.4	3.3	3.0	2.8	3.5	3.2	3.2
Mean	**3.53**	**3.57**	**3.29**	**3.54**	**3.57**	**3.67**	**3.57**	**3.29**	**3.06**	**3.55**	**3.37**	**3.48**

Notes:

CEN: Central

WAC: Wan Chai

NOP: North Point

SWH: Sai Wan Ho

TST: Tsim Sha Tsui

HUH: Hung Hom

KOC: Kowloon City

KWT: Kwun Tong

SKT: Sam Ka Tsuen

C: Commercial Pier Community (Central, Wan Chai, Tsim Sha Tsui)

R: Residential Pier Community (North Point, Sai Wan Ho, Kowloon City, Sam Ka Tsuen)

M: Mixed Pier Community (Hung Hom, Kwun Tong)

Variability of satisfaction between pier communities

To examine the variability of satisfaction among different pier communities, ANOVA was performed. The results shown in Table 5.30 indicate that the "Node" dimension has an F-value of 2.417, suggesting a significant variation in satisfaction levels across various locations. This statistically significant finding indicates that certain pier communities differ in terms of accessibility, connectivity, and overall infrastructure.

In contrast, the F-values for the "Service" and "Sustainability" dimensions were lower, at 1.502 and 1.202, respectively. These lower values suggest less pronounced differences between communities, which do not reach statistical significance at the conventional threshold ($\alpha = 0.05$). The lack of significant differences in these dimensions might imply a more uniform level of service quality and sustainability across different pier communities.

Table 5.30 ANOVA for satisfaction between pier communities

Dimension		Sum of Square	*df*	Mean Square	*F* value	*p* value
Node	Between Groups	10.625	8	1.328	2.417	.016*
	Within Groups	120.328	219	.549		
Service	Between Groups	4.646	8	.581	1.502	.158
	Within Groups	84.686	219	.387		
Sustainability	Between Groups	4.945	8	.618	1.202	.299
	Within Groups	112.614	219	.514		

*. Correlation is significant at the 0.01 level (2-tailed).

5.3.2 Connection time and mode for FTOD sites

Understanding how people access and use ferry services is essential for optimising transportation networks and enhancing overall accessibility. Therefore, this analysis includes examining connection times and modes of transportation to and from the pier. By evaluating the efficiency and convenience of different transportation options in different pier communities, district-based characteristics in the FTOD network can be investigated.

Table 5.31 shows the Connection Time and Transport Mode taken by respondents for their last ferry trip from the origin to the pier and from pier to the destination. Most respondents would walk or bike to or from the pier to take ferry, with the highest usage reported for the connection time range of 6-10 minutes. Bus is also adopted as a mode of transportation across all time ranges, with the highest usage reported for connection time ranges of 21-30 minutes and 31 minutes or above. Fewer respondents would take MTR for connection and respondents would take for shorter duration for less than 20 minutes, since MTR also provides cross-harbour services with 4 metro lines. And for minibus, resident buses and taxi/private vehicles, these modes of transportation are less commonly used compared to other major modes of transportation, since minibus and resident buses usually connect to MTR stations as last-mile connections.

Regarding connection time, most respondents take 6-10 minutes or 11-20 minutes to and from the pier for their last ferry trip, with an average connection time of 15.5 minutes. Among all transportation modes, walking and biking have the shortest average connection time of 10.5 minutes, while the longest connection time is associated with bus transportation, averaging 22.5 minutes.

Table 5.31 Connection time and transport mode taken by respondents for their last ferry trip from origin to pier and from pier to destination

Time	Mode						Total
	Bus	Bike/ Walking	MTR	Resident Bus	Minibus	Taxi/ Private Vehicle	
≦5 mins	15	52	7	0	1	2	**77 (15.3%)**
6-10 mins	18	100	26	0	4	1	**149 (29.7%)**
11-20 mins	35	79	27	2	2	2	**147 (29.3%)**
21-30 mins	40	12	16	0	2	2	**72 (14.3%)**
≧ 31 mins	39	3	14	0	1	0	**57 (11.4%)**
Total	147 (29.3%)	246 (49%)	90 (17.9%)	2 (0.4%)	10 (2%)	7 (1.4%)	**502**
Average Connection Time (mins)	22.5	10.5	17.9	15.5	15.7	13.6	**15.5**

Table 5.32 shows the connection time and transport mode for individual pier communities. The distribution of transportation modes across all piers does not vary a lot and walking and bike are the most dominant modes of connection, exception are Tsim Sha Tsui and Kwun Tong, where the adoption of bus and walking/bike as connection is similar. The average connection time varies slightly across different pier communities, ranging from 10.5 minutes to 17.9 minutes. Kwun Tong has the highest average connection time at 17.9 minutes, followed by Hung Hom at 17.0 minutes, indicating longer travel times for residents to pier in these areas. Kowloon City has the shortest average connection time at 10.5 minutes, followed by North Point at 11.1 minutes.

Table 5.32 Connection time and transport mode for individual pier community

	Bus	Bike/ Walking	MTR	Resident Bus	Minibus	Taxi/ Private Vehicle	Average Connection Time (mins)
Central	34	70	26	1	1	3	15.0
Wan Chai	9	22	9	0	1	1	14.9
North Point	9	29	9	0	0	0	11.1
Sai Wan Ho	9	13	2	1	1	0	14.9
West Kowloon Cultural District	0	0	1	0	0	0	15.5
Tsim Sha Tsui	56	66	29	0	1	2	16.7
Tsim Sha Tsui East	0	3	1	0	0	1	16.3
Hung Hom	9	15	3	0	2	0	17.0
Kowloon City	5	6	2	0	0	0	10.5
Kai Tak Cruise Terminal	0	3	0	0	1	0	14.3
Kwun Tong	10	12	4	0	2	0	17.9
Sam Ka Tsuen	4	7	2	0	1	0	15.8

Table 5.33 presents a further analysis of the first-mile and last-mile connection transport modes utilised by passengers to travel to and from ferry piers. The majority of respondents adopt the same transportation modes for the two connection journeys, while one-fourth of respondents adopt bus-walk or walk-bus as connections. A notable decrease is observed in MTR usage when passengers travel as last-mile connection, suggesting that fewer passengers transfer to the MTR post-ferry.

Table 5.33 Connection transport mode between origin to pier and pier to destination

Mode		Pier to Destination					
		Bus	Bike/ Walking	MTR	Resident Bus	Minibus	Taxi/ Private Vehicle
Origin to Pier	Bus	11.6%	13.1%	2.8%	0.0%	0.8%	0.0%
	Bike/ Walking	12.7%	28.3%	4.8%	0.0%	0.8%	1.2%
	MTR	5.6%	8.0%	6.4%	0.0%	0.4%	0.4%
	Resident Bus	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%
	Minibus	0.0%	0.4%	0.8%	0.4%	0.0%	0.0%
	Taxi/ Private Vehicle	0.4%	0.0%	0.4%	0.0%	0.4%	0.0%

5.3.3 Site quantitative analysis

To evaluate the overall sustainability of FTOD (Ferry-Transit-Oriented Development) implementation, several key factors are taken into consideration, including population density, land use diversity, street density, and access to green spaces. By analysing these elements, it is possible to assess the degree to which FTOD initiatives contribute to urban sustainability.

