



# SMT201 Geospatial Analytics for Urban Planning

Group Report  
Prepared for Professor Kam Tin Seong

## Paradisiacal Punggol



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# Introduction

## Our Preferred Planning Area

Punggol is a planning area and new town situated on the Tanjong Punggol peninsula in the North-East Region of Singapore. As we explored the area, we observed that despite an increasing number of land area made for residential, Punggol still lacks the basic amenities to serve the incoming residents. Even as Punggol aims to be the next digital district, it should always seek to address residents' basic needs first. Hence, we decided to take up Punggol and recommend the building of facilities in available and suitable spaces within Punggol.

## Approach

We first cleaned our datasets, including population data and network data (Bus Stops and MRT Stations). In this stage, we also checked each of our geometry layers to ensure that all layers in QGIS are checked and in working condition. To obtain greater details, we cleaned the population data from SingStats, and conducted an analysis of demographics via **graph visualisation in R**.

When we first conducted **proximity analysis**, we realized there were residential areas that were highly unserved. Hence, we conducted multiple **land suitability analysis** to determine the most suitable place to plant new education, eldercare and clinical facilities. We made use of the **SAGA Analytical Hierarchical Process** to simulate and ensure the consistency weightage, which is dependent on suggested factors.

## Punggol as a place to work-play-learn-live

As we noticed a significant number of residents who travel out of Punggol to work daily, we challenge the notion that Punggol is the paradisiacal planning area that allows all residents to work, play, learn and live at the same time, because it certainly is a difficult task to migrate all work areas into Punggol that is already limited on space.

## Infrastructures in Punggol

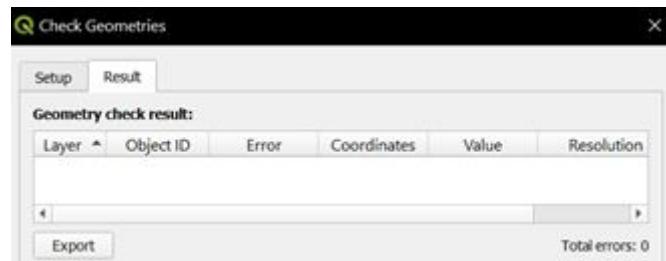
Before we suggest any changes, we must first take a look at current plans so as to make our suggestions more useful, as we might also be able to integrate our ideas with existing infrastructures. Here we observe the infrastructures of Punggol:

Current Infrastructure(s) to 2019	Planned Infrastructure(s) to 2025
<p><u>Smart Towns and Homes</u></p> <ul style="list-style-type: none"><li>• architects and engineers use smart planning tools and data analytics to analyse the wind flow, solar irradiance and shaded areas within a town, and determine how best new flats can be designed and sited to provide maximum thermal comfort and a more conducive</li></ul>	<p><u>Open Digital Platform</u></p> <ul style="list-style-type: none"><li>• centralise the data collection of single estate systems (facilities, building and estate management systems, district cooling system, pneumatic waste conveyancing system, autonomous goods delivery systems, access and security systems, carparks system,</li></ul>

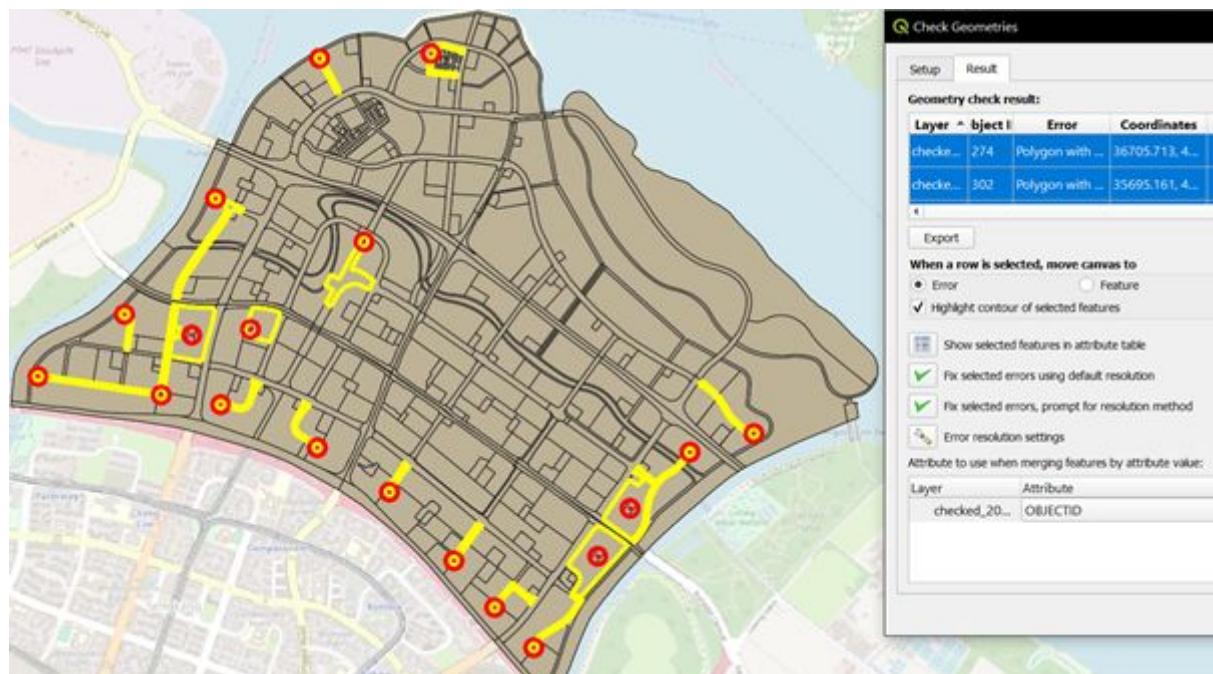
living environment for residents	traffic lights system, and autonomous vehicles)
<u>Transportation</u> <ul style="list-style-type: none"><li>• Punggol LRT, MRT, Bus Interchange</li></ul>	<u>Centralised Logistics Hub</u> <ul style="list-style-type: none"><li>• a single stop where all goods can be dropped off and picked up, improving productivity and reducing traffic</li></ul>
<u>Amenities</u> <ul style="list-style-type: none"><li>• Waterway@Punggol</li></ul>	<u>District Cooling System</u> <ul style="list-style-type: none"><li>• centralises cooling needs, expect space and cost savings with a reduction in the district's carbon footprint</li></ul>
	<u>Pneumatic Waste Collection</u> <ul style="list-style-type: none"><li>• a district-wide underground vacuum-pipe network, this would eliminate the need for waste collection trucks and eradicate the odour from refuse chutes.</li></ul>
	<u>Smart Energy Grid</u> <ul style="list-style-type: none"><li>• enable consumers to adopt clean sources of energy for daily use (e.g. charging electric vehicles), facilitate greater energy efficiency and savings (e.g. through smart metering).</li></ul>

## Methodology

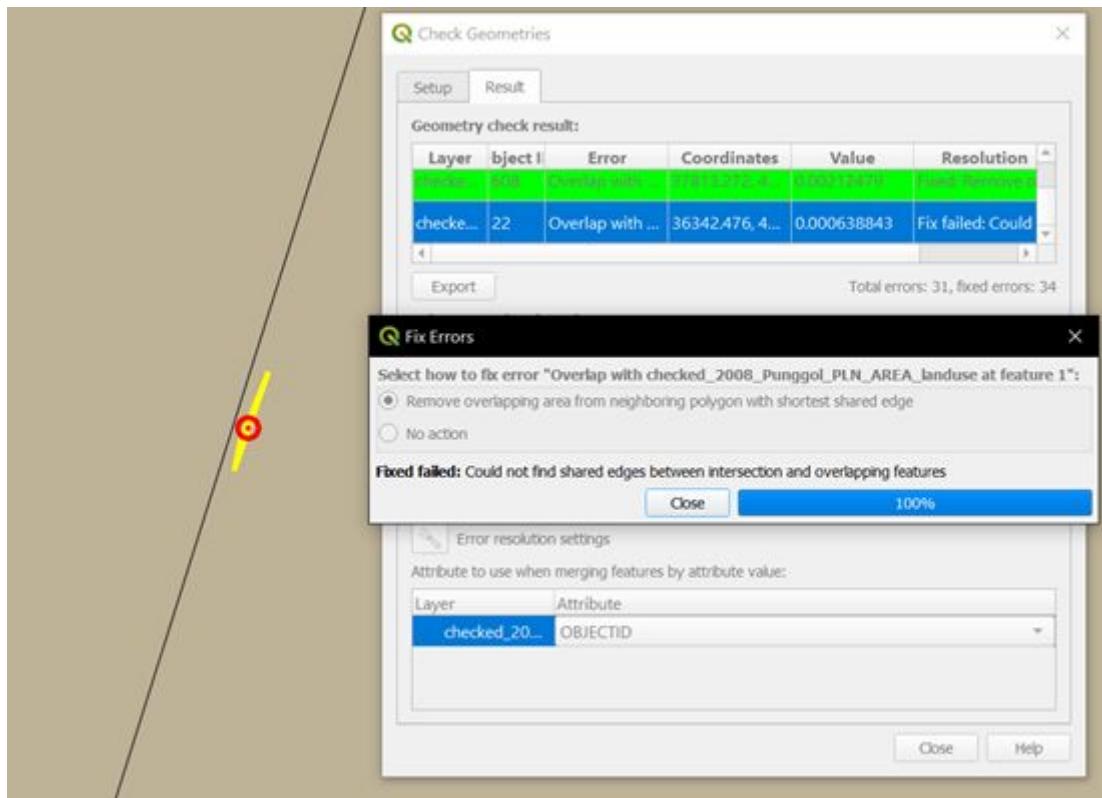
Before we proceed with our tasks, we use Geometry checker to check all our layers including our Subzone and land use layers to ensure there are no errors related to Geometry when we move on. In the case of NO ERROR, it would show that total errors:0



In the case of ERROR, we just fix selected errors using default resolution. Some of the errors found in 2008 Punggol Land use Layer was Overlap with neighbouring polygon, Polygon with hole and Gaps. While resolving some of the errors, other errors get resolved too and new gap errors get created too.



For errors that could not be fixed, we have to manually erase it.



At the end of fixing all the errors, the geometry checker will give a new ‘checked’ layer and the attributes table of the original layer and the checked layer show the same number of total attributes which is 609.

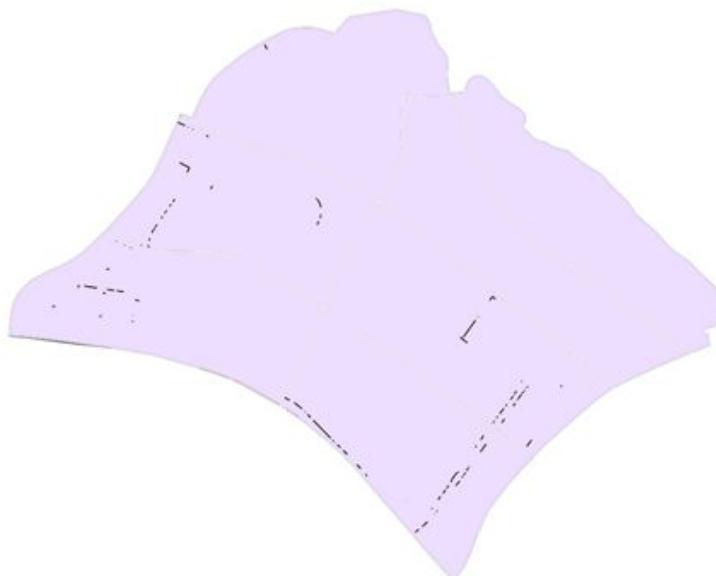
## 1. Land use Change Detection between 2008 & 2014

To do land use change detection, we need the description of the land use of the two years to compare, thus we use UNION to overlay the two landuse layers and create a new column called “Change” using Field Calculator as shown below.

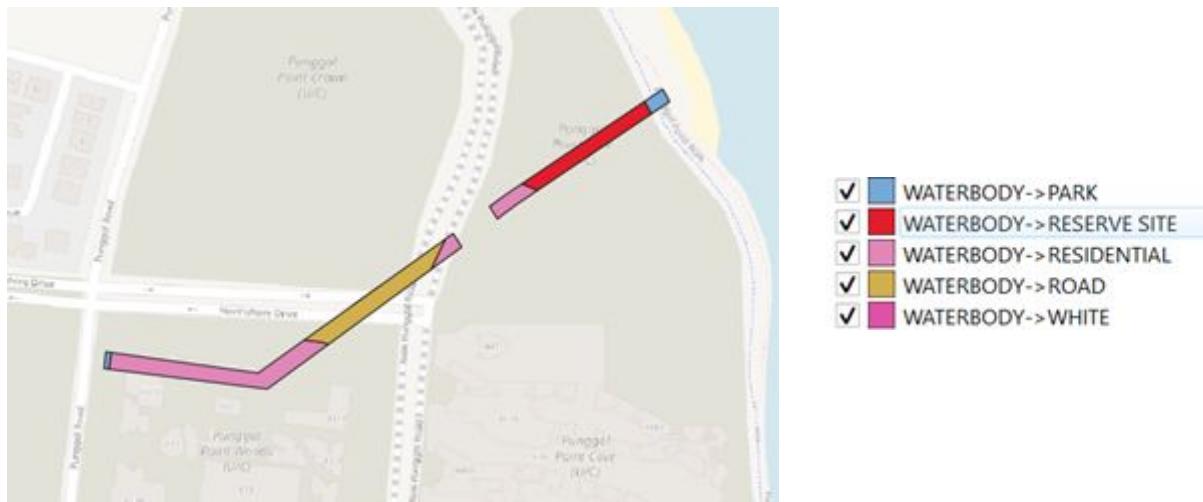
R_B_MN	INC_CRC_3	L_UPD_X_ADDR_3	ADDR_4PE_Len	HAPE_Area_	Change	
1	0 A88C11ACC4B5...	2014...	35855...	4311...	900.6... 43678.90... CIVIC & COMMUNITY INSTITUTION->COMMERCIAL & R...	
2	0 1B733B04000C...	2014...	36919...	4181...	1507...	66697.05... CIVIC & COMMUNITY INSTITUTION->RESIDENTIAL
3	0 0728D4861413...	2014...	35748...	4417...	934.6... 26454.66... CIVIC & COMMUNITY INSTITUTION->RESIDENTIAL	
4	0 C99B639E33F2...	2014...	35931...	4307...	791.9... 12294.17... CIVIC & COMMUNITY INSTITUTION->ROAD	
5	0 1A635242ADB1...	2014...	36323...	4409...	6037...	122224.4... CIVIC & COMMUNITY INSTITUTION->ROAD
6	0 55C2164866A6...	2014...	35070...	4281...	1488... 29525.52... CIVIC & COMMUNITY INSTITUTION->ROAD	
7	0 E0644C485A02...	2014...	34889...	4291...	1179... 17083.88... CIVIC & COMMUNITY INSTITUTION->ROAD	
8	0 BEC5F830D098...	2014...	36890...	4274...	459.8... 13047.89... COMMERCIAL & RESIDENTIAL->COMMERCIAL	
9	0 9E8DE3B98CA5...	2014...	36856...	4269...	220.8... 222.1092... COMMERCIAL & RESIDENTIAL->COMMERCIAL	
10	0 65A7B65E8C4E...	2014...	38164...	4254...	1698... 12352.05... COMMERCIAL & RESIDENTIAL->PARK	
11	0 36719991660E...	2014...	36944...	4279...	1049... 5117.698... COMMERCIAL & RESIDENTIAL->PARK	
12	0 BD1A0BF6F3F5...	2014...	38038...	4268...	858.6... 45644.29... COMMERCIAL & RESIDENTIAL->RESIDENTIAL	
13	0 D0E3CFCEC783...	2014...	37026...	4265...	686.4... 27255.13... COMMERCIAL & RESIDENTIAL->RESIDENTIAL	
14	0 4E6E0105F91D...	2014...	36774...	4283...	641.7... 25063.12... COMMERCIAL & RESIDENTIAL->RESIDENTIAL	

### Data Cleaning Methods

A lot of combinations of landuse change will surface but some of the changes are not substantial enough, especially when you can only see line segments in the map



We also checked the rows one by one to ensure the changes are relevant, unlike the waterbody changes



This usually results from the changes that are not complete such as 'ROAD->' or '->ROAD' and the waterbody changes hence we deleted the rows with incomplete change in our attribute table.

