Human Factors Considerations in Station Planning & Design

Philip Leung
Civil & Building Engineering Manager
Agenda

- Background
- Station Planning
- Station Capacity
- Computational Simulation
Focuses on health and safety, the UK Health and Safety Executive (HSE) defines HF as:

“The environmental, organizational and job factors, and human individual characteristics which influence behaviour at work in a way can affect health and safety.”

Three main groups of factors

- **Organization**
  - culture, leadership, resources, work patterns, communications...

- **Job**
  - task, workload, environment, display and controls, procedures

- **Individual**
  - skills, personality, attitudes, risk perception...
To achieve good performance we need to optimise the influences on behaviour

- **The job** – what are people being asked to do and under what circumstances? (e.g. the task, workload, working environment, procedures, displays and controls).

- **The individual** – who is doing it? (e.g. their competence, skills, personality, attitudes, and risk perception).

- **The organisation** – how is the work organised? (e.g. leadership, resources, work pattern, planning, communication, and culture)
Can people reach everything?
Is there enough space to work?
Are there obstructions?
Can a good working posture be achieved?

Can procedures be followed in the workplace?
Is there time pressure?
What working hours or breaks?
What training is given?
What level of supervision is there?

Is there good:
working culture?,
leadership?
motivation?

Is there good:
working culture?,
leadership?
motivation?

Is there the lighting OK?
Is noise a distraction or does it prevent good communication?
Does the temperature make people tired?

Does a person need:
good vision/hearing,
strength,
personal traits?

Is the machine/tool easy to use?
Is it available where it is needed?
Does the interface meet expectations?
Human Factors Considerations in Station Planning and Design

• Increasing Crowdedness

• Station Capacity

• Disabled and Aging Passengers

• Escalators Safety

• Fire Safety and Evacuation
Virtual Design and Construction
Virtual Design and Construction
Services Clash Analysis
Virtual Design and Construction
CCTV Coverage Test & Signage Visibility Simulation
Kowloon Bay Station
Shadow Range Study
12th day of June 9:00am to 7:30pm
Kowloon Bay Station
Daily Average Radiation
12th day of June 9:00am to 7:30pm
Virtual Design and Construction
Fire Simulation
Station Planning and Design
Factors affecting passenger flow in stations

• Walking Speed

• Familiarity with Stations

• Passenger Flow within Stations
  – Counterflow
  – Crossflow

• Waiting passengers and queues

• Trip Purposes

• Luggage
Relationship between Flow, Density and Walking Speed

\[ \text{Passenger Flow Rate (} q \text{)} = \text{Density (} k \text{)} \times \text{Walking Speed (} u \text{)} \]

\[ (\text{Pax/min/m}) \quad \times \quad (\text{Pax/m}^2) \quad \times \quad (m/\text{min}) \]

In reality, passengers’ walking speed is a function of their density

\[ q = k \times F(k) \]
Fundamental Diagram

Capacity

Maximum Flow Rate \( (q_m) \)

Optimal Density \( (k_0) \)

S. P. Hoogendoorn et al. (2007)
**Fruin: Level of Service Standard**

A  Normal walking speed can be freely selected & slower pedestrians can be easily overtaken. Crossing conflicts can be easily avoided.

B  Restricted walking speed; overtaking slower pedestrians is difficult. Counter-flows & crossing movements severely restricted. Some probability of reaching critical density causing temporary stoppages.

C  Restricted ability to select normal walking speed & freely pass others. High probability of conflict where crossing movements & counter-flows exist. Conflict avoidance requires frequent adjustment of walking speed & direction. Flow is reasonably fluid, however considerable friction & interaction between pedestrians is likely to occur.

D  Restricted walking speed; overtaking slower pedestrians is difficult. Counter-flows & crossing movements severely restricted. Some probability of reaching critical density causing temporary stoppages.

E  Walking speed & passing ability is restricted for all pedestrians. Forward movement is possible only by shuffling. Counter-flows & crossing movements extremely difficult. Flow volumes approach limit of walking capacity.

F  Severely restricted walking speed; frequent unavoidable contact with others; reverse or cross movements are virtually impossible. Pedestrian flow is sporadic & unstable.