Weighting on sustainable FTOD indicator

Prior to conducting quantitative analysis, the weighting of the three aspects of economic efficiency, social equity and environmental protection is ranked by the survey respondents. These rankings were then converted into specific weightings, as listed below in Table 5.34.

According to the weightings derived from the survey responses, there is a notable imbalance in the importance attributed to each of these aspects. Economic efficiency receives the highest weighting of 0.47, suggesting that stakeholders attribute significant importance to the economic aspects of FTOD. And for social equity (0.30) and environmental protection (0.23), the weighting received is much lower. This imbalance suggests that respondents tend to prioritise economic considerations over other factors when assessing FTOD's sustainability.

Table 5.34 Weighting on sustainable FTOD dimension

Sustainability Dimension	Raw Mean	Weighting
Economic Efficiency	1.59	0.47
Social Equity	2.11	0.30
Environmental Protection	2.30	0.23

For each sub-indicator under the same sustainability dimension, their weightings are calculated by the Principal Component Analysis, as shown in Table 5.35. In economic efficiency, commercial density is weighed as most important, while in social equity, number of bus route is significant important than the other two indicators. For environmental protection, the highest weighting is open space density.

Table 5.35 Weighting on sustainable FTOD sub-indicator

Sustainability Dimension	**Indicator**	**Factor Loading**	**Normalised Weight**
Economic Efficiency *(0.47)*	Population Density	0.863	0.33
	Employment Density	0.807	0.29
	Commercial Density	0.92	0.38
Social Equity *(0.30)*	Rent-to-income Ratio	0.785	0.34
	No. of Bus Route	0.914	0.46
	Land Use Diversity	0.62	0.2
Environmental Protection *(0.23)*	Recycle Facilities Density	0.787	0.32
	Street Pavement Density	0.765	0.30
	Open Space Density	0.856	0.38

Sustainable FTOD score

Table 5.36 presents Sustainable FTOD scores across various pier communities, in terms of weighting of economic, social, and environmental dimensions from the public, and Figure 5.1 displays the map of the Sustainable FTOD Index and Satisfaction Score in each pier community. Overall speaking, traditional urban core areas like Wan Chai (0.562) and Central (0.546) demonstrate relatively higher overall Sustainable FTOD Scores compared to other pier communities. However, some mixed development areas like Kowloon City (0.434) and Kwun Tong (0.419) also fall within a moderate range. Lower scores are observed in some pier communities with fewer commercial development, such as West Kowloon Cultural District and Sam Ka Tsuen, which are reflected in their respective Scores of 0.300 and 0.241.

Traditional business areas like Central, Wan Chai, and Tsim Sha Tsui tend to have relatively higher economic ratings compared to other pier communities, especially with their higher employment density and commercial intensity. Conversely, other non-commercial communities such as those of West Kowloon Cultural District and Sam Ka Tsuen, exhibit much lower economic ratings.

From the perspective of social dimension, residential areas like Sam Ka Tsuen, Kowloon City, and Kwun Tong exhibit higher scores, indicating better diversity and modal connection in these areas. Tsim Sha Tsui and North Point have relatively lower social scores, suggesting areas with potentially weaker social equity.

Regarding environmental dimension, West Kowloon Cultural District, North Point, and Tsim Sha Tsui East exhibit stronger environmental indicators compared to other pier communities. However, for Sam Ka Tsuen which is an industrial area, not much pedestrian pavement has been provided in the area and open space is also scarce.

Table 5.36 Sustainable FTOD score of pier community

Pier Community	Dimension												Sustainable FTOD Score
	Economic				Social				Environmental				
	P	E	C	**W. Score**	I	B	D	**W. Score**	R	S	O	**W. Score**	
Central	0.00	1.00	0.78	**0.584**	0.13	1.00	0.22	**0.546**	0.17	0.80	0.22	**0.379**	**0.525**
Wan Chai	0.13	0.94	0.76	**0.601**	0.21	0.41	0.60	**0.383**	0.22	0.68	0.33	**0.401**	**0.489**
North Point	1.00	0.13	0.11	**0.409**	0.03	0.40	0.11	**0.216**	1.00	0.69	0.00	**0.527**	**0.379**
Sai Wan Ho	0.72	0.05	0.00	**0.255**	0.30	0.31	0.66	**0.382**	0.62	0.55	0.46	**0.538**	**0.359**
West Kowloon Cultural District	0.20	0.07	0.01	**0.092**	0.00	0.53	0.32	**0.307**	0.05	0.33	1.00	**0.495**	**0.251**
Tsim Sha Tsui	0.04	0.36	1.00	**0.496**	0.14	0.40	0.00	**0.229**	0.32	0.93	0.08	**0.411**	**0.397**
Tsim Sha Tsui East	0.07	0.80	0.91	**0.597**	0.23	0.41	0.31	**0.326**	0.39	1.00	0.39	**0.575**	**0.511**
Hung Hom	0.68	0.17	0.35	**0.406**	0.19	0.11	0.69	**0.257**	0.18	0.95	0.27	**0.448**	**0.372**
Kowloon City	0.91	0.18	0.19	**0.426**	0.17	0.16	1.00	**0.338**	0.19	0.48	0.60	**0.431**	**0.401**

Pier Community	Economic				Social				Environmental				Sustainable FTOD Score
	P	E	C	**W. Score**	I	B	D	**W. Score**	R	S	O	**W. Score**	
Kai Tak Cruise Terminal	0.06	0.00	0.84	**0.336**	0.89	0.00	0.30	**0.363**	0.00	0.00	0.91	**0.343**	**0.346**
Kwun Tong	0.17	0.41	0.77	**0.469**	0.55	0.22	0.62	**0.413**	0.11	0.28	0.30	**0.230**	**0.397**
Sam Ka Tsuen	0.25	0.01	0.21	**0.165**	1.00	0.04	0.52	**0.464**	0.22	0.14	0.11	**0.156**	**0.252**

Notes:

