DCPC Model Guideline

Development Capacity Estimation
Based on Pedestrian Congestion Level

Pedestrian Department

November 2014

1. Objective and Principles of DCPC (Development Capacity over Pedestrian Congestion) Model

a) DCPC Model is a computerised model that seeks to estimate the occupant flow of a proposed development in order to forecast likely future levels of congestion in its correspondent pedestrian road.

b) The basic principle of DCPC model underlies in providing an indication of Q-value by comparing the subject development with identical or similar existing development, which takes reference from Market Direct Comparison Approach in real estate valuation. The Q-value will be used to determine whether the existing pavement design can cope with potential surplus of pedestrian supply due to the construction of proposed development.

c) The DCPC Model assesses development potential on both newly supplied land and occupied land, zoned for any of the following uses: Residential (private only), Commercial/Residential, Commercial and Industrial. The valuation of impact over pedestrian congestion by mixed-use land requires case-by-case review due to the large variance between projects.

d) For new town construction, the result of occupant flow estimation of proposed building represents pedestrian road occupant flow, and could be directly used to calculate effective pavement width through Q formula. However, extra flow brought by adjacent development shall be considered as a whole in valuation.

e) For occupied land with existing buildings, the estimated flow serves as a reference on pedestrian flow increase after development. To ensure the congestion level above LOS C, Q-value is limited below 23 given effective width of the pedestrian road is held constant in site. If the new development is evaluated to impose a surplus of Q-value above 23, either Street Width Adjustment Scheme will be adopted or the proposed development gets disapproved.

2. Basis of DCPC Model

2.1 Pedestrian Congestion Calculation-Q value

a) The congestion level of a selected pedestrian road is determined by two factors:

- Pedestrian flow per unit time in a selected unit space
- Effective width of the pavement

b) $\mathbf{Q} = \frac{\textbf{Max flow in 15 minites}}{\textbf{Effective width} * \textbf{15}}$

c) Exhibit 18-3 lists the criteria for pedestrian LOS on walkways. It includes the service measure of space and the supplementary criteria of unit flow rate, speed, and v/c ratio. Note that LOS thresholds summarized in Exhibit 18-3 do not account for platoon flow, but instead assume average flow throughout the effective width. Exhibit 18-4 addresses the LOS in platoons, where LOS in platoons is generally one level lower than the average flow criteria for LOS.

EXHIBIT 18-3. AVERAGE FLOW LOS CRITERIA FOR WALKWAYS AND SIDEWALKS

LOS	Space (m^2/p)	Flow Rate (p/min/m)	Speed (m/s)	v/c Ratio
A	> 5.6	≤ 16	> 1.30	≤ 0.21
B	> 3.7–5.6	> 16–23	> 1.27–1.30	> 0.21–0.31
C	> 2.2–3.7	> 23–33	> 1.22–1.27	> 0.31–0.44
D	> 1.4–2.2	> 33–49	> 1.14–1.22	> 0.44–0.65
E	> 0.75–1.4	> 49–75	> 0.75–1.14	> 0.65–1.0
F	≤ 0.75	variable	≤ 0.75	variable

EXHIBIT 18-4. PLATOON-ADJUSTED LOS CRITERIA FOR WALKWAYS AND SIDEWALKS

LOS	Space (m^2/p)	Flow Rate[a] (p/min/m)
A	> 49	≤ 1.6
B	> 8–49	> 1.6–10
C	> 4–8	> 10–20
D	> 2–4	> 20–36
E	> 1–2	> 36–59
F	≤ 1	> 59

Note:
a. Rates in the table represent average flow rates over a 5- to 6-min period.