*Source: Pedestrian Planning and Design, John J. Fruin, 1987*
### Design Capacity in NWDSM

<table>
<thead>
<tr>
<th></th>
<th>Maximum Practical Capacity (MPC)</th>
<th>Design Factor 0.8 (Normal)</th>
<th>Design Factor 0.6 (New Station)</th>
<th>Design Factor 0.9 (Emergency)</th>
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</thead>
<tbody>
<tr>
<td>Escalator (speed 0.75 m/s)</td>
<td>150</td>
<td>120</td>
<td>90</td>
<td>135</td>
</tr>
<tr>
<td>Stair (Uni-directional)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up</td>
<td>63</td>
<td>50</td>
<td>37</td>
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<tr>
<td></td>
<td>Down</td>
<td>70</td>
<td>56</td>
<td>42</td>
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<tr>
<td>Stair (Bi-directional)</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Up</td>
<td>50</td>
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<td>30</td>
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<tr>
<td></td>
<td>Down</td>
<td>56</td>
<td>44</td>
<td>33</td>
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<td>Passage</td>
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<td></td>
<td>Uni-directional</td>
<td>88</td>
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<tr>
<td></td>
<td>Bi-directional</td>
<td>70</td>
<td>56</td>
<td>42</td>
</tr>
<tr>
<td>AFC Gates (Turnstile Gate)</td>
<td>35</td>
<td>28</td>
<td>-</td>
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### MTR’s Level of Service Standard

#### Fruin Level of Service Standard

<table>
<thead>
<tr>
<th>LOS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<tbody>
<tr>
<td>Walkway</td>
<td>&lt;0.31</td>
<td>0.31-0.43</td>
<td>0.43-0.72</td>
<td>0.7-1.1</td>
<td>1.1-2.2</td>
<td>&gt;2.2</td>
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<tr>
<td>Queuing</td>
<td>&lt;0.82</td>
<td>0.8-1.1</td>
<td>1.1-1.5</td>
<td>1.5-3.6</td>
<td>3.6-5.6</td>
<td>&gt;5.6</td>
</tr>
<tr>
<td>Staircase</td>
<td>&lt;0.54</td>
<td>0.54-0.72</td>
<td>0.7-1.1</td>
<td>1.1-1.5</td>
<td>1.5-2.7</td>
<td>&gt;2.7</td>
</tr>
</tbody>
</table>

#### New Works Design Standard

<table>
<thead>
<tr>
<th>LOS</th>
<th>Good</th>
<th>Acceptable</th>
<th>Undesirable</th>
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</thead>
<tbody>
<tr>
<td>Escalator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At concourse &amp; entrance levels</td>
<td>No Waiting</td>
<td>0 – 15 sec.</td>
<td>Exceed 15 sec.</td>
</tr>
<tr>
<td>At Platform</td>
<td>No Waiting</td>
<td>0 – 30 sec.</td>
<td>Exceed 30 sec.</td>
</tr>
<tr>
<td>TIMs, TMs, AVMs</td>
<td>No Waiting</td>
<td>0 – 30 sec.</td>
<td>Exceed 30 sec.</td>
</tr>
<tr>
<td>AFC Gates</td>
<td>No Waiting</td>
<td>0 – 10 sec.</td>
<td>Exceed 10 sec.</td>
</tr>
<tr>
<td>Lifts</td>
<td>No Waiting</td>
<td>0 – 30 sec.</td>
<td>Exceed 30 sec.</td>
</tr>
<tr>
<td>Journey Time</td>
<td>From Entrance to Platform</td>
<td>0 – 3 minutes</td>
<td>3 – 6 minutes</td>
</tr>
<tr>
<td></td>
<td>For Interchange</td>
<td>0 – 3 minutes</td>
<td>3 – 6 minutes</td>
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</table>
## MTR’s Classification of Congestion

<table>
<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
<th>Action Required</th>
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</thead>
<tbody>
<tr>
<td>CG1 – Safety Compromised Level</td>
<td>Crowding at critical location, duration, and situation that has safety concern</td>
<td>Condition at which service level must be reduced</td>
</tr>
<tr>
<td>CG2 – Alert Condition Level</td>
<td>Congestion level that the passenger flow efficiency starts to drop</td>
<td>Permanent crowd control to be put in place by operator. Commission works on congestion work.</td>
</tr>
<tr>
<td>CG3 – Sub-standard Customer Service Level</td>
<td>Congestion level that impede passengers’ usual walking speed and step length</td>
<td>Intermittent crowd control to be put in place by operator. Commission studies on congestion relief schemes</td>
</tr>
<tr>
<td>CG4 – Target Customer Service Level</td>
<td>Congestion level that passengers can move at their unimpeded speed and step length</td>
<td>Maintain through station management action.</td>
</tr>
</tbody>
</table>
Overall travelling time calculation from entrance to platform:

\[ T = t_1 + Q_1 + t_2 + Q_2 + t_e + t_3 \]

where

- \( T \) = Overall travelling time
- \( t \) = Travelling time of a given distance, based on 1.35 m/s, or \( D / 1.35 \), where \( D \) = distance
- \( t_e \) = Travelling time at escalator, based on 0.75 m/s*, or \((2R+3+2) / 0.75\), where \( R \) = floor-to-floor height
- \( Q \) = Desirable queuing time (max.):
  - 10 seconds for AFC gates*
  - 15 seconds for escalator*
Passenger Flow Data

KOB Demand Variations & Growth

**Monthly Variation**

<table>
<thead>
<tr>
<th>Month</th>
<th>% of Monthly Average Weekday Incoming Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>80</td>
</tr>
<tr>
<td>Feb</td>
<td>85</td>
</tr>
<tr>
<td>Mar</td>
<td>90</td>
</tr>
<tr>
<td>Apr</td>
<td>95</td>
</tr>
<tr>
<td>May</td>
<td>100</td>
</tr>
<tr>
<td>Jun</td>
<td>105</td>
</tr>
<tr>
<td>Jul</td>
<td>110</td>
</tr>
<tr>
<td>Aug</td>
<td>115</td>
</tr>
<tr>
<td>Sep</td>
<td>120</td>
</tr>
<tr>
<td>Oct</td>
<td>115</td>
</tr>
<tr>
<td>Nov</td>
<td>110</td>
</tr>
<tr>
<td>Dec</td>
<td>105</td>
</tr>
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</table>

**Annual Growth**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Annual Incoming Passengers (Millions)</th>
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</thead>
<tbody>
<tr>
<td>97</td>
<td>32</td>
</tr>
<tr>
<td>98</td>
<td>34</td>
</tr>
<tr>
<td>99</td>
<td>36</td>
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<tr>
<td>00</td>
<td>38</td>
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<tr>
<td>01</td>
<td>40</td>
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<tr>
<td>02</td>
<td>42</td>
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<tr>
<td>03</td>
<td>97</td>
</tr>
<tr>
<td>04</td>
<td>98</td>
</tr>
<tr>
<td>05</td>
<td>99</td>
</tr>
<tr>
<td>06</td>
<td>00</td>
</tr>
</tbody>
</table>
Passenger Profile

Mong Kok (MOK)

Kowloon Bay (KOB)

Adult: 87.4%
Student: 6.7%
Senior Citizen: 3.3%
Child: 1.7%
Disabled: 0.2%
Tourist: 0.6%

Adult: 78.2%
Student: 14.2%
Senior Citizen: 4.7%
Child: 2.6%
Disabled: 0.4%
Tourist: 0.0%
Passenger Flow Characteristics (Weekdays)

Mong Kok (MOK)

Time

Passenger Flow

DF Capacity (In) - 18+1 Gate
DF Capacity (Out) - 26+1 Gate
MPC Capacity (In)
MPC Capacity (Out)
Passenger Flow Characteristics (Weekdays)

Kowloon Bay (KOB)

V/C = 0.66
Passenger Flow Characteristics (Weekdays)

Tsim Sha Tsui (TST)

[Bar chart showing passenger flow over time, with peaks and valleys indicating high and low flow periods.]

- **DF Capacity (In)** - 26+1W Gate
- **DF Capacity (Out)** - 37+1W Gate
- **MPC Capacity (In)**
- **MPC Capacity (Out)**
Passenger Flow Characteristics (X’mas Eve)

Tsim Sha Tsui (TST)

<table>
<thead>
<tr>
<th>Time</th>
<th>Passenger Flow</th>
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<tbody>
<tr>
<td>5:00</td>
<td>0</td>
</tr>
<tr>
<td>5:30</td>
<td>1000</td>
</tr>
<tr>
<td>6:00</td>
<td>2000</td>
</tr>
<tr>
<td>6:30</td>
<td>3000</td>
</tr>
<tr>
<td>7:00</td>
<td>4000</td>
</tr>
<tr>
<td>7:30</td>
<td>5000</td>
</tr>
<tr>
<td>8:00</td>
<td>6000</td>
</tr>
<tr>
<td>8:30</td>
<td>7000</td>
</tr>
<tr>
<td>9:00</td>
<td>8000</td>
</tr>
<tr>
<td>9:30</td>
<td>9000</td>
</tr>
<tr>
<td>10:00</td>
<td>10000</td>
</tr>
</tbody>
</table>