W. Score: Weighted Score (under each dimension)

P: Population Density

E: Employment Density

C: Commercial Density

I: Rent to Income Ratio

B: Bus Route

D: Land Use Diversity

R: Recycling Facilities Density

S: Street Pavement Density

O: Open Space Density

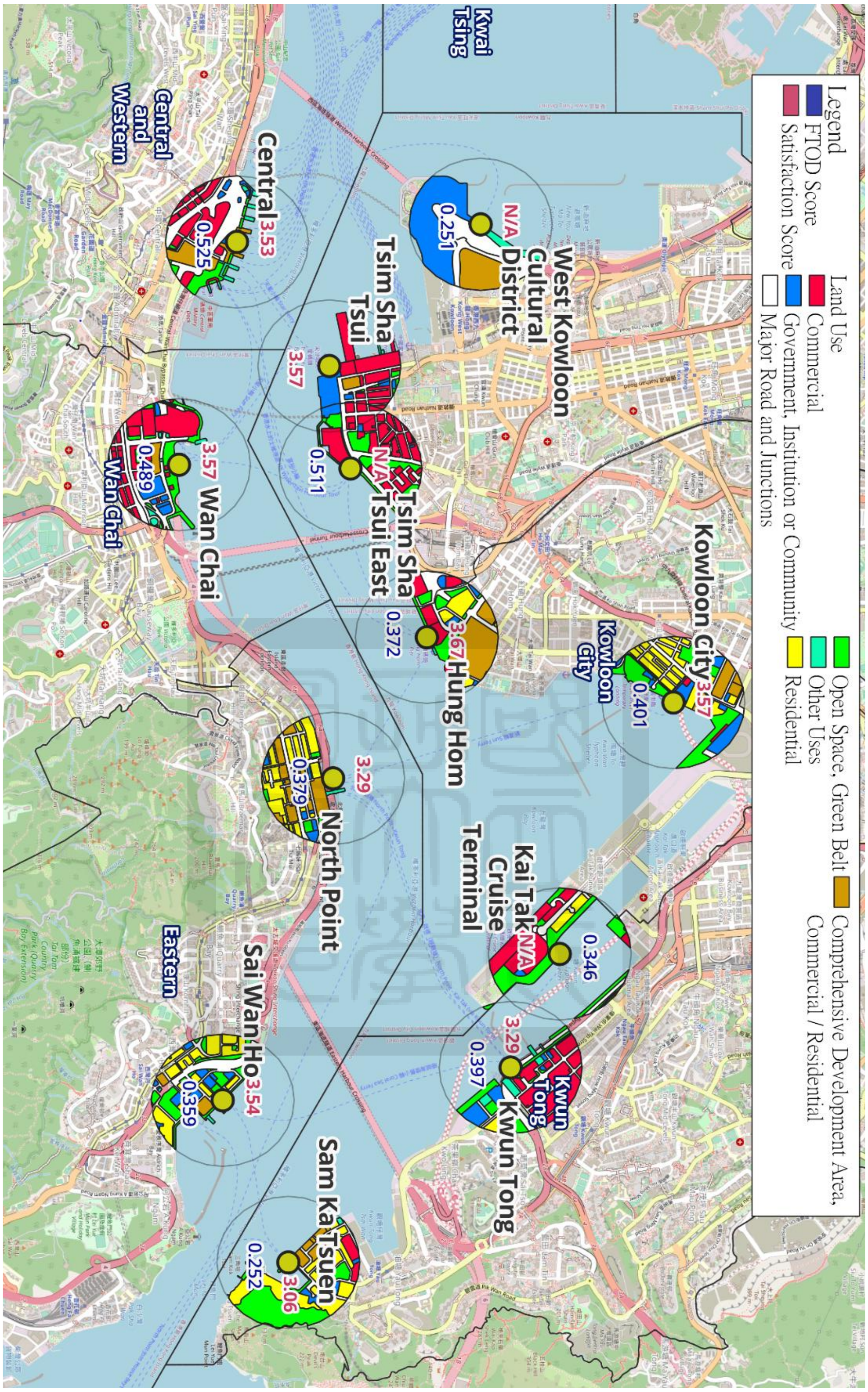


Figure 5.1 Sustainable FTOD index, satisfaction score and land use map of pier community

Word in Blue: Sustainable FTOD Index

Word in Red: Mean Satisfaction Score (from Respondents)

5.4 Perception towards FTOD

This section investigates into the perceptions surrounding the implementation of FTOD within and beyond the Victoria Harbour region. Through survey data, stakeholders' viewpoints on the effectiveness of measures aimed at facilitating FTOD and their overall perception of FTOD's potential impact across various dimensions have been explored.

Through the exploration of perceptions towards FTOD, insights to inform strategic decision-making and policy formulation aimed at promoting sustainable urban development and enhancing transportation connectivity within the urban region can be contributed.

5.4.1 Effectiveness on measures facilitating FTOD

Evaluating the perceived effectiveness of various initiatives, such as providing transfer concessions and enhancing connectivity between piers and other transit hubs, offers valuable insights into stakeholders' perspectives on the feasibility and impact of FTOD measures. This analysis is crucial for understanding the public's support for the potential success of FTOD initiatives.

Among the measures assessed, "Improving connection between pier and bus/ MTR station" received the highest mean score of 4.15, suggesting that respondents generally view enhanced transportation connectivity as crucial for promoting FTOD.

For "Rearrangement of ferry destination" with a mean score of 4.00, also indicates a strong support for initiatives aimed at expanding ferry routes to key destinations such as CBD.

For “Providing transfer concessions between ferry and bus/ MTR” received a moderate mean score of 3.86, suggesting that respondents perceive the integration of different modes of transportation as an essential component of FTOD.

For "Revitalising pier communities to accommodate diversified land use" with a mean score of 3.78, indicates moderate support for efforts to diversify land use and enhance the liveability of pier areas.

On the other hand, "Establishing more retail facilities in and around the pier" received a relatively lower mean score of 3.39, suggesting a relatively moderate level of support for this measure.

Table 5.37 summarises the perceived effectiveness of these initiatives:

Table 5.37 Effectiveness of initiatives for facilitating FTOD

Initiatives	**Mean**	**SD**
a.) Providing Transfer Concession between ferry and bus/ MTR	3.86	0.91
b.) Establishing more retail facilities in and around the pier	3.39	0.98
c.) Improving connection between pier and bus/ MTR station	4.15	0.84
d.) Revitalising pier communities to accommodate diversified land use	3.78	0.91
e.) Rearrangement of ferry destination, e.g. Increasing routes to CBD	4.00	0.83

Comparative analysis of perceived effectiveness of initiatives facilitating FTOD between two rider groups

For providing transfer concession, regular riders (mean = 4.16) perceive higher effectiveness compared to non-regular riders (mean = 3.77). The t-value of -3.01 indicates a statistically significant difference ($p < 0.01$), suggesting that regular riders find providing transfer concession more effective than non-regular riders.

For establishing more retail facilities, regular riders (mean = 3.64) perceive higher effectiveness compared to non-regular riders (mean = 3.31). The t-value of -2.35 suggests a statistically significant difference ($p < 0.05$), indicating that regular riders also find Establishing more retail facilities more effective than non-regular riders.

For improving connection to nearby nodes, regular riders (mean = 4.25) perceive slightly higher effectiveness compared to non-regular riders (mean = 4.12). However, the t-value of -1.05 does not reach statistical significance ($p > 0.05$), suggesting that there is no significant difference in perception between the two groups of riders.

For revitalizing pier communities, both non-regular and regular riders have the same mean score (3.78) for revitalizing pier communities. Therefore, a t-value of -0.002 indicates no significant difference in perception between the two groups of riders ($p > 0.05$).

Finally, for rearrangement of destination, regular riders (mean = 4.16) perceive slightly higher effectiveness compared to non-regular riders (mean = 3.95). However, the t-value of -1.76 does not reach statistical significance ($p > 0.05$), suggesting that there is no significant difference in perception between regular and non-regular riders.

In summary, regular riders generally perceive initiatives such as providing transfer concessions and establishing more retail facilities to be more effective compared to non-regular riders. However, there are no significant differences in perception between the two groups for initiatives such as improving connection, revitalizing pier communities, and rearrangement of destinations. Table 5.38 compares the effectiveness of Initiatives for facilitating FTOD between two rider groups.

