Extended Essay for Geography

Topic: Traffic Congestion in Hong Kong

Research Question: What is the relationship between land-use intensity and traffic congestion in different parts of Hong Kong's urban areas?

Candidate Number: gzk284

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Contents

0 Abbreviations List

CBD	Central business district
GFA	Gross Floor Area
KOW	Kowloon Peninsula
HBO	Home-based-others (commuters)
HBS	Home-based-school (commuters)
HBW	Home-based-work (commuters)
HK	Hong Kong
HKI	Hong Kong Island
LUI	Land-use Intensity
PLVI	Peak Land Value Intersection
PR	Plot Ratio
QoL	Quality of Life
SRCC	Spearman's Rank Correlation Coefficient
TC	Traffic Congestion
TCI	Traffic Congestion Index
TMT	Trip-making-time
TST	Tsim Sha Tsui
TSY	Tsing Yi
VoT	Behavioural value of time
WEK	Weekend
WEP	Weekday-evening-peak
WMP	Weekday-morning-peak
WOP	Weekday-off-peak

1 Introduction

1.1 Research question and objective

The research question of this study is *"What is the relationship between land-use intensity (LUI) and traffic congestion (TC) in different parts of Hong Kong's (HK's) urban areas?"* The aim of this study is to examine the relationship with reference to the spatial and temporal context of HK's urban development.

1.2 Research Hypotheses

Since plot ratio (PR) and traffic congestion index (TCI) are justified proxy indicators for LUI and TC, my hypotheses are :

Null Hypothesis (H_0): TCI and PR in HK's urban areas are not correlated (R=0)

Alternative Hypothesis (H_1): TCI and PR in HK's urban areas are correlated (R$\neq$ 0)

1.3 Literature Review

1.3.1 Understanding land-use intensity (LUI)

By definition, land use intensity is "the extent to which land is used" (Zhang et al, 2017), an indicator for spatial interactions among places, transport and, economic demands.

1.3.2 Understanding Traffic Congestion (TC) and its significance for HK

TC refers to the reduction in vehicle movement (Downs, 2018), and occurs when there is a deficit between traffic demand and supply; that is, demand for traffic is considerably higher than supply, leading to competing use of road infrastructure. High demand can be caused by too many vehicles, a result of an inadequate public transport system for both passengers and freight, leading to excessive vehicle ownership (Transport Advisory committee, 2014); low supply can be attributed to an inadequate road system, a result of over-development, out-of-sync traffic signals

and obstacles like road maintenance.

Examples for primary effects of TC include increased travel time and worsened roadside air quality; Both tangible and intangible secondary effects include wasted time on individuals, additional logistical costs for businesses and worsened quality of life (QoL). Yet, the complexity of interactions between road users and its infrastructure contributes to a greatly dynamic nature of our transport system, which often makes TC unpredictable.

While Hong Kongers take pride in being efficient, average car journey speed in urban areas drastically dropped from 25.6 km/h in 2003 to 22.7 km/h in 2013 (Transport Advisory committee, 2014) as outlined by figure 1. Considering the fact that TC is a worsening negative externality, it is therefore an issue worthy of scrutiny.

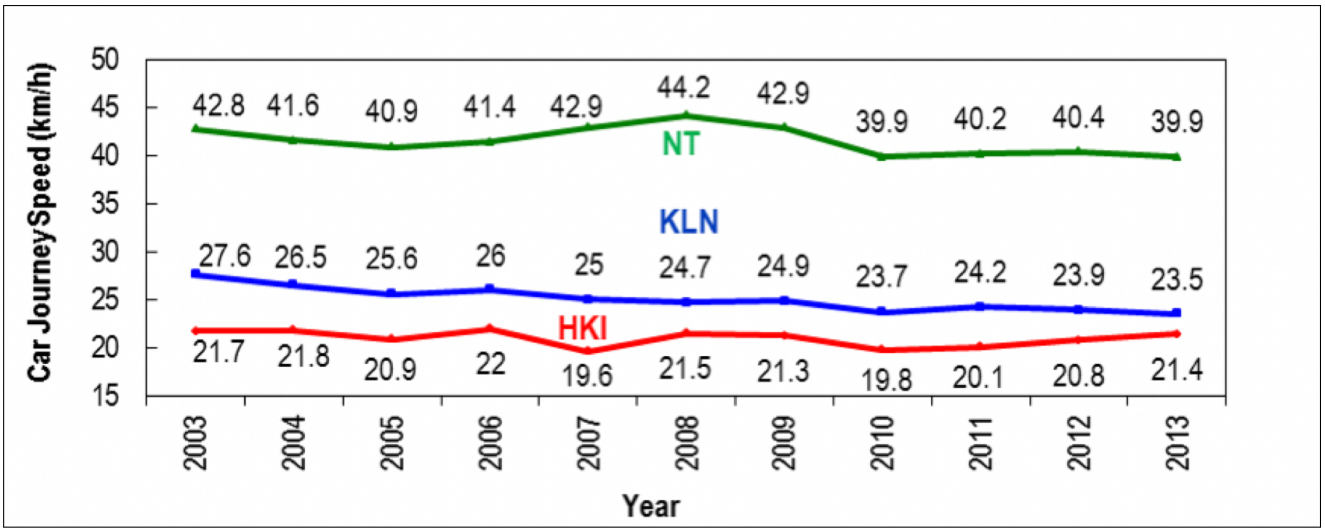

Figure 1: Car journey speeds during morning-peak hours on weekdays (2003-2013) (Transport Advisory committee, 2014)

1.3.3 Land-use intensity and congestion in the context of urban land-use models

The Core-Frame Model as outlined in figure 2 describes internal zoning in the central-business-district (CBD) with respect to the Bid-rent theory, which states that the accessibility is proportional to the attractiveness of a plot.

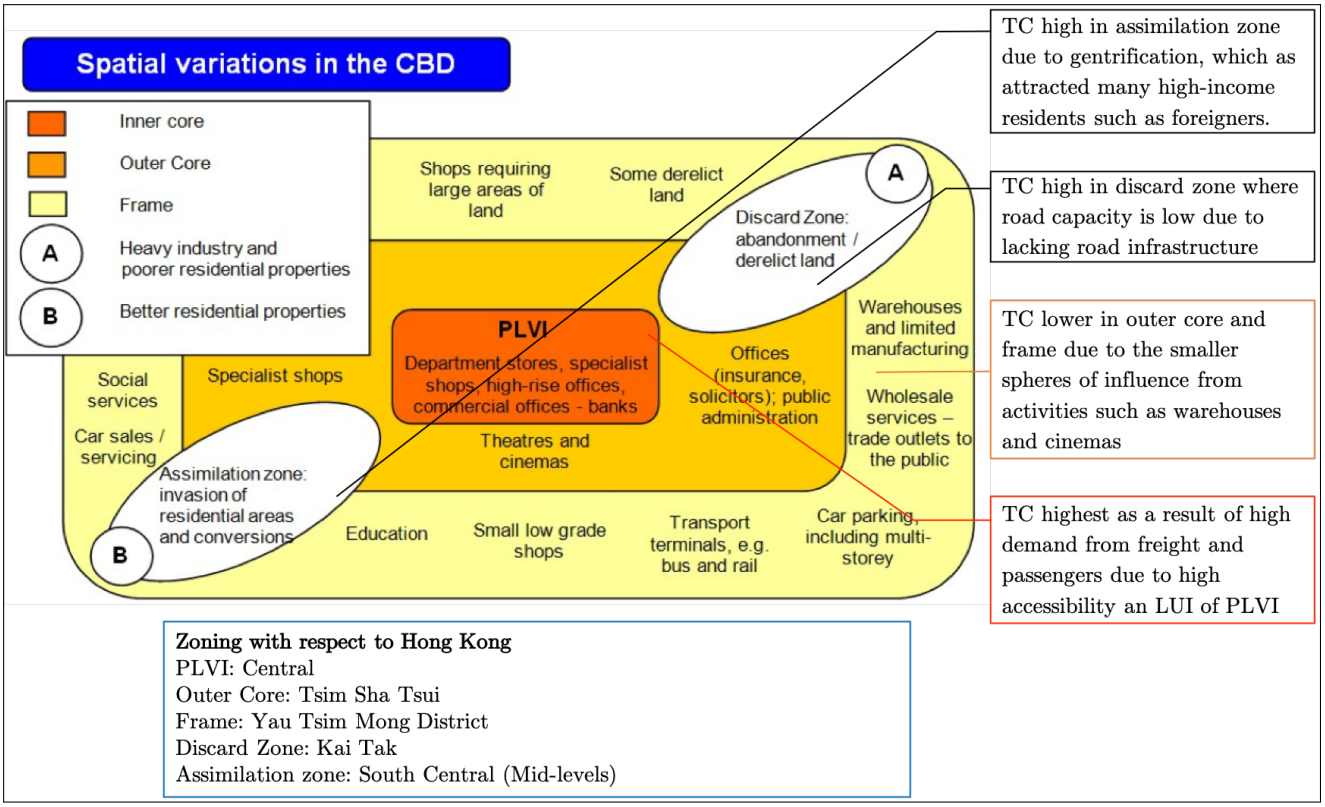

Figure 2: CBD Core-Frame Model (Burdett) of Hong Kong, annotations devised by author.

The variation of the LUI in urban areas of HK as a whole can be represented by the multi-nuclei-model, figure 3.

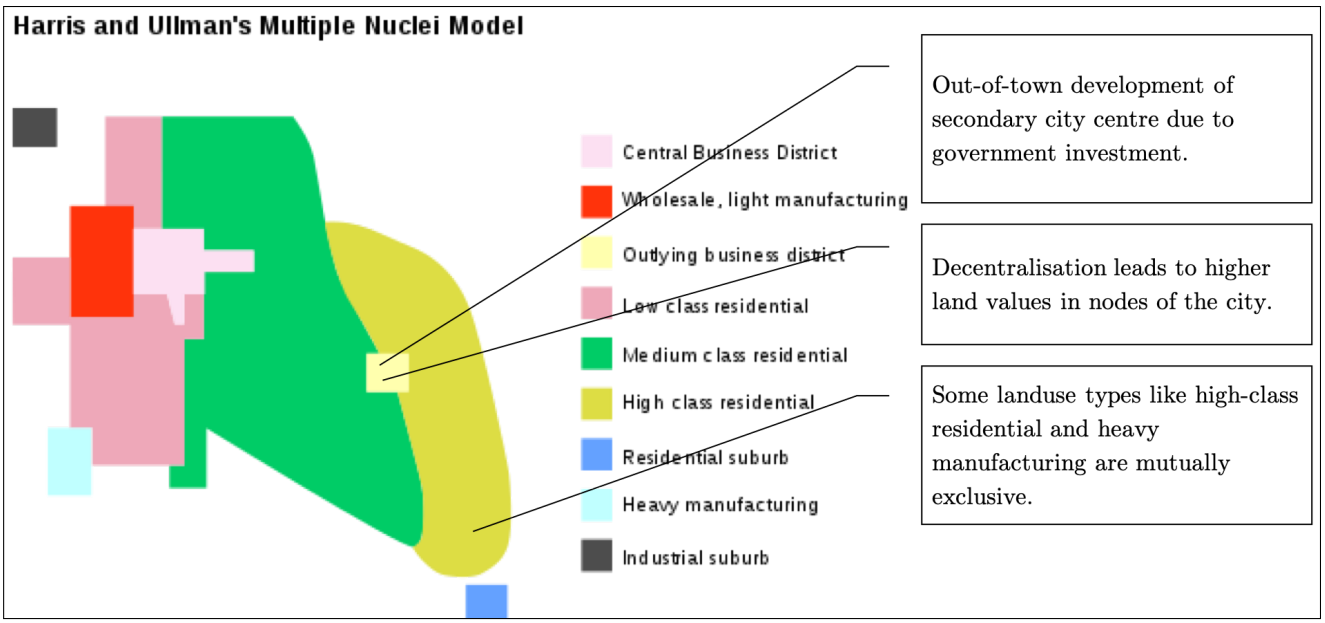

Figure 3: The multi-nuclei-model reflects the diverse nature of large urban areas, annotations devised by author. (SuzzaneKn, 2009)

In context, Central is HK's CBD, where the city's key finance and consulting institutions are located to take advantage of the convergence of railways as shown in figure]reffig:mtr . On the other hand, there are multiple secondary business districts or nodes, like Tsim Sha Tsui (TST) in the Kowloon Peninsula (KOW) developed as a result of decentralisation of businesses and urban renewal; these locations are deemed attractive for some enterprises as they are closer to suburbs, where the majority of HK's population reside in. Since a higher LUI represents a greater density of human activities, regions with higher LUI will have greater TC. The spatial distribution of nodes and cores mentioned are outlined in figure 5.

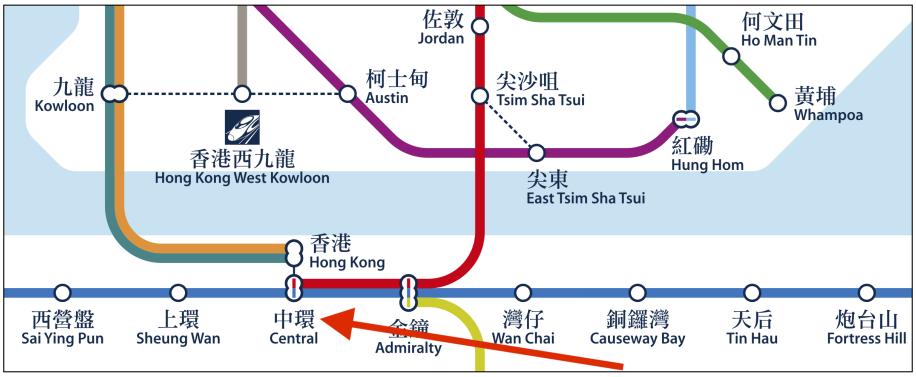

Figure 4: The system map shows convergence of 4 railway lines in Central, where Central and Hong Kong are connected stations with one paid zone. ((MTR)

Figure 5: Cores and nodes of CBDs in HK, key devised by author. (Lam, 2011)

In this research, LUI and TC will be compared across various zones; the choice of locations will later be justified.