DF Capacity (In) - 15+29B+1W Gate
DF Capacity (Out) - 19+29B+1W Gate
MPC Capacity (In)
MPC Capacity (Out)
Station Capacity
Station Capacity Measurement

Concourse

Platform
Station Capacity (KOB)

Entry Capacity (ppm) of Facilities
- Actual: 327 (Max), 321 (Av. 17-21 Oct 2011)
- 562
  - Entrances
- 308
  - AFC Gates
- 240
  - Vertical Link
- 76
  - Platform

Exit Capacity (ppm) of Facilities
- Actual: 351 (Max), 336 (Av. 17-21 Oct 2011)
- 555
  - Entrances
- 364
  - AFC Gates
- 360
  - Vertical Link
- 76
  - Platform
**Station Capacity (KWT)**

**Entry Capacity (ppm) of Facilities**

- **Entrances**: 713
- **AFC Gates**: 392
- **Vertical Link**: 360
- **Platform**

<table>
<thead>
<tr>
<th>Entrances</th>
<th>AFC Gates</th>
<th>Vertical Link</th>
<th>Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>713</td>
<td>392</td>
<td>360 (Ex)</td>
<td>312</td>
</tr>
</tbody>
</table>

**Exit Capacity (ppm) of Facilities**

- **Entrances**: 756
- **AFC Gates**: 532
- **Vertical Link**: 360
- **Platform**

<table>
<thead>
<tr>
<th>Entrances</th>
<th>AFC Gates</th>
<th>Vertical Link</th>
<th>Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>756</td>
<td>532</td>
<td>360 (In)</td>
<td>312</td>
</tr>
</tbody>
</table>

**Graphs**

- Left graph: Bar chart showing capacity in ppm for different sections (Entrances, AFC Gates, Vertical Link, Platform).
- Right graph: Bar chart showing capacity in ppm for different sections (Entrances, AFC Gates, Vertical Link, Platform).
Station Capacity (1)

KOB - Entry Peak Patronage larger than 4740

Frequency

KOB - Exit Peak Patronage larger than 5400

Frequency
Station Capacity (2)

KOB - Entry Peak Patronage larger than 3600

- Frequency
- 15-min Peak Patronage

KOB - Exit Peak Patronage larger than 5400

- Frequency
- 15-min Peak Patronage
Passenger Waiting Time at Escalator Landings

![Graph showing waiting times and frequencies for E1, E2, E3, E4, and E5]
Escalator Throughput
Walking Speed
MTR's Assumed Walking Speed for Station Design

The diagram illustrates a normal distribution of walking speeds, with 99.7% of the population falling within ±3 standard deviations (s.d.), 95.4% within ±2 s.d., and 68.3% within ±1 s.d. The mean walking speed is 1.35 m/s, with standard deviation values of ±0.585, ±0.840, ±1.095, ±1.350, ±1.605, ±1.860, and ±2.115 m/s.
### Passenger Walking Speed - Mong Kok (MOK)

<table>
<thead>
<tr>
<th>Passengers groups</th>
<th>Minimum speed [m/s]</th>
<th>Maximum speed [m/s]</th>
<th>Average speed [m/s]</th>
<th>Standard deviation [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.63</td>
<td>4.22</td>
<td>1.28</td>
<td>0.39</td>
</tr>
<tr>
<td>Female</td>
<td>0.54</td>
<td>2.03</td>
<td>1.21</td>
<td>0.25</td>
</tr>
<tr>
<td>Elderly</td>
<td>0.54</td>
<td>1.65</td>
<td>1.08</td>
<td>0.27</td>
</tr>
<tr>
<td>Children</td>
<td>0.75</td>
<td>3.14</td>
<td>1.24</td>
<td>0.41</td>
</tr>
<tr>
<td>Disabled</td>
<td>0.54</td>
<td>1.54</td>
<td>0.94</td>
<td>0.29</td>
</tr>
<tr>
<td>Passengers with luggage</td>
<td>0.92</td>
<td>1.82</td>
<td>1.26</td>
<td>0.22</td>
</tr>
</tbody>
</table>
## Passenger Walking Speed - Mong Kok (MOK)