Table 5.38 Effectiveness of initiatives of facilitating FTOD between two rider groups

Initiatives	Category	N	Mean	SD	t-value
a.) Providing Transfer Concession	Non-regular Rider	210	3.77	.94	-3.01**
	Regular Rider	64	4.16	.72	
b.) Establishing more retail facilities	Non-regular Rider	210	3.31	.98	-2.35*
	Regular Rider	64	3.64	.97	
c.) Improving connection	Non-regular Rider	210	4.12	.85	-1.05
	Regular Rider	64	4.25	.82	
d.) Revitalising pier communities	Non-regular Rider	210	3.78	.89	-.002
	Regular Rider	64	3.78	1.00	
e.) Rearrangement of destination	Non-regular Rider	210	3.95	.84	-1.76
	Regular Rider	64	4.16	.78	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

5.4.2 Perception of implementing FTOD in NDA/ New Town

Table 5.39 displays the perception of implementing FTOD in NDA or New Town, which captures stakeholders' perceptions of FTOD's potential benefits across key dimensions, including mobility, economic development, social equity, and environmental sustainability. By analysing stakeholders' expectations and concerns regarding FTOD's impact on urban mobility, economic benefits, social equity, and environmental quality, opportunities and challenges associated with implementing FTOD can be identified and explored.

Mobility enhancement has the highest score of aspect that the average mean score is 3.89, with individual scores for increasing the willingness to use ferries and relieving the shortage of public transport supply at 3.90 and 3.87, respectively, reflecting an overall positive outlook on the role of ferry services improving mobility.

The economic benefit aspect has a mean score of 3.65, with "boasting business development in waterfront areas" and "increasing the flow of people at the waterfront" receiving high scores of 3.98 and 4.03, respectively. However, "raising property value" has a lower mean of 3.32, suggesting less perceived impact on real estate markets.

The social equity aspect shows a mean score of 3.30, reflecting a neutral perception of FTOD's role in promoting social equity. Statements such as "enhancing social interaction" and "increasing mobility for the underprivileged" score 3.33 and 3.26, respectively, indicating that it may not perceive FTOD as significantly contributing to social equity.

For environmental protection, the mean score is 3.63, with "improving waterfront landscape" receiving a relatively high score of 3.90, and "reducing greenhouse gases and pollution" scoring lower at 3.35, suggesting that FTOD's impact on environmental sustainability may vary depending on the specific environmental factors.

Table 5.39 Statement of perception on implementing FTOD in NDA or New Town

Aspect	Statement	Mean
Mobility Enhancement	a) Increase willingness of using ferry	3.90
	b.) Relieve shortage of supply of public transport	3.87
	Mean	**3.89**
Economic Benefit	c.) Boast business development in waterfront area	3.98
	d.) Raising property value	3.32
	e.) Increase flow of people at waterfront	4.03
	Mean	**3.65**
Social Equity	f.) Reduce personal economic burden	3.25
	g.) Enhance social interaction	3.33
	h.) Increase mobility for underprivileged	3.26
	Mean	**3.30**
Environmental Protection	i.) Improve waterfront landscape	3.90
	j.) Reduce greenhouse gases and pollution	3.35
	Mean	**3.63**

The correlation Table 5.40 reveals several significant relationships among perceptions of FTOD. Enhanced public transport supply correlates with increased willingness to use ferries, higher business development, and improved social interaction. Business development positively associates with pedestrian flow, property values, and landscape improvement. Increased pedestrian flow and social interaction correlate with higher property values and reduced pollution. Improved social interaction significantly enhances mobility and reduces economic burdens and pollution. Enhanced mobility for the underprivileged is linked to better social interaction, reduced economic burdens, and improved landscapes.

Table 5.40 Correlation matrix in the statement of FTOD perception evaluation

	W	S	B	V	F	E	I	U	L	P
W	1									
S	.442**	1								
B	.400**	.449**	1							
V	.269**	.373**	.445**	1						
F	.321**	.319**	.513**	.399**	1					
E	.140*	.357**	.218**	.342**	.155*	1				
I	.344**	.289**	.332**	.407**	.234**	.449**	1			
U	.163**	.230**	.213**	.346**	.152*	.498**	.546**	1		
L	.288**	.254**	.468**	.223**	.385**	.243**	.432**	.418**	1	
P	.304**	.354**	.279**	.392**	.268**	.473**	.511**	.484**	.433**	1

Notes:

W: Increase willingness of using ferry

S: Relieve shortage of supply of public transport

B: Boast business development in waterfront area

V: Raising property value

F: Increase flow of people at waterfront

E: Reduce personal economic burden

I: Enhance social interaction

U: Increase mobility for underprivileged

L: Improve waterfront landscape

P: Reduce greenhouse gases and pollution

Comparative analysis of perception of FTOD between two rider groups

Table 5.41 shows the comparative analysis of ferry rider perception on dimensions of FTOD. From the perspective of mobility enhancement, the mean perception score is higher among regular riders (4.16) compared to non-regular riders (3.81), and the t-value of -3.48 suggests that the difference in perception scores between regular and non-regular riders is statistically significant ($p < 0.001$), suggesting that regular riders perceive greater mobility enhancement compared to non-regular riders.

Considering economic benefit, the mean perception score is slightly higher for regular riders (3.86) compared to non-regular riders (3.75). However, the t-value of -1.15 indicates that this difference is not statistically significant ($p > 0.05$).

From the perspective of social equity, the mean perception score is substantially higher among regular riders (3.71) compared to non-regular riders (3.15) The t-value of -4.68 suggests that the difference in perception scores between the two groups is statistically significant ($p < 0.001$), implying that regular riders perceive greater social equity compared to non-regular riders.

Finally, from the perspective of environmental protection, the mean perception score is higher among regular riders (3.82) compared to non-regular riders (3.57). The t-value of -2.21 suggests that the difference in perception scores between regular and non-regular riders is statistically significant ($p < 0.05$), suggesting that regular riders perceive greater environmental protection compared to non-regular riders.

To sum up, regular riders generally perceive higher levels of mobility enhancement, social equity, and environmental protection compared to non-regular riders. However, there is no statistically significant difference in the perception of economic benefit between the two groups.

Table 5.41 Comparative analysis of ferry rider perception on dimensions of FTOD

Dimension	Category	N	Mean	SD	t-value
Mobility Enhancement	Non-regular Rider	200	3.81	.71	-3.48***
	Regular Rider	61	4.16	.60	
Economic Benefit	Non-regular Rider	200	3.75	.66	-1.15
	Regular Rider	61	3.86	.69	
Social Equity	Non-regular Rider	200	3.15	.83	-4.68***
	Regular Rider	61	3.71	.77	
Environmental Protection	Non-regular Rider	200	3.57	.82	-2.21*
	Regular Rider	61	3.82	.66	

***. Correlation is significant at the 0.001 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Chapter 6 Discussion

The discussion section explores the aspects of FTOD in Hong Kong, emphasising the usage patterns, efficiency, and sustainability of ferry routes and pier communities. Through detailed analysis, the study evaluates the role of ferry services and pier hubs in urban mobility, considering both quantitative and qualitative dimensions. Findings from ferry route usage and efficiency evaluation are also synthesised, examine the performance and satisfaction of FTOD sites, and explore public perception towards FTOD. By integrating these perspectives, the discussion provides a comprehensive understanding of how ferry services and the concept of FTOD can contribute to sustainable mobility in Hong Kong.

