ACCESSIBILITY OF HARBOUR CROSSINGS IN HONG KONG

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Hong Kong has three vehicular harbour crossings. The two-lane Cross Harbour Tunnel (CHT) was the first road crossing across the Victoria Harbour. Before the opening of the tunnel, residents and vehicles crossed the harbour on both passenger and vehicular ferries, regular vehicular ferries ceased operations in 1998. Those ferries were inefficient, leading to jams in docks and had a low capacity for vehicles. As the population of Hong Kong increased, the number of harbour-crossing journeys also increased. By 1989, Eastern Harbour Crossing (EHT) opened, a dual-use harbour crossing with two lanes and double tracks currently carrying the Tseung Kwan O Line of the MTR. From the development of Eastern New Territories and the congestion in the CHT, the EHT also became very popular. As part of the Airport Core Programme, the three-lane Western Harbour Crossing (WHT) opened in 1997 and is under private operation until 2023 due to the Build-Operate-Transfer model.

The tolerable capacity is defined as levels of congestion which does not affect non-harbour crossing traffic thus, tolerable to drivers (Transport and Housing Bureau, 2010). That is different to the designed capacity of the tunnels due to various capacities of connecting roads, which increases the capacities for the CHT and EHT while bottlenecking the WHC. The designed capacity of tunnels does not account for connecting roads. The daily average flow accounts for the daily average number of cars passing through the tunnels.

The Cross Harbour Tunnel has long been the bottleneck of Hong Kong’s traffic flow, and two out of three tunnels have gone beyond their limits during rush hour (Transport Department, 2018a). The traffic congestion problem on harbour-crossing main roads is adversely impacting the functioning of our society and economy. Hindering the economy through wasted man-hours, vehicle operating costs and fuel costs while also damaging the environment due to additional vehicle emissions where 3,800 tons of carbon dioxide may be reduced if traffic redistribution is done properly. With more optimal traffic conditions, studies show that up to HK$600 million per year could be gained by our society (Transport Department, 2018a). Thus, we hope to obtain and analyse data to improve our understanding of the issue, possibly aiding strategies to mitigate this issue.
To conduct our research, we are simulating the journey of the average daily commute by private car drivers in all eighteen districts in Hong Kong from their homes (a residential district) to their workplaces (a commercial district) via a harbour crossing. Since the scope of this research is rather large, the journey is divided into two parts in the analysis for better organization, readability and simplification. The routes are set to show the shortest driving time based on the ArcGIS online database. The departure time is set to be 08:30 on 27th April, 2020 (Mon).

The first part (Analysis 1) covers the journey from residential zones to the entrances of the three harbour-crossings. We selected 18 starting points from the 18 districts of Hong Kong based on the centroids of the district constituency with the highest population density in each district. This represents the average commuter of the district as the constituency with the highest population serves a well representation for most commuters of the district.

The second part of the analysis (Analysis 2) simulates private car drivers’ commuting from the exits of the three existing harbour crossings.

In 2017, private cars, motorcycles and taxis constitute around 70% of tunnel traffic at the Cross Harbour Tunnel while only transporting a minor portion of passengers, the majority of users are in franchised and non-franchised buses. Although encouragement to use public transport or park-and-ride facilities has been made, many users of the tunnel are required to cross the tunnel due to social obligations or otherwise. Harbour-crossing journeys are important in integral to daily life to significant numbers of residents in Hong Kong, when including journeys made on the MTR system, 16% of all trips made are cross-harbour (Transport Department, 2011a). Improvements such as redistribution of traffic would greatly improve the quality of life for many residents, saving up to 19,400 man-hours daily for public transport users and 17,600 hours daily for truck drivers (Transport Department, 2018a).

**METHODOLOGY**

**Aims of the analysis:**

1. To better understand the reasons behind the current phenomenon
2. To suggest measures that are able to relieve the situation
3. To suggest long-term measures that are able to eliminate the underlying causes of the phenomenon

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towards significant commercial centres on both sides of Victoria Harbour. The outline zoning plan (ESRI China (Hong Kong), 2019) was used to locate commercial clusters, and the centroid of those clusters were used as endpoints.

After finding out the routes of both analyses, the travel distance and travel time for each route will be measured. Then, the cost of each journey is calculated in reference with the gas cost added with the tunnel toll for private cars. The gas cost is set to be $0.7 per km for a 1500cc small size Japanese automobile (Moneyhero, 2020). The following table shows the equation used in the calculation:

<table>
<thead>
<tr>
<th>Tunnel</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Harbour Tunnel</td>
<td>$(\text{Distance} \times 0.7) + 75 + \text{Other Tolls}$</td>
</tr>
<tr>
<td>Central Harbour Tunnel</td>
<td>$(\text{Distance} \times 0.7) + 20 + \text{Other Tolls}$</td>
</tr>
<tr>
<td>Eastern Harbour Tunnel</td>
<td>$(\text{Distance} \times 0.7) + 25 + \text{Other Tolls}$</td>
</tr>
</tbody>
</table>

To ensure a simple and clear comparison, we classified 18 starting points from 18 districts into 5 territories in legislative council geographical constituencies. Then we calculated the average value of each category.