1.3.4 The significance of this investigation

Past journals on land-use often utilised complex variables which are accounted for during land-use zoning, such as employment, population density and land-use diversity. For instance, a study on relationship between TC and land-use zoning concluded that:

> ...(T)he influence of the high proportion of commercial land use on the traffic congestion was significant. Also, we (.....) performed a linear regression analysis between the congestion time and the ratio of four types of land use. The results showed that the reasonable ratio of land use types could efficiently reduce congestion time. (Zhang et al, 2017)

A further in-depth study on these journals shows that scholars often only select a few point of interests (POI) for analysis, such as houses and shops, instead of analysing urban-land-attributing-data. Consequently, these studies offered little to no objective conclusions regarding the "perfect" ratio of land-use types that could efficiently reduce TC; to a certain extent, they do not aid the planning of urban land-use.

While LUI is independent of the complex spatial and temporal patterns regarding the commute of consumers from residences to their second or third places of lives and other factors like friction of distance, from a city planner's perspective, LUI is a quantified variable that can be easily controlled during planning stage. Therefore, the relationship between LUI and TC is a worthy subject for scrutiny, and further analysis of this relationship would testify the ability of LUI to tackling the root causes of TC.

2 Methodology

2.1 Sampling of data collection points

Throughout this investigation, both primary and secondary data research methods will be employed. Primary research involves collecting data on behalf of the author, which involves collecting data from various databases and collating them to make them relevant and specific for this investigation; secondary research involves collecting data from previously conducted studies directly relevant to this research. (DeVault, 2018). For instance, most data in this study will be obtained through primary research, since gross floor area (GFA) (refer to section 2.2) and area of land plot is often measured using Google Maps' area calculation utility.

To investigate the relationship between PR (refer to section 2.2) and TCI (section 2.3), which are proxy indicators for LUI and TC respectively, PR and TCI at each location will be calculated. The TCI quantifies traffic from different points of the urban area to a suburb; the selected location is Tsing Yi (TSY) MTR on account of the following reasons:

1. When a 9.5km radius circle is drawn from TSY, the circumference spans across a large proportion of KOW and northern HK Island (HKI), which maximises the number of data points in different parts of HK's urban areas. Note that these data points will often be referred by their bearings later in the essay.

2. TSY is in Tsuen Wan new town, an out-of-town residential suburb that has a demographic with a wide income discrepancy. Hence, residents, albeit blue or white-collar-workers, will typically commute from home to urban areas for work during daytime and vice versa in the evening; therefore, they will experience TC.

Figure 6 maps the data points of this study.

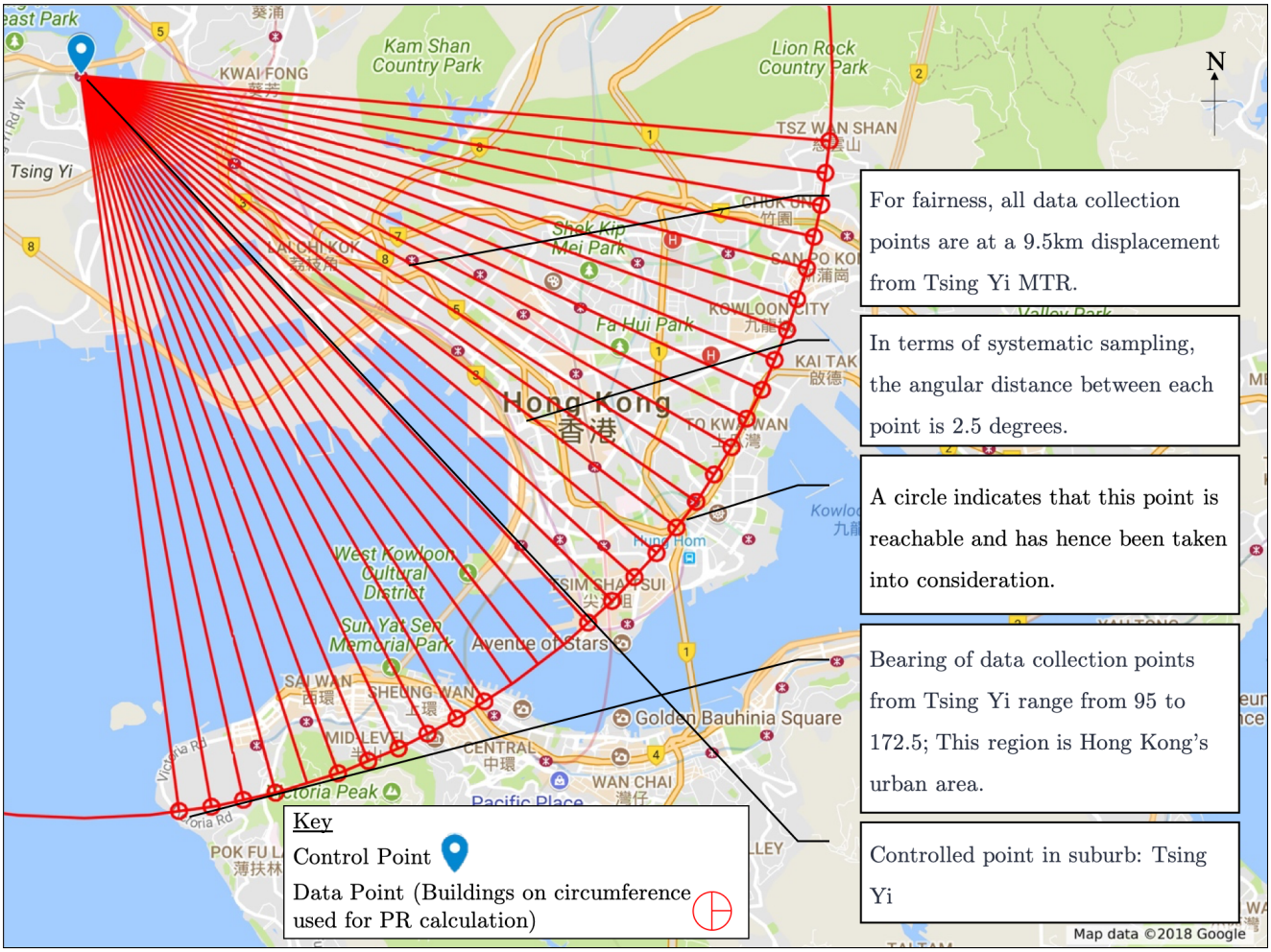

Figure 6: Map of study with annotations devised by author, 1:92800 (Google Maps, 2018)

2.1.1 Additional Justifications

At each point, the PR of buildings on the circumference of a 100m-radius circle will be accounted to give an average PR. This radius has been selected for several reasons:

1. To ensure data points are sufficiently far apart and do not overlap.

2. To ensure a sufficient amount of buildings for PR calculation.

3. A 100m radius circle has an area of 0.03142 km^2, and with HK's average population density being 6690 persons/ km^2, this results in a population of around 210 within a circle; this is within close range of the "Exclusive Dunbar Number" of 150, which is the optimum population size of a community (Allen, 2004).

2.1.2 Excluding errors

Some buildings are errors to be excluded from PR calculation, with several justifications:

1. Buildings under construction: They do not reflect a regular density of human activities.

2. Parks and other outdoor recreational facilities: They are often a result of government spending, and also do not reflect a regular density of human activities

3. One-storey structures: Many are informal structures that are often not recorded on mapping databases like MapKing. Since it is difficult to track their existence, for consistency, they will be completely eliminated.

That said, if the GFA (refer to section 2.2) offered by a building's property developer includes the errors above, errors will not be excluded since the composition of the GFA is unknown.

2.2 Quantifying land-use Intensity

2.2.1 Significance of Plot Ratio(PR) and Gross Floor Area (GFA)

In this essay, the proxy indicator for LUI is plot ratio (PR), which is the ratio of total usable floor space (GFA) of a land plot to the area of the land plot (Cheung, 2007); It quantifies the density of human activities and usage of land.

Another key terminology closely related with PR is GFA; in HK, this typically refers to the total floor area inside a building, including walls and excluding roofs (Buildings Department, 2018). This number is often utilised in PR calculation since PR of buildings are typically not offered directly by property developers.

2.2.2 Calculating PR

Figure 7 is a flowchart devised by the author that outlines the process of calculating PR.

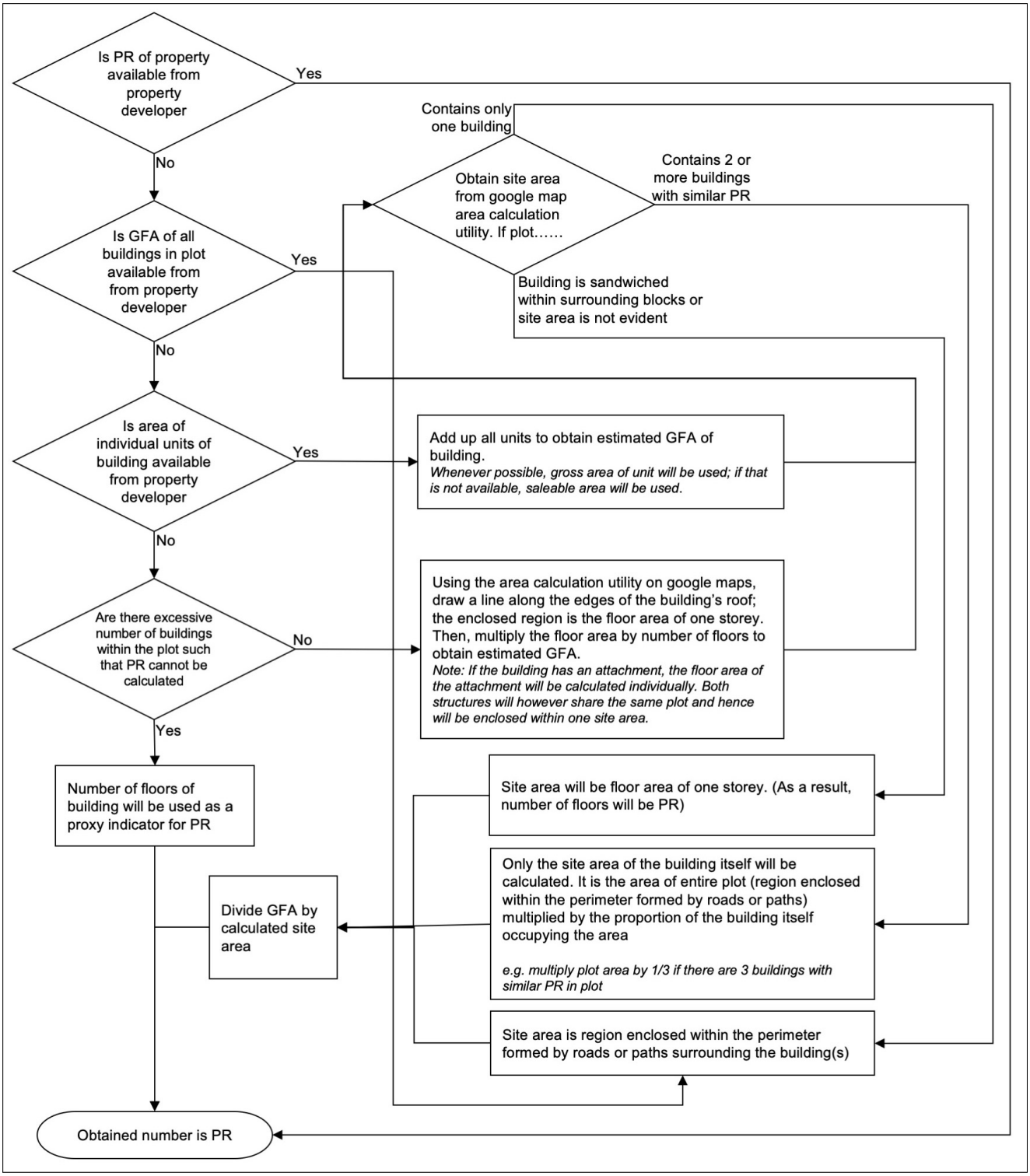

Figure 7: Flow chart for extracting data for PR calculation, devised by author.

This has been developed not only to maintain the consistency of PR calculation, but also to minimise the uncertainty of each number. Additional guidelines regarding the calculation of GFA using Google Maps' area calculation utility have been attached in appendix 4.

2.3 Calculating Traffic Congestion Index (TCI)

The TCI devised by the author is the difference between the free flow time and total travel time (referred to "duration" and "duration in traffic" respectively in raw data) between different points and TSY, resulting in a number in seconds. While "duration" is calculated according to the averages of all historical traffic data from local transport departments and mobile users, "duration in traffic" is modelled according to a smaller subset of data with respect to weekly, monthly and yearly patterns. Consequently, it is normal for TCI to yield a negative number.

The dates selected to resemble a typical Monday to Sunday for data extraction is 2019/10/14-20 on account of the following reasons:

1. It is in the future such that it is modelled by Google's algorithms rather than collated historical data, which are prone to other fluctuations.

2. It is after the 2019 IB examinations such that the data remains consistent should examiners wish to verify the data.

3. Primary and secondary school students take their summer holidays in July and August, whereas the back-to-school season, Mid-Autumn Festival, National Day and Chung-Yueng Festival take places in September and the first 2 weeks of October; these dates have been avoided since there will likely be abnormal travelling patterns of large masses leading to abnormal TC .

The time used for data extraction has been justified in figure 8.

Purpose	Selected Time	Unix Time Stamp	Direction
Typical Weekday Morning Peak	08:30, since 08:00-09:00 is peak hour for departure time of mechanised transport of both HBW and HBS commuters (Transport Department, 2014).	2019/10/14 , 08:30: 1571041800, 2019/10/15 , 08:30: 1571128200, 2019/10/16 , 08:30: 1571214600, 2019/10/17 , 08:30: 1571301000, 2019/10/18 , 08:30: 1571387400	From Tsing Yi, since residents of new towns commute to CBD for work in the morning.
Typical Weekday Off Peak	13:30, since it is right between 08:30 and 18:30. Incidentally, 13:30-14:30 is the lowest proportion of trips for departure time of mechanised transport of HBW commuters, while close to the secondary peak (10:00-12:00) of HBO commuters.	2019/10/14 , 13:30: 1571059800 2019/10/15 , 13:30: 1571146200 2019/10/16 , 13:30: 1571232600 2019/10/17 , 13:30: 1571319000 2019/10/18 , 13:30: 1571405400	
Typical Weekday Evening Peak	18:30 since 18:00-19:00 is peak hour for departure time of mechanised transport of HBW commuters (Transport Department,2014)	2019/10/14 , 18:30: 1571077800, 2019/10/15 , 18:30: 1571164200 2019/10/16 , 18:30: 1571250600, 2019/10/17 , 18:30: 1571337000, 2019/10/18 , 18:30: 1571423400	To Tsing Yi, since commuters return home from work in the evening.
Typical Weekends Mornings and Afternoon	08:30 and 13:30, to maintain consistency with weekday data. (Data summed into one category since travelling patterns are less evident).	2019/10/19 , 08:30: 1571473800, 2019/10/19 , 13:30: 1571491800, 2019/10/20 , 08:30: 1571560200, 2019/10/20 , 13:30: 1571578200	From Tsing Yi, to maintain consistency with weekday data.
Weekends Evening	18:30, to maintain consistency with weekday data.	2019/10/19 , 18:30: 1571509800, 2019/10/20 , 18:30: 1571596200	To Tsing Yi, to maintain consistency with weekday data.