6.1 Ferry route usage and efficiency evaluation

Route usage

Analysing the ferry routes taken by respondents during their most recent trip, the H01 and H03 routes emerged as the most popular. These routes connect high-traffic commercial areas like Central and Tsim Sha Tsui, which are significant business districts and retail hubs. Despite nearby cross-harbour MTR service, these routes still attract considerable ferry usage, drawing both commuters and visitors. Conversely, routes connecting residential and mixed land-use communities, such as North Point and Sam Ka Tsuen, are less popular, likely due to their lower levels of commercial activity and fewer tourist attractions.

When considering the primary purposes for taking the ferry, the most common purpose for both non-regular and regular riders are for recreation (42.6%) and excursion (23.1%), instead of commuting (17.9%), which may prove that ferry transport is yet to be the dominant mode for passenger to consider as cross-harbour transport mode, especially for the non-regular rider which accounts for the majority within the sample. However, the result also suggests that ferry services play a significant role in leisure and recreational activities, catering to those seeking scenic rides or relaxation during their free time.

Influencing factor of usage

Regarding the perspective of importance of factors in influencing usage of the inner-harbour ferry service, service hour and frequency are ranked the most important, and the results are also in line with Tsoi & Loo study (2021) on usage of territory-wide ferry service in Hong Kong. Since most routes operate in a frequency of half an hour or even less, compared to other cross-harbour bus lines or MTRs which typically have a frequency of 10 minutes or even more, this could be a barrier to ferry usage. The shorter service hours of no service after the afternoon peak hour also contributed to the reason for more concern about service hours of ferry routes. Moreover, the analysis also reveals that route-related factors (mean of 3.86) are more important than vessel-related factors (mean of 3.58), which suggests that the reliability and connectivity of ferry routes are more essential to users, possibly since these attributes directly impact commuting and travel efficiency. On the other hand, a larger deviation has been observed between non-regular and regular riders on the capacity affecting usage of ferry, probably because regular riders are more likely to take ferry during peak hour, when the load factor is higher and thus more likely for the vessel to reach full capacity.

Route efficiency

For the efficiency of ferry route, in both models, the high efficiency of routes connecting Central Business Districts (CBDs), such as route H01, is expected due to consistent demand from commuters and tourists. This suggests that this route is effectively utilizing its resources to maximize service provision. In contrast, regarding other routes connecting residential areas with commercial or industrial districts, like North Point and Kowloon City, may face operational challenges and fluctuating demand, leading to lower efficiency scores.

Routes with higher peer counts, such as H01 with two peers, are more likely to benefit from mutual learning opportunities. In contrast, routes with no identified peers, such as H02, H03, H05, and H08, lack significant similarities with other routes, potentially indicating unique operational characteristics that require tailored improvement strategies.

Slack variable analysis indicated that significant reductions in input variables could improve efficiency, which suggests that optimising vessel deployment could play a crucial role in enhancing route efficiency, though the actual scale of reduction would need to consider passenger feedback, as reducing some surplus service may not be favourable for existing passengers.

6.2 Quantitative analysis on FTOD site

Site sustainability

Unlike conventional TOD analysis, which emphasises efficiency, sustainable FTOD site analysis incorporates broader criteria, including social, environmental, and economic dimensions. In this framework, individual densely populated commercial districts like Tsim Sha Tsui do not achieve high sustainability scores as expected. This is largely due to a lack of land use diversity and open spaces, which negatively impacts their performance in the social and environmental dimensions of sustainability.

For instance, Tsim Sha Tsui, a renowned commercial district with a cluster of scenic spots along the waterfront, demonstrates the limitations of the traditional TOD framework when applied to sustainable FTOD framework. Despite its higher economic activity and efficiency in terms of transportation, the area suffers from limited land use diversity and inadequate open spaces. These factors contribute to lower scores in social and environmental sustainability.

In contrast, other CBDs like Central and Wan Chai perform better across all dimensions of sustainability. These districts benefit from a relatively balanced mix of commercial and recreational spaces, enhanced public amenities, and green spaces, which contribute to higher social and environmental sustainability scores.

Residential and mixed-use pier communities that are proximate to the inner city, such as Kowloon City and Kwun Tong, also score higher in terms of land use diversity and connectivity under the social equity dimension. Though these areas are early developed and had suffered from urban decay in previous decades, with the revitalisation and land use restructuring attempts, these areas also integrate residential development with commercial, recreational, and public facilities, fostering a more vibrant and sustainable community.

For some lagged-behind pier communities like Sam Ka Tsuen and West Kowloon Cultural District, since large-scale development projects are in progress, and their industrial and institutional designations respectively limit development diversity. Further development and revitalisation strategies, for instance, enhancing attractiveness of public space to achieve balanced, sustainable mobility based on the concept of FTOD can be achieved in the pier communities with moderate and lower scores.

Satisfaction

From the perspective of satisfaction analysis, the highest satisfaction indicator is the choice of ferry destination with a high mean score of 3.71, implying a positive perception of the availability and accessibility of ferry routes among respondents, coupled with a low standard deviation, which suggests a consistent level of satisfaction across respondents regarding ferry destinations. In addition, the pier with the highest mean score is the Hung Hom Pier, which was rebuilt after the 1990s with relatively newer facilities. Moreover, it is connected to a covered bus terminal for a short distance with a covered walkway, which favours passengers to connect.

On the other hand, aspects related to the hardware of pier require improvement. The comfort of the pier waiting area and sufficiency of pier facilities received a relatively low mean score of 3.22 and 3.36, respectively, suggesting that existing infrastructure might need upgrades or expansion to better accommodate stakeholders' needs.

To analyse the satisfaction across different types of pier communities, residential communities generally scored lower than mixed and commercial communities in most aspects. This suggests that pure residential communities may have challenges like fewer amenities or less diverse activities around the pier, contributing to lower satisfaction scores. The significant variability in the "node" dimension highlights the importance of focusing on specific locational factors when assessing satisfaction levels in pier communities. The uniformity observed in the "service" and "sustainability" dimensions might reflect consistent service delivery and sustainability practices across the different pier communities, potentially due to standardised policies and practices implemented by the government authorities and operators.

Connectivity

For the connection time and mode, the majority of respondents in the survey tend to walk or bike to or from the pier, with the highest connection times falling within the 6 to 10 minute range. This preference for active mobility suggests a strong pedestrian-friendly environment around ferry piers. According to the principles of TOD, creating a walkable environment is crucial for reducing reliance on automobiles and promoting public transit usage (National Academies of Sciences, Engineering, and Medicine, 2004). The integration of pedestrian and cycling infrastructures around ferry piers can further support this trend, encouraging more residents to opt for these sustainable modes of transportation.

Bus transportation is also a commonly adopted mode across all time ranges, with the highest usage in longer connection durations of 21-30 minutes and over 31 minutes which indicates that bus services play a key role in connecting distant neighbourhoods to ferry piers. Moreover, to take a closer look at the individual pier communities, in Tsim Sha Tsui and Kwun Tong, the usage of bus transportation is nearly equivalent to walking and biking, due to the presence of large bus terminals at these piers which influences residents' choices to choose bus for connection when travelling to and from the pier.

6.3 Perception towards FTOD

Perception of current FTOD initiatives

Although the concept of FTOD is relatively novel, the general public holds a positive view of its potential effects, especially with the implementation of the FTOD policy framework. Rather than focusing on large-scale revitalisation projects, respondents showed a preference for measures that improve the connectivity of ferries with other modes of transport and key economic activities. The high scores for "improving connection between pier and bus/ MTR station" emphasise the importance of seamless intermodal transfer options, including covered walkways in short distances, in encouraging the use of ferry services as part of a comprehensive transit network. Research indicates that well-designed intermodal connections, such as covered walkways and short-distance transfers, significantly boost public transit ridership and improve the overall satisfaction of commuters (Currie & Delbosc, 2011).