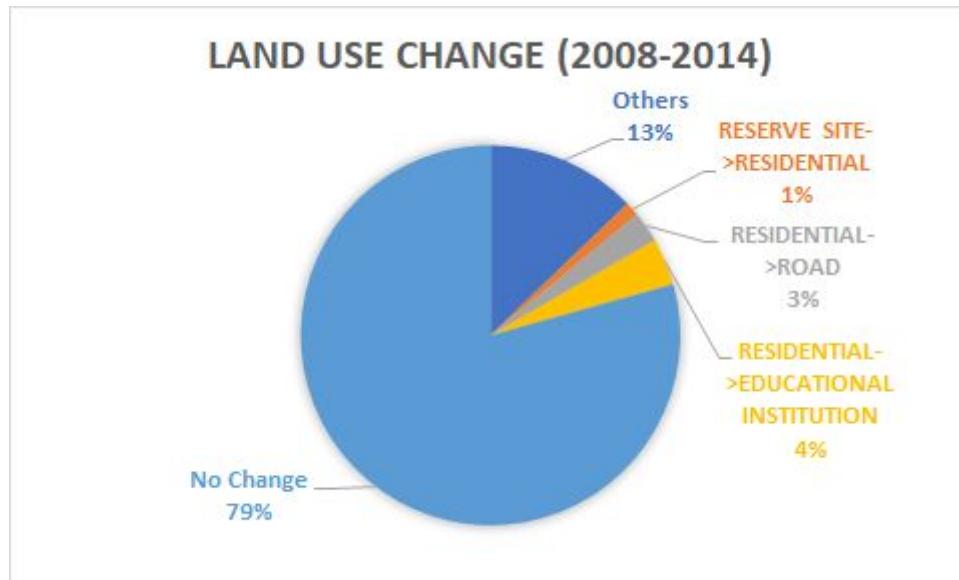
Punggol_Landuse_union : Features Total: 2239, Filtered: 2239, Selected: 32						
	WHL_Q_MX_2	R_B_MN	INC_CRC_3	EL_UPD_XADDR_3_ADDR_APE_Lent	HAPE_Area_	Change
1749	0	0	8C6AAE4C9DF6...	2014...	36840...	4411...
1750	0	0	91B68FB09C3A...	2014...	36375...	4410...
1751				NULL		ROAD->
1752				NULL		ROAD->
1753				NULL		ROAD->
1754				NULL		ROAD->
1755				NULL		ROAD->
1756				NULL		ROAD->
1757				NULL		ROAD->
1758				NULL		ROAD->
1759				NULL		ROAD->
1760				NULL		ROAD->
1761				NULL		ROAD->
1762				NULL		ROAD->

## Results

No.	Change	Sum of Area	Percentage
1	RESIDENTIAL->BUSINESS PARK	746.4872486	0.0079247%
2	TRANSPORT FACILITIES->EDUCATIONAL INSTITUTION	906.7742108	0.0096263%
3	RESERVE SITE->TRANSPORT FACILITIES	934.47583	0.0099204%
4	EDUCATIONAL INSTITUTION->PLACE OF WORSHIP	1238.203136	0.0131447%
5	ROAD->TRANSPORT FACILITIES	1319.953696	0.0140126%
6	PARK->COMMERCIAL	1326.362913	0.0140806%
7	TRANSPORT FACILITIES->ROAD	1353.50807	0.0143688%
8	PLACE OF WORSHIP->WHITE	1995.016008	0.0211790%
9	HEALTH & MEDICAL CARE->EDUCATIONAL INSTITUTION	2148.737199	0.0228109%
10	PARK->LIGHT RAPID TRANSIT	2532.883774	0.0268890%
11	PARK->COMMERCIAL & RESIDENTIAL	2668.774242	0.0283316%
12	OPEN SPACE->COMMERCIAL	3074.765865	0.0326416%
13	OPEN SPACE->BUSINESS PARK	3326.170059	0.0353105%
14	PLACE OF WORSHIP->ROAD	3537.670813	0.0375558%
15	PARK->CIVIC & COMMUNITY INSTITUTION	3545.803616	0.0376422%
16	ROAD->RESERVE SITE	3802.170106	0.0403638%
17	EDUCATIONAL INSTITUTION->COMMERCIAL	3880.711301	0.0411975%
18	RESERVE SITE->WHITE	5281.881533	0.0560723%
19	ROAD->WHITE	5298.670567	0.0562506%
20	CIVIC & COMMUNITY INSTITUTION->RESIDENTIAL	5810.379244	0.0616829%
21	RESIDENTIAL->TRANSPORT FACILITIES	5992.937317	0.0636209%
22	TRANSPORT FACILITIES->RESIDENTIAL	6182.565144	0.0656340%
23	CIVIC,COMMUNITY INSTITUTION->COMMERCIAL & RESIDE	6454.423434	0.0685200%
24	OPEN SPACE->PLACE OF WORSHIP	6554.218977	0.0695794%
25	EDUCATIONAL INSTITUTION->OPEN SPACE	7378.982727	0.0783351%
26	RESIDENTIAL->COMMERCIAL	7902.672464	0.0838946%
27	ROAD->BUSINESS PARK	8079.114025	0.0857677%
28	PLACE OF WORSHIP->EDUCATIONAL INSTITUTION	8357.516188	0.0887232%
29	COMMERCIAL->RESIDENTIAL	8599.774802	0.0912950%
30	PARK->EDUCATIONAL INSTITUTION	9639.451263	0.1023322%
31	PLACE OF WORSHIP->RESIDENTIAL	11620.19272	0.1233597%
32	COMMERCIAL & RESIDENTIAL->COMMERCIAL	13121.32447	0.1392957%
33	ROAD->PARK	14034.01243	0.1489848%
34	SPORTS & RECREATION->COMMERCIAL & RESIDENTIAL	14079.44233	0.1494670%
35	EDUCATIONAL INSTITUTION->BUSINESS PARK	14768.58597	0.1567830%
36	RESERVE SITE->PARK	16803.60906	0.1783867%
37	PARK->ROAD	18327.18553	0.1945610%
38	RESIDENTIAL->PLACE OF WORSHIP	19322.5948	0.2051282%
39	OPEN SPACE->RESIDENTIAL	20835.19698	0.2211860%
40	OPEN SPACE->ROAD	21246.91876	0.2255568%

41	COMMERCIAL & RESIDENTIAL->RESIDENTIAL	21785.96935	0.2312794%
42	EDUCATIONAL INSTITUTION->RESERVE SITE	26913.91206	0.2857175%
43	RESIDENTIAL->CIVIC & COMMUNITY INSTITUTION	29773.07438	0.3160703%
44	PARK->RESIDENTIAL	31618.36424	0.3356598%
45	EDUCATIONAL INSTITUTION->WHITE	31853.07722	0.3381515%
46	RESERVE SITE->EDUCATIONAL INSTITUTION	32851.95121	0.3487556%
47	OPEN SPACE->RESERVE SITE	34642.89263	0.3677682%
48	OPEN SPACE->EDUCATIONAL INSTITUTION	44727.20817	0.4748230%
49	ROAD->EDUCATIONAL INSTITUTION	49443.04869	0.5248863%
50	RESERVE SITE->ROAD	60330.02043	0.6404621%
51	RESERVE SITE->BUSINESS PARK	60381.85266	0.6410124%
52	RESIDENTIAL->WHITE	70315.99913	0.7464730%
53	RESIDENTIAL->RESERVE SITE	72098.97915	0.7654011%
54	RESIDENTIAL->PARK	76242.84382	0.8093923%
55	EDUCATIONAL INSTITUTION->ROAD	81011.74722	0.8600189%
56	ROAD->RESIDENTIAL	94618.57816	1.0044687%
57	EDUCATIONAL INSTITUTION->RESIDENTIAL	96115.90962	1.0203643%
58	RESERVE SITE->RESIDENTIAL	112360.4088	1.1928155%
59	RESIDENTIAL->ROAD	249130.1341	2.6447598%
60	RESIDENTIAL->EDUCATIONAL INSTITUTION	376321.6477	3.9950221%
61	No Change	7473196.222	79.3352812%
<b>Total Area</b>		<b>9419763.96</b>	<b>100.00000000%</b>

The total area of land use change amounts to 9419763 m<sup>2</sup>. In km<sup>2</sup>, it will be 9.42 km<sup>2</sup> and this roughly corresponds to the area of Punggol subzone which is 9.57 km<sup>2</sup>.



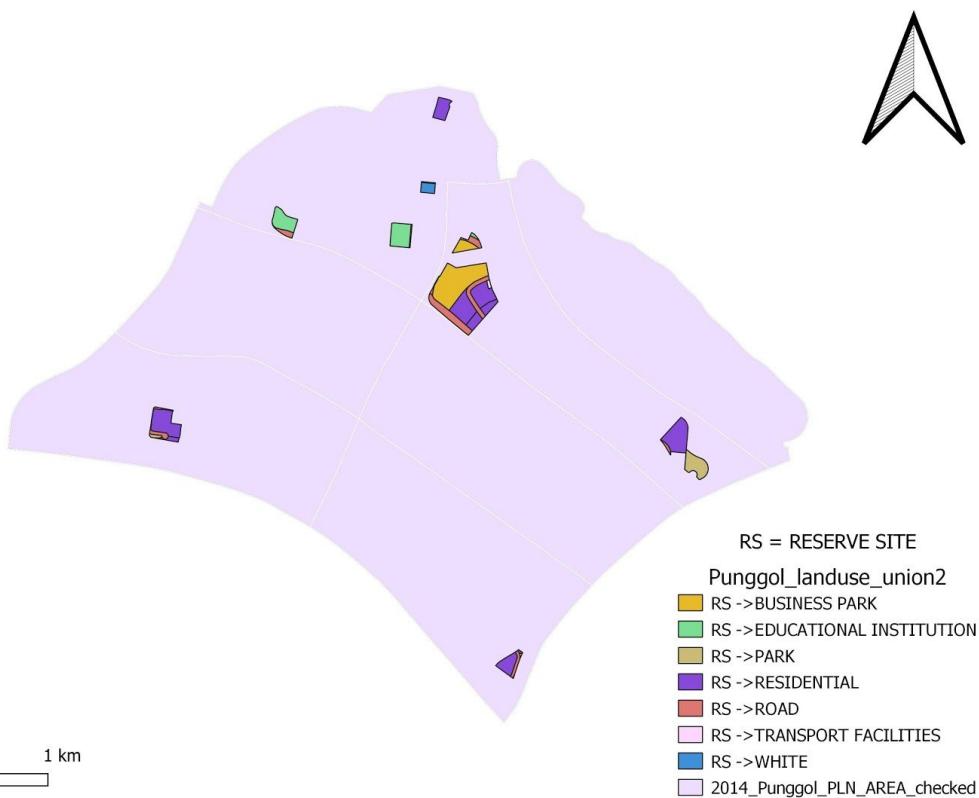
We can see that the land use change that has the highest percentage of change is actually land use with no change which accounts to 79% of the area. The residential to educational institution change is the next highest as it accounts for the development of the learning cluster near the Punggol digital district.

## Details of Landuse Change between 2008 & 2014

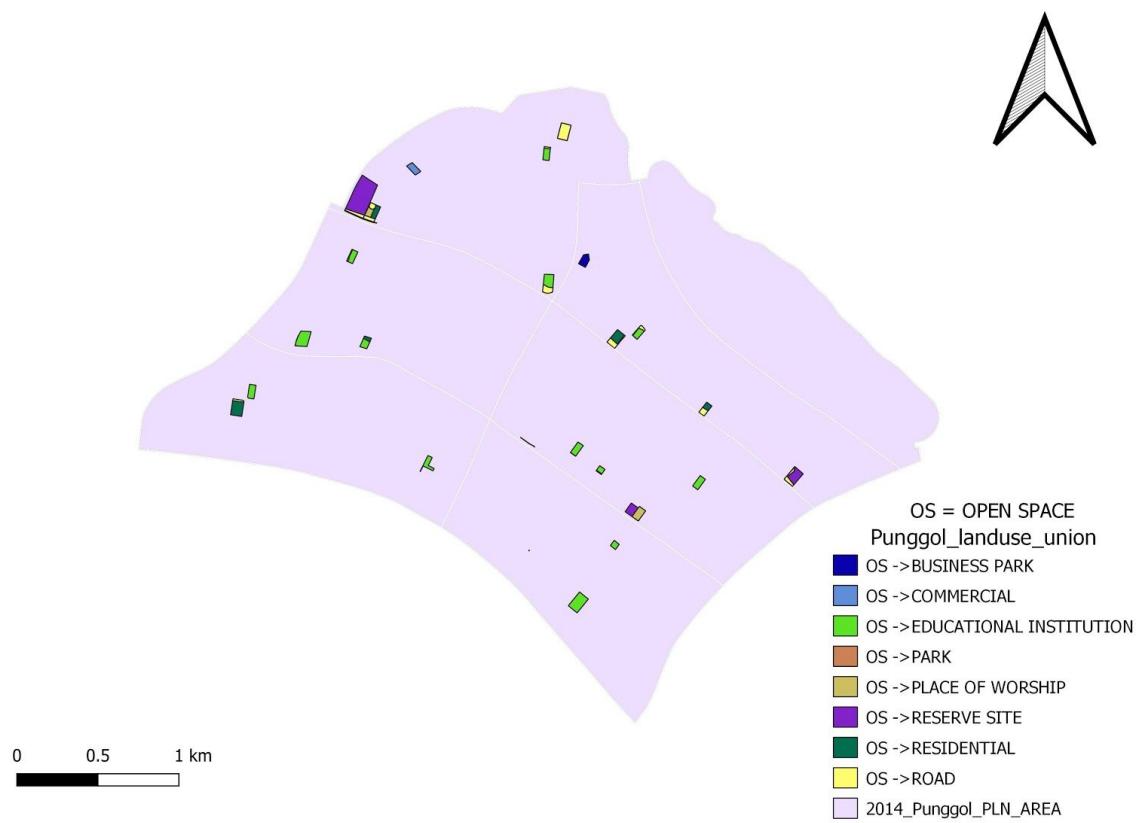
- ❖ Same Land Use (No Change)