<table>
<thead>
<tr>
<th>Passengers groups</th>
<th>Minimum speed [m/s]</th>
<th>Maximum speed [m/s]</th>
<th>Average speed [m/s]</th>
<th>Standard deviation [m/s]</th>
</tr>
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<tbody>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>0.63</td>
<td>3.14</td>
<td>1.36</td>
<td>0.39</td>
</tr>
<tr>
<td>PM</td>
<td>0.74</td>
<td>4.22</td>
<td>1.22</td>
<td>0.39</td>
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<tr>
<td><strong>Female</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>0.70</td>
<td>2.03</td>
<td>1.35</td>
<td>0.30</td>
</tr>
<tr>
<td>PM</td>
<td>0.54</td>
<td>1.70</td>
<td>1.09</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>Elderly</strong></td>
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<td></td>
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<tr>
<td>AM</td>
<td>0.63</td>
<td>1.65</td>
<td>1.14</td>
<td>0.29</td>
</tr>
<tr>
<td>PM</td>
<td>0.54</td>
<td>1.21</td>
<td>1.00</td>
<td>0.23</td>
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<td>0.75</td>
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<td>PM</td>
<td>0.78</td>
<td>1.76</td>
<td>1.19</td>
<td>0.26</td>
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<tr>
<td><strong>Disabled</strong></td>
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<tr>
<td>AM</td>
<td>0.79</td>
<td>1.28</td>
<td>1.01</td>
<td>0.22</td>
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<td>PM</td>
<td>0.54</td>
<td>1.52</td>
<td>0.90</td>
<td>0.33</td>
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<tr>
<td><strong>Passengers with luggage</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>AM</td>
<td>0.92</td>
<td>1.82</td>
<td>1.26</td>
<td>0.25</td>
</tr>
<tr>
<td>PM</td>
<td>1.09</td>
<td>1.36</td>
<td>1.25</td>
<td>0.10</td>
</tr>
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</table>
# Passenger Walking Speed - Mong Kok (MOK)

<table>
<thead>
<tr>
<th>Area</th>
<th>Minimum speed [m/s]</th>
<th>Maximum speed [m/s]</th>
<th>Average speed [m/s]</th>
<th>Standard deviation [m/s]</th>
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<tbody>
<tr>
<td>Walkway</td>
<td>0.54</td>
<td>4.22</td>
<td>1.17</td>
<td>0.25</td>
</tr>
<tr>
<td>Ramp</td>
<td>0.29</td>
<td>3.71</td>
<td>0.96</td>
<td>0.25</td>
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<tr>
<td>Stair (Upward)</td>
<td>0.15</td>
<td>1.88</td>
<td>0.52</td>
<td>0.23</td>
</tr>
<tr>
<td>Stair (Downward)</td>
<td>0.25</td>
<td>1.67</td>
<td>0.70</td>
<td>0.19</td>
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## Passenger Walking Speed

<table>
<thead>
<tr>
<th>Station</th>
<th>Minimum speed [m/s]</th>
<th>Maximum speed [m/s]</th>
<th>Average speed [m/s]</th>
<th>Standard deviation [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mong Kok (MOK)</td>
<td>0.54</td>
<td>4.22</td>
<td>1.17</td>
<td>0.25</td>
</tr>
<tr>
<td>Kwun Tong (KWT)</td>
<td>0.43</td>
<td>0.92</td>
<td>1.02</td>
<td>0.26</td>
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<tr>
<td>Kowloon Bay (KOB)</td>
<td>0.42</td>
<td>2.45</td>
<td>1.05</td>
<td>0.21</td>
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<tr>
<td>Kowloon Tong (KOT)</td>
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<td>3.47</td>
<td>1.16</td>
<td>0.25</td>
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<tr>
<td>Wanchai (WAC)</td>
<td>0.41</td>
<td>2.45</td>
<td>1.03</td>
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<tr>
<td>Admiralty (ADM)</td>
<td>0.54</td>
<td>2.84</td>
<td>1.16</td>
<td>0.21</td>
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</table>
## Passenger Walking Speed

