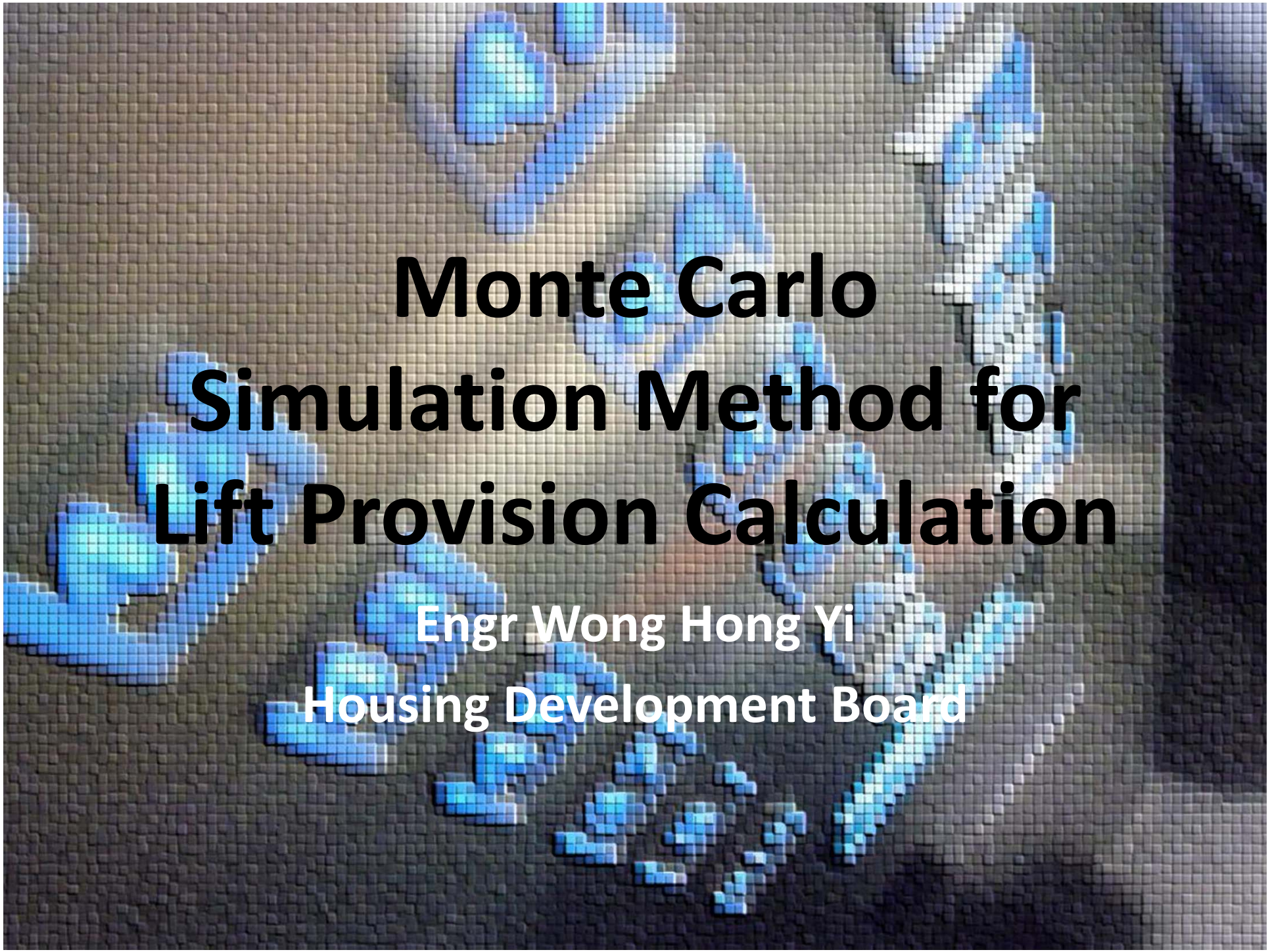

Monte Carlo Simulation Method for Lift Provision Calculation

Engr Wong Hong Yi
Housing Development Board

Objective

- Highlight the changes in building designs since 1990s and how they will affect the planning of vertical transportation at HDB Blocks

- Introduce the Monte Carlo Simulation Method for Lift Provision Calculation; a more accurate lift provision calculation method

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Contents

- Changes in Building Designs
- Comparison of the Current Method and the Simulation Method
- Demonstration of the Simulation Method
- Moving Forward

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Changes in Building Heights

- Low Buildings



12-Storey Blocks in Choa Chu Kang (Built in 1990s)