- ❖ Changes from Reserve Sites



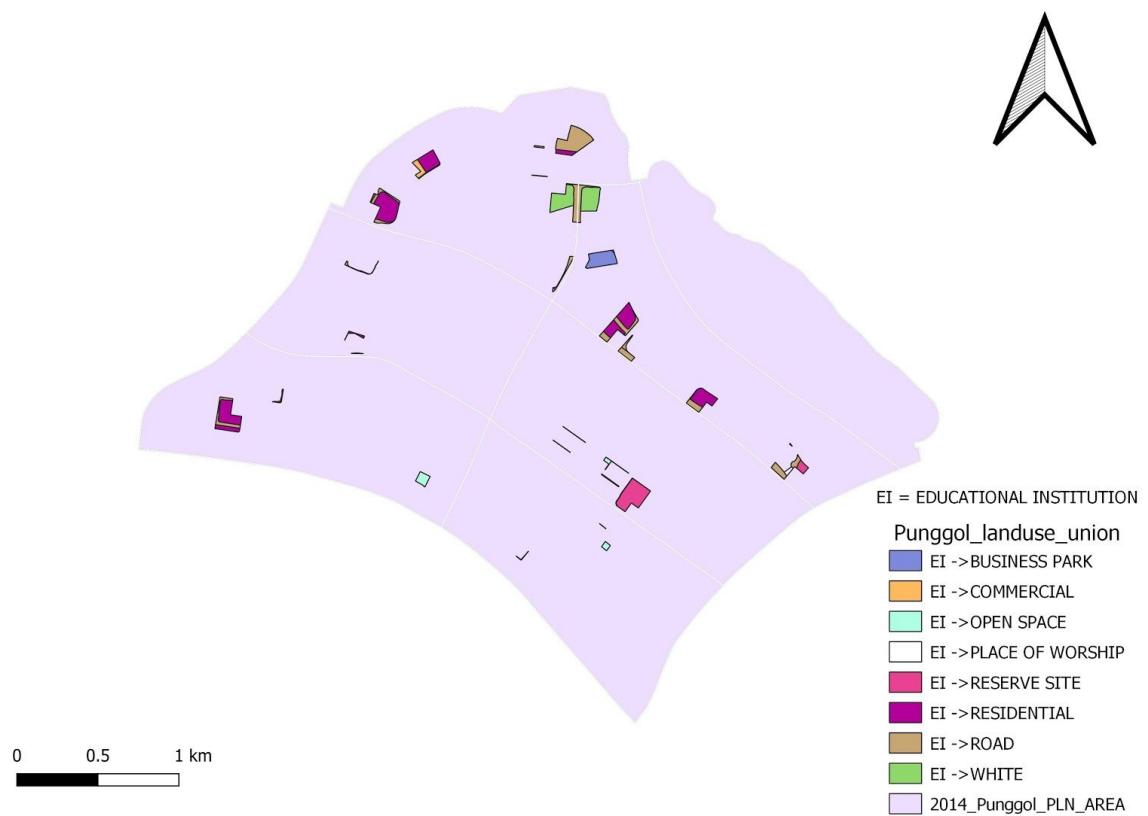
❖ Changes from Open Spaces



❖ Changes from Residential areas



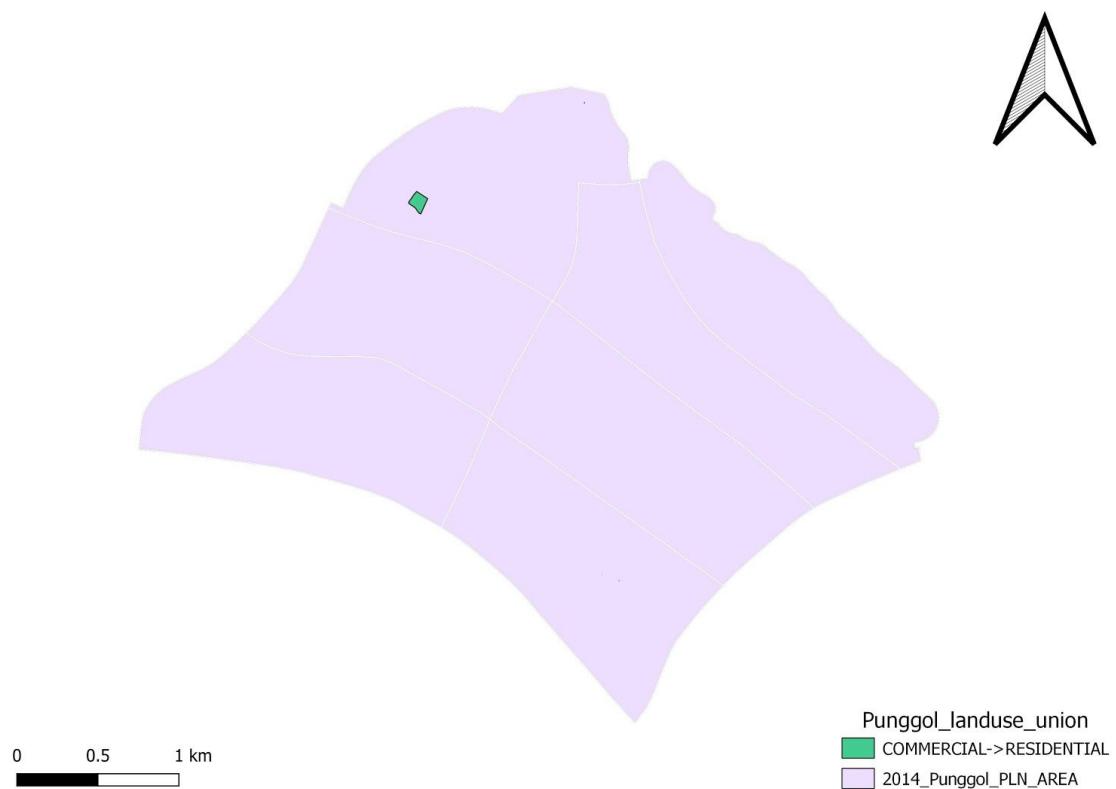
❖ Changes from Educational Institutions



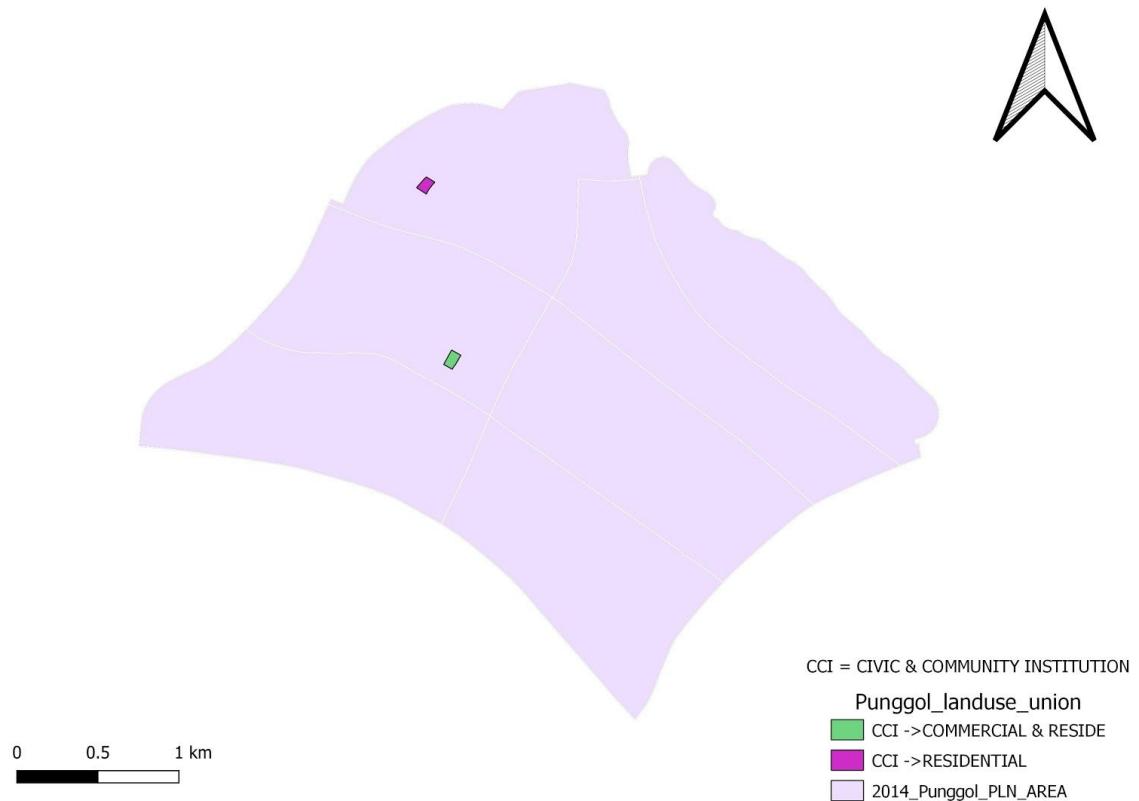
❖ Changes from Commercial & Residential areas



❖ Changes from Commercial areas



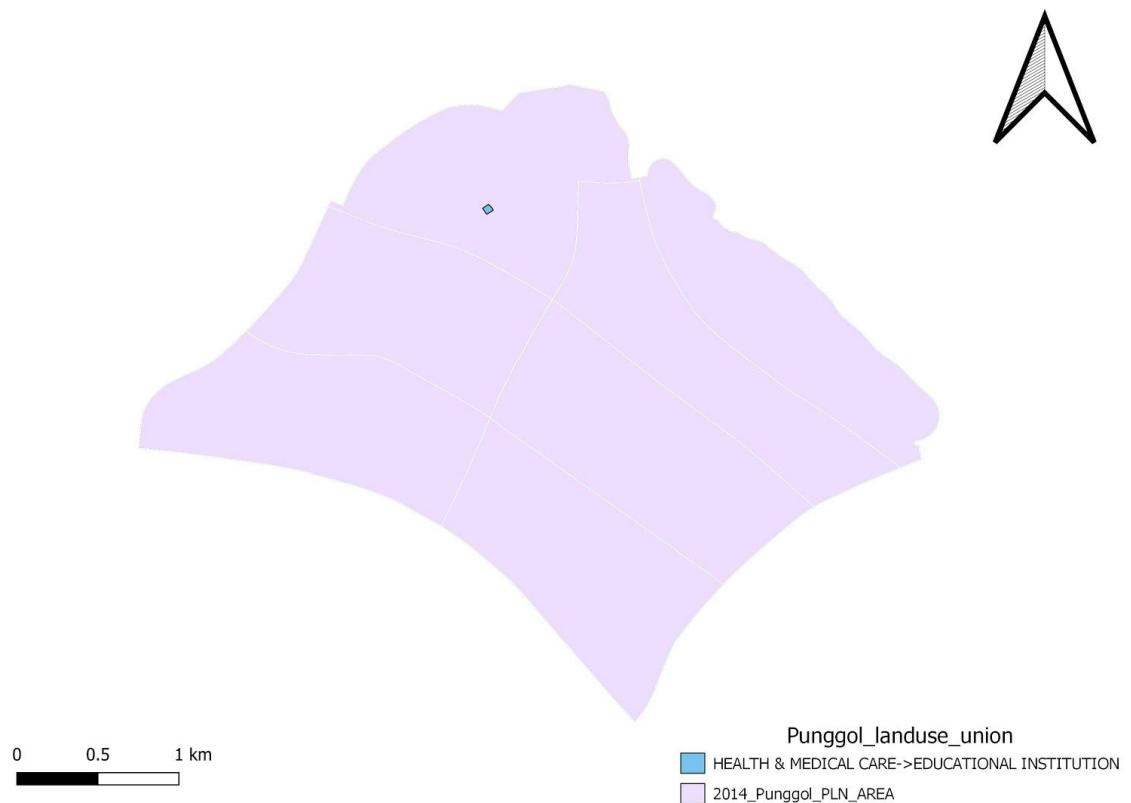
❖ Changes from Civic & Community Institutions



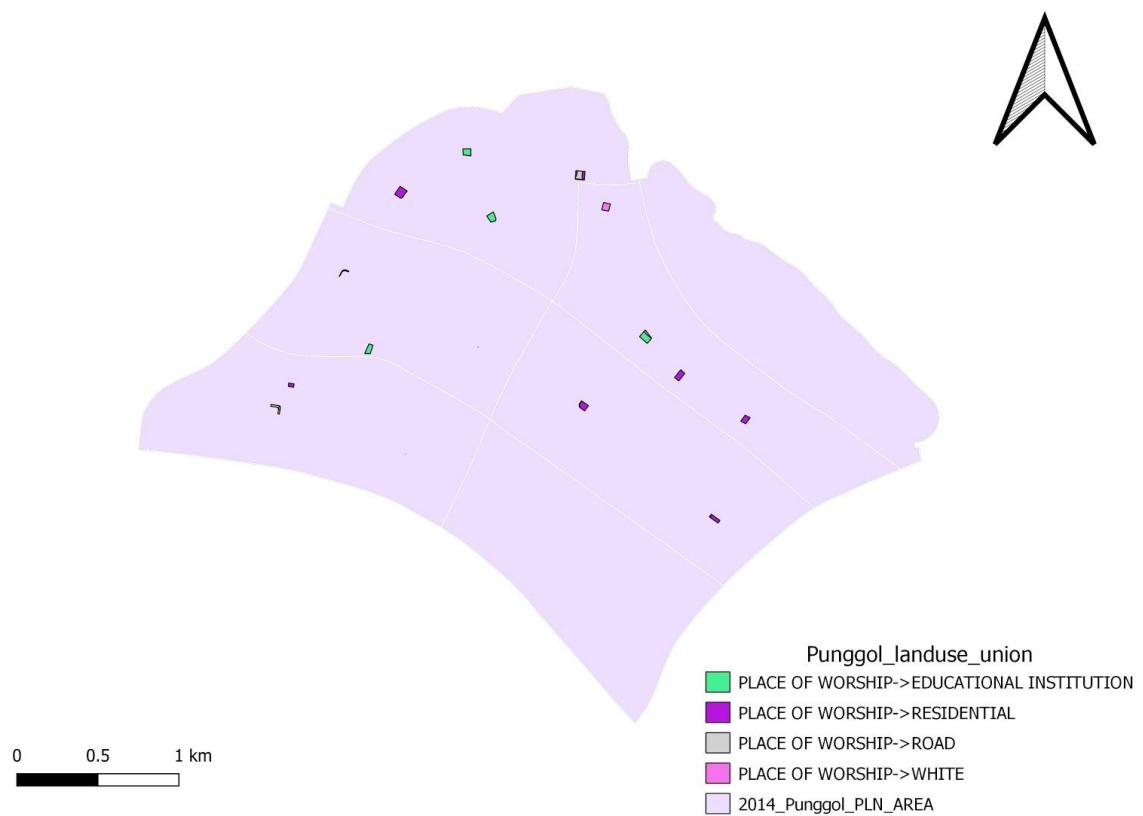
❖ Changes from Parks



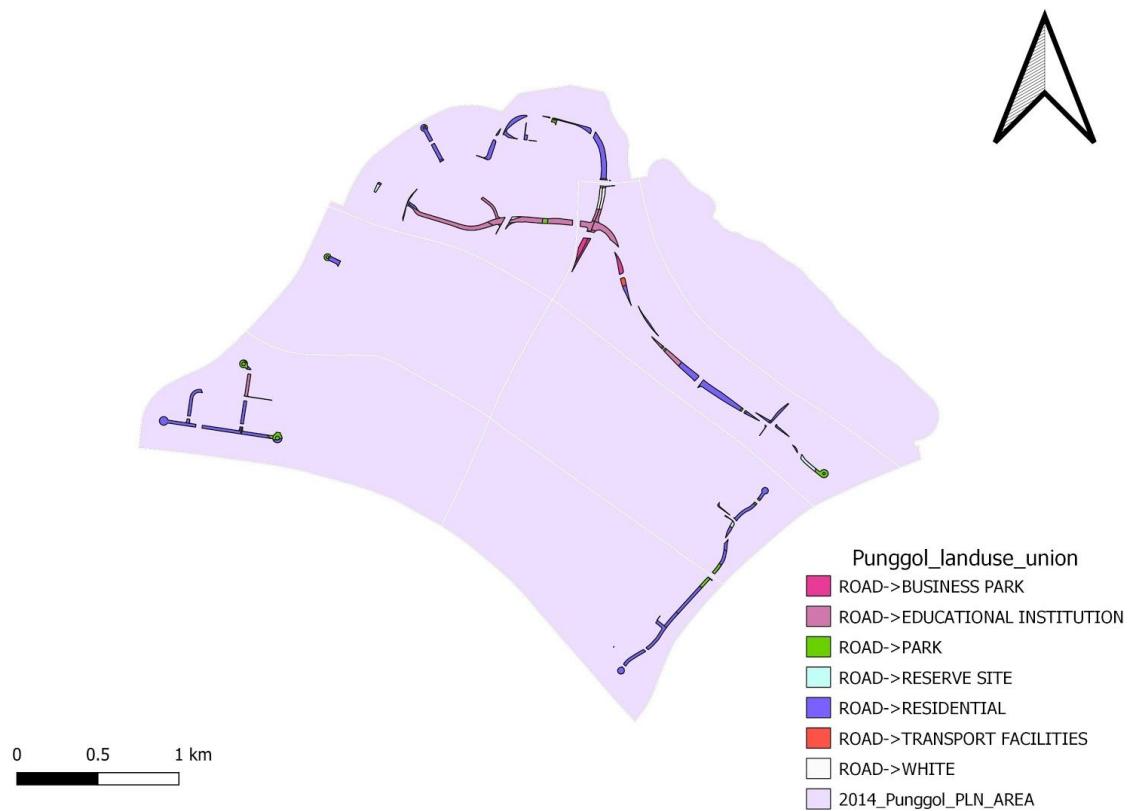
❖ Changes from Health & Medical Care centres