From the classification system, four streets are chosen to measure their respective flow rate and pedestrian space based on the LOS system stated in the highway capacity manual, i.e. LOS A – LOS D. Then, based on the questionnaires, it is believed that LOS C is the baseline in which the street is congested. Hence, LOS C (Pedestrian Space > 2.2-3.7 m^2/p; Flow Rate > 23-33 p/min/m) is adopted as the point where pedestrian congestion would occur, and streets in Hong Kong should achieve a level above C (i.e. LOS A/B) in order to have a pleasant walking environment.

d) Based on the formula: $Q=\frac{\text{Max flow in 15 minites}}{\text{Effective width}*15}$, there is a relationship between the pedestrian flow with the effective width on street. Illustration: If we want to achieve a street condition above LOS C, Q would need to be smaller than 23, which is the minimum required level. (i.e. Q < 23)

Therefore, 23 > Max flow in 15mins/ 15 x Effective Width (Ew)

→ 345Ew > Max flow in 15mins

2.2 Regression Model

a) Regression model is adopted to make expected occupant flow valuation through market approach. It is assumed that the average occupant flow of the selected development project x_i, $F(x_i)$, be the variable to be forecasted. Also the prime assumption is made that the dependent variable can be expressed as a function of some known and measurable variables.

To reveal not only the coefficient but also how significant the impact imposed by independent variables on regressand, Ordinary Least Squares (OLS) technique will be used in DCPC analysis, which minimizes the sum of squared differences between the actual and the forecast values of dependent variable.

b) Denotation

In primary regression model construction, the following independent variables have been short-listed:

List of variables used and description	
$F(x_i)$	Average occupant flow of the selected development x_i to its correspondent pedestrian road
$PR(x_i)$	Plot ratio of the selected development x_i
$OCap(x_i)$	Occupant Capacity of the selected development x_i
$UFA(x_i)$	Usable Floor Area of the selected development x_i
A, B, C	Site classification of the selected development x_i (Dummy variables)

c) Building the Regression Model

$$F_{(xi)}=\beta_0+\beta_1 PR_{(xi)}+\beta_2 OCap_{(xi)}+\beta_3 UFA_{(xi)}+\delta_0 A+\delta_1 B+\delta_2 C+\varepsilon$$

β_i, δ_i: intercept/coefficient of proposed attributes

ε: error term

The regression model will gradually eliminate the irrelevant variables through observation on t-statistics and R^2. The former one tests the significance of the effect of the proposed attribute holding other variables constant, with the latter one refers to the percentage of data in dependent variable that could be explained by the variation in the independent variables, consequently suggesting whether the measurement fits the model.

The output of the linear regression model is expected to be an occupant flow range: ($F_{(xi)}$-2*Standard Error, $F_{(xi)}$+2*Standard Error), considering errors in regression model. It is recommended that the higher number be selected for Q value calculation.

3. Structures of DCPC Model

The model comprises a general process routine and two sub-routines, as described below. These are illustrated diagrammatically in Figures 3-1 to 3-3.