Figure 8: Justifications for data extraction times devised by author, with reference to Transport Department, 2014.

By accounting for the reasons mentioned, a better representation of the relationship between the two variables investigated will be given.

After the needed fields are inserted into the following table (Figure 9), the entire line becomes a web address; an HTML with “duration” and “duration in traffic” between all destination(s) and origin(s) will be generated.

https://maps.googleapis.com/maps/api/distancematrix/json?units=metric
(Insert “& origins=” if direction is from TSY, insert “&destinations=” if direction is to TSY.)
22.358530,%20114.107306
(Insert “& destinations=” if direction is from TSY, insert “& origins=” if direction is to TSY.)
22.350982, 114.199523 | 22.347289, 114.199007 | 22.343580, 114.198459 | 22.339939, 114.197601 | 22.336294, 114.196709 | 22.332723, 114.195505 | 22.322266, 114.191180 | 22.318912, 114.189323 | 22.315628, 114.187447 | 22.312461, 114.185286 | 22.309321, 114.183101 | 22.306365, 114.180655 | 22.303406, 114.178188 | 22.300644, 114.175461 | 22.297894, 114.172711 | 22.295375, 114.169757 | 22.286281, 114.156954 | 22.284290, 114.153563 | 22.282562, 114.149979 | 22.274922, 114.127287 | 22.273617, 114.119324
& departure _ time=
(Insert Unix Time Stamp)
& key=AIzaSyBHRgzR18aJmTCSGdd83pfErnGeAMuppVQ

Figure 9: HTML address for extracting TC data.

2.4 Measuring and Validating Correlation

2.4.1 Statistical Analysis - Spearman's Rank Correlation Coefficient (SRCC)

While the Pearson correlation assumes a normal distribution for a bivariate population, the non-parametric Spearman's Rank Correlation Coefficient (SRCC) is based on the sequential nature of the data. Hence, SRCC has been selected to quantify the correlation between two variables.

After the total of difference squared, that is, the difference between rank of congestion and rank of PR, is calculated as outlined by figure 10, the correlation coefficient is calculated according to figure 11;

Variable 1: Congestion	Rank	Variable 2: PR	Rank	Difference between Ranks Squared
				Total of Difference Squared

Figure 10: Table headings for calculating SRCC, devised by author.

$$R = 1 - \frac{6\sum d^2}{n^3 - n}$$

$$where$$

$$R = SRCC$$

$$d^2 = Difference\ squared$$

$$n = number\ of\ data\ sets\ or\ pairs$$

Figure 11: Calculation of SRCC (Nagle, 2003)

Figure 12 is a spectrum which demonstrates the meaning of the correlation coefficient R.

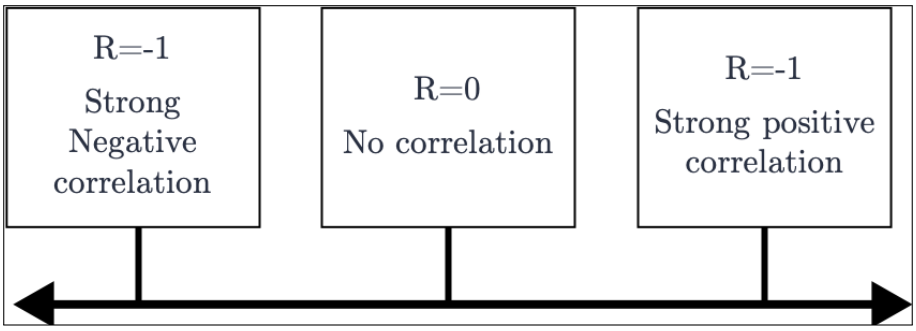

Figure 12: The significance of R-value (correlation coefficient), devised by author.

2.4.2 Hypothesis Testing with t-test

By definition, t-test measures how significant the correlation is whenever a population variance is estimated from its sample variance. In geography, strong correlation refers to 95% level of confidence or 5% rejection level, though varying levels of confidence will be used as well.

The test statistic (t-value) is calculated as outlined by figure 13:

$$t = \left| R \sqrt{\frac{n-2}{1-R^2}} \right|$$

t: Test Statistic
R: Spearman's rank correlation coefficient
n: Number of data points (21)

Note: |x| represents a positive result regardless of the polarity of x

Figure 13: Formula for test statistic (t-value)

In this scenario, the bivariate population has a two-tailed student's t distribution t(n-2) with degree of freedom n-2. The corresponding critical value for the 5% rejection level in this study is $t_{\alpha/2}$=2.0930 (Gerstman, 2016), which defines the two tailed critical region. If the magnitude of t-value is greater than the critical value, t-value will be in the rejection region as illustrated by figure 14, which means correlation between the variables is validated. (Quin et al. 108)

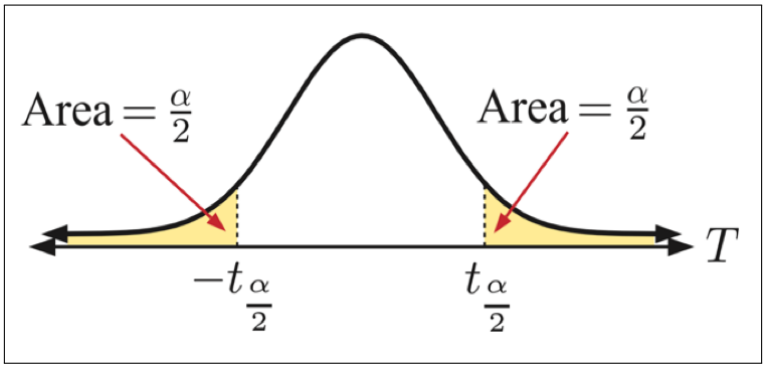

Figure 14: If test statistic lies within yellow region, correlation is validated; reject null hypothesis in favour of alternative hypothesis. (Quin et al. 108)

Overall, the combination of justified sampling methods, calculations of PR and TCI, SRCC and hypothesis testing will quantify and effectively validate the relationship between LUI and TC.

3 Data Analysis

3.1 Temporal variation for traffic congestion

3.1.1 Weekday-morning-peak (WMP)

Figures 15 and 16 outlines the key findings for the relationship between PR and WMP TCI:

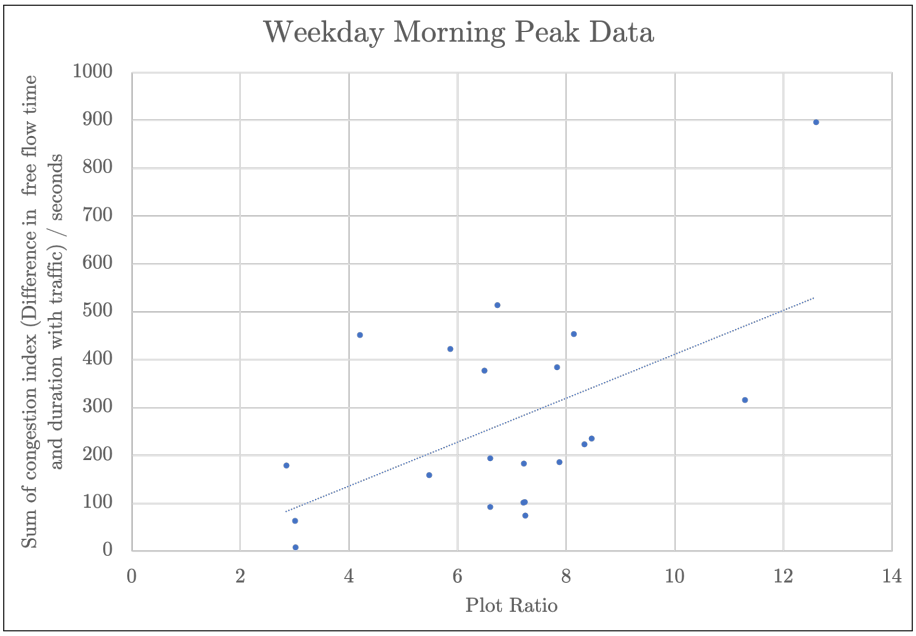

Figure 15: WMP data

R-value	0.4558
T-value	2.2324
Critical value from T-table	2.0930
Reliability of R-value	Yes

Figure 16: Summary table for WMP data

The R-value of 0.4558 indicates a moderate positive correlation between PR and WMP TCI, which is in line with alternative hypothesis H_1. In addition, at a 5% rejection level, the t-value 2.2324 is within the rejection region, so H_1 should be accepted. Several factors explain this correlation:

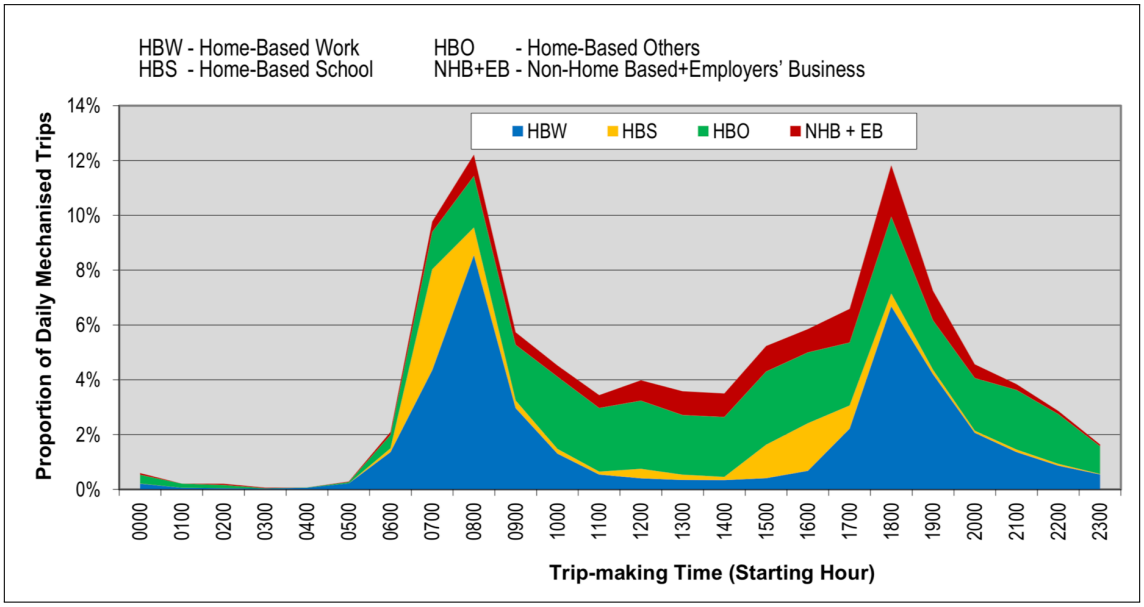

Figure 17: Hourly profiles of mechanised trips (Transport Department, 2011)

1. During WMP hours, there is an influx of commuters travelling from suburbs to their workplace, which leads to a huge demand for traffic, and hence a greater amount of TC. This is intensified by the fact that the morning trip-making-timea (TMT) of HBW commuters coincide with home-based-school (HBS) commuters as outlined by figure 17 (Transport Department, 2011).

2. Coincidentally, the data point with the highest average plot ratio of 12.6 has the highest TCI of 896s during WMP, as outlined by the rightmost point of the graph. This point is bearing of 150 on the map of study and is in the Central and Western District, which houses HK's CBD. Figure 18 shows Aberdeen street at bearing 150, where road capacity is limited due to the hilly terrain; meanwhile, traffic demand is high as a result of the sheer amount and density of residential-commercial mixed-use buildings, intensifying TC. Two factors combined, this further testifies the positive correlation between TC and LUI.

Figure 18: Aberdeen street at bearing 150. (Taken by author)

3.1.2 Weekday-evening-peak (WEP)

Figures 19 and 20 outlines the key findings for the relationship between PR and WEP TCI:

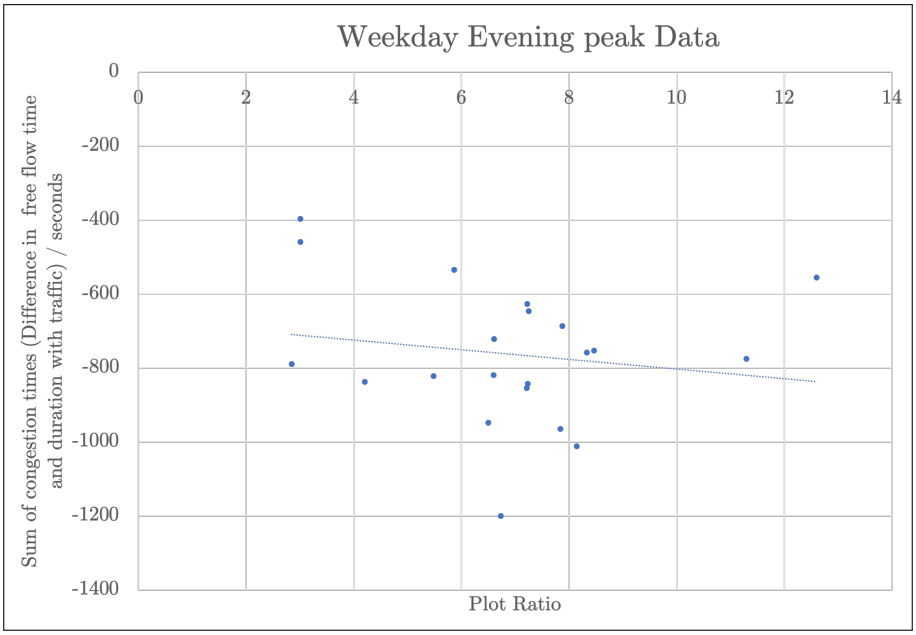

Figure 19: WEP data

R-value	-0.1260
T-value	0.5535
Critical value from T-table	2.0930
Reliability of R-value	No

Figure 20: Summary table for WEP data.