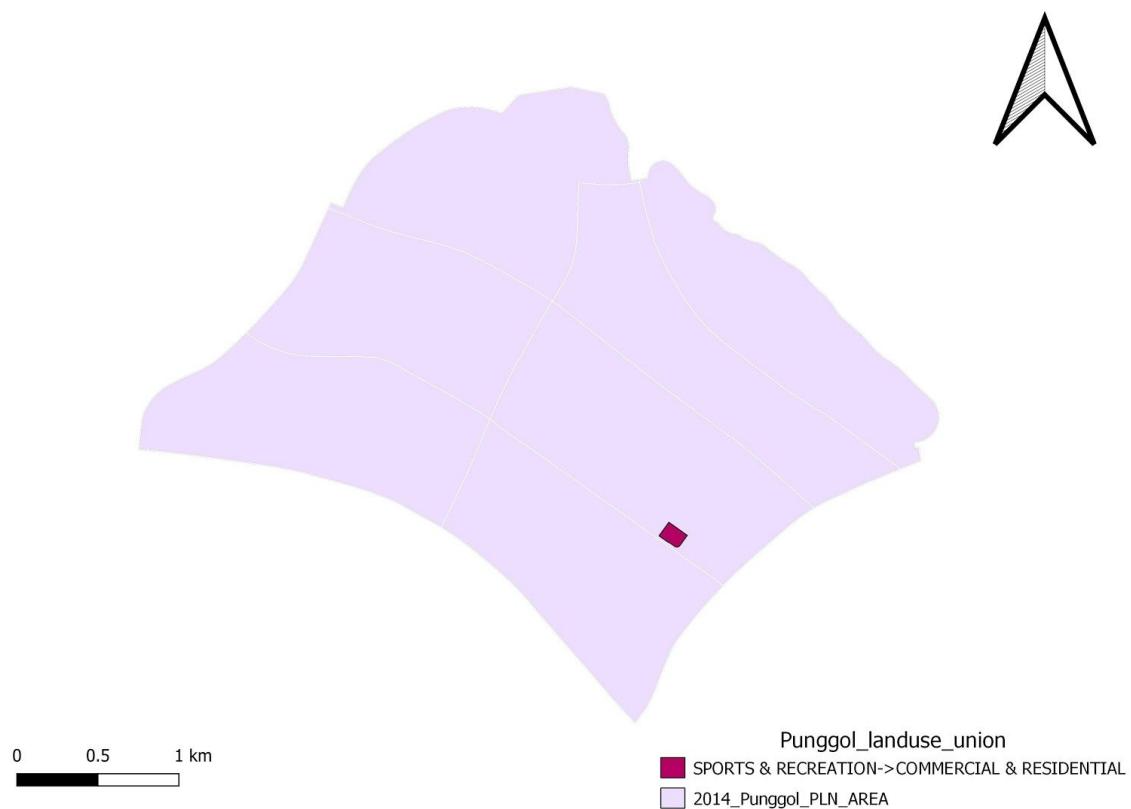
❖ Changes from Places of Worship



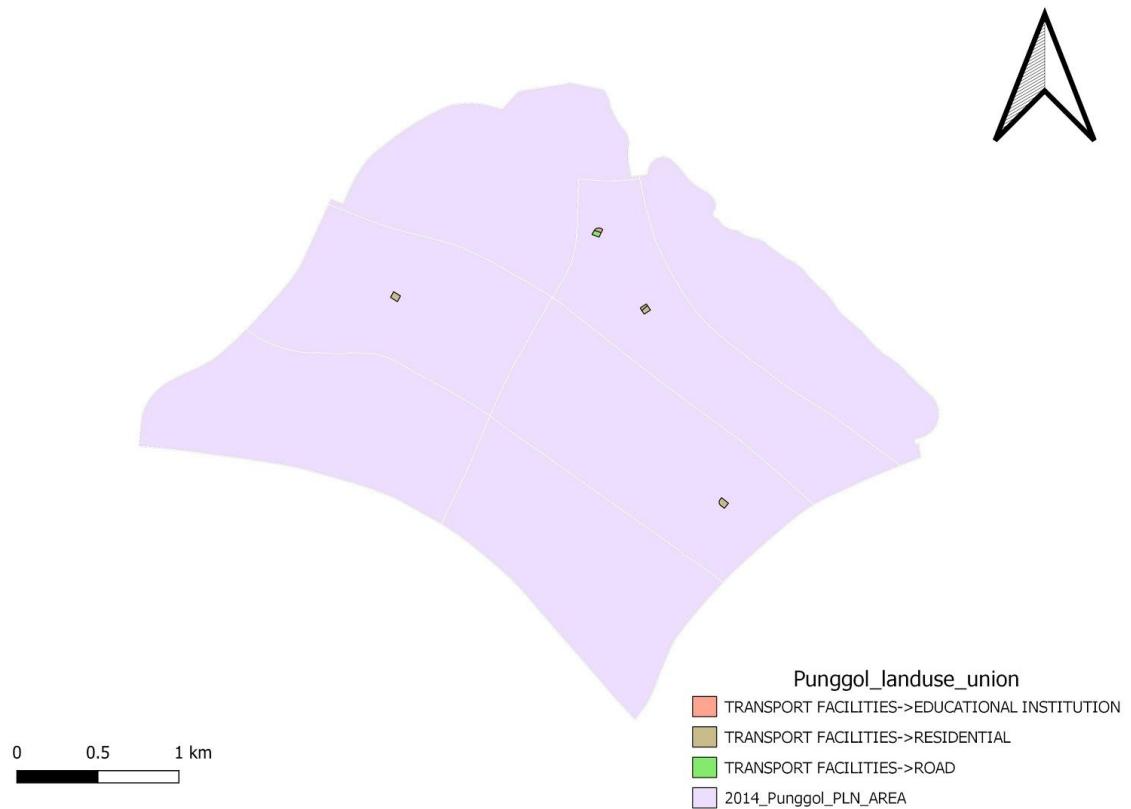
❖ Changes from Roads



❖ Changes from Sports & recreation



❖ Changes from Transport facilities



## 2. Population Growth Trend & Forecast

In this population we will be using the Singstat's 'Singapore Residents by Planning AreaSubzone, Age Group, Sex and Type of Dwelling, June 2011-2019' data provided. There are few objectives that we want to understand from the population historical data:

- Understand the population trend for each subzone and age group classification (younger group, economic active group, and aged population) in order to facilitate basic necessities for each age group.
- Forecast the future population trend up to 2024 using the auto ARIMA model to re-evaluate the MP19.
  - Interpreting the Arima model
    - <https://people.duke.edu/~rnau/411arim.htm#arima010>
  - Similar application of ARIMA model in forecasting population trends
    - Zakria, Muhammad & Muhammad, Faqir. (2009). Forecasting the population of Pakistan using ARIMA models.. Agri. Sci. 46. Retrieved from [https://www.researchgate.net/publication/228468254\\_Forecasting\\_the\\_population\\_of\\_Pakistan\\_using\\_ARIMA\\_models](https://www.researchgate.net/publication/228468254_Forecasting_the_population_of_Pakistan_using_ARIMA_models)
    - Nyonyi, T and Mutongi, C. (2019). Prediction of total population in Togo using ARIMA models. Retrieved from [https://mpra.ub.uni-muenchen.de/93983/1/MPRA\\_paper\\_93983.PDF](https://mpra.ub.uni-muenchen.de/93983/1/MPRA_paper_93983.PDF)
    - Lin, Bin-Shan, et al. "Using ARIMA Models to Predict Prison Populations." Journal of Quantitative Criminology, vol. 2, no. 3, 1986, pp. 251–264. JSTOR, www.jstor.org/stable/23365635. Retrieved from [https://www.jstor.org/stable/23365635?seq=1#page\\_scan\\_tab\\_contents](https://www.jstor.org/stable/23365635?seq=1#page_scan_tab_contents)
- Make recommendations according to the population trend insights

### Data Cleaning Methods

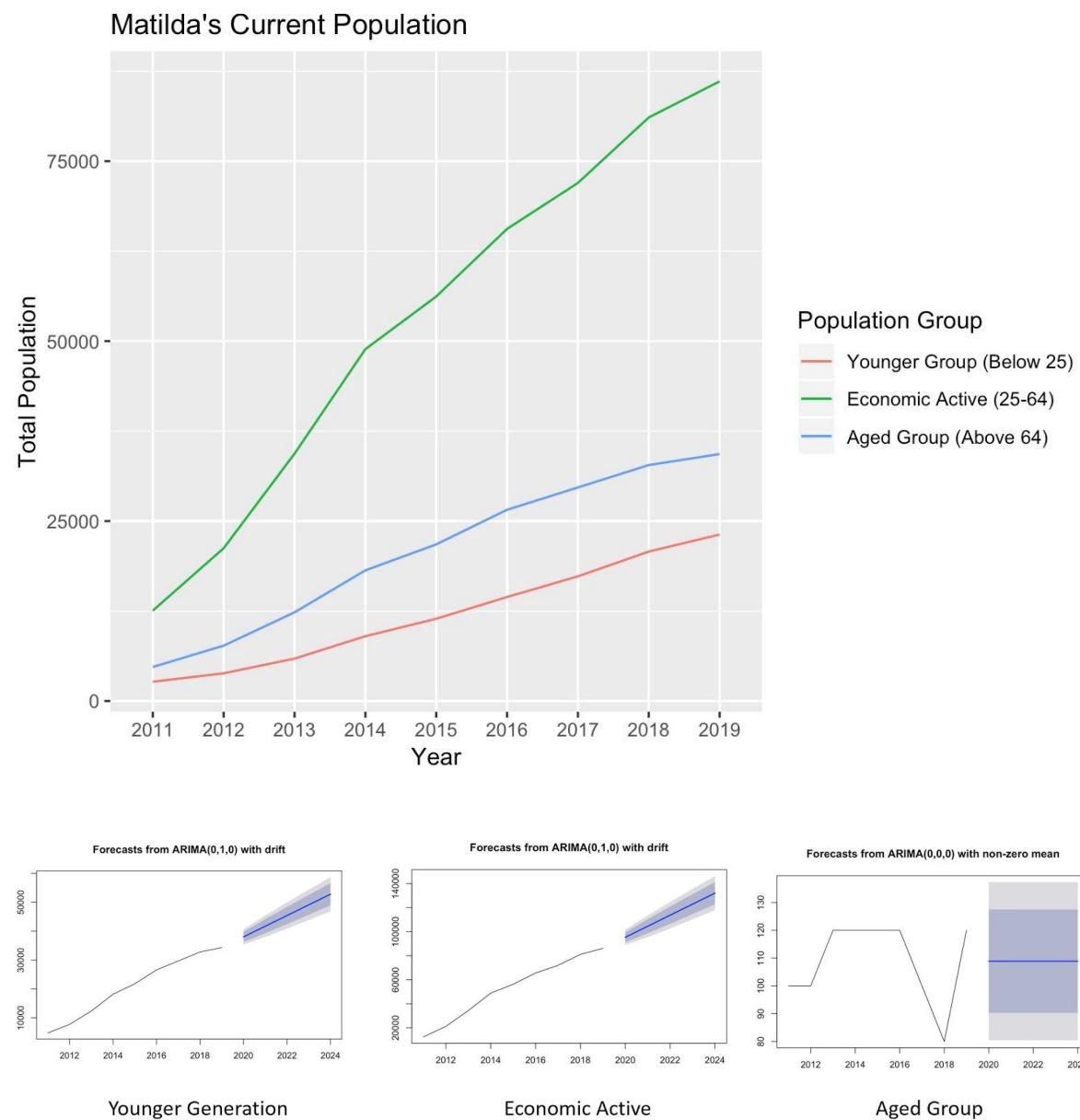
- Data is cleaned to only show Punggol PA and its subzones.
- Age group were classified into a new group with the following requirement:
  - **Younger Population:** 0-24
  - **Economic Active:** 25-64
  - **Aged Population:** 65 above
- Summation group by was performed according to each subzone and age group classification.
- Reverse data frame vector was performed to swap rows and columns formatting as it is required to perform graph visualisation in R.
  - R: [Punggol Forecast Population Analysis](#)
  - R: [Punggol Peak Hour Travel Pattern Analysis](#)

### Visualisations

- Datatable view of forecast population per age group classification and subzones.
- Plotting time series line graph on each subzone's population trend.
- Plotting the ARIMA forecasted population on each Subzone.

## Results

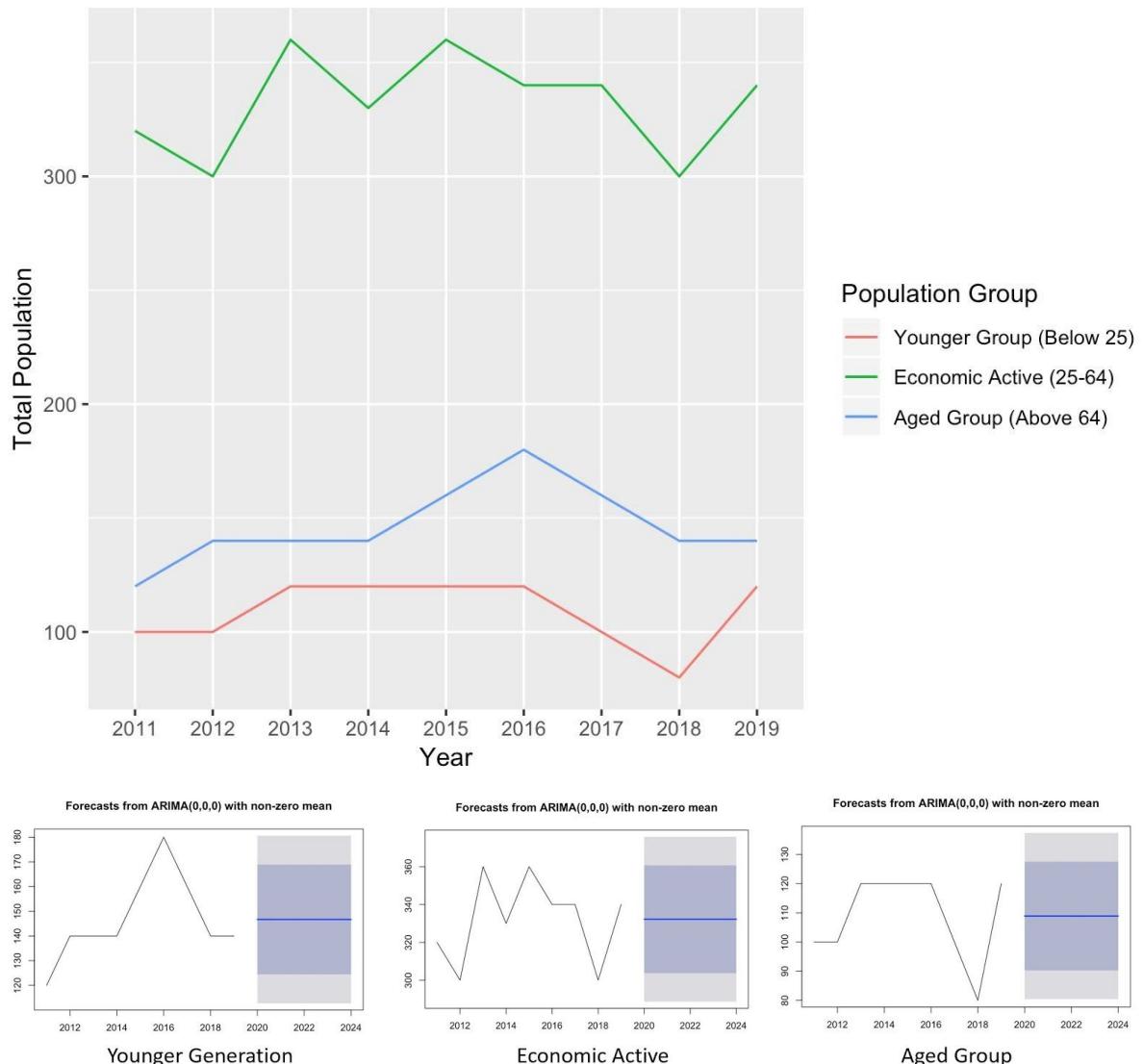
### Matilda's Population Trend



First, the Matilda subzone is one of the most populated subzones in Punggol. The Matilda subzone has been populated ever since the initiation of HDB buildings in Punggol. The subzone is continuously growing ever since 2011 for all age groups. Interestingly the subzone is predominantly filled with the economic active group. Based on the 9 years trend, an ARIMA (0,1,0) with random walk were applied to predict the population for the next 5 years. We predict that there is a major growth in population for this subzone. We anticipate the there is a growing number of younger age group as the economic active age group might plan to start a family.

## Northshore's Population Trend

### Northshore's Current Population



Next, the Northshore subzone is rather a newer region in Punggol. We haven't observed a significant rise in terms of population. However, there are on-going government plans of developing smart HDB in these regions for example the Punggol Northshore Residences I and II.

## PUNGOL



**LEGEND:**  
 ● MRT Line & Station    ○ LRT Line & Station    ===== Under Construction/Future Road    (w/d) Under Construction    co Common Green    ⚡ MRT Line & Station (under construction)

**Notes:**  
 All proposed developments are subject to change and planning approval.  
 Proposed Places of Worship includes Buddhist, Hindu, Chinese Temple, Hindu Community Centre/Club, Association, Home for the Aged, etc., subject to change and planning approval.  
 Proposed Civic & Community Institution includes examples like Hospitals, Polyclinics, Clinics, Nursing Homes and Educare Facilities, etc., subject to change and planning approval.  
 Proposed Health & Medical Care includes examples such as Hospitals, Polyclinics, Clinics, Nursing Homes and Educare Facilities, etc., subject to change and planning approval.  
 The proposed developments are subject to change and planning approval according to the Building Development Control guidelines. For example, places of worship and funeral parlours may also include columbarium as an ancillary use, while community centres may also include childcare centres, and schools may be upgraded or built with higher-rise blocks. The implementation of the facilities is subject to review from time to time by the relevant authorities.

# Communal leisure park comprises community-related developments such as pre-cut yards, ready-mixed concrete plants, workers' dormitories (i.e. PPT Lodge 1A and PPT Lodge 1B), and aggregate and sand workshops.  
 # Punggol Town Hub is an Integrated Development which includes Community Club, Regional Library, HDB Branch Office, Hawker Centre, Childcare Centre and Service Centres.  
 \*\* These sites are currently being studied/proposed for rezoning as part of Draft Master Plan 2019, subject to review.

The information contained herein is subject to change at any time without notice and cannot form part of an offer or contract. While reasonable care has been taken in providing this information, HDB shall not be responsible in any way for any damage or loss suffered by any person whether directly or indirectly as a result of reliance on the said information or as a result of any error or omission therein.