- General process routine

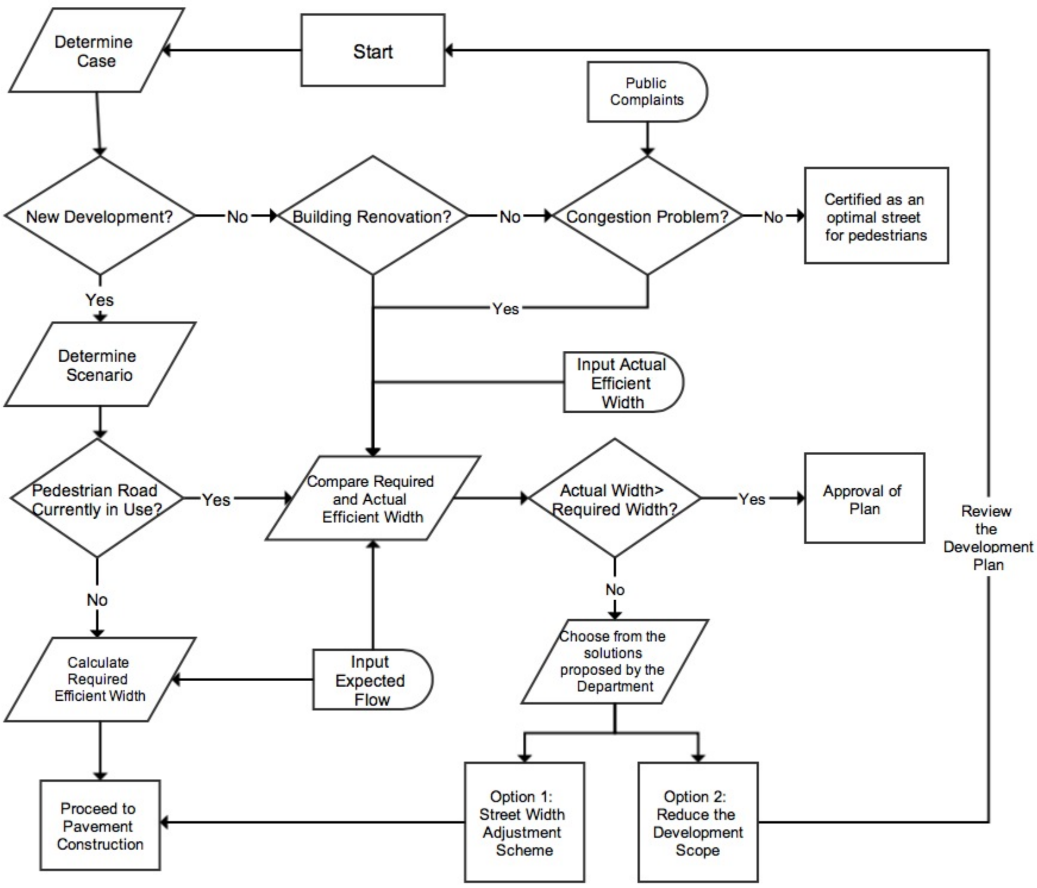

Figure3-1 Development Capacity Model- General Process Routine

- SR1: Input, output and calculation process of Q value

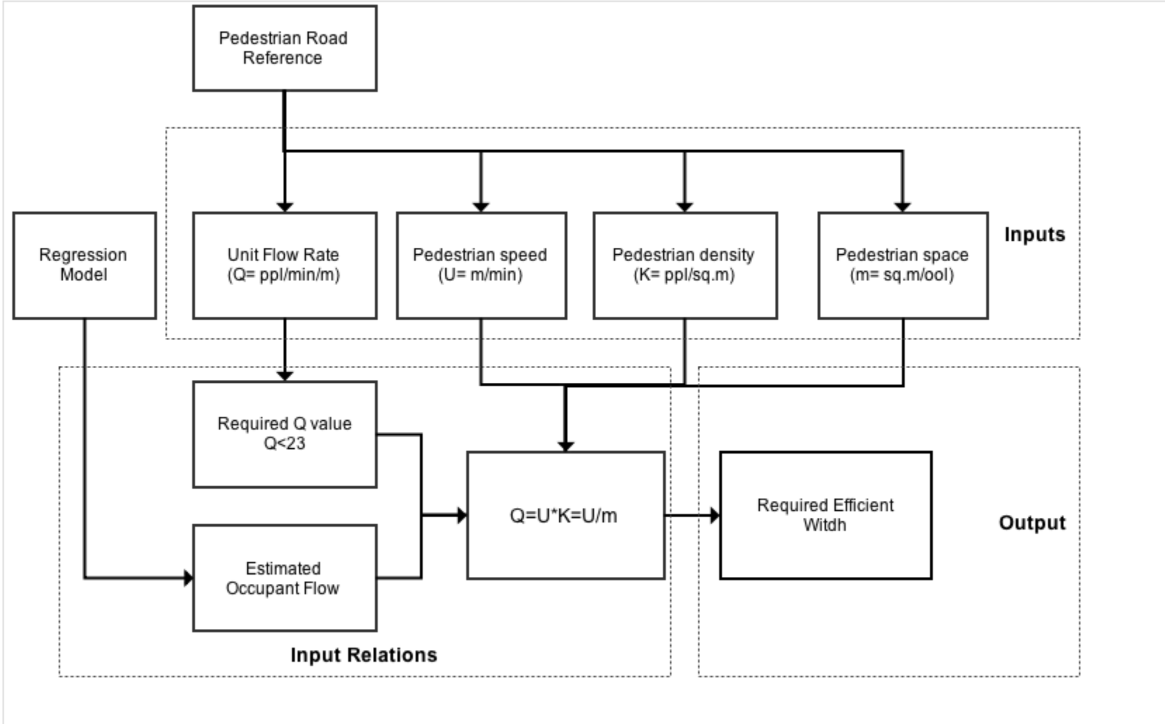