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Changes in Building Heights

- Tall Buildings



Mega tall HDB Blocks – Pinnacle@Duxton (50-Story blocks)

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Changes in Flat Types Composition

- Uniformed Flat Types



A typical 5-room point block in Toa Payoh (Built in 1990s)

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Changes in Flat Types Composition

- Varied Flat Types



A mixed flat types block – Punggol Tree Lodge

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Changes in Number of Dwelling Units

- Smaller number of dwelling units per block



HDB Blocks at Bishan Estate

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Changes in Number of Dwelling Units

- Increase in number of dwelling units per block



Links between what look seemingly like 2 separate blocks

Each floor has 8 units

However, only 2 lifts are available at each floor

Joint blocks Design – Teban Vista at Jurong East

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Changes in Layout of Amenities

- Link bridges to Roof Top Gardens



Garden at Toa Payoh Estate

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Changes in Layout of Amenties

- Link Bridges to Roof Top Gardens



Rooftop Garden at Punggol Breeze

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Changes in Layout of Amenties

- Link bridges to MSCP



Standalone Multi-story Carpark at Toa Payoh

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Changes in Layout of Amenties

- Blocks connected to MSCP



Newly Built HDB Estate at Telok Bangah with Connected MSCP

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More Affluent Residents



New Generation of Residents

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Current Method : RTT Formula

- Theoretical approach based on a research by Dr. Gina Barney in the 1970s
- Based on Round Trip Time (RTT) Formula
- Easy tool that works well for standard low-rise buildings but not for high-rise buildings
- HDB requirements:
  - Handling Capacity >6%
  - Average Waiting Time <54 secs
- Many limitations and lead to Low Lift Services Satisfaction Rate in many new estates

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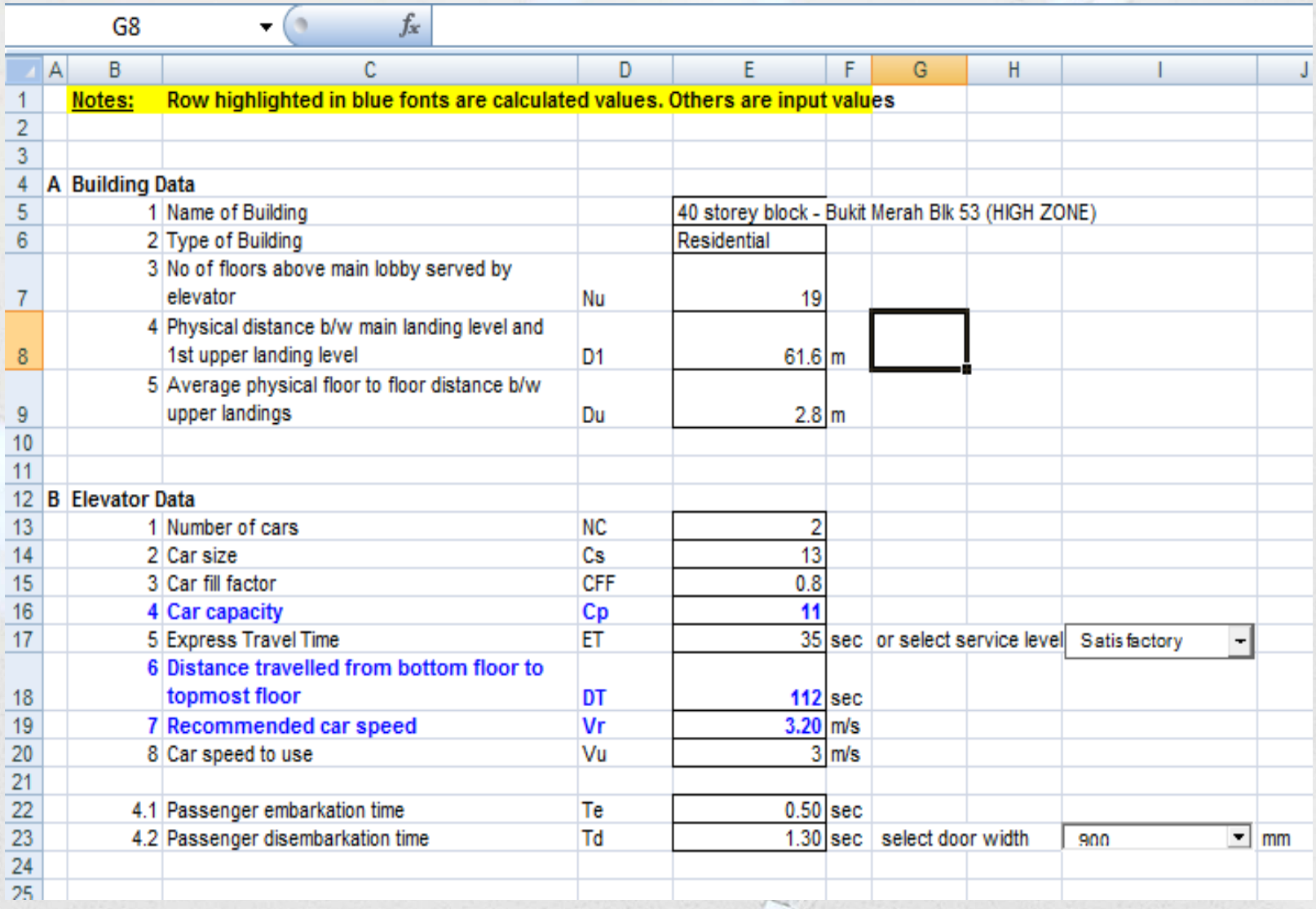
RRT Formula Method in Excel