The R-value of -0.1260 indicates a weak negative correlation between PR and WEP TCI, which opposes H_1. At a 5% rejection level, the t-value -0.5535 is within the confidence region, so H_1 should be rejected. Several reasons explain this phenomenon:

1. During WEP, while there are HBW commuters travelling from their workplaces back to the suburbs, unlike WMP, their TMT does not coincide with HBS commuters, which is 16:00 to 17:00 in the evening, as outlined by figure 17 (Transport Department, 2011). Combined with the fact that HK has the longest overtime working hours in Asia (Regus, 2015), TMT of commuters are often delayed in the evening, resulting in less TC.

2. Ma Tau Wai (bearing 120) houses a high density of industrial buildings as well, leading to a high PR; however, likely as a result of the nature of 9-to-5 operation hours of factories, the return-trip TMT of these workers are earlier, which explains the extreme low TCI of -1199s, the bottommost point on figure 19.

3.1.3 Weekday-off-peak (WOP)

Figures 21 and 22 outlines the key findings for the relationship between PR and WOP TCI:

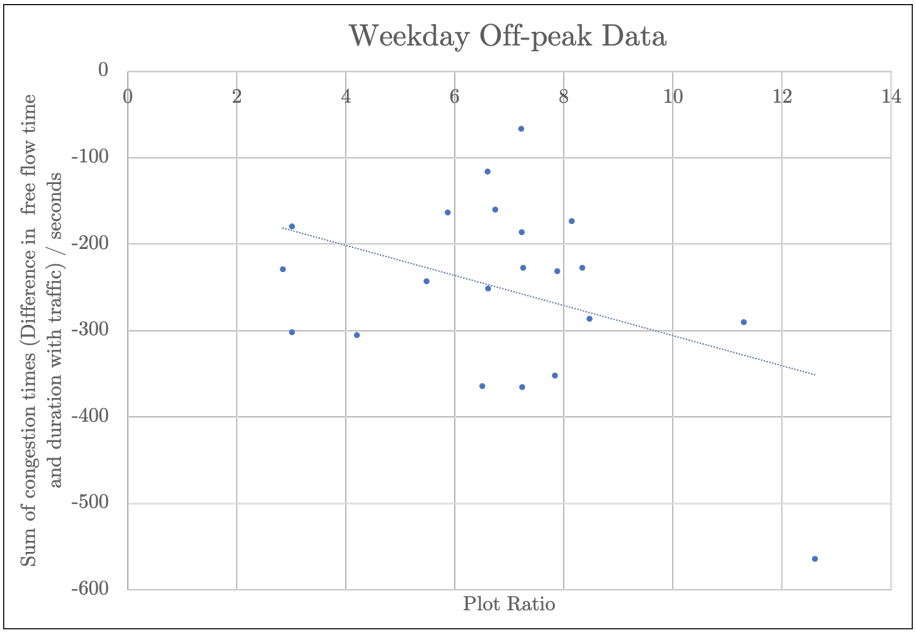

Figure 21: WOP data

R-value	-0.1734
T-value	0.7674
Critical value from T-table	2.0930
Reliability of R-value	No

Figure 22: Summary table for WOP data.

The R-value of -0.1734 indicates a weak negative correlation between PR and WOP TCI, which opposes H_1. At a 5% rejection level, the t-value -0.7674 is within the confidence region, so H_1 must be rejected. Several factors explain this weak negative correlation:

1. As outlined by figure 17, the main group of commuters departing between 13:00 and 14:00 are home-based others commuters (HBO) (Transport Department, 2011). This demographic typically engage in non-conventional business activities, such as teleworking (working from home) and cross-boundary activities; hence, their travel times are often arbitrary, leading to a less-pronounced relationship between PR and TCI.

2. The behavioural value of time (VoT) is the amount of money in cents commuters are willing to trade off with per-minute time saving. Among both private-car owners and non-private-car owners, HBOs have the lowest VoT of 72 and 57 respectively (Transport Department, 2011). In other words, they are least likely to pay more to switch to another transport mode for time-saving during TC, hence leading to more TC.

3.1.4 Weekends (WEK)

Figures 23 and 24 outline the key findings for the relationship between PR and WEK TCI:

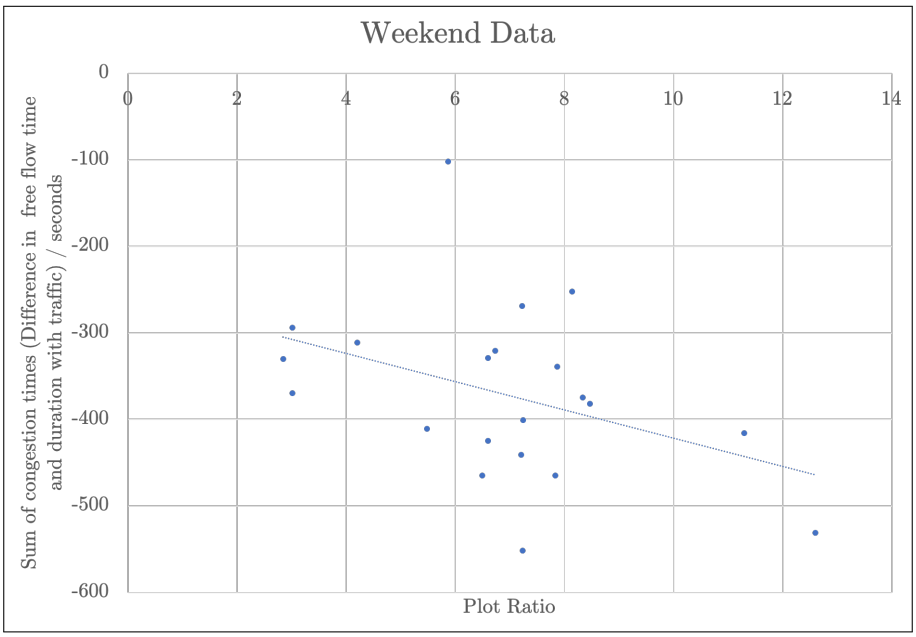

Figure 23: WEK data

R-value	-0.3370
T-value	1.5602
Critical value from T-table	2.0930
Reliability of R-value	No

Figure 24: Summary table for WEK.

The R-value of -0.3307 indicates a weak negative correlation between PR and WEK TCI, which opposes H_1. At a 5% rejection level, the t-value -1.5602 is within the confidence region, so H_1 must be rejected. This can be explained through various factors:

1. While H_1 should not be accepted at a 95% confidence test, the distinctively negative R-value should be placed under scrutiny. Whereas the TCI for bearing 150 in Central (rightmost point on figure 23) is highest for the WMP data set, it is the lowest for this data set. One explanation is that HBW commuters do not travel to their normal workplace during weekends, leading to less TC.

2. Although all WEK TCIs are negative, the highest one is -102s, uppermost point on figure 23 (Bearing 125). This is likely because bearing 125 is near the cross-harbour tunnel where bottle-neck traffic occurs, which leads to a high TCI despite the moderate PR of 5.8645. This shapes the negative correlation between PR and WEK TCI.

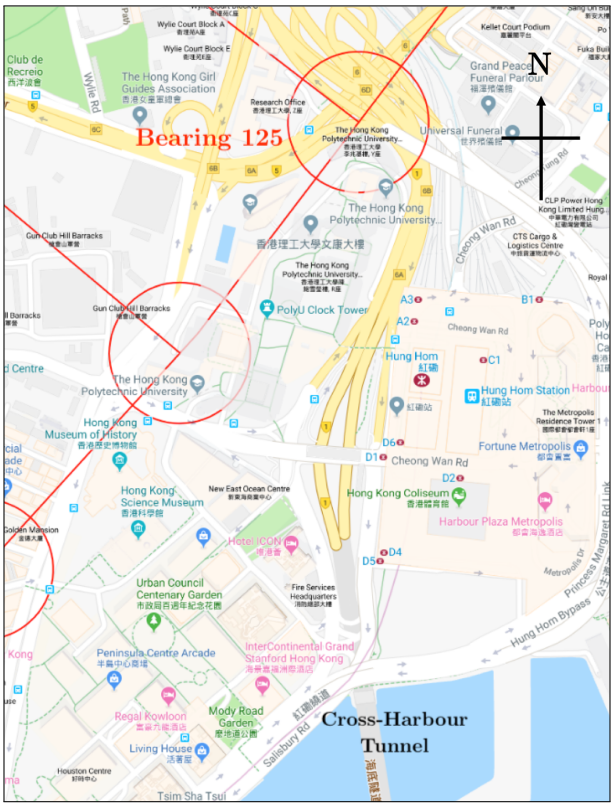

Figure 25: Bearing 125, where highways 1 and 5 merge near the cross-harbour tunnel, annotations devised by author. (Google Maps, 2018)

3.2 Spatial variation of plot ratio and Peak traffic congestion

In the following section, a qualitative analysis will be performed for the spatial variation of data, as shown in figures 26 and 27. Only WMP TC data is used since it is the only data set with validated correlation.

In terms of PR, spatial variation resembles a few distinct features from the the multi-nuclei-model; it is highest in Central, HK's CBD, medium at nodes like TST and Kai Tak, and low in between the formerly mentioned core or nodes, as outlined by figure 28; however, PR is higher at the northern end of the transect, contradicting the claims made by the multi-nuclei-model. On the contrary, the pattern for TC appears to be less pronounced.

Yet, the 2 factors alone do not explain or validate the hypotheses. Considering the 2 factors in conjunction, various aspects of figure 26 appear to support the positive correlation as indicated in section 3.3.1:

1. Central has the highest PR and TCI as indicated by the tall red block at bearing 150. Indeed, the predominant group of buildings in this area are unnamed Tong-Lau (refer to appendix 1), which are mostly a blend of commercial and residential use, most of which built since British occupation in the mid-19th-century. Moreover, the grid-lock road pattern contributes to reduced travel speeds, whereas the large population of occupiers of these buildings contribute to a high traffic demand, leading to a deficit in traffic consumption, and hence severe TC.

2. The least congested points have the lowest PRs, as indicated by the low green blocks in West of HKI at bearings 167.5 and 172.5. The buildings at these 2 bearings are are all low-height yet high-class residential blocks, such as Villa Cecil (refer to appendix 1). Despite the in-existence of a comprehensive road network in the area, the low population-density plays a part in the low traffic demand, hence contributing to a less TC.

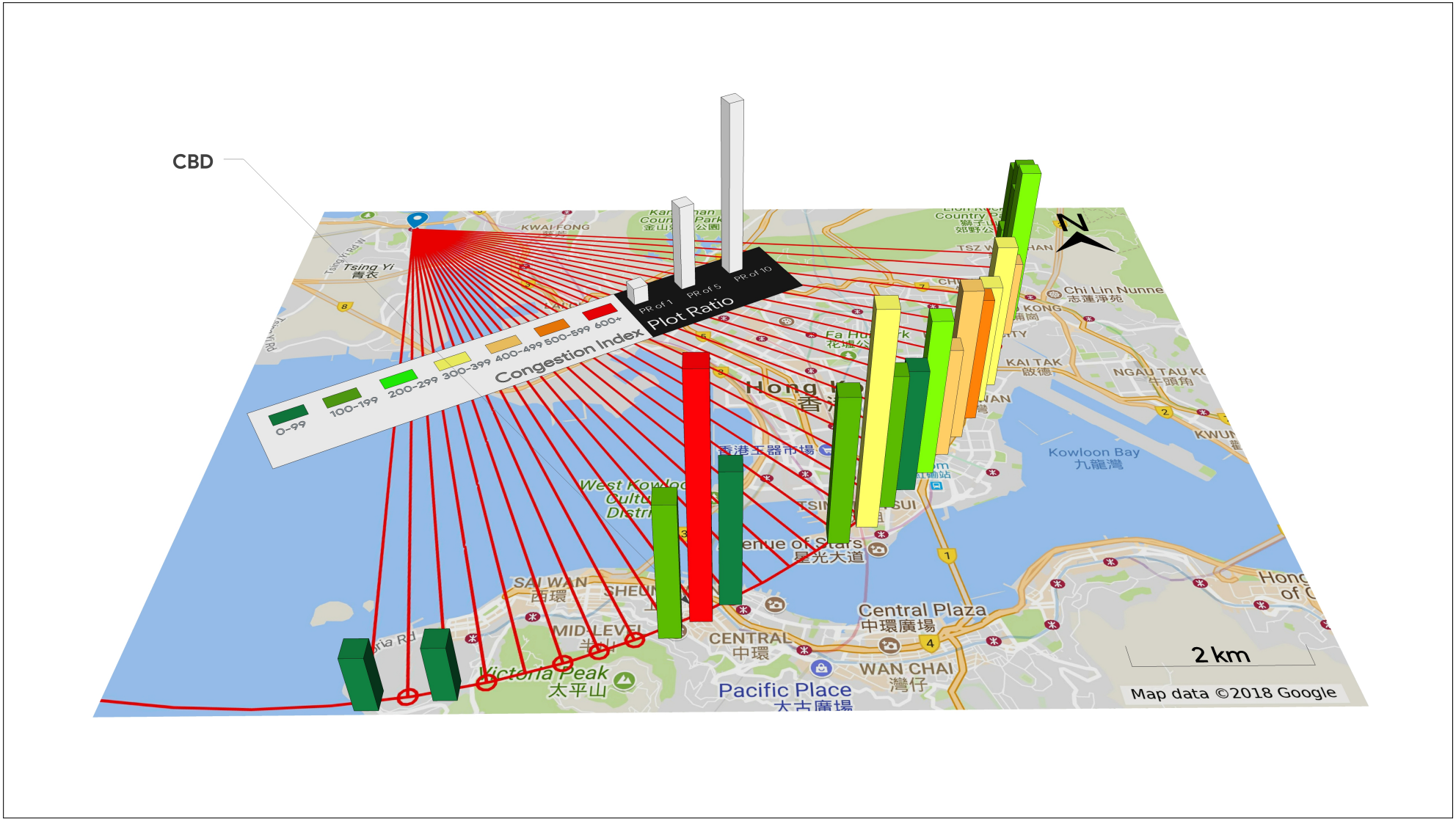

Figure 26: PR (indicated by block height) and TC (indicated by colour) of data collection points, legend and scale in map. (Diagram devised by author)