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean speed (m/s)</th>
<th>Standard deviation (m/s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>CROW (11)</td>
<td>1.4</td>
<td></td>
<td>Netherlands</td>
</tr>
<tr>
<td>Daamen (10)</td>
<td>1.41</td>
<td>0.215</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Daly et al. (12)</td>
<td>1.47</td>
<td></td>
<td>United Kingdom</td>
</tr>
<tr>
<td>FHWA (13)</td>
<td>1.2</td>
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<td>United States</td>
</tr>
<tr>
<td>Fruin (9)</td>
<td>1.4</td>
<td>0.15</td>
<td>United States</td>
</tr>
<tr>
<td>Hankin and Wright (14)</td>
<td>1.6</td>
<td></td>
<td>United Kingdom</td>
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<tr>
<td>Henderson (15)</td>
<td>1.44</td>
<td>0.23</td>
<td>United States</td>
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<tr>
<td>Hoel (16)</td>
<td>1.50</td>
<td>0.20</td>
<td>United States</td>
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<tr>
<td>Institute of Transportation Engineers (17)</td>
<td>1.2</td>
<td></td>
<td>Austria</td>
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<tr>
<td>Knoflacher (18)</td>
<td>1.45</td>
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<td>United States</td>
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<tr>
<td>Koushki (19)</td>
<td>1.08</td>
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<td>Saudi-Arabia</td>
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<tr>
<td>Lam et al. (20)</td>
<td>1.19</td>
<td>0.26</td>
<td>Hong Kong</td>
</tr>
<tr>
<td>Morrall et al. (21)</td>
<td>1.25</td>
<td></td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>Navin and Wheeler (22)</td>
<td>1.32</td>
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<td>Canada</td>
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<tr>
<td>O’Flaherty and Parkinson (23)</td>
<td>1.32</td>
<td>1.0</td>
<td>United States</td>
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<td>Older (24)</td>
<td>1.30</td>
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</tr>
<tr>
<td>Pauls (25)</td>
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</tr>
<tr>
<td>Roddin (26)</td>
<td>1.6</td>
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</tr>
<tr>
<td>Sarkar and Janardhan (27)</td>
<td>1.46</td>
<td>0.63</td>
<td>India</td>
</tr>
<tr>
<td>Sleight (28)</td>
<td>1.37</td>
<td></td>
<td>United States</td>
</tr>
<tr>
<td>Tanariboon et al. (29)</td>
<td>1.23</td>
<td></td>
<td>Singapore</td>
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<tr>
<td>Tanariboon and Guyano (30)</td>
<td>1.22</td>
<td></td>
<td>Thailand</td>
</tr>
<tr>
<td>Tregenza (31)</td>
<td>1.31</td>
<td>0.30</td>
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<tr>
<td>Virkler and Elayadath (32)</td>
<td>1.22</td>
<td></td>
<td>United States</td>
</tr>
<tr>
<td>Young (33)</td>
<td>1.38</td>
<td>0.27</td>
<td>United States</td>
</tr>
</tbody>
</table>

**Estimated overall average** | 1.34             | 0.37                     |
Station Simulation
Station Capacity Measurement

Concourse (AM)

Platform (AM)
Path Selection Model

Evaluate the weighting (attraction effect) between the gates and the escalators / stairs by using Artificial Neuron Network (ANN) model.

1. Distance between gates of exit gate group 1 and Entrance A
2. Number of gates of exit gate group 1

1. Distance between gates of exit gate group 6 and Entrance A
2. Number of gates of exit gate group 6

1. Distance between gates of exit gate group 1 and Entrance E
2. Number of gates of exit gate group 1

1. Distance between gates of exit gate group 6 and Entrance E
2. Number of gates of exit gate group 6

Possibility of going to Entrance A from Gate 1
Possibility of going to Entrance A from Gate 2
Possibility of going to Entrance A from Gate 5
Possibility of going to Entrance A from Gate 6

Possibility of going to Entrance E from Gate 1
Possibility of going to Entrance E from Gate 2
Possibility of going to Entrance E from Gate 5
Possibility of going to Entrance E from Gate 6
Flow model

Pedestrian movement rules

Pedestrian area

Potential collision detection

Movable distance

Collision with others

Collision with Walls
Passenger Flow Simulation
Passenger Flow Simulation

Pax/m²

0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
1.800
2.000
2.200
2.400
Undesirable Passenger Flow Areas

Crossflow
Undesirable Passenger Flow Areas

AFC Gates blocked by queuing passengers
Undesirable Passenger Flow Areas
MPC = (4.5/2) x 70
= 157.5 Ped/min