## Flat Details & Availability

[Sign in to 'My Bookmarks'](#)

Flat Type

2-Room Flexi (Short Lease/99-Year Lease)

Ethnic Group

All Ethnic

Flat Availability

Any

Project Name

Any

[Search](#)

**Find the cheapest available unit based on your search criteria (Not Booked)?**

**Click on block no. to view availability and maps/plans**

<b>435A</b>	<b>435B</b>	<b>438A</b>	<b>438B</b>	<b>438C</b>	<b>442B</b>
<b>443B</b>	<b>445A</b>	<b>445B</b>			

Block	435A	Street	NORTHSORE DR
Delivery Possession Date	30 Sep 2024 (Estimated)		

Estimated Completion Date	30 Sep 2023
Available Ethnic Quota	Malay-15, Chinese-55, Indian/ Other Races-8

**Mouseover unit number for selling price and gross floor area**

For the upcoming next five years or so, the number of populations might increase exponentially, especially with the attractive government's plan for the smart HDB which in turn will probably attract most of the economic active group.

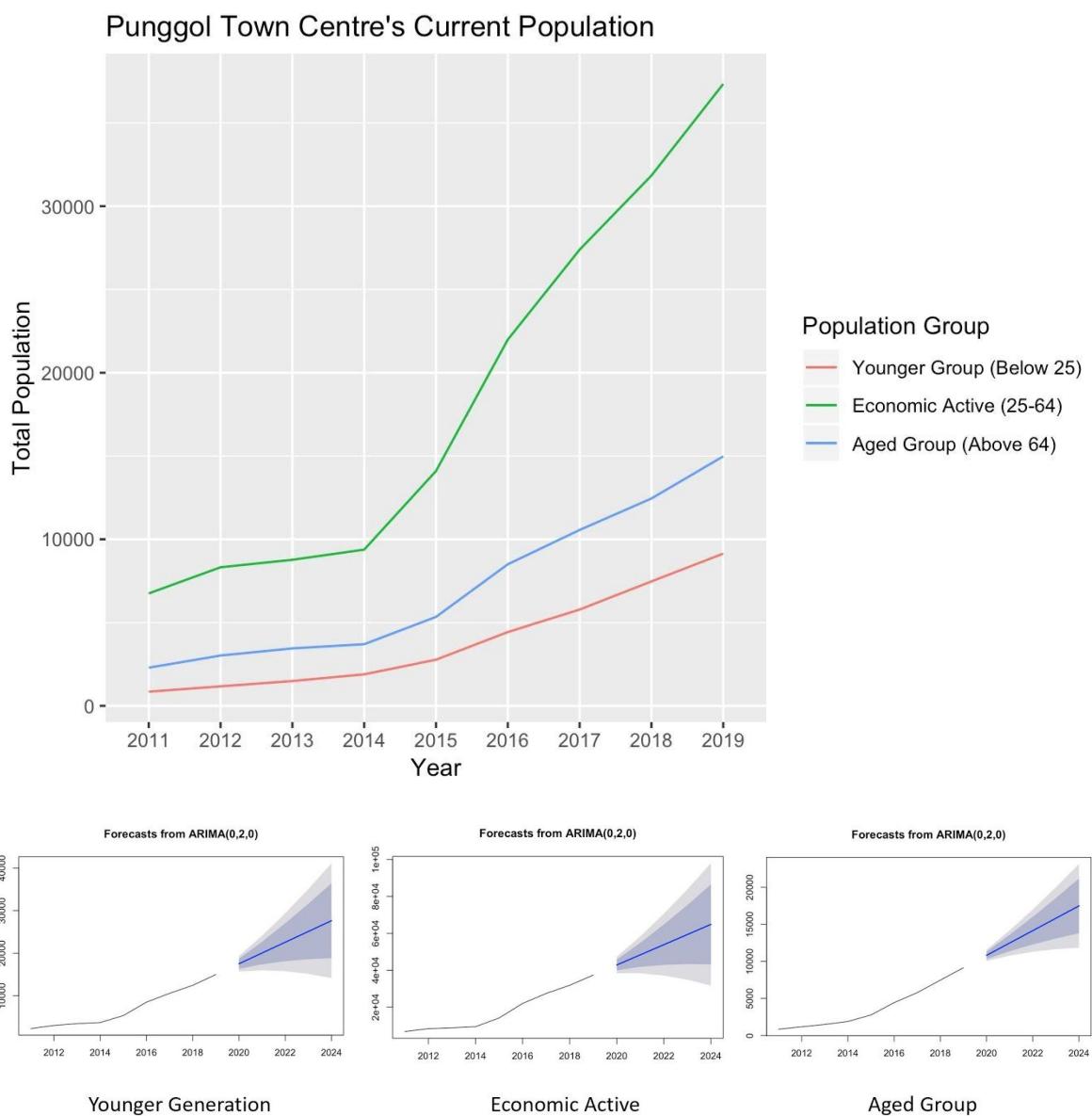
Ref:

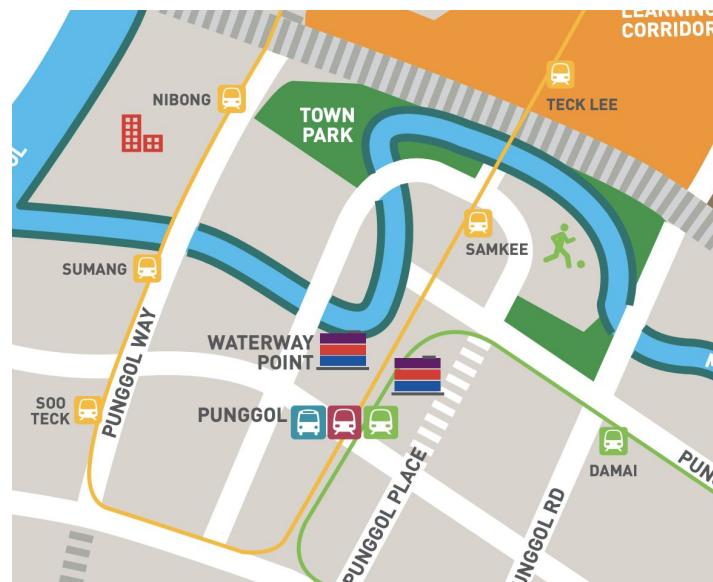
1.

[https://www.straitstimes.com/sites/default/files/attachments/2019/04/22/ST\\_20190422\\_IHOMEFIN\\_AL\\_4787163.pdf](https://www.straitstimes.com/sites/default/files/attachments/2019/04/22/ST_20190422_IHOMEFIN_AL_4787163.pdf)

2. [https://esales.hdb.gov.sg/bp25/launch/19sep/bto/19SEPBT0\\_page\\_2671/about0.html#](https://esales.hdb.gov.sg/bp25/launch/19sep/bto/19SEPBT0_page_2671/about0.html#)

## Punggol Town Centre's Population Trend





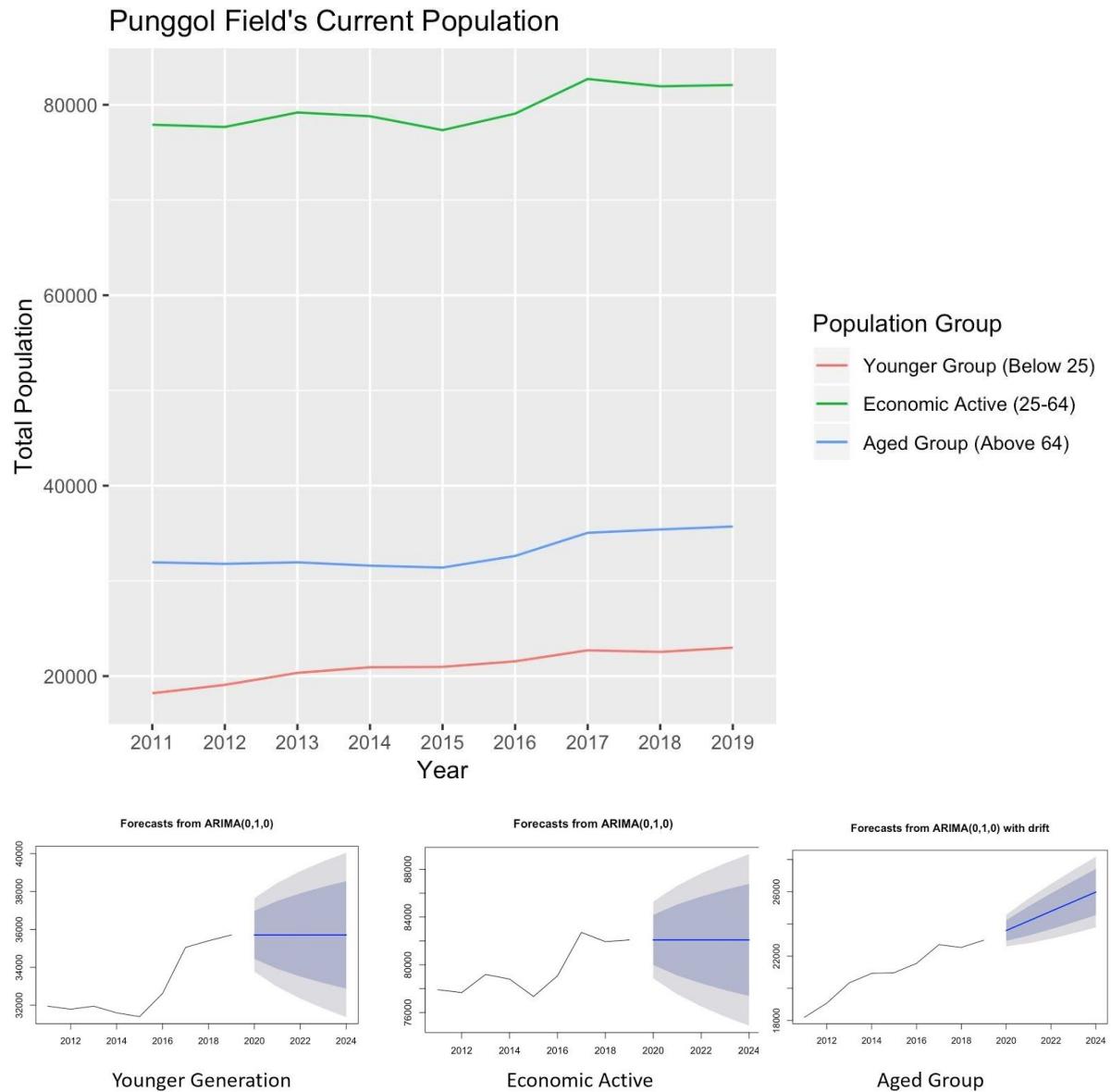
The Punggol Town Centre is located at the heart of Punggol planning area. This shows a major exponential growth. This exponential growth could have been caused by the past few year's major development by the government, especially through the integrated development near Punggol MRT also the new HDB appearance at the Nibong LRT proximity.



We are projecting that exponential growth will diminish as most of the region haven't progressed much from previous Masterplan 2008 and Masterplan 2014. Additionally, most of the locations in the area are currently occupied or already planned. However, with the current figure of the economic active population there is a possibility that the younger group might still spike due to family plans and rather mid age group living in the area. We should not deny the potential addition of the aged population even though it might not rise significantly for the next 5 years, but however an early

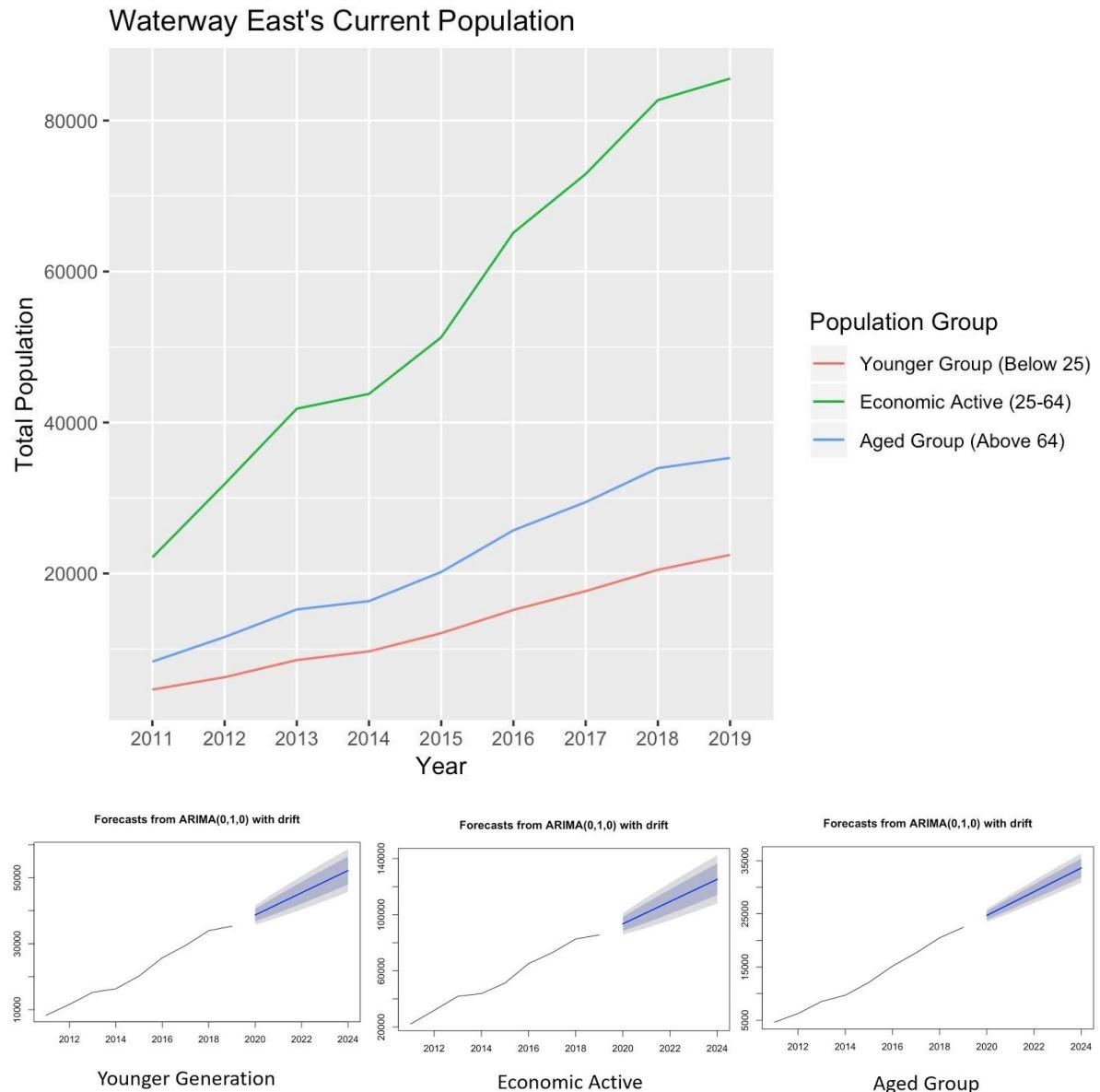
planning is always good to ensure that needs are always met, example: building elderly centres as this subzone currently has approximately 9000. We recommend a child centre built nearby homes as there are only a few in this region.

### Punggol Field's Population Trend



The Punggol Field subzone is rather been mostly an occupied zone since 2011 and growing at a rather consistent rate ever since. According to the change model analysis as described in the previous section. This area had mostly minor changes to an additional education institute and residential facilities. We are not projecting that there will be major changes in terms of figure, but there is a possibility that the aged group might rise about 4000 for the next 5 years, thus suggesting the need of more elderly facilities.

## Waterway East's Population Trend



Similar to Matilda and Punggol Town Centre, the Waterway East has one of the fastest growing subzones in Punggol. We can observe a similar trend of age group division, where the economic active dominates the population. In terms of its current figure, Waterway East have reached Punggol Field's figure. However, when it comes to potential growth, we project that there will be an increased number of addition across all age group classifications.

Coney Island and Punggol Canal have 0 population recorded so we are not going to focus on these particular subzones.