## ROUTE ANALYSIS

Below are various figures representing data generated.

**Table:**

<table>
<thead>
<tr>
<th>Territory</th>
<th>Average Travel Time</th>
<th>Average Distance</th>
<th>Average Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Territories East</td>
<td>24.1 mins</td>
<td>24.85 km</td>
<td>$109.1</td>
</tr>
<tr>
<td>New Territories West</td>
<td>19.7 mins</td>
<td>23.07 km</td>
<td>$103.7</td>
</tr>
<tr>
<td>Kowloon East</td>
<td>11.9 mins</td>
<td>7.52 km</td>
<td>$81.8</td>
</tr>
<tr>
<td>Kowloon West</td>
<td>6.5 mins</td>
<td>4.21 km</td>
<td>$78.0</td>
</tr>
<tr>
<td>Hong Kong Island</td>
<td>9.6 mins</td>
<td>6.42 km</td>
<td>$79.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Territory</th>
<th>Average Travel Time</th>
<th>Average Distance</th>
<th>Average Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Territories East</td>
<td>23.3 mins</td>
<td>22.12 km</td>
<td>$44.2</td>
</tr>
<tr>
<td>New Territories West</td>
<td>24.1 mins</td>
<td>24.43 km</td>
<td>$49.7</td>
</tr>
<tr>
<td>Kowloon East</td>
<td>9.0 mins</td>
<td>5.84 km</td>
<td>$24.1</td>
</tr>
<tr>
<td>Kowloon West</td>
<td>7.0 mins</td>
<td>4.61 km</td>
<td>$23.2</td>
</tr>
<tr>
<td>Hong Kong Island</td>
<td>7.4 mins</td>
<td>5.08 km</td>
<td>$24.8</td>
</tr>
</tbody>
</table>
The analysis is summarized by combining two analyses into 4 distinctive harbour crossing journeys from residential zones to commercial districts in eastern and western parts of Hong Kong Island or Kowloon. Then, the accessibility is measured based on driving time and the cost comparison of three tunnels is calculated.
1. Accessibility of the three tunnels

Four commercial centres are selected not because of its significance in commercial sector, but also it keeps certain distance from the tunnels which would not be too close from one of the tunnel to give an useful summary.

For the route to Central, the centre part between WHT and CHT, we can see WHT has dominance in accessibility from New Territories West. Kowloon West shares similar journey time (0.2 mins difference) with WHT in terms of CHT though it has the highest accessibility using CHT with the rest part of Kowloon and New Territories.

Eastern part of Kowloon and New Territories shows the highest accessibility when using EHT to North Point, with the central location between CHT and EHT. Meanwhile, the journey time is faster to use CHT to move across the harbour for North Point.

In terms of the analysis cross harbour driving for Hong Kong Island residents, the data is displayed through 4 districts of Hong Kong Island. For the journey to Mong Kok, most part of Hong Kong Island are more accessible by CHT. Central and Western District by WHT shares the same time with Wan Chai using the CHT.

Kowloon East, the second CBD in Hong Kong, is more accessible from eastern part of Hong Kong Island by EHT without a doubt. However, EHT has the similar accessibility with CHT from Wan Chai and Southern District despite their proximity to CHT.

2. Cost Comparison

From analysis 1, when comparing the average cost of three tunnels, we found that the Western Harbour Tunnel is 2.93 times and 2.25 times more expensive than the Cross Harbour Tunnel and the Eastern Harbour Tunnel respectively. The over-priced Western Harbour Tunnel may be one of the reasons why drivers prefer using the other two tunnels in normal journeys.

From accessing the tunnels and the end point using the most accessible tunnel, the average travel cost for New Territories is $65.2, for Kowloon is $27.2 and for Hong Kong Island is $43.9. The cost gap between New Territories and other parts of Hong Kong in mostly because the additional toll from other tunnels or bridges causing an imbalance in travel cost between 3 districts.
Conclusion of the findings:

The over-priced Western Harbour Tunnel discourages regular uses, causing under-utilization and more flow onto the other two cheaper tunnels. The WHT failed to divert traffic flow from two other tunnels, despite it showing good accessibility to major commercial clusters. More remoted New Territories is also having a significantly high travel cost than Kowloon and Hong Kong Island.

In addition to that, the Cross Harbour Tunnel has a more accessible location from major parts of Hong Kong and to major commercial districts on Hong Kong Island and Kowloon West, causing an imbalance of traffic flow for three tunnels and over-saturated CHT.
Two main suggestions are suggested to resolve this urban issue of traffic congestion.