The relatively higher score for "providing transfer concession between ferry and bus/MTR" underscores the importance of incentivising the use of multiple transport modes. This could increase ferry ridership while reducing transportation costs for existing ferry users, as reflected in a t-test analysis showing regular riders' support for this initiative. "rearrangement of route destinations to CBD" also received a higher score, suggesting that longer-haul ferry routes to central business districts could attract more commuters, as current routes often offer only one destination across the harbour.

Perception on future FTOD planning

From a broader perspective, the public's perception of promoting FTOD in new towns or new development areas indicates a generally positive attitude towards its potential benefits. The highest mean score was for mobility enhancement, emphasising that ferry services can play a significant role in addressing public transport shortages and promoting sustainable transportation. However, public perception towards social equity of FTOD would bring remain neutral, suggesting that the initiatives of FTOD may not be adequate to alleviate the current challenges of equity issues in Hong Kong. Therefore, future FTOD policies should incorporate more inclusive measures to ensure that benefits are equitably distributed among all social groups.

Moreover, regular ferry riders tend to have more favourable perceptions of FTOD in most aspects. This could suggest that consistent use of ferry services leads to a better understanding and appreciation of their benefits, highlighting the need for further promotion of the usage of ferry services to engage non-regular riders. Case studies from cities with FTOD implementations, such as Stockholm and Sydney, illustrate the importance of public awareness and engagement in fostering a more positive perception of ferry services (Tanko et al., 2018).

Chapter 7 Conclusion

This thesis concludes with policy recommendations derived from the comprehensive analysis of FTOD in Hong Kong. Overall, the findings suggest that promoting FTOD in Hong Kong could be feasible, provided that challenges related to service frequency, operational efficiency, pier infrastructure quality, and intermodal connectivity are addressed. The positive public perception and specific recommendations for improving connectivity support the idea that FTOD could play an emerging role in enhancing sustainable mobility in Hong Kong.

7.1 Policy suggestion

Route-related measures

Given the crucial role that ferry service quality plays in implementing FTOD, it is imperative to enhance the performance of current ferry routes to encourage greater usage among passengers for cross-harbour transportation. Based on the questionnaire results from this study, the two factors that most influence the willingness to use ferries are service hours and frequency. A thorough review of existing ferry routes is essential to determine how these factors can be improved.

One key observation is that many inner-harbour routes operate with only one vessel, thereby limiting the ability to increase frequencies due to speed constraints within the harbour. Take route H06 operated by Fortune Ferry as an example, this route has only 1 vessel deployed, the sailing time for a round trip is 25 minutes (excluding 3-4 minutes berthing time in two piers) and the frequency of the route during weekday is 30 minutes, which has no room to increase the frequency further unless expanding fleet size.

The expansion of service hours also presents challenges, requiring additional staff and potentially increased working hours, thereby adding operational complexities. Taking Sun Ferry as an example, the working hours of inner-harbour ferry route staff are 14 hours

(06:30-20:30) without shift, which is in line with the service hour of routes (07:00-20:00). In case of expanding the service hour to midnight (07:00-23:00), extra shifts may be required (06:30-15:00/15:00-23:30) to fulfil a reasonable working hour requirement. Therefore, under current circumstances, it would be challenging for operators to easily increase frequency and service hours.

However, routes with lower efficiency may adopt possible measures for improvement. For instance, the adoption of smaller vessels during non-peak hours could minimize input, along with maintaining a reasonable frequency. The two routes operated by Sun Ferry (H04, H05) serve as a case study. Despite having higher capacity fleets compared to other routes with similar patronage and frequency, these two routes exhibit lower load factors (<20%), indicating inefficiencies even during peak times. Since these vessels are rented from other operators, there is greater flexibility to rent smaller vessels, which can be more cost-effective and efficient, thus promoting economic sustainability.

Another policy suggestion is to encourage inter-modal transfer concessions between ferries and other public transport systems like buses and MTR. Although ferry and bus operators are separate entities, complicating the provision of fare concessions, the MTR has demonstrated the feasibility of concessions with minibus routes and kaito routes. The government may mediate and facilitate discussions for bus, rail, and ferry operators on inter-mode transfer concession schemes, potentially mandating this as part of the renewal process when extending bus and ferry service franchises. By promoting seamless connectivity between different transport modes, which reduces the reliance on private vehicles, and lowers overall carbon emissions

Finally, expanding more ferry destinations in the CBD could significantly impact public willingness to use ferries. While the water taxi route initially targeted high-end commuter services but shifted toward tourist cruises, the concept of multi-stop and longer routes can be expanded to more routes. For instance, services connecting eastern Kowloon areas like Kwun Tong and Kai Tak to Central. The case in New York illustrates that since the multi-point water taxi links between TODs, which withstands competition with other major modes of transportation (Thompson et al., 2007). Moreover, since most urban destinations of the outlying island ferry routes are concentrated in Central, these routes may also extend to other urban areas of Hong Kong during peak hours, for instance, Kwun Tong and Hung Hom while Central act as en-route mid-stop, which can expand the coverage of existing outlying island route, as well as act as supplement to the inner-harbour ferry route with the adoption of faster vessel to improve passenger satisfaction. This concept aligns with public opinion, which supports more extensive ferry routes and destinations.

Pier-related measures

As indicated by the questionnaire results, the aspects of pier satisfaction that received the lowest ratings were the comfort of the waiting environment and the sufficiency of pier facilities. These deficiencies not only hinder passenger usage but also impede the effectiveness of FTOD. Therefore, it is imperative to innovate existing piers and design new-generation piers for future development areas. Given that most piers are owned by the government and operators have limited financial resources for pier renovations, the government should allocate more resources to renovate inner-harbour ferry piers and improve their connectivity to nearby communities by providing shelters, which raise the attractiveness of taking ferry.

Although a small proportion of respondents agree on the effectiveness of providing more retail facilities at piers to enhance FTOD, this policy can still prove effective for piers located in residential or industrial areas. These retail and commercial facilities need not adhere to conventional formats such as convenience stores or tuck shops; instead, they can be flexible and innovative. For example, HYF, a former operator of inner-harbour passenger ferries that still owns a pier for cruise ferries, established a retail store selling souvenirs and ready-to-eat meal sets at its pier for cruise passengers and residents. Ferry operators can utilise idle spaces within pier premises to increase non-fare box revenue, and diversifying income sources from ferry operations can enhance the financial sustainability of the ferry industry. Moreover, renting idle pier spaces to local businesses or entities can also enhance the social cohesion of the community, for instance, by acting as a community art gallery or holiday market.

Community-related measures

To address the unique needs of pier communities, integrating the physical attributes of FTOD sites with traditional TOD indicators, along with insights from public surveys, can provide a comprehensive framework for urban development strategies tailored to both existing and emerging pier communities. These strategies should be designed to align with the general public's preferences while fostering sustainable development.