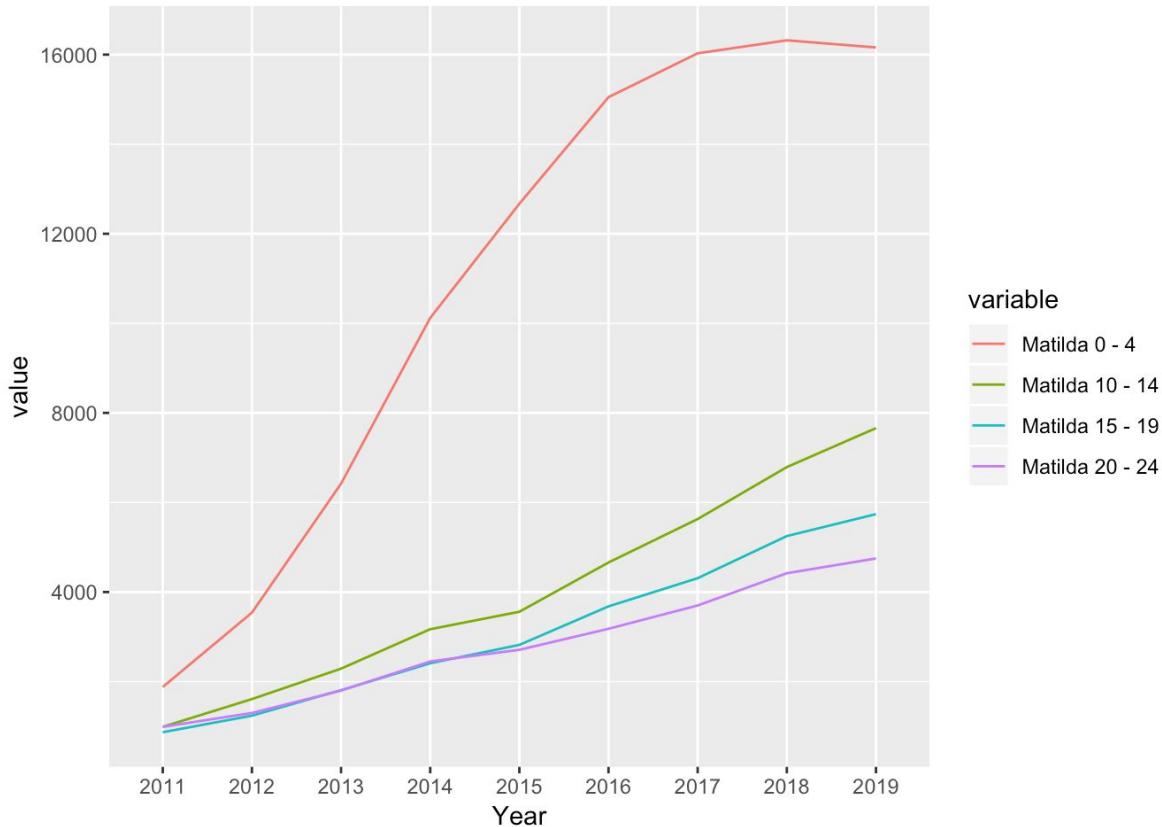
## Analysing The Younger Population's Needs

Going deeper into analysing each younger age group education needs

Level/Grade	Typical age
Preschool	
Pre-school playgroup	3–4
Kindergarten	4–6
Primary school (Children enter P1 upon the year they turn 7)	
Primary 1	6–7
Primary 2	7–8
Primary 3	8–9
Primary 4	9–10
Primary 5	10–11
Primary 6	11–12
Secondary school (Children enter S1 upon the year they turn 13)	
Secondary 1	12–13
Secondary 2	13–14
Secondary 3	14–15
Secondary 4	15–16
Secondary 5 (available for normal academic stream only)	16–17
Secondary 6 (available for Integrated Programme only)	17–18
Post-secondary education	
Junior College, Polytechnic or Arts Institution, followed by University education	Junior College age 16–18, Polytechnic Age 16–19

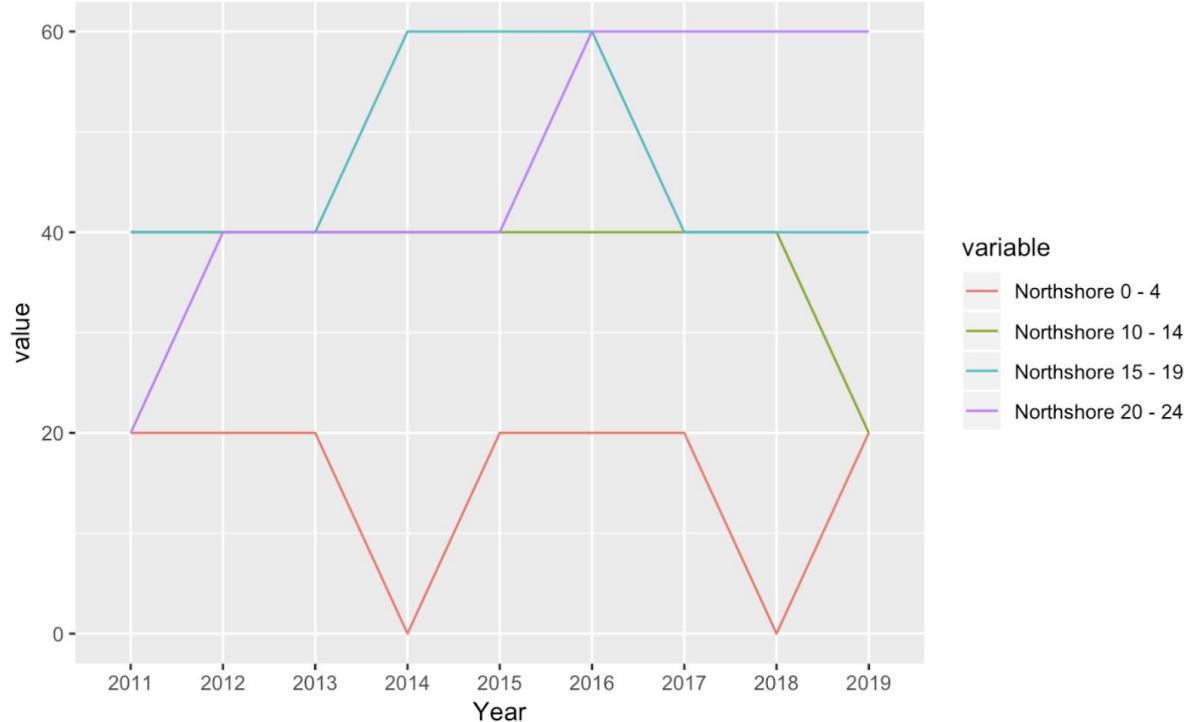
In this section we will perform a micro analysis of the younger age group needs. The diagram above clearly separates different education stages of each young group classification. We will make recommendations whether there is a need to revise the current availability pre-school, kindergarten, primary school, secondary school, and post-secondary education.

## Matilda's Younger Group Population Trend



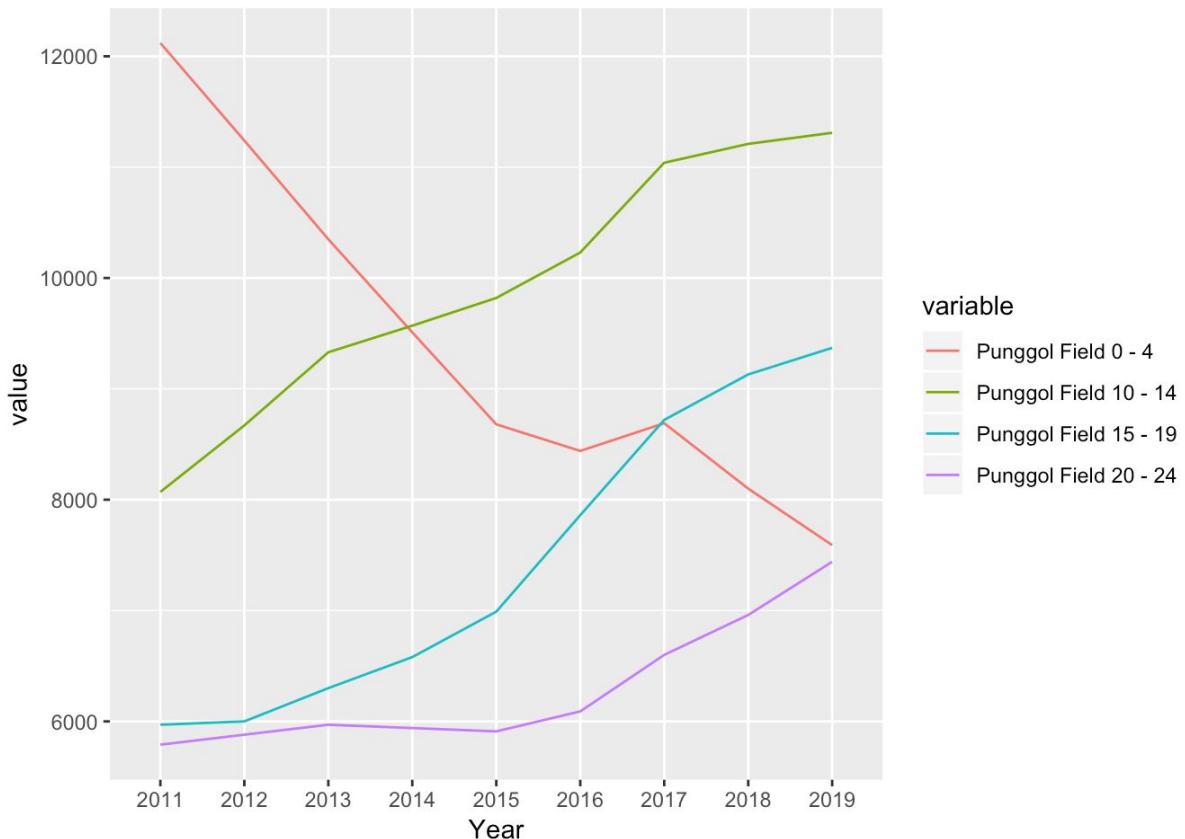
The above line chart depicts the historical younger group population trend in Matilda's subzone. Interestingly the subzone are predominantly filled with age group 0 - 9 which emphasises the need of having preschool and primary school nearby residential buildings. Proximity to residential areas are important in this subzone so that parents can drop or pick-up their kids before or after work conveniently. From this figure we can conclude that for the next 5 years, preschools, kindergarten and primary schools are priority.

## Northshore's Younger Group Population Trend



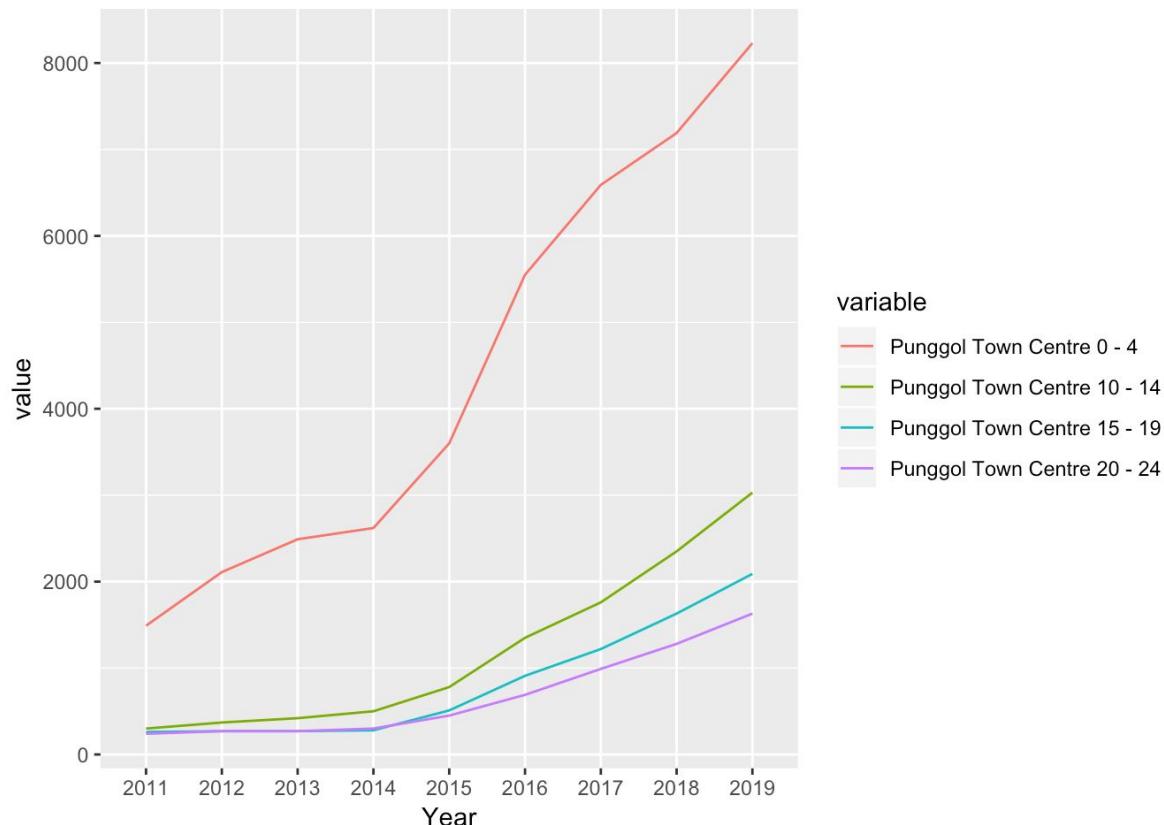
As per discussed under the “Northshore’s Population Trend” section, the government are rolling out HDB on-going projects that will be projected to complete in 4 or more years. Thus, even though the younger population figure seems to be less significant as compared to other subzones, the subzone will experience a major spike once units are completed. Thus, there is a need for proper planning to ensure that the younger age group needs are met.

## Punggol Field's Younger Group Population Trend



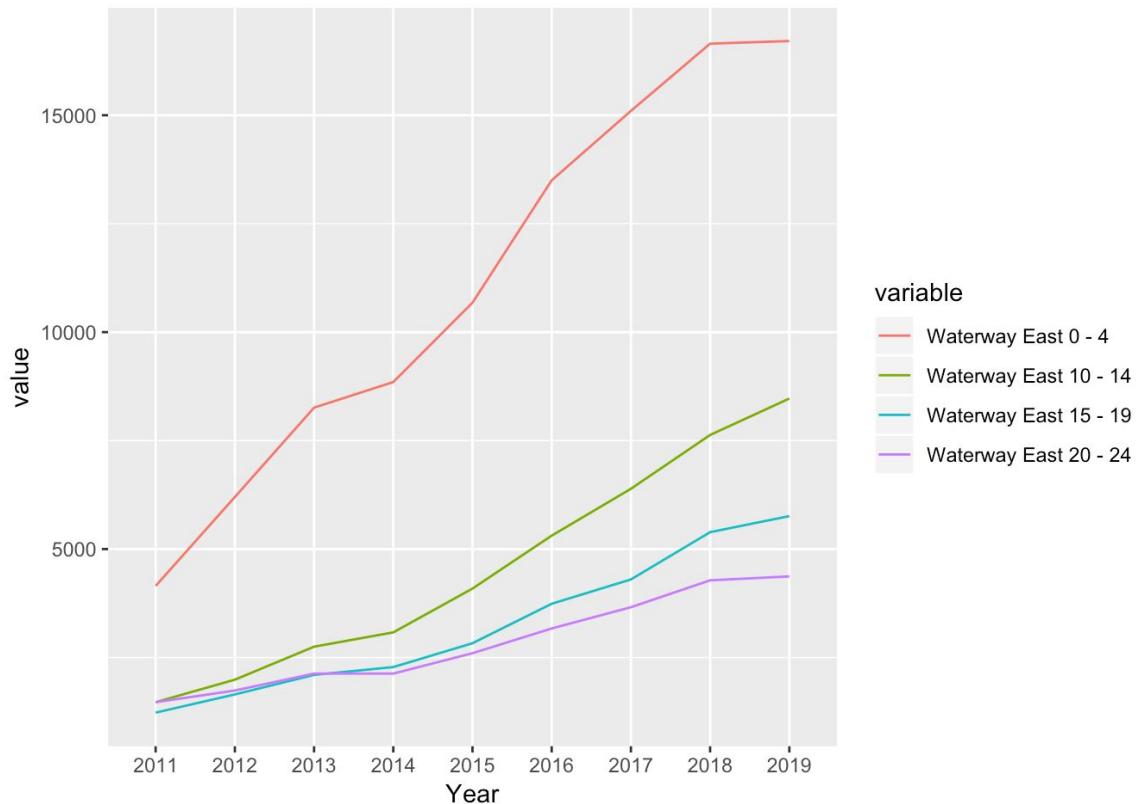
The Punggol Field's subzone is rather different as compared to Matilda's. Younger age group comprises of majority 10-19 years old which touches primary, secondary, and some post-secondary level of education. Despite the pretty big ratio of secondary and post-secondary figures, our team believes these planning facilities for these 2 stage of education should consider a higher level planning zone, for example across Punggol planning area instead of just subzone. As age group tend to be more independent, accessibility is not an issue as long as the number of supply meets the demand. Thus we are only prioritising the facility for primary school here.

## Punggol Town Centre's Younger Group Population Trend



The Punggol Town Centre have roughly consistent growth rate in terms of number per each group. Our team observes a pretty similar case to the Matilda's Subzone where total population of 0-9 age group are way more than the other age groups. We will prioritise in building more preschools, kindergarten and primary schools for these age groups.

## Waterway East's Younger Group Population Trend



The Waterway East's have also a roughly consistent dominant total of age group 0 - 9. Our team believes that this trend of dominant age group of 0 - 9 years old is not random, the fact that it has appeared to be distinctly apparent on 3 out of 5 occupied subzone. This trend also implies that most of current Punggol residents are young family and it is continuously adding. If we consider the current social norm in Singapore, newly married couples will tend to look for a new BTO as they venture out to a new phase of life together. Coupling with the recent BTO launches especially in the Northshore subzone, we expect the same pattern to happen again. Where it emphasizes the need of more children facilities in the region.