G8

	A	B	C	D	E	F	G	H	I	J
1		Notes:	Row highlighted in blue fonts are calculated values. Others are input values							
2										
3										
4	A	Building Data								
5		1	Name of Building		40 storey block - Bukit Merah Blk 53 (HIGH ZONE)					
6		2	Type of Building		Residential					
7		3	No of floors above main lobby served by elevator	Nu	19					
8		4	Physical distance b/w main landing level and 1st upper landing level	D1	61.6	m				
9		5	Average physical floor to floor distance b/w upper landings	Du	2.8	m				
10										
11										
12	B	Elevator Data								
13		1	Number of cars	NC	2					
14		2	Car size	Cs	13					
15		3	Car fill factor	CFF	0.8					
16		4	Car capacity	Cp	11					
17		5	Express Travel Time	ET	35	sec	or select service level		Satisfactory	
18		6	Distance travelled from bottom floor to topmost floor	DT	112	sec				
19		7	Recommended car speed	Vr	3.20	m/s				
20		8	Car speed to use	Vu	3	m/s				
21										
22		4.1	Passenger embarkation time	Te	0.50	sec				
23		4.2	Passenger disembarkation time	Td	1.30	sec	select door width		900	mm
24										
25										

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Advanced Method: Simulation Method

- Mimics the actual operations of lift systems
- Based on Object Orientated Programming & Statistics
- Widely used Lift Analysis Method
  - Established Lift Companies, i.e. KONE, Otis
  - Consultants, i.e. Ove Arup
- ELEVATE - Industry-recognised software

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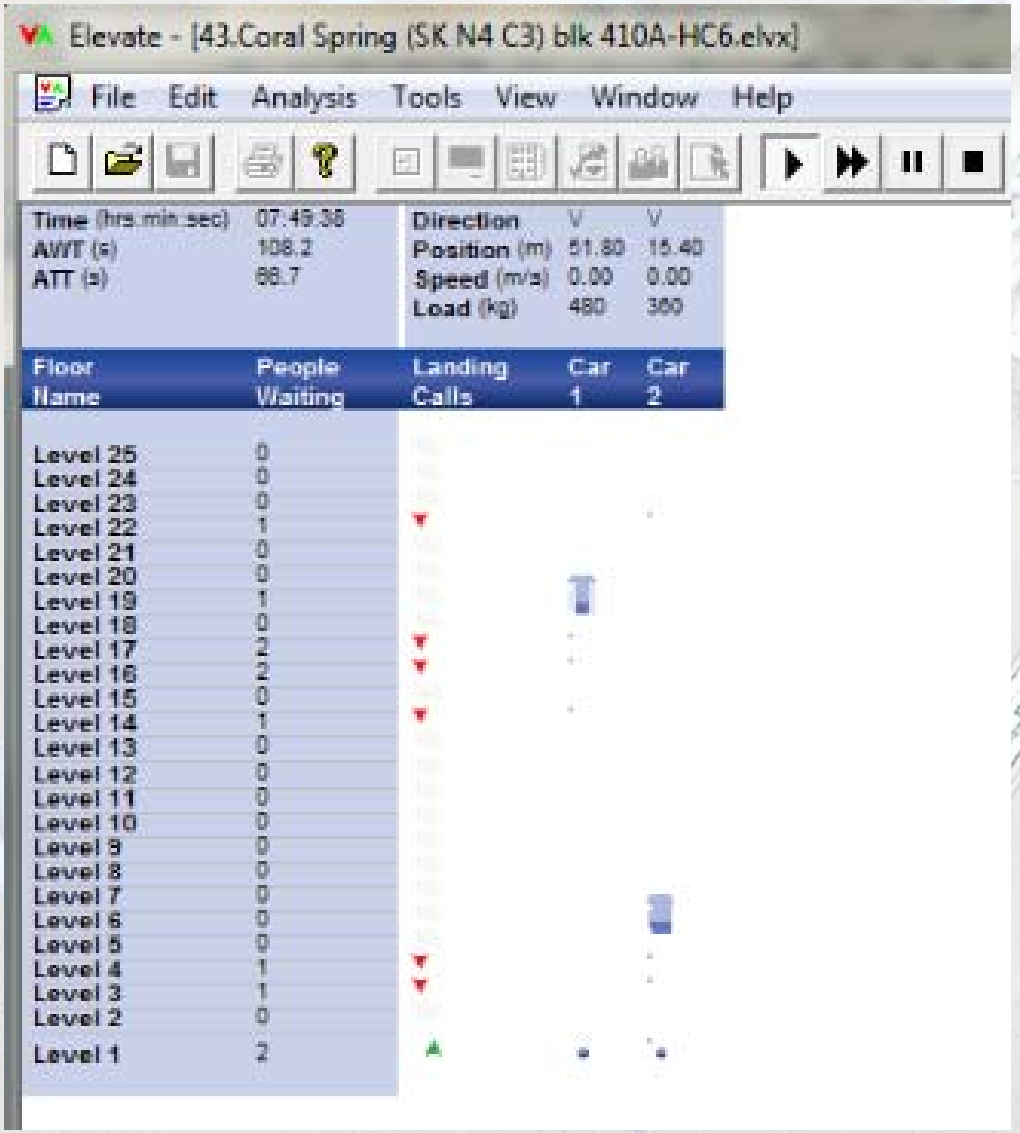
Simulation Method in ELEVATE