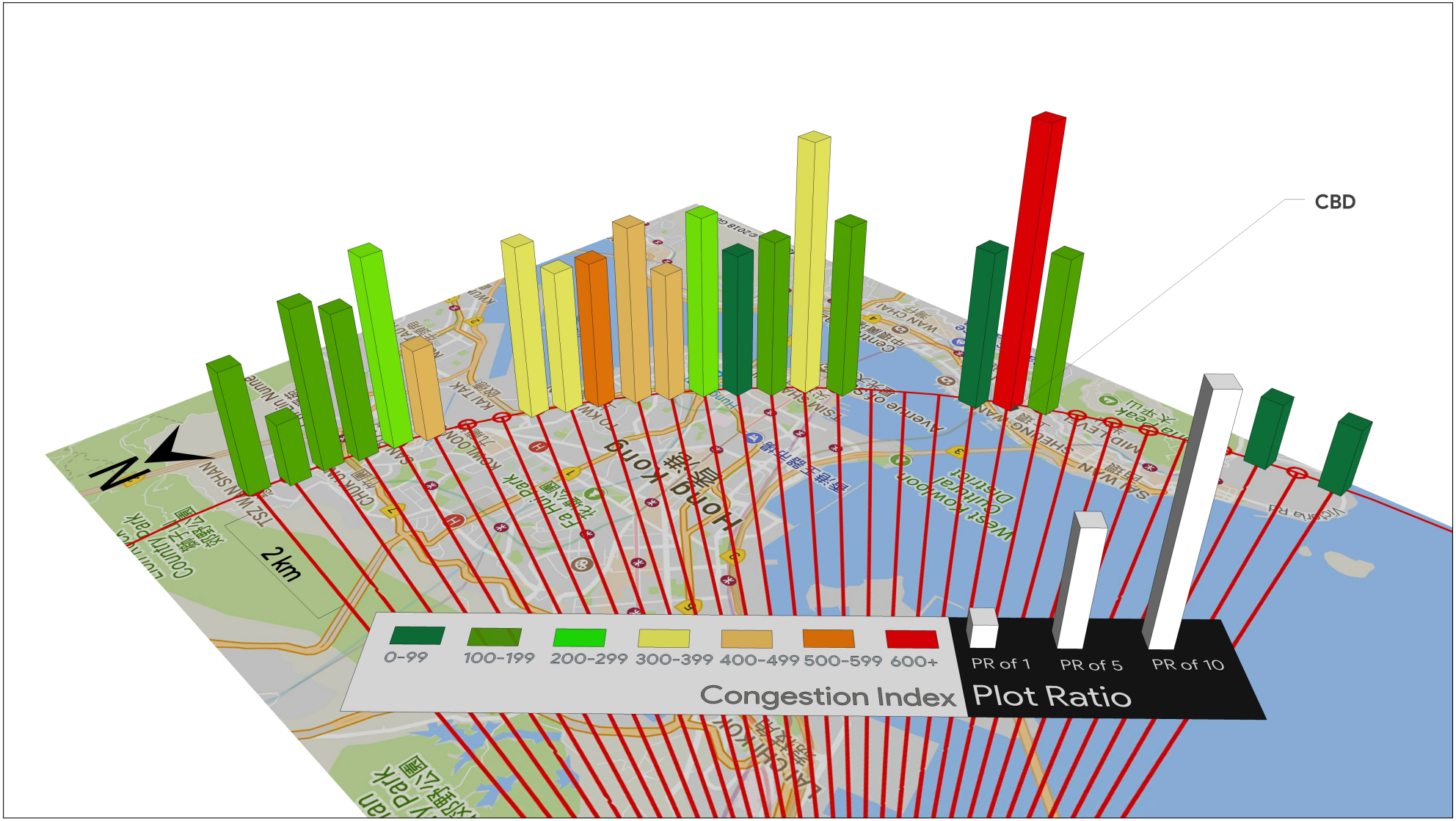

Figure 27: Alternative perspective of figure 26, legend and scale in map. (Diagram devised by author)

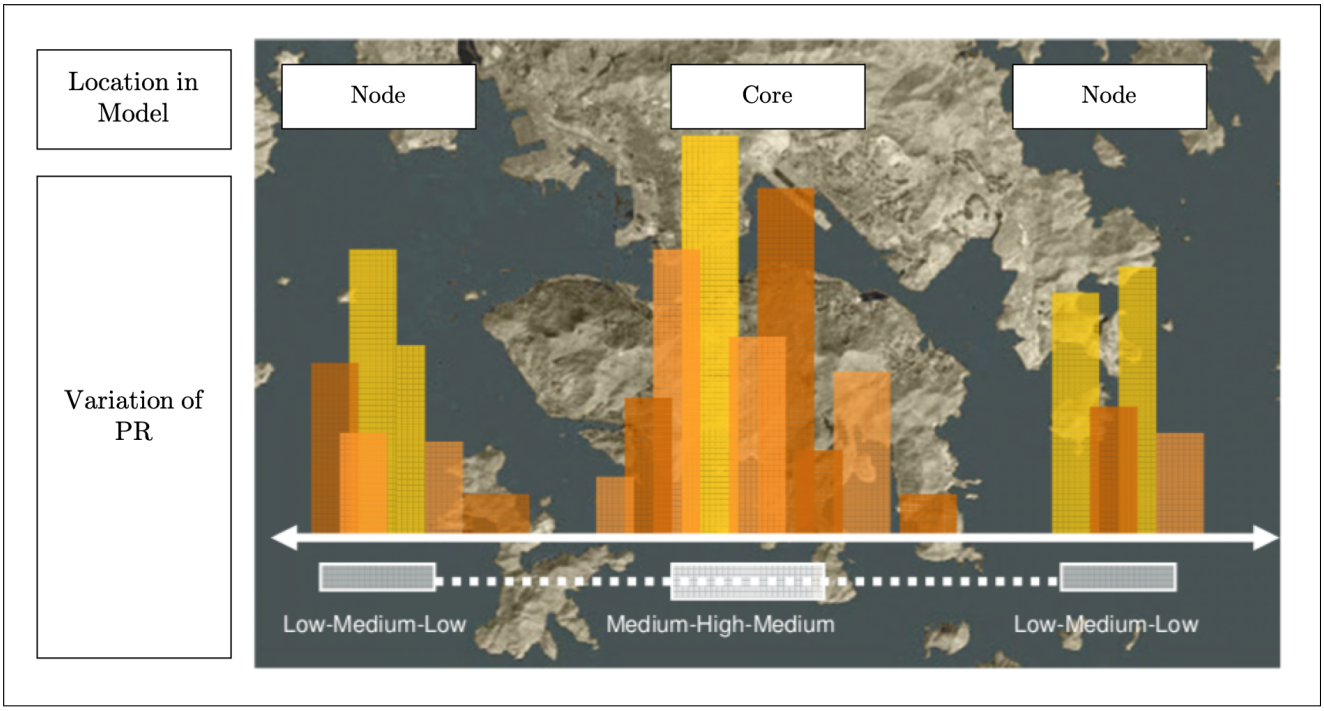

Figure 28: Variation of PR in multi-nuclei model, annotations devised by author. (Lam, 2011)

Yet, several observations indicate that PR and TC are not positively correlated as indicated in section 3.3.1 :

1. Despite the relatively modest PR of 5.5, 7.2 and 6.6 at bearings 95, 102.5 and 105 respectively, their TCIs are extremely low as indicated by those green blocks. As a result of high urban-renwal costs in the inner city, these regions in Northern KOW had previously been "greenfield sites" and were later developed into newer high-density estates for a predominantly low-income demographic of these public estates; hence residents have a greater reliance on public transport rather than cars, relieving TC in these regions. For instance, a brief count performed by the author shows that approximately 6% of franchised bus routes in HK terminate or stop within a 100m radius of these bearings, which is substantial considering the 651 routes operated by franchised bus companies including Kowloon-Motor-Bus (KMB), CityBus and New-World-First-Bus (NWFB).

2. Various factors explain the abnormally high TCI of 452 (indicated with amber) at bearing 107.5 in Kowloon City despite the modestly low PR of 4.2. On one hand, most buildings in

this area are old-style Tong-Lau's, which are low in height and PR due to the infeasibility and costs of lifts at the time of construction and building height regulations in-place for Kai Tak Airport, closed in 1997. On the other hand, TC is severe due to the immense bypassing traffic at Prince Edward Road East, which serves as a gateway between East KOW and Yau Tsim Mong.

3. As outlined by figure 27, TST (bearings 135 to 137.5), the outer frame of the CBD, has a moderate PR but considerably lower TCI. This reason is, despite the high concentration of offices and leisure landmarks like museums to satisfy tourism and economic activities, there are frequent public transport services to satisfy the large traffic consumption demand, which encourages both HBW commuters and tourists to take full advantage of public transport. In addition, there is a wide range of pedestrian-priority facilities that increases accessibility, such as segregated pedestrianised streets and tunnels, which foster walk-only trips for short distances, further reducing TC. These factors combined result in a negative correlation between PR and TC.

4 Evaluation

There are several issues within my data collection and analysis that can be improved upon:

1. In an attempt to create a more inclusive environment for the public, the government has developed height-profiles and building-height-regulations to retain a coherent topography along the harbour, to create open spaces for recreational activities, and to better the micro-climate of crowded cityscapes (Planning Department, 2002). However, owing to the fact that the relationship between LUI and TC is a predominantly quantitative analysis, socio-economic factors have been omitted. Indeed, investigating the relationship between building height and TC may yield a correlation more in-line with the predictions of the multi-nuclei-model and the government's height-profiles.

2. The single-transect design only allows for a single-dimensional analysis merely exclusive to the scenario investigated. Increasing the number of transects by placing a few more circles with reduced radius from TSY would possibly allow the mapping of a concentric pattern of data, which would offer a more holistic overview of the correlation.

3. Currently, the TCI yields negative values for WOP, WEP and WEK. Instead, WOP may be used as an alternative precise indicator for free-flow-traffic, which can then be compared with WMP, WEP and WEK, possibly yeidling highly-correlated results worthy of further analysis.

5 Conclusion

The aim of this study was to validate the statement "TCI and PR in HK's urban areas are correlated". This involved:

1. Collecting the TCI and PR of data points situated at 9.5km from TSY, each of which are spaced 2.5 degrees apart,
2. Using SRCC to quantify the correlation between the 2 variables and performing hypothesis testing to validate my hypotheses.
3. Performing qualitative analysis with respect to the spatial variation of the 2 variables.

Figure 29 summarises the key findings of the temporal variation of TCI with respect to PR.

	WMP	WEP	WOP	WEK
R-value	0.4558	-0.1260	-0.1734	-0.3370
T-value	2.2324	0.5535	0.7674	1.5602
Critical value from T-table	2.0930			
Reliability of R-value	Yes	No	No	No

Figure 29: Key Findings for this study

On one hand, the spatial distribution of PR and hence LUI follows the multi-nuclei-model, where LUI is highest at the CBD and in nodes (secondary-business-districts); on the other hand, time-space convergence has changed the CBD model from a single-nucleus model in the past to a multiple-nuclei model in the present where different districts are becoming increasingly dependent among one another, leading to a more complex spatial distribution in TC, and hence a minimal correlation between LUI and TCI in WEP, WOP and WEK.

As outlined in this study, the WMP test yielded a reliable R-value and hence a statistically significant correlation. Hence, at a 5% rejection level, the alternative hypothesis "WMP TCI and PR in HK's urban areas are correlated" should be accepted. Indeed, since PR has been chosen as a proxy indicator for land-use intensity, it can be justified that there is a positive relationship between land-use intensity and traffic congestion in different parts of HK's urban areas, and that the relationship is valid only for weekday-morning-peaks.

The key justification for this positive correlation is coincidence of departure times by HBW and HBS suburban commuters during WMP (Transport Department, 2011) and is intensified as a result of the high density of socio-economic activities in the core of the core-frame-model. With respect to these factors, traffic congestion (especially weekday-morning-peak congestion) must be solved to improve QoL for commuters, and the 2 key solutions are:

1. Effective planning regarding the separation of departure times by HBW and HBS commuters
2. Decentralising economic activities from HK's CBD.

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7 Appendices

The following list is an overview of the appendices for this investigation.

Appendix 1: Raw data for calculating plot ratio

Appendix 2: Congestion Index for all data points

Appendix 3: Summary for congestion index and average PR of all points

Appendix 4: Additional guidelines for calculating GFA on Google Maps

Appendix 1: Raw Data for calculating Plot Ratio

	Building Name	Address	Address (Coordinates)	Number of Floors (Including Ground Floor)	Floor Area of each floor (Square Feet)	Gross Floor Area	Site Area	Plot Ratio	Notes	Average Plot Ratio
95	Tsz Oi Court Block K Oi Wah House	Tsz Oi Court Block K Oi Wah House Fung Wah St Tsz Wan Shan	22.351925, 114.199124	41	6056	248296	88349.21	8.431178955		5.479015283
	Tsz Oi Court Block J Oi Wing House	Tsz Oi Court Block J Oi Wing House Fung Wah St Tsz Wan Shan	22.351702, 114.199580	41	6056	248296				
	Tsz Oi Court Block L Oi Hong House	Tsz Oi Court Block L Oi Hong House Fung Wah St Tsz Wan Shan	22.351636, 114.199105	41	6056	248296				
	Tsz Ching Estate Ching Tak House	80 Tsz Wan Shan Road, Tsz Wan Shan	22.351305, 114.200303	27	6286.12	169725.24	105,785.80	3.626895322	(和諧三型 1P*1, 1B*8, 2B*7, 3B*1)	
	Tsz Ching Shpping Centre Phase 1	Tsz Ching Shpping Centre Phase 1, Tsz Wan Shan	22.350992, 114.200499	3	6954.51	20863.53				
	Tsz Ching Estate Ching Fai House (Main Tower)	81 Tsz Wan Shan Road, Tsz Wan Shan	22.350606, 114.200854	27	6098.8316	164668.4532			(和諧3A型 1B*6, 2B*9, 3B*1)	
	Tsz Ching Estate Ching Fai House (Attachment)		22.350606, 114.200854	16	1776.05	28416.8			副翼第一型	
	Tsz Oi Court Block B Oi Yin House	2 Wan Wah St, Tsz Wan Shan	22.350284, 114.199214	36	6574	236664	108091.1333	4.378971572		
	Tsz Oi Court Block A Oi Wai House	2 Wan Wah St, Tsz Wan Shan	22.350126, 114.199563	36	6574	236664				
	Tsz Lok Estate Lok Wong House	10 Wan Wah St	22.348051, 114.198568	38	7336.6813	278793.8894	146,391.51	3.808880575	(和諧一型第 六 款 1B*4, 2B*8, 3B*4)	
	Tsz Lok Estate Lok Shing Huse	10 Wan Wah St	22.348051, 114.198569	38	7336.6813	278793.8894				