1. Improvements on Public Transport

There are various different strategies to improve the traffic conditions in the tunnels. A common suggestion to build a fourth crossing across Victoria Harbour is not suggested due to the psychology of drivers. More people would drive if the capacity of the tunnels would increase, thus not necessarily improving the issue of congestion. Instead the most impactful strategy is to increase the number of cross harbour journeys on public transportation. Making public transport cheaper or even free, a strategy used in Luxembourg (Mobilite Gratuite, 2020), can reduce drivers, though this might not be effective in Hong Kong as most people who are incentivised by finance already take public transportation as the cost of car ownership is extremely high and simply not needed, as shown from the low percentage of lower income residents with cars (Transport Department, 2011a). Thus, instead of financial incentives, convenience should be considered most important when trying to convert drivers to public transport. More direct and frequent connections to CBDs or existing transport systems can be made to rural or suburban areas where cars are used for necessity or convenience and not for social obligations. Although this might not be entirely economically practical, it would help resolve this urban issue. Pedestrianisation or having transit only streets in the CBD may also further discourage car usage as it becomes more convenient to take faster public transport.

To more specifically target cross harbour traffic, alternate harbour crossing methods may be encouraged, this may include building more harbour crossing metro lines as well as making ferries more attractive. In the case of the Netherlands, cycling infrastructure is well integrated and has priority over cars in the inner city. Bike parking spots are plentiful near large stations and to aid river-crossing journeys, ferries are free and accessible (Amsterdam TIPS, 2020).

2. Toll Adjustments

Toll adjustments are the most likely strategy the Hong Kong government is going to undertake as it is quick to implement and effective. Another options for toll adjustments may include extra charges on the Cross Harbour Tunnel during peak periods (e.g. 0800-0930, 1900-2030) as the measure against externality of traffic congestion, encourages flexible working hour to avoid high commuter cost or uses of the similarly-accessible Western Harbour Tunnel.

3. Increasing the Accessibility of WHT

In order to increase the utilization of WHT, construction for bypasses is a solution to increase the connectivity of WHT to other parts of Hong Kong. For example, the Central-Wanchai Bypass, linking up Wan Chai North and North Point to Central through a tunnel, helps WHT users avoid the heavy surface traffic when heading towards central and eastern part of Hong Kong Island. Same measures can also adopt to the Kowloon side (i.e. Central Kowloon Route: connects WHT to Kowloon East from 2025). With the completion of bypasses, accessibility to WHT increases, the CHT and EHT’s traffic flow towards places like Kowloon East, North Point and Wan Chai can be diverted by WHT, which alleviate the congestion in those tunnels.
LIMITATIONS

1. Lack of Appropriate Data
The accuracy of the analysis can be improved if data on the distribution of job opportunities in a commercial zone can be obtained. Currently, the end point is set as the centroid of the commercial zone which does not necessarily represent where the majority of people will go. This is similar for the residential distribution, in Hong Kong, wealthy rural and suburban neighborhoods with less optimal public transport, such as Rural North West New Territories and Rural South East New Territories (RSENT) are more likely to own cars, with 42.3% of households in RSENT owning a car (Transport Department, 2011b). That could potentially be better represented by the constituency with the lowest population density, rendering the starting points for the first part inaccurate, despite that, the aforementioned areas are overly large and broad to condense into one point with the only roads linking to the center of town or the constituency with the highest population, thus the latter was chosen in this investigation. Adding on, the data shows the proportion of households with cars, which is different from the number of cars in the area, the number of harbour-crossing journeys is also different depending on the district. More accurate data on where car-owners live and places they go to will greatly improve the accuracy of this analysis. During the deindustrialization of Hong Kong, many former industrial buildings were converted into commercial buildings. Planning authorities have not changed the subsequent land uses and those office buildings continue to be on industrial zoned lands. More so, other commercial buildings are not in the commercial cluster and were not included in our analysis. Commuters commonly go to places other than their homes and their workplace, those journeys are not represented. The proportion of home to work journeys in comparison to other journeys as well as the proportion of those journeys that require harbour crossings may also increase the accuracy of this investigation.

2. Commuting Times Not Realistically Reflected
Our analysis does not take traffic congestions into account. The driving time and the suggested route displayed in the analysis are just theoretical and optimal data based on the distance and the traffic regulation of the road. This may affect the analysis result as traffic congestions are often found at CHT and EHT but not at WHT. Drivers often change routes according to the congestion in various bottlenecks, including the harbour-crossings. Other bottlenecks in Hong Kong include the various land-tunnels connecting Kowloon and Sha Tin, Lung Cheung Road, Kwun Tong Road and Gascoigne Road.

CONCLUSION

The road network is the backbone of economic and social activities in Hong Kong. Traffic congestions at the harbour crossings continually hinders economic development and the quality of life of resident. The reasons for the congestion is believed to be related to the following two factors. High tolls of the Western Harbour Tunnel and the imbalanced accessibility for the three tunnels. While the root cause of the traffic is the imbalanced distribution of homes and jobs between the two sides of the harbour. Strategies to more evenly distribute traffic and to reduce demands are approaches to this issue and should be made by the government to improve quality of lives of residents.
VIDEO & WEBSITE

Video: https://drive.google.com/open?id=1ntVllsm9FdArKYe3L-o71YX0I4IE1uXI
Website: https://adrian0t.wixsite.com/hcaa-2020

BIBLIOGRAPHY


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