In the government's planning proposal, the East Lantau Metropolis, situated in the channel between the western part of Hong Kong Island and the eastern part of Lantau Island, is slated for reclamation and development into the third central business district (CBD) and new town post-2030. Despite the proposed transportation infrastructure for this development, which includes roads and a railway tunnel connecting Hong Kong Island to Lantau Island, there remains untapped potential for the outlying island ferry system to complement the existing road transport network. This initiative presents an opportune setting for the establishment of an FTOD site, facilitating efficient ferry connectivity for residents residing at a distance from rail nodes. Therefore, planners and policymakers should focus on developing comprehensive multimodal transportation networks that facilitate seamless transfers between ferries, buses, as well as other transportation modes in these new FTOD communities.

For existing pier communities with considerable potential yet constrained by current infrastructure, revitalization emerges as a viable avenue. Despite ongoing redevelopment projects adjacent to certain piers, such as those in North Point and Sai Wan Ho on Hong Kong Island, these endeavours have failed to integrate ferry transportation into their master plans. This oversight has prevented the ferry transport system from capitalising on the successes of TOD projects in these local communities. To mitigate this issue, the government can address the matter through land rezoning, designating the pier area and its adjacent land as a comprehensive development area (CDA). This designation would permit composite development atop piers for commercial use, with the adjacent land earmarked for high-density commercial and residential purposes. Such an approach would facilitate the establishment of high-density commercial and residential land use on the landside of the piers, fostering a more vibrant and economically robust environment capable of supporting a more efficient ferry system. Moreover, by promoting high-density, mixed-use developments, which further reduces the need for longer commuting journeys and support the wider use of public transportation, especially ferry transport.

7.2 Research limitation

1. Distribution constraints of questionnaires: The study's reliance on e-questionnaires due to the physical constraints of conducting conventional questionnaires in Hong Kong, which limited the diversity and representativeness of sample in terms of gender and age. Future studies could consider a hybrid approach, where e-questionnaires are supplemented with targeted face-to-face interviews, particularly in public spaces near ferry terminals, to enhance the demographic representativeness of the sample.
2. Exclusion of financial variables in DEA analysis: Due to the inability to obtain financial information on ferry routes since the financial transparency of the ferry industry is rather low, financial variables are not included in the DEA analysis. In addition, external socio-economic factors are not included in the second stage of DEA analysis due to time constraints. Future research could establish collaborations with ferry operators or government agencies to access financial data, providing a more comprehensive analysis. Incorporating external socio-economic factors into the DEA analysis could also offer a broader context for interpreting efficiency scores and provide a more robust foundation for policy recommendations.
3. Absence of expert input on sustainability dimensions: The lack of expert involvement in weighing the importance of different sustainability dimensions in the FTOD analysis could compromise the technical accuracy of the sustainable FTOD index. Future studies shall consider engaging experts in urban planning, transportation, and sustainability to contribute their insights into the development of the FTOD index, which pave way for a comparison study on the perspective between experts and the public to be done on investigating the difference on the benefits of FTOD, thereby enriching the analysis with a diverse range of views.

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Appendices

Sample of Questionnaire Questions

Dear Respondents,

Thank you for taking your precious time on this questionnaire. This research thesis is regarding the ferry services in Hong Kong and we are sincerely inviting you for your valuable feedback on the ferry service demand and the views on Ferry-Based Transit-Oriented Development (FTOD). This questionnaire will take 5-10 minutes to complete. This questionnaire is for academic propose only and all collected information (if any) will remain anonymous and strictly confidential, and will be destroyed after the research has been accomplished. Your response would be appreciated.

Personal Demographic Information
a. What is your Gender? ☐Male ☐Female
b. What is your Age? ☐20 or below ☐20-30 ☐31-40 ☐41-50 ☐51-60 ☐60-70 ☐71 or above
c. What is your District of Residence? ☐Central & Western ☐Eastern ☐Wan Chai ☐Southern ☐Kowloon City ☐Sham Shui Po ☐Yau Tsim Mong ☐Wong Tai Sin ☐Kwun Tong ☐Kwai Ching ☐Tsuen Wan ☐Sai Kung ☐Sha Tin ☐Tai Po ☐Tuen Mun ☐Yuen Long ☐North ☐Islands ☐Others
d. What is your Personal Average Monthly Income? ☐$0-10,000 ☐$10,001-20,000 ☐$20,001-30,000 ☐$30,001-40,000 ☐$40,001-50,000 ☐$50,001 or above

e. What is your Occupation Status?

☐Full-Time Work ☐Part-Time Work ☐Self-employed ☐Employer ☐Homemaker

☐Unemployed ☐Student ☐Retired

f. What is your education level? *(Including the programme you have completed or will be completed)*

☐Senior Secondary (Form 7) or below ☐Sub-Degree ☐Bachelor ☐Postgraduate

Section 1: Ferry usage experience

1. What is your major mode crossing the Victoria Harbour?

☐Bus ☐Ferry ☐MTR ☐Private Vehicle ☐Minibus

2. How often do you take inner-harbour ferry in the past one year?

Inner-harbour ferry refers to ferry routes operate within Victoria Harbour, between Hong Kong Island and Kowloon

☐Everyday ☐Few times a week ☐Once a week ☐Few times a month

☐Once a month ☐Few times a year ☐Haven't taken inner-harbour ferry

3a. On your last inner-harbour ferry trip, where is the origin pier?

☐Central ☐Wan Chai ☐North Point ☐Sai Wan Ho

☐West Kowloon Cultural District ☐Tsim Sha Tsui ☐Tsim Sha Tsui East

☐Hung Hom ☐Kowloon City ☐Kai Tak Cruise Terminal ☐Kwun Tong

☐Sam Ka Tsuen

3b. As above, where is the destination pier?

☐Central ☐Wan Chai ☐North Point ☐Sai Wan Ho

☐West Kowloon Cultural District ☐Tsim Sha Tsui ☐Tsim Sha Tsui East

☐Hung Hom ☐Kowloon City ☐Kai Tak Cruise Terminal ☐Kwun Tong

☐Sam Ka Tsuen

4. For your last journey on ferry, 4a. What is your travelling purpose? *If there are more than one purpose, select the one with most importance* ☐Commuting to school/ workplace ☐Perform essential task, e.g. medical check ☐Recreation and Sport ☐Shopping ☐Excursion, e.g. going to scenic spots or taking ferry as sightseeing ☐Others
4b. Which type of transport mode you have adopted for connection from origin of the journey to ferry pier/ from ferry pier to destination of the journey? *If the connection journey is composed of more than 1 mode, choose the transport mode with the longest traveling time* i.) From journey origin to pier ☐Bus ☐Bike or Walking ☐MTR ☐Resident Bus ☐Minibus ☐Taxi/ Private Vehicle ii.) From pier to journey destination ☐Bus ☐Bike or Walking ☐MTR ☐Resident Bus ☐Minibus ☐Taxi/ Private Vehicle
4c. As above, how long is the time for the transport mode you have adopted for connection? - i.) From journey origin to pier ☐≦5 mins ☐6-10 mins ☐11-20 mins ☐21-30 mins ☐≧31 mins - ii.) From pier to journey destination ☐≦5 mins ☐6-10 mins ☐11-20 mins ☐21-30 mins ☐≧31 mins

5. For your last journey on ferry, how would you rate the satisfaction of the origin pier and its proximate community according to the following factors?