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Comparison of the Methods

- Assumptions

RTT Formulas (Current)	Simulation (Proposed)
Assumes all floors are equally populated, i.e. same flat type	Allows user to specify the population of each floor, i.e. allow different flat types
Assumes 1 entrance to building	Allows user to set multiple entrances, i.e. able to account for link bridges to MSCP/Gardens
Assumes lift cars present themselves at main terminal at an evenly spaced time	Accounts for different scenarios of car movements
Assumes no passenger has to wait more than a single trip	Accounts for passengers waiting for more than a single trip

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Case Studies

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Teban Vista Blk 20

- 40 Storeys
- 8 units of 3 & 4 Rms Flats
- 2 High & 2 Low Zone Lifts (transfer at 21st)
- Est. Building Population: 980
- Link Bridge to MSCP





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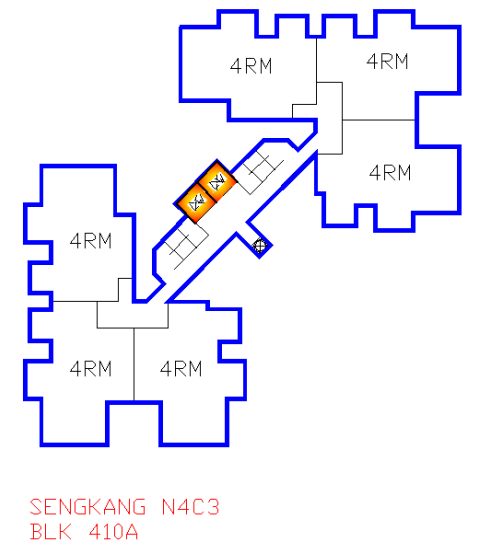
Sengkang Coral Spring Blk 410A

- 25 Storeys, 2 Lifts
- 6 units of 4 Rooms- Flats
- Est. Building Population: 518





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Accuracy of Simulated Waiting Time

	Simulated Waiting Time (s)	Ground Measurements' Waiting Time (s)	Difference (s)
Teban Vista (Low Zone Lifts)	53.2 (4.6%)	51.1 (4.6%)	+2.1
Teban Vista (High Zone Lifts)	42.8 (3.2%)	44.8 (3.2%)	-2.0
Sengkang Coral Spring	51.5 (3.6%)	49.4 (3.6%)	+1.9

Simulated Waiting Time is obtained using the ELEVATE software
Figures in () are the handling capacity experienced on ground

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Demonstration using ELEVATE Simulation Software

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Moving Forward

- HDB is in the process of reviewing the lift provision requirements

- We are looking at integrating the use of simulation method in the lift provision calculation

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Thank You