97.5	Ho Lap Primary School (Sponsored by Sik Sik Yuen) Main Block	Tsz Lok Estate Phase II, Tsz Wan Shan, Wong Tai Sin, Kowloon	22.347076, 114.198104	8	11249.27	89994.16	99061.28	1.038178792		2.842713243
	Ho Lap Primary School (Sponsored by Sik Sik Yuen) Attachment			2	6,424.58	12849.16				
	Tsz Lok Estate Lok Hop House	10 Wan Wah St	22.346768, 114.199997	31	6286.12	194869.72	71084.71	2.741373215	(和諧三型 1P*1, 1B*8, 2B*7, 3B*1)	
	Tsz Lok Estate Lok Yan House	10 Wan Wah St	22.348098, 114.199309	39	7336.6813	286130.5707	75,647.48	3.782420389	(和諧一型第 5 款 1B*8, 1P*4, 2B*4, 3B*4)	
100	Fung Cheung Building	5-33 Wan Fung St, Chuk Un	22.344411, 114.198281	22	4411.97	97063.34	9378.3	10.34977981		7.223824409
	14-20 Ngan Fung St	14-20 Ngan Fung St	22.344350, 114.198104	6	4350.67	26104.02	4350.67	6		
	Fung Wong Cheung Building	11 Ngan Fung St	22.344161, 114.197883	19	4289.57	81501.83	8650.93	9.421163967		
	24 Sheung Fung St	25 Sheung Fung St	22.344460, 114.197708	6	10,526.56	63159.36	15,006.80	4.208716049		
	Sheung Fung Street Market	Fei Fung St, Chuk Un	22.343884, 114.197163	7	16,224.26	113569.82	21,779.25	5.214588197		
	On Lee Building	9-15 Fei Fung St	22.343544, 114.197315	21	14,562.03	305802.63	17,730.15	17.24760535		
	Fung Tak Shopping Centre	Fung Tak Centre, Fung Tak Est, Diamond Hill, Diamond Hill	22.343801, 114.199875	3	83,152.28	249456.84	83,152.28	3		
	St Bonaventure Church	89 Po Kong Village Rd, Diamond Hill	22.344559, 114.198763	3	8,885.19	26655.57	14,191.79	1.878238756		
	Po Fat Building	Po Fat Building, 54-66 Wan Fung St, Chuk Un	22.344358, 114.198490	21	1,510.62	31723.02	4,122.91	7.69432755		
	Lionrise Tower 6	8 Muk Lun St	22.340773, 114.197800	38	7090	269420	38117.872	14.13615115	There are 42 numbered floors; Floors 4,13,14,24,34 don't exist	
	Lionrise Tower 5	8 Muk Lun St	22.340752, 114.197328	38	7090	269420				
	Lionrise Tower 1	8 Muk Lun St	22.340077, 114.196639	38	4113	156294	19,058.94	8.200562718		
	Hong Kong Sheung Kung Hui Calvary Church	6 Shatin Pass Rd, Chuk Un	22.339610, 114.196976	3	9,874.93	29624.79	11,735.74	2.524322284		

102.5	Wong Tai Sin District Police Headquarters Central Block	2 Shatin Pass Road	22.339335, 114.196723	7	9,899.05	69293.35	88,865.55	1.547462093		6.60212456
	Wong Tai Sin District Police Headquarters Northwest Attachment	3 Shatin Pass Road	22.339623, 114.196621	4	5,423.73	21694.92				
	Wong Tai Sin District Police Headquarters Northeast Attachment	4 Shatin Pass Road	22.339576, 114.196946	4	4,791.80	19167.2				
	Wong Tai Sin District Police Headquarters Southern Attachment	5 Shatin Pass Road	22.339268, 114.196329	3	9,120.20	27360.6				
105	Choi Hung Road Sports Centre	150 Choi Hung Road	22.337041, 114.196473	3	33,003.94	99011.82	404,043.86	0.245052158		8.466431821
	Ho Lap College Main Block	15 Tseuk Luk St	22.336583, 114.195784	6	13,636.93	81821.58	46,322.67	1.9578988		
	Ho Lap College Attachment		22.336997, 114.195561	1	8,873.52	8873.52				
	永樂樓	San Po Kong, 16-42 Tseuk Luk St	22.336198, 114.195822	6	10,818.16	64908.96	15,199.24	4.270539843		
	Tong Seng Mansion	1-33 Kam Wing St	22.336102, 114.195684	6	10756.43	64538.58	16,009.06	4.031378482		
	Po Leung Kuk Ho Sau Nan Primary School Western Block	30 Hong Keung St San Po Kong	22.335321, 114.196633	7	4607.33	32251.31	24,278.43	2.73203951		
	Po Leung Kuk Ho Sau Nan Primary School Central Block		22.335171, 114.196701	6	3,371.84	20231.04				
	Po Leung Kuk Ho Sau Nan Primary School Eastern Block		22.335206, 114.196963	8	1,730.91	13847.28				
	74-78 Tseuk Luk St	74-78 Tseuk Luk St	22.335519, 114.196871	6	5,201.36	31208.16	6,515.74	4.789657046		
	Efficiency House	35 Tai Yau St San Po Kong	22.335735, 114.197363	15	24,692.16	370382.4	24,692.16	15		
	Jing Wah Building	10 Sam Chuk St San Po Kong	22.336020, 114.197497	9	12,694.79	114253.11	12,694.79	9		

	Kai Yip Factory Building	15-17 Sam Chuk St	22.336222, 114.197833	7	10,940.76	76585.32	10,940.76	7		
	33 Tai Yau St (Lower Block)	33 Tai Yau St	22.336409, 114.197698	2	7,848.79	15697.58	7,848.79	21.55195387		
	33 Tai Yau St (Upper Block)			21	7,307.58	153459.18				
	Laurels Industrial Centre Carpark	32 Tai Ya St	22.337087, 114.197455	3	29,823.86	89471.58	29,823.86	22.55223033		
	Laurels Industrial Centre Upper Block			22	26,505.59	583122.98				
107.5	Lee Kau Yan Memorial School Northern Block	596 Prince Edward Rd E, Kowloon City	22.331970, 114.194929	7	11,093.22	77652.54	63,976.36	1.816752938		4.200613616
	Lee Kau Yan Memorial School Southern Block		22.331665, 114.194599	3	12,858.90	38576.7				
	Mikiki Mall	638 Prince Edward Rd E	22.333221, 114.196317	2	99,325.74	198651.48	146,542.29	1.355591481		
	Mikiki Blocks 1A,1B,2A,2B			44	12562	552728	58616.916	9.429496427	There are 50 numbered floors for each block; Floors 4,13,14,24,34,44 don't exist	
115	Freder Centre	68 Sung Wong Toi Rd Ma Tau Kok	22.322758, 114.191700	5	66,666.53	333332.65	66,666.53	5		7.835142868
	KK Industrial Building	5 Mok Cheong St Ma Tau Kok	22.322414, 114.192145	8	18202.09	145616.72	18,202.09	8		
	Harbour 8 Degrees Podium	199 Kowloon City Rd, To Kwa Wan	22.322966, 114.190801	2	37,023.91	74047.82	37,023.91	14.43194141		
	Harbour 8 Degrees	199 Kowloon City Rd, To Kwa Wan	22.322966, 114.190801	17	27075.24	460279.08				
	Sky Towers Podium	38 Sung Wong Toi Rd, Ma Tau Chung	22.323407, 114.190238	3	126,846.60	380539.8	126,846.60	15.0843444		
	Sky Towers 1,2,3,5,6,7	38 Sung Wong Toi Rd, Ma Tau Chung	22.323407, 114.190238	47	32614	1532858				

	Luen Ming Hing Factory Building	36 Mok Cheong St Ma Tau Chung	22.322606, 114.190195	12	19,176.64	230119.68	19,176.64	12		
	The Zutten	50 Ma Tau Kok Rd, To Kwa Wan	22.321877, 114.190343	0	0	0	0	0		
	Fung Yi St East/ Luk Ming St West	Fung Yi St East/ Luk Ming St West	22.321747, 114.191495	8	17,209.14	137673.12	17,209.14	8		
	Luk Ming St East/ Lijn Cheung St West	Luk Ming St East/ Lijn Cheung St West	22.321803, 114.191858	8	17,996.15	143969.2	17,996.15	8		
	Good Harvest Air Frieght Centre	70-78 Sung Wong Toi Rd Ma Tau Kok	22.322792, 114.192299	0	0	0	0	0		
117.5	Cheung Wan Building	8-10 Ma Hang Chung Rd	22.319670, 114.188511	10	5,934.88	59348.8	12,248.01	4.845587161		6.497819836
	Full Moon Mansion Upper Block (5-11/F)	51 Pau Chung St	22.319572, 114.188764	7	2,881.89	20173.23	10,872.11	6.85550275		
	Full Moon Mansion Lower Block			5	10,872.11	54360.55				
	18-30 Hung Kwong St	18-30 Hung Kwong St	22.319310, 114.188435	9	5,758.07	51822.63	5,758.07	9		
	21-35 Hung Kwong St	21-35 Hung Kwong St	22.319349, 114.188650	6	3,519.04	21114.24	4,571.95	4.618213235		
	15-29 Wing Yiu St	15-29 Wing Yiu St	22.319144, 114.188398	9	10,536.32	94826.88	10,536.32	9		
	12-26 Wing Yiu St	12-26 Wing Yiu St	22.318965, 114.188282	9	12,322.80	110905.2	12,322.80	9		
	May Court	38-44 Pau Chung St	22.318489, 114.188563	12	2,889.67	34676.04	4,596.72	7.543648515		
	Shing Yip Building	34-36 Pau Chung St	22.318378, 114.188496	6	1,378.18	8269.08	2,309.62	3.580277275		
	33 Kowloon City Road	34 Kowloon City Road	22.318244, 114.188751	4	1,258.04	5032.16	1,784.70	2.819611139		
	74 Kowloon City Road	75 Kowloon City Road	22.318095, 114.189070	4	3,028.10	12112.4	3,843.58	3.151332872		
	Yick Fu Building Upper Block	89 Ha Heung Rd	22.318131, 114.189395	11	2,580.00	28380	5,477.07	7.181602572	Adding area of flats	
	Yick Fu Building Lower Block			2	5,477.07	10954.14				

	Wah King Mansion	46-48A Sheung Heung Rd	22.317937, 114.189604	14	4530	63420	8,437.96	7.516034681	Adding area of flats	
	Ting Sun Plaza	33 Sheung Heung Rd	22.318322, 114.189851	11	6,123.95	67363.45	6,123.95	11		
	Cheong Wah Factory Building	39-41 Sheung Heung Rd	22.318095, 114.190504	11	20,565.44	226219.84	20,565.44	11		
	To Kwa Wan Sports Centre	To Kwa Wan Sports Centre, Ha Heung Rd, To Kwa Wan	22.318871, 114.190303	3	29,718.69	89156.07	250,799.56	0.355487346		
120	Gainfull Centre	161 Ma Tau Wai Rd	22.316496, 114.187807	4	8,432.30	33729.2	8,432.30	4		6.73455768
	Lucky Building	294-312 Ma Tau Wai Rd	22.316599, 114.187379	19	9098	172862	12,310.00	14.04240455	Adding area of flats	
	4 Kiang Su St	4 Kiang Su St	22.316448, 114.187096	5	2,295.23	11476.15	2,511.03	4.570295855		
	Caron Court	7-9 Kiang Su St	22.316175, 114.186578	n/a	n/a	9391	2,862.42	3.28079038	Adding saleable floor area	
	181-185 Kau Pui Lung Road	181-185 Kau Pui Lung Road	22.316011, 114.186582	6	3,776.09	22656.54	5,017.86	4.515179778		
	Lok Man Sun Chuen site 3 Block H Lok Chee Lau	109-111 Ko Shan Rd	22.315250, 114.186526	24	14,131.10	339146.4	55688.965	6.090010831		
	90 Ko Shan Road	91 Ko Shan Road	22.314870, 114.187013	6	2,672.05	16032.3	4,403.52	3.640791912		
	224 Ma Tau Wai Road	224 Ma Tau Wai Road	22.314545, 114.187255	8	4,569.97	36559.76	5,442.25	6.71776563		
	Wearbest Building Northern Block	66 To Kwa Wan Rd	22.315958, 114.188793	13	13,053.16	169691.08	32,180.95	9.757569929		
	Wearbest Building Central Block		22.315755, 114.188684	7	10,140.53	70983.71				
	Wearbest Building Southern Block		22.315590, 114.188569	9	8,148.12	73333.08				
	Yick Man Building	5-19 Ha Heung Rd	22.316016, 114.188333	12	2593	31116	6,551.86	6.749185727	Adding area of flats	
	Yick Man Building Platform			2	6,551.86	13103.72				
	Luen Yip Building	10-16A Kowloon City Rd	22.316089, 114.188061	12	2387	28644	4,440.45	8.450697564	Adding saleable floor area	
	Luen Yip Building Platform			2	4,440.45	8880.9				

	24 Kowloon City Road	24 Kowloon City Road	22.316343, 114.188193	9	602	5418	602	9		
122.5	Fook Sing Mansion	16-22 Shun Yung St	22.311533, 114.185286	18	2900	52200	6149.28	8.488798689		8.138323719
	Paramount Mansion	387-393A Chatham Rd N	22.311484, 114.185499	18	4898	88164	8,203.80	10.74672713	Adding area of flats	
	The Evergreen	395 Chatham Rd N	22.311760, 114.185422	n/a	n/a	33718	12,637.83	2.66802133	Adding saleable floor area for flats 1-8	
	Yee Fai Bulding	423-433 Chatham Rd N	22.312532, 114.186187	26	2056	53456	7,413.31	9.210814063	Adding area of flats	
	Yee Fai Bulding Platform			2	7,413.31	14826.62				
	Wing Lam Mansion	1A-1J San Lau St	22.312917, 114.186182	24	1420	34080	3,558.43	9.577257386	Adding area of flats	
125	Bulkeley Building	264-268 Chatham Rd N	22.308502, 114.183357	9	4,012.87	36115.83	5,334.34	6.770440204		5.864534937
	Chinachem (Hung Hom) Comm Centre Upper Block	Hung Hom, 270-274 Chatham Rd N	22.308594, 114.183474	10	5,649.97	56499.7	5,974.62	12.45661816		
	Chinachem (Hung Hom) Comm Centre Lower Block			3	5,974.62	17923.86				
	21 Valley Road	21 Valley Road	22.309990, 114.183690	4	1,426.49	5705.96	2,674.39	2.133555689		
	Chuen Fat Building	5 Valley Rd	22.309839, 114.183867	24	1672	40128	5,068.08	7.917791353	Adding area of flats	
	Hung Hing Court	1-3 Valley Rd	22.309748, 114.183989	n/a	n/a	14760	2,694.77	5.477276354		
	281 Chatham Rd N	281 Chatham Rd N	22.309679, 114.184046	5	3,463.27	17316.35	40128	0.431527861		
127.5	Hong Kong Polytechnic University Core W (Ho Iu Kwong Building/Industrial Centre)		22.305665, 114.180709	6	22,398.38	134390.28		7		8.333333333
	Hong Kong Polytechnic University Core Z		22.306700, 114.179569	12		279861.67		12		