MPC = (4.5/2) x 70
= 157.5 Ped/min

MPC = (4.5/2) x 70
= 157.5 Ped/min

MPC = 2 x 50
= 100 Ped/min

MPC = 2 x 50
= 100 Ped/min

MPC = 2.25 x 50
= 112.5 Ped/min

MPC = 2.25 x 50
= 112.5 Ped/min
Entrances may be blocked by pedestrians during rainy days
### Passenger Flow at Station Entrances

#### 7. Weekday Entrance Pedestrian Flow

<table>
<thead>
<tr>
<th>Direction/Entrance</th>
<th>No. of Pedestrians</th>
<th>Estimate Daily</th>
<th>Sketch for Entrance Location of the Station</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Morning Peak Hour</td>
<td>Off Peak Hour</td>
<td>Evening Peak Hour</td>
</tr>
<tr>
<td>Towards MTR</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A</td>
<td>379</td>
<td>1327</td>
<td>2730</td>
</tr>
<tr>
<td>B</td>
<td>64</td>
<td>412</td>
<td>588</td>
</tr>
<tr>
<td>C</td>
<td>735</td>
<td>877</td>
<td>1792</td>
</tr>
<tr>
<td>D1</td>
<td>268</td>
<td>450</td>
<td>1128</td>
</tr>
<tr>
<td>D2</td>
<td>698</td>
<td>288</td>
<td>696</td>
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<tr>
<td>D3 N.A.</td>
<td>577</td>
<td>1081</td>
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<td>D4 N.A.</td>
<td>382</td>
<td>568</td>
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<tr>
<td>E</td>
<td>1098</td>
<td>1380</td>
<td>2871</td>
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<tr>
<td>F</td>
<td>1544</td>
<td>2505</td>
<td>7450</td>
</tr>
<tr>
<td>DL1</td>
<td>59</td>
<td>129</td>
<td>265</td>
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<tr>
<td>From MTR</td>
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<tr>
<td>A</td>
<td>1800</td>
<td>909</td>
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<td>B</td>
<td>225</td>
<td>376</td>
<td>755</td>
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<tr>
<td>C</td>
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<td>1610</td>
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<tr>
<td>D1</td>
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<td>523</td>
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<tr>
<td>D2</td>
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<td>D3 N.A.</td>
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<tr>
<td>D4 N.A.</td>
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<td>487</td>
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<tr>
<td>E</td>
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<td>F</td>
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<td>1824</td>
<td>4245</td>
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<tr>
<td>DL1</td>
<td>97</td>
<td>93</td>
<td>134</td>
</tr>
</tbody>
</table>
Development near MTR Stations

- URA KWUN TONG TOWN CENTRE REDEVELOPMENT
  - NOT MORE THAN 1,700 RES FLATS
  - NOT MORE THAN 400 HOTEL RMS
  - OFFICE 65,860sqm
  - RETAIL 49,660sqm
  - PTI 2,700sqm
  - GUC 1,240sqm
  - AWC BY MPC IN JAN 2009

- PROPOSED LUEM ON ST MILESIDE
  - ESC, LNK & ELEVATED SYSTEM BY ID

- GRADE-SEPARATED PEDLINK BY CEDD

- PROPOSED NOT EXCEEDING 98-RM HOTEL
  - AWC BY MPC IN APR 2011

- 298-RM HOTEL
  - AWC BY MPC IN OCT 2010
  - (UPDATED IN MAY 2011)

- 110-RM HOTEL
  - AWC BY MPC IN SEPT 2011

- KWUN TONG FERRY PIER
  - WATERFRONT DEVELOPMENT SITE AS PART OF ENERGIZING
  - KLN EAST

- NOT MORE THAN 300 RES FLATS,
  - 3 LEVELS OF PUBLIC HEALTH CENTRE
  - AWC BY MPC IN OCT 2008

- REDEVELOPMENT OF
  - KWUN TONG SWIMMING POOL &
  - RECREATION GROUND BY ASD
  - PH 1: SCHEDULED COMPLETION IN DEC 2012,
  - PH 2: SCHEDULED COMPLETION IN DEC 2014

- 58-536sqm COMMERCIAL
  - DEVELOPMENT AWC BY MPC IN APR 2010
  - (PART OF ENERGIZING KLN EAST)

- METHADONE CLINIC
  - AWC BY MPC IN DEC 2010

- GOVT SITE FOR DEVELOPMENT AS
  - PART OF ENERGIZING KLN EAST

MTR Station Planning Portal - KWT