As we focus on providing children facilities especially the education needs, we will roughly measure the approximate ratio of available educational facilities on each subzone, number of pre-school, kindergarten and pre-schools, and lastly the total of 0-9 age group.

Assumptions Taken:

- **Facilities to Students Ratio Assumptions**

Daycare & Pre-school, Kindergarten: 1:200 (Assumption 80% of kids go to preschool)

Primary school: 1:1000

- 50% of parents prefer sending their kids to a nearby school.

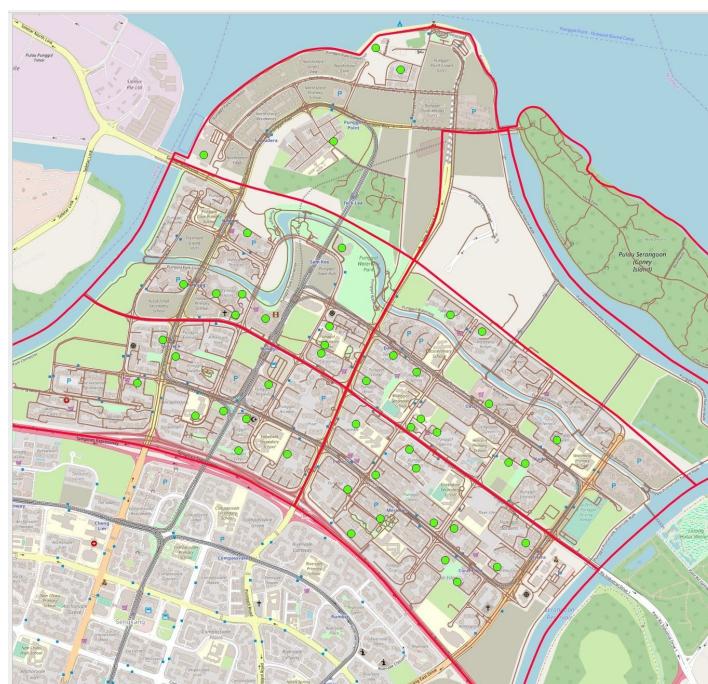
<b>Subzone</b>	<b>Total 0-9 Y.O. Population (2019/Projected)</b>	<b>Ratio</b>
Matilda	Pre-school: 16160 (0-4) Primary: 13,230 (5-9) = <b>29,390</b>	<b>Preschool:</b> 200: 16160*0.8 ~ 65 facilities / 2 = 33 facilities  <b>Primary:</b> 1000: 29390 ~ 30 Schools / 2 = 15 facilities
Punggol Town Centre	Pre-school: 8230 (0-4) Primary: 5730 (5-9) = <b>13,960</b>	<b>Preschool:</b> 200: 8230*0.8 ~ 33 facilities / 2 = 17 schools  <b>Primary:</b> 1000: 5730 ~ 6 Schools / 2 = 3 schools
Waterway East	Pre-school: 16710 (0-4) Primary: 13050 (5-9) = <b>29,760</b>	<b>Preschool:</b> 200: 16710 *0.8 ~ 67 facilities / 2 = 34 schools  <b>Primary:</b> 1000:13050 ~ 13 Schools / 2 = 7 schools
Northshore	*187,800 * 10% (assumption of incoming Northshore population by 2024) * 10% (assumption have a kid below 5 years old) = <b>1,878</b>  *187,800 * 10% (assumption of incoming Northshore population by 2024) * 5 % (assumption have a kid between 5- 10years old) = <b>939</b>	<b>Preschool:</b> 200: 1,878 *0.8 ~ 8 facilities / 2 = 4 schools  <b>Primary:</b> 1000:939 ~ 1 Schools
Punggol Field	Pre-school: 7590 (0-4) Primary: 9950 (5-9) = <b>17,540</b>	<b>Preschool:</b> 200: 7590/ *0.8 ~ 31 facilities / 2 = 6 schools  <b>Primary:</b> 1000:9950 ~ 10 Schools / 2 = 5 schools

### **Facilities to Cater for the Younger Population's Needs**

- Mainly narrowed down in ensuring that school are all provided
- Library looking at the trends of younger group rise.
  - However its already planned. Punggol's library is currently being built and will be available in 2021.
  - Library planned "Punggol Town Hub to open in 2021"  
<https://www.channelnewsasia.com/news/singapore/punggol-town-hub-2021-hawker-centre-library-10800152>

## **3. Land Suitability Analysis (Green Zone) For School Redevelopment**

In this section we will explore options in meeting the younger population needs especially in catering for the preschool and primary school needs as mentioned in the previous section. We note that there is a greater demand yet limited supply of schools in order to fulfill the Masterplan 2019's vision of Punggol as a place to play-work-learn-live. Going back to the numbers, 5 out 7 subzones in Punggol are currently growing in terms of the number of population between 0 - 9 years old. Moreover, a further migration of the economic active especially the newly married couples through the recent purchase of BTOs will pose as an increase potential number of these age group.



The above map shows the currently available childcare centre and schools in Punggol retrieved from the Data.Gov site, shows a lack of supply for the demand to meet the current vision. Next, we will evaluate alternative recommendations that can be performed. We will apply a land suitability analysis to predict where in Punggol subzones can we add on the number of supply for this need.

For this land suitability, we will develop what we call a green zone to identify preferred locations with multi-weighted criterias with the following suggested factors:

- Economic factor:  $<= 15\text{deg}$  slope for an ease of construction development which results in no additional time and manpower cost. Our team aims to look at the potential of building an integrated schools within pre-existing buildings, the reason is to leverage and optimise the use of empty & reserved land for something else. Thus, the slope standardisation method was not performed.
- Road Accessibility factor:  $<= 100\text{m}$  from roads for ease of private transportation.
- Children Risks Avoidance factor:  $>= 150\text{m}$  away from school as a highly important factor as parents would want to send their kids to a less risky locations with lesser construction areas.
- Favourable Objects Proximity factor:  $<= 500\text{m}$  from favourable objects for better outdoor learning possibilities such as empty fields, grass, playground, etc.
- Public Transport Accessibility factor:  $<= 200\text{m}$  from public transportation data points for convenience of majority population.
- Residential Proximity factor:  $<= 300\text{m}$  from residential because we want to go back to the Masterplan 2019 vision to create Punggol as a place to play-work-learn-live.

		Pre-schools & Primary Schools Green Zone Centre Prioritization Matrix					
Pairwise Comparison Matrix		Economic	Road Accessibility	Children Risks Avoidance	Favourable Objects Proximity	Public Transport / Residential Proximity	
	Economic	1	2	1/2	3	2	1
Economic	1	2	1/2	3	2	1	
Road Accessibility	1/2	1	1/3	2	1/2	1/3	
Children Risks Avoidance	2	3	1	3	3	3	
Favourable Objects Proximity	1/3	1/2	1/3	1	1/2	1/3	
Public Transport Accessibility	1/2	2	1/3	2	1	1/2	
Residential Proximity	1	3	1/3	3	2	1	

We make use of the SAGA Analytical Hierarchical Process to simulate and ensure the consistency weightage based on what is a priority. The above picture shows the priority matrix we have plotted.

AHP-1	CA	Lambda	CI	CI/RI
0.189	1.01027	6.243068096	0.04861362	0.039204532
0.092	1.055739		Randomness Index, RI	
0.337	0.955266		3	0.58
0.067	0.944215		4	0.9
0.120	1.080539		5	1.12
0.194	1.197039		6	1.24
0.000	0		7	1.32
0.000	0		8	1.41
0.000	0		9	1.45
0.000	0		10	1.51
0.000	0		11	1.52
0.000	0		12	1.54
0.000	0		13	1.56
0.000	0		14	1.58
0.000	0		15	1.59

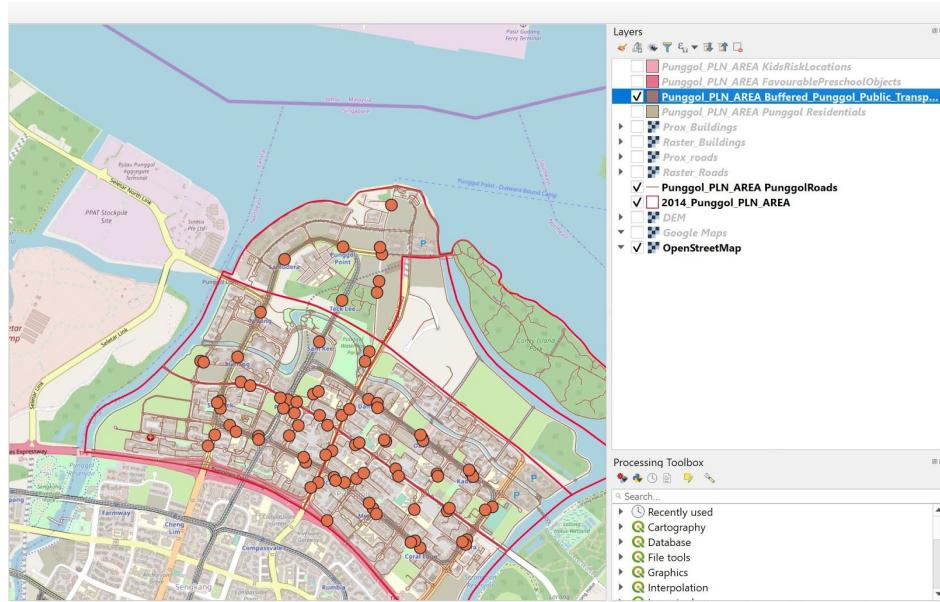
AHP		Consistency check
1	0.189	18.9%
2	0.092	9.2%
3	0.337	33.7%
4	0.067	6.7%
5	0.120	12.0%
6	0.194	19.4%

The current random index represents a consistent prioritisation matrix by weighing Economic factor as 18.9%, road accessibility factor as 9.2%, children risks avoidance factor as 33.7%, favourable Objects Proximity factor as 6.7%, public transport accessibility factor as 12%, and residential Proximity factor as 19.4%.

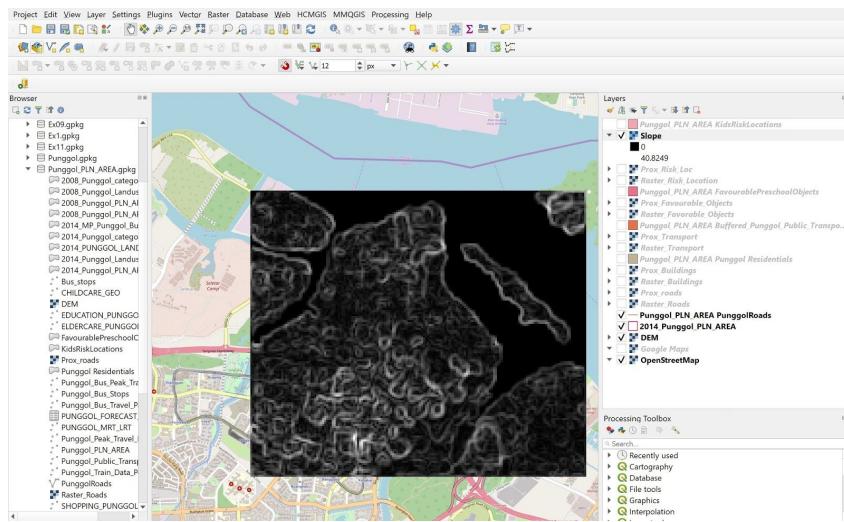
children risks avoidance, residential proximity factor, economic factor, public transport accessibility factor, road accessibility factor and favourable objects proximity factor in that order.

#### Methods taken:

1. Binary land suitability modelling by using raster-based GIS operations in QGIS. By transforming export vector layers into raster layer for computation. Each layer attributes were added with a 'POI\_CODE' = 1 to represent the binary value.



2. Catering to MRT/LRT stations and bus stops in Punggol, we apply buffering from the vector geometric tools of 50m dimension to represent its station reachability.



3. Next, we perform 'Rasterize (Vector to Raster)' to each 'POI\_CODE' function to convert into raster format.
4. For each Rasterized vector, we generate a proximity analysis using the 'Raster > Analysis > Proximity (Raster Distance)'.

**Raster Calculator**

**Raster Bands**

- Binary\_Favourable\_Objects@1
- Binary\_Residential@1
- Binary\_Risks@1
- Binary\_Transport@1
- Binary\_roads@1
- Binary\_slope@1
- DEM@1
- Prox\_Buildings@1
- Prox\_Favourable\_Objects@1
- Prox\_Risk\_Loc@1
- Prox\_Transport@1
- Prox\_roads@1

**Result Layer**

Output layer: [ ] ...

Output format: GeoPackage

Selected Layer Extent

X min: 33890.49350 X Max: 39085.49350

Y min: 40636.08180 Y max: 45026.08180

Columns: 1039 Rows: 878

Output CRS: EPSG:3414 - SVY21 / Singapore TM

Add result to project

**Operators**

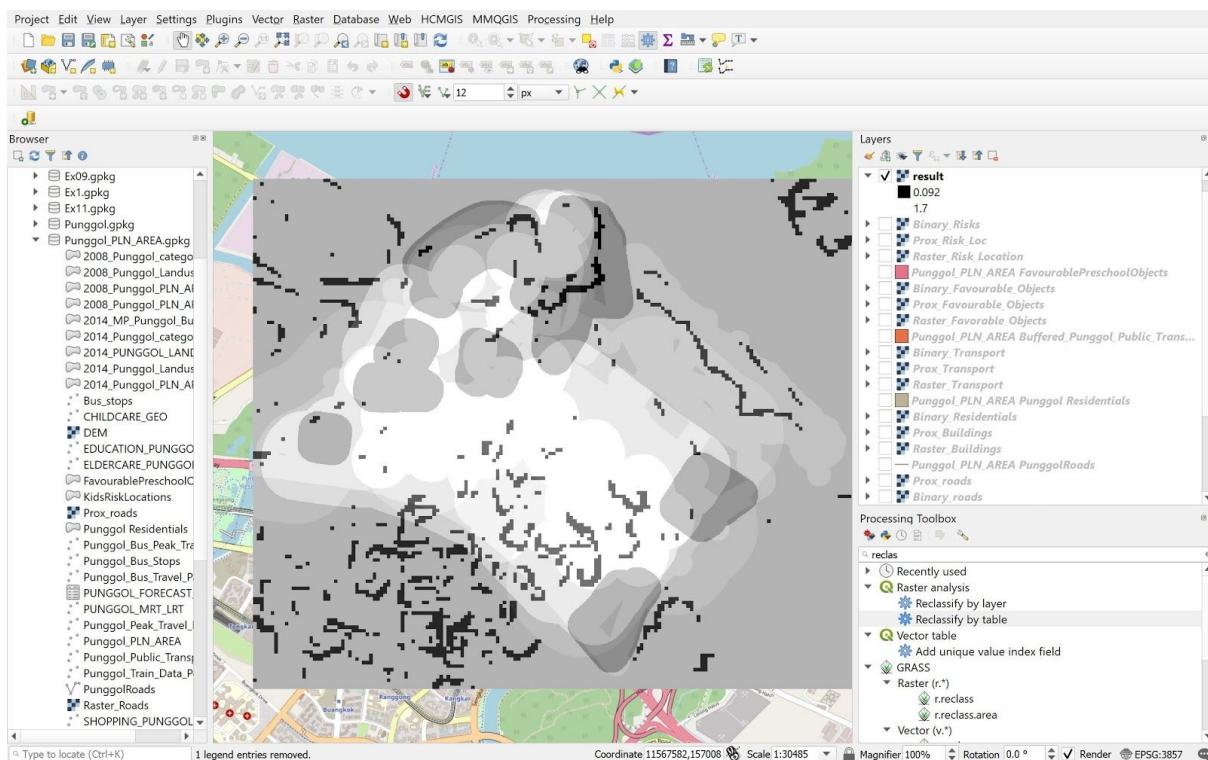
+	*	sqrt	cos	sin	tan	log10	(
-	/	^	acos	asin	atan	ln	)
<	>	=	!=	<=	>=	AND	OR

**Raster Calculator Expression**

```
"Binary_slope@1" * 0.189 + "Binary_roads@1" * 0.092 + "Prox_Risk_Loc@1" * 0.337 +
"Binary_Favourable_Objects@1" * 0.067 + "Binary_Transport@1" * 0.12 + "Binary_Residential@1" * 0.194
```

Expression valid

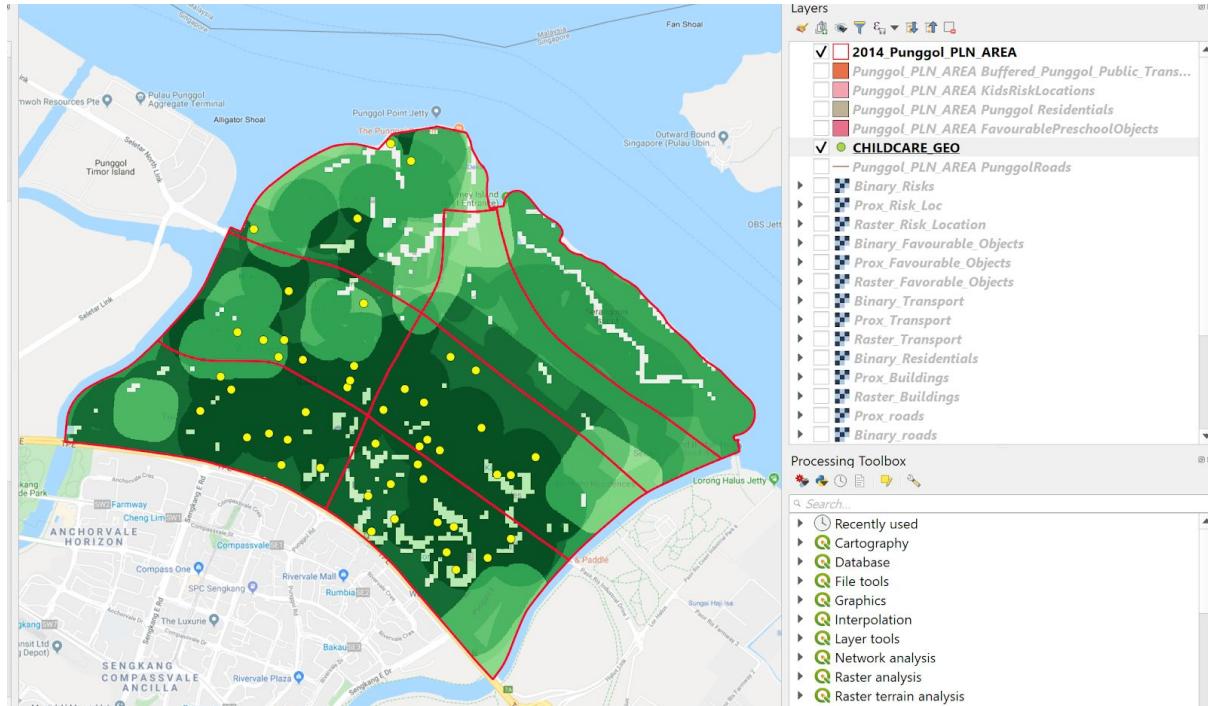
5. Ranking land suitability modelling of the generate raster-based layers, we perform the binary multiplication with the analysed weightage for each factor using the Raster Calculator.