	Hong Kong Polytechnic University Core U (Realink Building)	11 Yuk Choi Rd, Hung Hom	22.305467, 114.181061	6		80729.33		6	number of floors used as an indicator for plot ratio	
130	Hong Kong Polytechnic University Core J (Stanley Ho Building)		22.303735, 114.178961					8		6.6
	Hong Kong Polytechnic University Chan tai Ho Building		22.303457, 114.179180					7		
	The Hong Kong Polytechnic University Chan Sui Wai Building, Wing EF		22.303128, 114.179317					7		
	The Hong Kong Polytechnic University Tang Ping Yuan Building, Wing CF		22.302953, 114.179013					7		
	The Hong Kong Polytechnic University Shaw Sports Complex		22.304273, 114.178651					4		
	Gun Club Hll Barracks	127 Austin Road	22.304784, 114.176681			307767.46	488,596.81		tends to zero	
	On Luen Building	1 Shun Yee St	22.300347, 114.174498	6	1936	11616	6,408.79	1.81251063	Adding saleable floor area f	
	Tern Commercial Building	39 Granville Road, Tsimshatsui, Kowloon, Hong Kong	22.300272, 114.174530	17	2,335.39	39701.63	3,696.71	10.73971991		
	Hang Lung Bank Tsimshattsui Branch Upper Block	46-48 Granville Rd	22.299937, 114.174797	15	1651	24765	3,298.94	9.789762772		
	Hang Lung Bank Tsimshattsui Branch Lower Block			3	2,510.28	7530.84				
	Grand Building	18-22 Granville Circuit	22.300039, 114.174936	n/a	n/a	26408	4,137.49	6.382613614	Adding saleable floor area f	
	Park Hotel Hong Kong Platform	Park Hotel Hong Kong, 61-65 Chatham Rd S, Tsim Sha Tsui	22.299753, 114.175466	3	26,335.20	79005.6	26,335.20	11.49373006		
	Park Hotel Hong Kong Western Block		22.299602, 114.175320	8	6,385.45	51083.6				
	Park Hotel Hong Kong Eastern Block		22.299667, 114.175610	13	13,276.96	172600.48				

132.5	Goden Mansion	83-85A Chatham Rd S	22.301130, 114.176152	n/a	n/a	43774	5,131.54	8.530382692	Adding area of flats http://hk.centadata.com/transactionhistory.aspx?type=1&code=ESGAPPAJPE&ci=zh-hk	7.209961148
	Beverley Commercial Centre	87-105 Chatham Rd S	22.301449, 114.175904	21	7934	166614	14,765.17	11.28425883	Gross rentable area	
	Shun Fai Building	64-66A Kimberley Rd	22.301406, 114.175359	18	1980	35640	5,068.80	7.03125	Adding area of flats	
	Beauty Mansion	69-71A Kimberley Rd	22.301559, 114.175041	10	2801	28010	4,859.73	5.763694691	Adding saleable floor area f	
	Pacific Building	65-67B Kimberley Rd	22.301421, 114.175009	11	3830	42130	6,677.92	6.30885066	Adding saleable floor area f	
	Carson Mansion	61-63 Kimberley Rd	22.301205, 114.174784	16	1980	31680	8,978.00	3.528625529	Adding area of flats	
	Luna Court	55 Kimberley Rd	22.301153, 114.174642	15	3699	55485	10,119.89	7.482767105	Adding area of flats	
	Luna Court Platform			2	10,119.89	20239.78				
	44 Kimberley Road	44 Kimberley Road	22.300744, 114.174420	10	1,291.85	12918.5	2,477.05	8.215276236		
	44 Kimberley Road Platform			3	2,477.05	7431.15				
	18 Kimberley Street	18 Kimberley Street	22.300586, 114.174451	4	2881.96	11527.84	4475.07	2.576013336		
	Tern Plaza	3A-3C Cameron Rd	22.298943, 114.172825	19	2983	56677	8,040.02	13.32025045	Typical Floor Area www.hongkongoffice.com/building_search/office_profile.asp?B=7095	
	Bodynits Building	3 Cameron Road, Tsimshatsui, Kowloon, Hong Kong	22.298881, 114.172694	17	1074	18258			Typical Floor Area www.hongkongoffice.com/building_search/office_profile.asp?B=7373	
	3 Cameron Road Platform	3 Cameron Road Platform	22.298916, 114.172743	4	8,040.02	32160.08				
	HSBC Building Tsim Sha Tsui Upper Block	82-84 Nathan Rd	22.298808, 114.172457	13	4130.68	53698.84	4,523.26	14.871712		
	HSBC Building Tsim Sha Tsui Platform			3	4,523.26	13569.78				

135	Haiphong Mansion	53-55 Haiphong Road	22.297993, 114.171836	15	8044.51	120667.65	8044.51	15		11.29560207
	Tsim Sha Tsui Mansion	87 Nathan Road	22.297691, 114.171863	17	9720	165240	18,177.69	9.090263944	Adding saleable floor area for blocks ABCD	
	Harilela Mansion	81 Nathan Rd	22.297463, 114.171948	18	3631	65358	11,291.42	5.788288807	Adding saleable floor area f	
	iSquare	63 Nathan Rd, Tsim Sha Tsui	22.296932, 114.171781	n/a	n/a	600,000	42,096.22	14.2530612	Total retail Floor Area	
	Hiranand House	1-3 Mody Rd	22.297162, 114.173129	11	1512.83	16641.13	4,500.18	8.697880974		
	Hiranand House Platform			5	4,500.18	22500.9				
	K11	18 Hanoi Rd, Tsim Sha Tsui	22.297385, 114.173581	n/a	n/a	1100000	92,891.26	11.84180299	http://www.hkexnews.hk/listedco/listconews/SEHK/2008/1030/00017_427408/E109.pdf	
	Grand Centre	14 Cameron Road	22.298552, 114.173444	18	n/a	75000	7,126.24	10.52448416	Total GFA	
	Hang Shun Commercial Building	12 Cameron Rd	22.298659, 114.173236	18	1422	25596	2,675.09	9.568276208	Typical Floor Area (Gross)	
137.5	Harbour City (Including Gateway ii, I and others)	1,197,648.47	22.296480, 114.167990	n/a	n/a	8410000	1,255,795.47	6.69695042	http://www.wharfreic.com/en/portfo_harbour_city.php	7.872015013
	1 Peking Road Shopping Arcade	1 Peking Rd, Tsim Sha Tsui	22.296014, 114.170022	n/a	n/a	284167.24	26,668.77	10.65543105	Total GFA http://www.hkie.org.hk/ea/eng/details.asp?id=20	
	Pacific Star Building Platform	2 Canton Rd	22.296241, 114.169386	3	1,918.24	5754.72	1,918.24	6.263663567		
	Pacific Star Building			9	695.61	6260.49				
147.5	1ifc, 2ifc, ifc mall, Four Seasons Hotel	8 Finance St, Central	22.285010, 114.158428	n/a	n/a	4474557.56	617,574.31	7.245375152	all owned by MTR https://www.mtr.com.hk/en/corporate/properties/tcl_hongkong.html	7.245375152

	Hong Kong Jewellery Building	178-180 Queen's Road Central	22.284818, 114.152832	22	1574	34628	4,261.82	8.125167182	http://www.gradeaoffice.com/node/37040 Typical Floor Area	
	Hang Lung House	184-192 Queen's Road Central	22.284858, 114.152675	26	4543.08	118120.08	4,889.02			
	18 Kau Yu Fong W	18 Kau Yu Fong W								
	21 Gough St	21 Gough St	22.284244, 114.152575	6	1010.84	6065.04	2,889.48	24.16027752		
	16 Gough St	16 Gough St	22.284079, 114.152594	6	500	3000	1190.62	2.519695621	https://www.spacious.hk/en/hong-kong/noho/16-gough-street/1125850-1-bath	
	Mee Lun st Public Toilet	Mee Lun st Public Toilet	22.283937, 114.152586	n/a	n/a	n/a	n/a	n/a		
	15 Aberdeen St	15 Aberdeen St	22.283878, 114.152732	3	n/a	2,168	884.19	2.451961682	Floor area of an en block unit for Floors G,1,2 http://www.primeoffice.com.hk/office-for-lease-for-sale/15-aberdeen- street-3080251	
	Gage St refuse Collection Point	38-42 Gage St	22.283616, 114.153018	n/a	n/a	n/a	n/a	n/a		
150	28-32 Gage St	28-32 Gage St	22.283403, 114.153195	5	1425	7125	1425	5	Ricacopp Properties: 4 floors, 3 units per floor; https://www.okay.com/en/building/gage-street-28-32/5793 , unit range is 450-500	12.60202644
	The Centre	99 Queen's Road Central, Central	22.284534, 114.154839	74	n/a	1,399,653	54,260.83	25.79490583	https://en.wikipedia.org/wiki/The_Center	
	亞細亞大廈	Central, 22-24 Gilman's Bazaar	22.284961, 114.154174	5	450	2250	704.83	3.192259126		

Shing Hing Commercial Building	21-27 Wing Kut St	22.285120, 114.154168	n/a	n/a	40819	2,815.45	14.49821521	http://hkapmc.org.hk/wp-content/uploads/2016/01/Hang%20Yick-PR.pdf
Wing Fu Building	18-24 Wing Kut St	22.285077, 114.153964	18	2200	39600	1,467.16	26.99092124	There are 4 units each with 550 ft2, https://www.spacious.hk/en/hong-kong/central/wing-fu-building/transactions
Wai Hing Commercial Building	17-19 Wing Wo St	22.285163, 114.153870	12	1,636.69	19640.28	1,636.69	12	
Grand Millenium Plaza (Mall and Tower)	181 Queen's Road Central, Sheung Wan	22.285345, 114.153479	n/a	n/a	1076391	77500.16	13.88888746	http://hsinyieh.com/en/project/offices/230
Merry terrace	4A-4P Seymour Rd	22.282474, 114.148877	n/a	n/a	202,944	52466	3.868105059	Saleable Area http://hk.centadata.com/transactionhistory.aspx?type=1&code=TZZHIHSJHM&info=basicinfo&ci=zh-hk, https://www.scmp.com/article/575158/owners-merry-terrace-agree-joint-deal
Robinson Place Blocks 1 and 2	70 Robinson Rd, Mid-level	22.281487, 114.149366	48	18309	878832	66,423.58	13.23072319	http://www1.centadata.com/fullsizefp.aspx?fpurl=http%253a%252f%252f202.72.14.52%252fimg%252fimg.aspx%253fdir%253d201406%2526name%253d04cpal00052608BNWCOCTI.jpg

152.5	Goldwin Heights Platform	2 Seymour Rd	22.281554, 114.149993	3	36,864.68	110594.04	36,864.68	12.97784329	http://hk.centadata.com/ViewImage.aspx?url=http://202.72.14.52/img/img.aspx!dir=201212$name=31cpal00046470EMIJWNQQ.jpg$org=Y	7.234712963
	Goldwin Heights			45	8174	367830				
	Garfield Mansion	23 Seymour Rd	22.281589, 114.150402	25	n/a	79947	7,843.97	10.19216035	http://hk.centadata.com/transactionhistory.aspx?type=1&code=OSUOQRFRRU&ci=zh-hk	
	Woodland Court + Podium	Woodland Court2-3 Woodlands Terrace, Mid-level	22.281944, 114.150481	26	n/a	45428	10,923.67	4.15867561	http://hk.centadata.com/transactionhistory.aspx?type=1&code=TZXLZHLHHM&ci=zh-hk	
	Dr Sun Yat Sen Museum	7 Castle Rd, Mid-level	22.282017, 114.150812	3	7,487.75	22463.25	10,080.13	2.228468284		
	Casa bella	117 Caine Rd	22.282741, 114.150869	34	3958	134572	6,816.10	19.74325494	http://hk.centadata.com/transactionhistory.aspx?type=1&code=SEPPWSPXPE&ci=zh-hk	
	WL residence	Sheung Wan, 7-9 Wing Lee St	22.283178, 114.150600	5	6,565.15	32825.75	6,565.15	5		
	King's College Old Boy's Association Primary School	58 Bridges St, Sheung Wan	22.283436, 114.150041	4	4,314.74	17258.96	7,915.26	2.180466592		
	Ladder St Building 1	unidentifiable	22.283357, 114.149415	4	1,990.91	7963.64	1,990.91	4		
	Ladder St Building 2		22.283248, 114.149310	7	977.59	6843.13	977.59	7		

	Sunny Sky Centre	5 Ladder Street, Ladder St, Central	22.283103, 114.149217	7	1,693.76	11856.32	1,693.76	7		
	Briar-caine Co-op Building	144 Caine Rd, Mid-level	22.282894, 114.148999	6	1800	10800	4,369.69	2.47157121	http://txhist.centadata.com/tfs_centadata/Pih2Sln/TransactionHistory.aspx?type=1&code=TZMLTHTRHM&info=basicinfo&ci=en-us	
167.5	7 Mount Davis Road	7 Mount Davis Road	22.274448, 114.128020	3	n/a	7960	9,938.21	0.800949064	Adding saleable floor area http://txhist.centadata.com/tfs_centadata/Pih2Sln/TransactionHistory.aspx?type=1&code=SDWDGPEJPS&info=basicinfo&ci=en-us	3.010085735
	Greenery Garden Blocks ABCD	2A Mount Davis Rd	22.275129, 114.128236	16	n/a	173506	23,173.57	7.487236537	http://hk.centadata.com/TransactionHistory.aspx?type=1&code=OJFFFRUROO	
	Greenvale Blocks 1,2,3,4,5	15-23 Mount Davis Rd	22.274211, 114.127169	varying	n/a	30944	41,699.48	0.742071604	http://hk.centadata.com/TransactionHistory.aspx?type=1&code=SDYYGPESPS	
172.5	Villa Cecil Phase II: Blocks 1,2,3	200 Victoria Rd, Mount Davis	22.272978, 114.119018	n/a	n/a	61700	27,347.43	2.256153503	saleable area	3.007767466
	Viva Cecil Phase I Blocks A1,2,3,4,5,6; B1,2,3,4, C		22.272516, 114.119644	n/a	n/a	48402	57,465.75	0.842275616	http://hk.centadata.com/TransactionHistory.aspx?type=1&code=TILTITLETT	