Figure3-2 Development Capacity Model Sub-routine1- Input, output of Q calculation

- SR2: Input, output and regression modeling

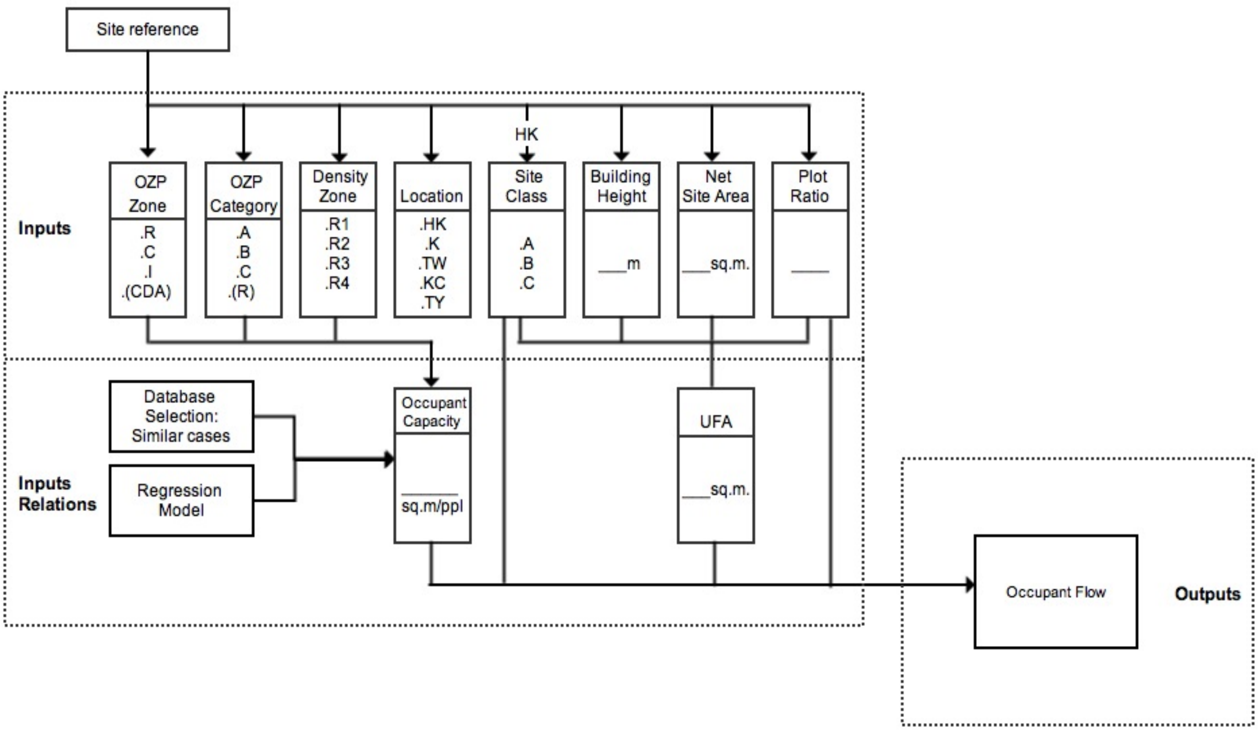

Figure3-3 Development Capacity Model Sub-routine2- Input, output and regression modeling