- a.) Choice of Ferry Destination

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied) ☐5 (Very Satisfied)

- b.) Sufficiency of Pier Facilities (e.g. Toilet, Vending Machine)

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied) ☐5 (Very Satisfied)

- c.) Easy accessing of Route Information (timetable, fare etc.)

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied) ☐5 (Very Satisfied)

- d.) Comfort of pier Waiting Area

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied) ☐5 (Very Satisfied)

- e.) Service Attitude of Operator Staff (at pier and on vessel)

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied) ☐5 (Very Satisfied)

- f.) Multi-modal Connectivity of pier (e.g. Connection with multiple transportation mode)

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied) ☐5 (Very Satisfied)

- g.) Walking Accessibility of pier

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied) ☐5 (Very Satisfied)

- h.) Diversity of (economic, leisure, social etc.) activities around the pier communities

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied)

☐5 (Very Satisfied)

- i.) Sufficiency of Greenery and open space

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied)

☐5 (Very Satisfied)

- j.) Density of Businesses and Services around the pier communities

☐1 (Very Dissatisfied) ☐2 (Dissatisfied) ☐3 (Neutral) ☐4 (Satisfied)

☐5 (Very Satisfied)

6. How important are the following factors in influencing your decision to take inner-harbour ferry?

If certain factor (e.g. faster speed) increases or decreases your willingness of taking ferry, it may refers to higher importance

- a.) Speed of route

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- b.) Frequency of route

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- c.) Punctuality of route

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- d.) Service hour of route

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- e) Fare of route

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- f.) Comfort of vessel environment

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- g.) Scenic view from vessel

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- h.) Safety of taking ferry

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

- i.) Capacity of vessel

☐1 (Very Unimportant) ☐2 (Unimportant) ☐3 (Neutral) ☐4 (Important)

☐5 (Very Important)

Section 2: View on Ferry-Based Transit-Oriented Development (FTOD)

7. For the following suggested measures, how would you evaluate the effectiveness to facilitate FTOD?

- a.) Providing Transfer Concession between ferry and bus/MTR

☐1 (Most Ineffective) ☐2 (Ineffective) ☐3 (Neutral) ☐4 (Effective)

☐5 (Most Effective))

- b.) Establishing more retail facilities in and around the pier

☐1 (Most Ineffective) ☐2 (Ineffective) ☐3 (Neutral) ☐4 (Effective)

☐5 (Most Effective))

- c.) Improving connection between pier and bus/MTR station

☐1 (Most Ineffective) ☐2 (Ineffective) ☐3 (Neutral) ☐4 (Effective)

☐5 (Most Effective))

- d.) Revitalising pier communities to accommodate diversified land use

☐1 (Most Ineffective) ☐2 (Ineffective) ☐3 (Neutral) ☐4 (Effective)

☐5 (Most Effective))

- e.) Rearrangement of ferry destination, e.g. Increasing routes to CBD

☐1 (Most Ineffective) ☐2 (Ineffective) ☐3 (Neutral) ☐4 (Effective)

☐5 (Most Effective))

8. Please rank the 3 Major aspects of sustainable FTOD in terms of their importance.

Please pull the most important aspect to the top

- Economic Efficiency

☐1 ☐2 ☐3

- Social Equity

☐1 ☐2 ☐3

- Environmental Protection

☐1 ☐2 ☐3

9. If FTOD and new ferry service will be established in new development area (NDA) of urban area or new town, do you agree with the following statements?

- a) Increase willingness of using ferry

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- b.) Relieve Shortage of Supply of Public Transport

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- c.) Boast business development in waterfront area

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- d.) Raising property value

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- e.) Increase flow of people at waterfront

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- f.) Reduce personal economic burden

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- g.) Enhance social interaction

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- h.) Increase mobility for underprivileged (e.g. low income, minority ethnicity)

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- i.) Improve waterfront landscape, e.g. Increase green and open space

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

- j.) Reduce greenhouse gases and pollution

☐1 (Very Disagree) ☐2 (Disagree) ☐3 (Neutral) ☐4 (Agree) ☐5 (Very Agree)

List of local Facebook groups

1. 西貢將軍澳討論區 (https://www.facebook.com/groups/80818851828/)
2. 香港渡輪討論區 Hong Kong Vessel Discussion Board (https://www.facebook.com/groups/hkvdb/)
3. 觀塘谷 (https://www.facebook.com/groups/467034677468624/)
4. 九龍城區群組（九龍城. 九龍塘. 黃埔. 紅磡. 土瓜灣. 何文田） (https://www.facebook.com/groups/816396979206435/)
5. 筲箕灣西灣河關注組 (https://www.facebook.com/groups/skwswh/)
6. 北角有樂 (https://www.facebook.com/groups/lightupnorthpoint/)
7. 油塘人之家 Home of Yau-Tonger (https://www.facebook.com/groups/homeofyautonger/)
8. 啟德 Kai Tak (https://www.facebook.com/groups/240428095502479/)
9. 荃灣友 (https://www.facebook.com/groups/727601220585091/)
10. 觀塘聯盟 (Kwun Tong Coalition) (https://www.facebook.com/groups/115881602077639/)
11. 灣仔人灣仔事 (https://www.facebook.com/groups/800569847287500/)
12. WanchaiCBGreaterBay 灣仔/銅鑼灣/大灣區 (https://www.facebook.com/groups/worldcriminalsathousandyears/)
13. 無無聊聊黃大仙群 (https://www.facebook.com/groups/678796279150054/)
14. 尖沙咀之友 (https://www.facebook.com/groups/315982855506741/)
15. 慈雲山資訊交流 (https://www.facebook.com/groups/2015twz2/)
16. 柴灣討論區 (https://www.facebook.com/groups/347688302354463/)
17. 九龍城開心 Share (https://www.facebook.com/groups/2722099514713953/)
18. 九龍灣 (https://www.facebook.com/groups/474404562660643/)

19. 港島東區 柴灣人 好多事 討論區

(https://www.facebook.com/groups/1758930721049907/)

20. 何文田土瓜灣之友 (https://www.facebook.com/groups/1847491125276445/)

21. 南區街坊之友 (https://www.facebook.com/groups/335680440416716/)

22. 住喺紅磡嗰度 (https://www.facebook.com/groups/1438053419818976/)

23. 藍田之友 (https://www.facebook.com/groups/237861027861/)

24. 柴灣小西灣快 d join la=]

(https://www.facebook.com/groups/157712594293055/)

25. 沙田/馬鞍山之友 (https://www.facebook.com/groups/372700526272413/)

26. 荃灣人討論區 (https://www.facebook.com/groups/278022514514813/)

27. 新蒲崗討論區 (https://www.facebook.com/groups/1237726583008693/)

28. 紅磡＊何文田＊黃埔＊資訊發佈會

(https://www.facebook.com/groups/2449201798465041/)

29. 九龍城・九龍塘・太子道西

(https://www.facebook.com/groups/271701814207702/)

30. 深水埗 Gogogo (https://www.facebook.com/groups/675401992495456/)

31. 黃大仙，牛池灣，鑽石山，慈雲山，新蒲崗，九龍灣，牛頭角，彩虹之友

(https://www.facebook.com/groups/334029757538803/)

32. 香港交通及突發事故報料區(https://www.facebook.com/groups/hkroad/)

33. 紅磡黃埔社區藍圖 (https://www.facebook.com/groups/2763971180378225/)