	Felix Villas Blocks 1-8	61 Mount Davis Rd	22.273236, 114.119914	n/a	n/a	118408	19,984.90	5.924873279	saleable area http://hk.centadata.com/transactionhistory.aspx?type=2&code=SSSPWPPEPS	

Apendix 2: Congestion Index for all data points

Typical Monday Morning Peak			Typical Tuesday Morning Peak			Typical Wednesday Morning Peak			Typical Thursday Morning Peak			Typical Friday Morning Peak			**Typical Weekday Morning-Peak**
Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Congestion Index (Sum of All differences)
1302	1327	25	1302	1332	30	1302	1330	28	1302	1345	43	1302	1335	33	159
1249	1277	28	1249	1282	33	1249	1280	31	1249	1297	48	1249	1288	39	179
1093	1125	32	1093	1127	34	1093	1123	30	1093	1141	48	1093	1132	39	183
1256	1290	34	1256	1289	33	1256	1288	32	1256	1307	51	1256	1300	44	194
1250	1290	40	1250	1293	43	1250	1296	46	1250	1307	57	1250	1299	49	235
1513	1598	85	1513	1599	86	1513	1611	98	1513	1602	89	1513	1607	94	452
1450	1500	50	1450	1505	55	1450	1511	61	1450	1523	73	1450	1595	145	384
1477	1526	49	1477	1530	53	1477	1537	60	1477	1549	72	1477	1620	143	377
1278	1371	93	1278	1378	100	1278	1365	87	1278	1407	129	1278	1383	105	514
1231	1313	82	1231	1320	89	1231	1301	70	1231	1349	118	1231	1326	95	454
1152	1229	77	1152	1236	84	1152	1216	64	1152	1263	111	1152	1239	87	423
1284	1300	16	1284	1315	31	1284	1324	40	1284	1329	45	1284	1375	91	223
1306	1304	-2	1306	1322	16	1306	1318	12	1306	1333	27	1306	1346	40	93
1242	1246	4	1242	1251	9	1242	1248	6	1242	1257	15	1242	1310	68	102
1229	1281	52	1229	1293	64	1229	1275	46	1229	1285	56	1229	1327	98	316
1113	1139	26	1113	1145	32	1113	1142	29	1113	1153	40	1113	1172	59	186
1152	1161	9	1152	1164	12	1152	1166	14	1152	1174	22	1152	1169	17	74
1536	1688	152	1536	1659	123	1536	1712	176	1536	1720	184	1536	1797	261	896
1306	1324	18	1306	1309	3	1306	1316	10	1306	1327	21	1306	1357	51	103
1490	1492	2	1490	1481	-9	1490	1487	-3	1490	1499	9	1490	1499	9	8
1434	1454	20	1434	1440	6	1434	1443	9	1434	1444	10	1434	1452	18	63

Typical Monday Evening Peak			Typical Tuesday Evening Peak			Typical Wednesday Evening Peak			Typical Thursday Evening Peak			Typical Friday Evening Peak			**Typical Weekday Evening-Peak**
Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Congestion Index (Sum of All differences)
1131	969	-162	1131	968	-163	1131	970	-161	1131	960	-171	1131	966	-165	-822
1063	905	-158	1063	903	-160	1063	903	-160	1063	908	-155	1063	907	-156	-789
910	787	-123	910	784	-126	910	782	-128	910	785	-125	910	786	-124	-626
996	854	-142	996	848	-148	996	847	-149	996	853	-143	996	856	-140	-722
1079	934	-145	1079	934	-145	1079	922	-157	1079	927	-152	1079	926	-153	-752
1032	864	-168	1032	865	-167	1032	862	-170	1032	864	-168	1032	868	-164	-837
985	795	-190	985	791	-194	985	790	-195	985	793	-192	985	792	-193	-964
958	769	-189	958	768	-190	958	766	-192	958	770	-188	958	769	-189	-948
1103	866	-237	1103	861	-242	1103	861	-242	1103	863	-240	1103	865	-238	-1199
1063	861	-202	1063	855	-208	1063	860	-203	1063	863	-200	1063	865	-198	-1011
1277	1155	-122	1277	1166	-111	1277	1175	-102	1277	1183	-94	1277	1171	-106	-535
832	681	-151	832	680	-152	832	678	-154	832	682	-150	832	681	-151	-758
1019	856	-163	1019	853	-166	1019	853	-166	1019	856	-163	1019	858	-161	-819
1131	950	-181	1131	957	-174	1131	955	-176	1131	963	-168	1131	976	-155	-854
983	827	-156	983	832	-151	983	823	-160	983	834	-149	983	824	-159	-775
873	734	-139	873	739	-134	873	731	-142	873	738	-135	873	737	-136	-686
1110	979	-131	1110	974	-136	1110	974	-136	1110	982	-128	1110	995	-115	-646
1044	930	-114	1044	926	-118	1044	924	-120	1044	937	-107	1044	948	-96	-555
1231	1057	-174	1231	1056	-175	1231	1050	-181	1231	1069	-162	1231	1081	-150	-842
1141	1082	-59	1141	1051	-90	1141	1044	-97	1141	1079	-62	1141	1053	-88	-396
1182	1109	-73	1182	1079	-103	1182	1072	-110	1182	1110	-72	1182	1081	-101	-459

Typical Monday Off-Peak	Typical Tuesday Off-Peak	Typical Wednesday Off-Peak	Typical Thursday Off-Peak	Typical Friday Off-Peak	**Typical Weekday Off-Peak**

Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Duration (1)	Duration in Traffic (2)	Difference (2)-(1)	Congestion Index (Sum of All differences)
1302	1251	-51	1302	1265	-37	1302	1249	-53	1302	1252	-50	1302	1250	-52	-243
1249	1190	-59	1249	1211	-38	1249	1197	-52	1249	1204	-45	1249	1214	-35	-229
1093	1046	-47	1093	1062	-31	1093	1051	-42	1093	1060	-33	1093	1060	-33	-186
1256	1198	-58	1256	1208	-48	1256	1203	-53	1256	1211	-45	1256	1209	-47	-251
1250	1188	-62	1250	1192	-58	1250	1189	-61	1250	1199	-51	1250	1196	-54	-286
1513	1436	-77	1513	1458	-55	1513	1449	-64	1513	1461	-52	1513	1456	-57	-305
1450	1372	-78	1450	1385	-65	1450	1370	-80	1450	1386	-64	1450	1385	-65	-352
1477	1396	-81	1477	1409	-68	1477	1395	-82	1477	1411	-66	1477	1410	-67	-364
1278	1218	-60	1278	1247	-31	1278	1199	-79	1278	1281	3	1278	1285	7	-160
1231	1170	-61	1231	1199	-32	1231	1151	-80	1231	1227	-4	1231	1235	4	-173
1152	1093	-59	1152	1122	-30	1152	1072	-80	1152	1151	-1	1152	1159	7	-163
1284	1233	-51	1284	1246	-38	1284	1224	-60	1284	1246	-38	1284	1244	-40	-227
1306	1263	-43	1306	1274	-32	1306	1256	-50	1306	1302	-4	1306	1319	13	-116
1242	1203	-39	1242	1205	-37	1242	1203	-39	1242	1242	0	1242	1291	49	-66
1229	1158	-71	1229	1175	-54	1229	1159	-70	1229	1183	-46	1229	1180	-49	-290
1113	1057	-56	1113	1072	-41	1113	1054	-59	1113	1077	-36	1113	1074	-39	-231
1152	1094	-58	1152	1121	-31	1152	1100	-52	1152	1110	-42	1152	1108	-44	-227
1536	1399	-137	1536	1423	-113	1536	1404	-132	1536	1441	-95	1536	1449	-87	-564
1306	1213	-93	1306	1248	-58	1306	1223	-83	1306	1239	-67	1306	1242	-64	-365
1490	1438	-52	1490	1457	-33	1490	1443	-47	1490	1470	-20	1490	1463	-27	-179
1434	1368	-66	1434	1378	-56	1434	1363	-71	1434	1376	-58	1434	1383	-51	-302

Saturday Morning			Saturday Afternoon			Saturday Evening			Sunday Morning			Sunday Afternoon			Sunday Evening			**Weekends**
Duration	Duration in Traffic	Difference in Duration	Duration	Duration in Traffic	Difference in Duration	Duration	Duration in Traffic	Difference in Duration	Duration	Duration in Traffic	Difference in Duration	Duration	Duration in Traffic	Difference in Duration	Duration	Duration in Traffic	Difference in Duration	Congestion Index (Sum of All differences)
1302	1327	25	1302	1252	-50	1131	980	-151	1302	1274	-28	1302	1269	-33	1131	957	-174	-411

1249	1292	43	1249	1216	-33	1063	930	-133	1249	1219	-30	1249	1224	-25	1063	911	-152	-330
1093	1133	40	1093	1066	-27	910	792	-118	1093	1073	-20	1093	1072	-21	910	787	-123	-269
1256	1298	42	1256	1215	-41	996	865	-131	1256	1227	-29	1256	1222	-34	996	860	-136	-329
1250	1277	27	1250	1202	-48	1079	944	-135	1250	1219	-31	1250	1200	-50	1079	934	-145	-382
1513	1635	122	1513	1469	-44	1032	890	-142	1513	1481	-32	1513	1453	-60	1032	877	-155	-311
1450	1515	65	1450	1397	-53	985	801	-184	1450	1400	-50	1450	1401	-49	985	791	-194	-465
1477	1540	63	1477	1422	-55	958	778	-180	1477	1425	-52	1477	1426	-51	958	768	-190	-465
1278	1361	83	1278	1304	26	1103	883	-220	1278	1256	-22	1278	1334	56	1103	859	-244	-321
1231	1312	81	1231	1263	32	1063	871	-192	1231	1204	-27	1231	1285	54	1063	863	-200	-252
1152	1227	75	1152	1183	31	1277	1145	-132	1152	1125	-27	1152	1208	56	1277	1172	-105	-102
1284	1327	43	1284	1251	-33	832	682	-150	1284	1252	-32	1284	1234	-50	832	679	-153	-375
1306	1333	27	1306	1300	-6	1019	862	-157	1306	1238	-68	1306	1250	-56	1019	854	-165	-425
1242	1271	29	1242	1268	26	1131	964	-167	1242	1165	-77	1242	1174	-68	1131	947	-184	-441
1229	1271	42	1229	1180	-49	983	821	-162	1229	1208	-21	1229	1158	-71	983	828	-155	-416
1113	1152	39	1113	1067	-46	873	734	-139	1113	1113	0	1113	1053	-60	873	740	-133	-339
1152	1148	-4	1152	1107	-45	1110	970	-140	1152	1133	-19	1152	1106	-46	1110	963	-147	-401
1536	1532	-4	1536	1436	-100	1044	929	-115	1536	1467	-69	1536	1413	-123	1044	924	-120	-531
1306	1284	-22	1306	1243	-63	1231	1067	-164	1306	1243	-63	1306	1245	-61	1231	1052	-179	-552
1490	1505	15	1490	1465	-25	1141	1027	-114	1490	1459	-31	1490	1474	-16	1141	1018	-123	-294
1434	1454	20	1434	1381	-53	1182	1056	-126	1434	1415	-19	1434	1379	-55	1182	1045	-137	-370

Appendix 3: Summary for Congestion Index and Average PR of all points

Point (Bearing)	Exact Point of Calculation for Traffic	Distance from City to Tsing Yi in km	Distance from Tsing Yi to City in km	Average PR	Congestion Index			
					Typical Weekday Morning-Peak	Typical Weekday Evening-Peak	Typical Weekday Off-Peak	Weekends
95	22.350982, 114.199523	13251	13891	5.5	159	-822	-243.0	-411
97.5	22.347289, 114.199007	13490	13820	2.8	179	-789	-229.0	-330
100	22.343580, 114.198459	12964	13149	7.2	183	-626	-186.0	-269
102.5	22.339939, 114.197601	13166	14058	6.6	194	-722	-251.0	-329
105	22.336294, 114.196709	13303	14082	8.5	235	-752	-286.0	-382
107.5	22.332723, 114.195505	13620	13959	4.2	452	-837	-305.0	-311
115	22.322266, 114.191180	14062	19274	7.8	384	-964	-352.0	-465
117.5	22.318912, 114.189323	13639	19697	6.5	377	-948	-364.0	-465
120	22.315628, 114.187447	13780	14381	6.7	514	-1199	-160.0	-321
122.5	22.312461, 114.185286	13317	14088	8.1	454	-1011	-173.0	-252
125	22.309321, 114.183101	12784	13543	5.9	423	-535	-163.0	-102
127.5	22.306365, 114.180655	11940	14421	8.3	223	-758	-227.0	-375
130	22.303406, 114.178188	12925	12476	6.6	93	-819	-116.0	-425
132.5	22.300644, 114.175461	12560	12177	7.2	102	-854	-66.0	-441
135	22.297894, 114.172711	12731	12293	11.3	316	-775	-290.0	-416
137.5	22.295375, 114.169757	12144	11925	7.9	186	-686	-231.0	-339
147.5	22.286281, 114.156954	15716	15344	7.2	74	-646	-227.0	-401
150	22.284290, 114.153563	14709	17429	12.6	896	-555	-564.0	-531
152.5	22.282562, 114.149979	15178	14892	7.2	103	-842	-365.0	-552
167.5	22.274922, 114.127287	15750	16971	3	8	-396	-179.0	-294
172.5	22.273617, 114.119324	16613	16873	3	63	-459	-302.0	-370

Appendix 4: Additional Guidelines for calculating GFA on Google Maps

When GFA has to be obtained manually using the area calculation utility on Google Maps, the following guidelines must be adhered to:

- To achieve highest consistency and least parallax error, the view-window of the maps application must be in 2D mode rather than 3D mode.
- If the building resembles the shape of a 2.5D structure (a structure with uniform cross-sectional area), draw a perimeter along the perimeters of the building's roof to obtain the floor area of one storey. Then multiply the area with number of floors (including ground floor and excluding roof) to obtain estimated GFA.
- If a building consists of multiple segments with different number of storeys, they will be divided into multiple segments which each resemble a 2.5D structure. Then calculate GFA of each 2.5D structure according to guideline 2. The resultant PR is the sum of GFA of each structure within the plot divided by the total site area.
- Ignore illegal add-on structures since they do not reflect formal activities. Underground structures have to be ignored too as they cannot be observed in most mapping systems.