6. The binary model is generated, however we need to clip raster to fit the Punggol subzone using the 'Clip Raster by Mask Layer' of the MP14 subzone boundary.
7. Finally, we run 'QGIS2Web' plug-in and deployed analysis app on the Heroku platform. The product can be found here:

<https://punggol-school-greenzone.herokuapp.com>

## Results



The above map shows the overall green zone suitability map for building new primary and preschool. The darker the green zone represents a more suitable location according to the weighted analysis.

Firstly, the Matilda, Punggol Town Centre, Punggol Field, and Waterway East has the most 0-9 age group population. However, the current figure of child centres and primary schools does not meet its tremendous demand. We can observe visually and count manual how many centres are there. This should be a priority that the government should prioritise because we are talking about ensuring about providing a good quality education for the future generations of Singapore. Between this 4 populated subzones most of the recommended locations are located at the heartbeat of Singapore which ensures the nearby proximity to community facilities, public transport, road network, and residential.



The challenge now is that the recommended green zones are populated with buildings, thus no empty land to build.



Our team believes that this challenge can pose as an opportunity in embedding preschool under the HDB blocks and future new residential as seen as the picture above. Additionally, as there is a high demand and low supply preschools in the Punggol region we can see the building of preschools as an open job opportunities for new teachers thus tackling Punggol as a place to play-work-learn-live.



Going back to the green zone land suitability analysis, the Northshore region will experience an exponential growth of economic active and the younger group age group with only 3 pre schools at the moment. The map above depicts the on-going Punggol redevelopment from Master Plan 2008. We can see that learners and creative corridors are being built nearby the subzone, that will most likely be the best place to plan the redevelopment of the facilities.

#### 4. Why Creating a Live-Work-Play-Learn Community can be challenging especially for the economic active?



Ever since the Masterplan 2008, Singapore envisions its planning subzones to be a place to live, play, work. Under the Draft Master Plan 2019 itself states that “Punggol Digital District will continue to provide jobs closer to home”. However can we evaluate whether this plan is applicable for the economic active age group?

Firstly, the Punggol Digital District (PDD) aims to bring together the Singapore Institute of Technology (SIT)’s campus and JTC’s Business Park spaces within Punggol North to create Singapore’s first truly smart district. Thus, potentially creating new opportunities for Punggol citizens and their surroundings. We will review the current possibilities and challenges of the current initiative, especially how likely it is to bring work closer to home.

To understand its possibilities it is important to perform analysis to understand where does most of the Punggol economic active group works. The explicit data for this case will be extremely hard to access, however we can imply that most citizens will travel to how using public transportation. The DataMall API provided by LTA summarises the monthly travel patterns by origin destinations to each train’s station and bus stops. Additionally, if we could gather both travel pattern data during AM & PM peak hour, we can probably capture most of the traveling to work trips.

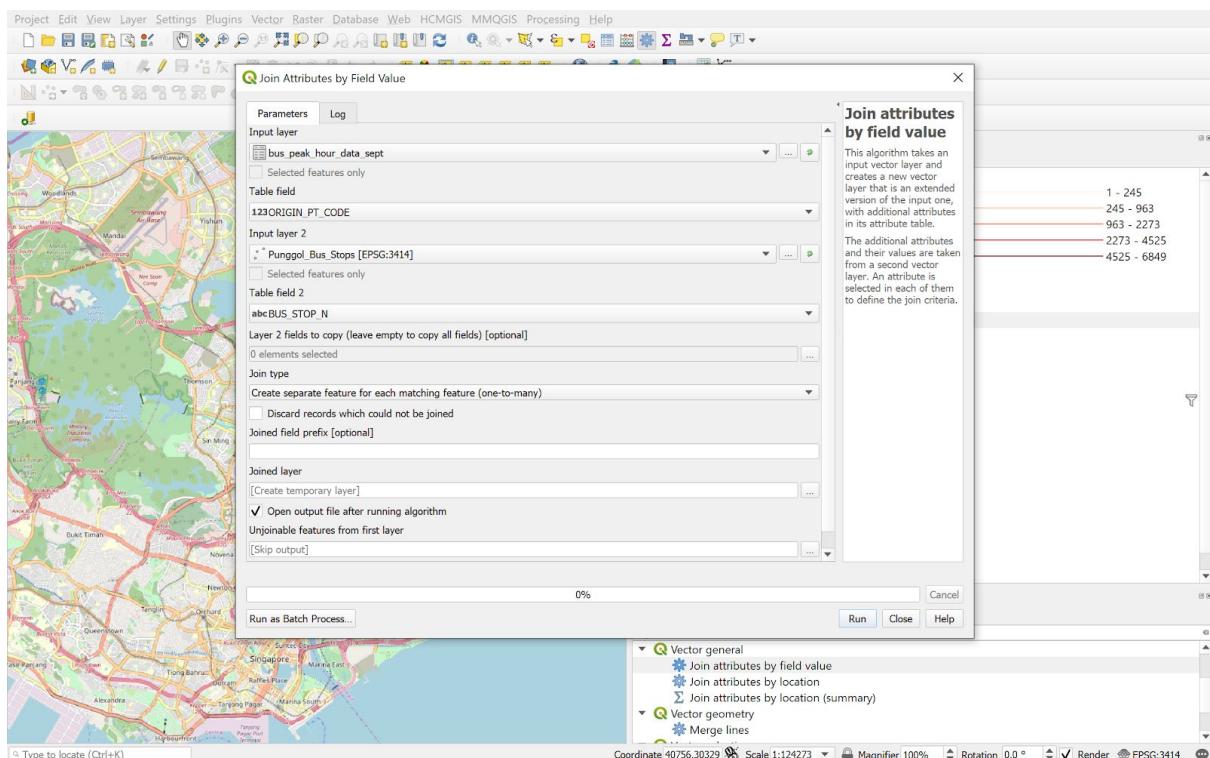
## Raw data overview:

YEAR_MONTH	DAY_TYPE	TIME_PER_HOUR	PT_TYPE	ORIGIN_PT_CODE	DESTINATION_PT_CODE	TOTAL_TRIPS
2019-09	WEEKDAY	13	TRAIN	NE11	NS19	3

Our assumption will be that AM peak hour is between 8 to 10 am interval. While PM peak hour takes time at 6 to 8 pm. Based on the raw data shown above, we can potentially filter time based on the peak hour timing on weekday and match train stations and bus stops to gather information of total trips which takes place during peak hour and punggol origin.

**Data Cleaning and filtering** were performed in R and published in RPubs [Punggol Peak Hour Travel Pattern Analysis](#). During the data cleaning process, we realised that MRT/LRT transfer stations such as Punggol, City hall, and Dhoby Ghaut had a special combined station code, thus we will only take the first mentioned station by default for data matching during analysis, eg: Punggol MRT was listed as “NE17-PTC”, R code transforms it into “NE17”. Also, the bus stop numbers which has a default 6 digits character was read as a digit thus losing its first “0” digit as it was converted into digit.

The MRT/LRT and bus stop vectors were exported in to geopackage. Since we are focusing on travel patterns from Punggol origin, we filter overall data points which falls under the Punggol Region using the **clip** method. Next we label the coordinate using X & Y geometry through adding new field using the **Field Calculator** feature. Syntax used was as simple as calling a built-in function that returns X & Y coordinates which are '\$x' and '\$y'. Next, we also label the entire MRT/LRT stations and bus stops. It is not possible to have 2 vector data points in a single row of data, thus we leverage on the 'X\_from' 'Y\_from' and 'X\_to' and 'Y\_to' when performing joining according to the appropriate 'ORIGIN\_PT\_CODE' and 'DESTINATION\_PT\_CODE'.

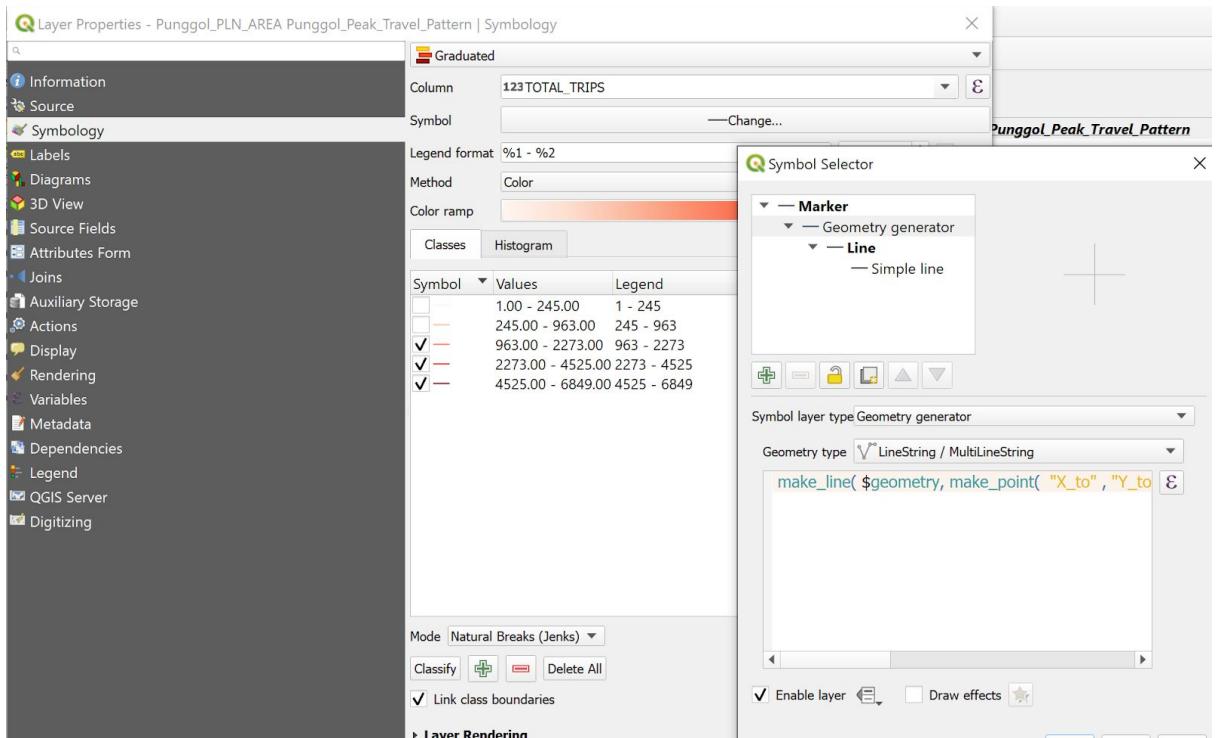


Next, we perform a one-to-many relational data joining of the “Passenger Volume by Origin Destination Bus Stops” and “Passenger Volume by Origin Destination Train Stations” using the **Vector general’s ‘Join attributes by field value’**, where input layer as the clean travel pattern data and second input layer as the vector point with the newly created X Y field. Next step uses the same method but linking bus destination all overall singapore travel data points, thus having 2 points of vector data in a row.

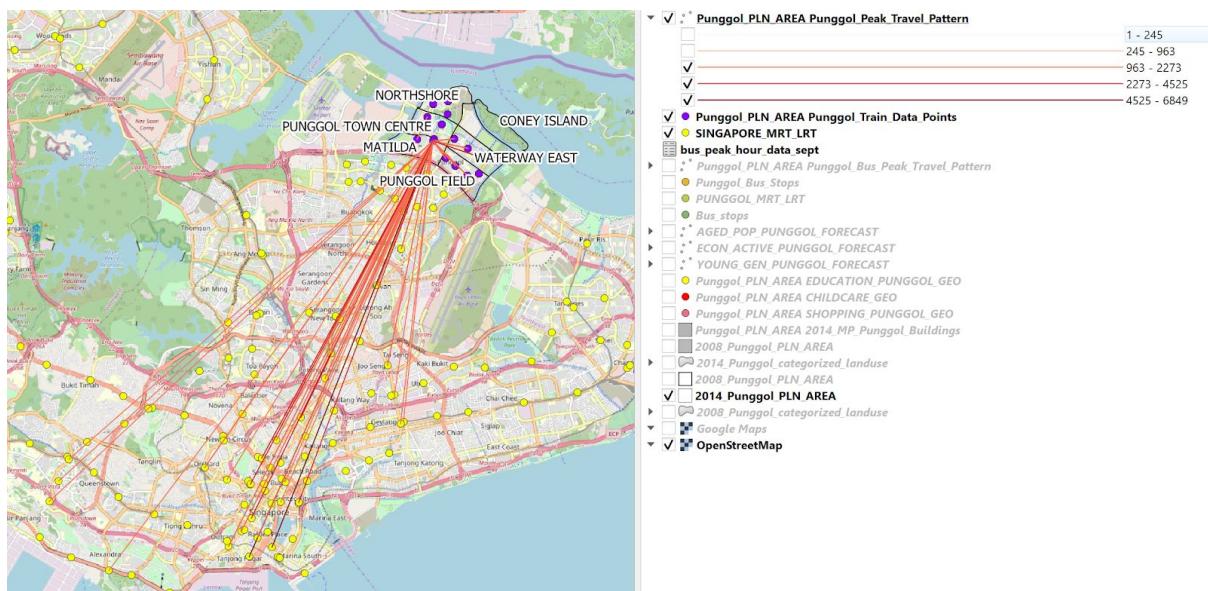
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	BUS_STOP	BUS_ROOFLOC	DESC_X	from	Y_from	field_1	YEAR	MONDAY_TYPE	TIME_PER_PT_TYPE	ORIGIN_PT	DESTINATI	TOTAL_TRI	ORI_ID	DEST_ID	fid_2	BUS_STOP	BUS_ROOFLOC	DESC_X	to	Y_to
2	65271	B08	OPP BLK 1&	36611	42422	53623	2019-09	WEEKDAY	18 BUS	65271	98099	32	65271	98099	18	98099	B02	BLK 269A	42470	38513
3	65271	B08	OPP BLK 1&	36611	42422	735289	2019-09	WEEKDAY	19 BUS	65271	98019	16	65271	98019	3097	98019	B02	OPP BLK 1&	42437	38222

In order to visualise, we export current data into a csv, to vectorise according to the joined X Y data points by importing as delimited layer file. Importing the delimited text layer will point to the ‘X\_from’ and ‘Y\_from’. We want to build a graduated network layer between to vector points using the graduated and customised geometry option. To do that we did the following steps:

1. Open imported layer’s symbology setting
  - a. Choose ‘Graduated’
  - b. Click ‘Symbol’ > ‘symbol layer type’ as ‘Geometry Generator’ and ‘Geometry type’ as ‘Line String/Multiline string’



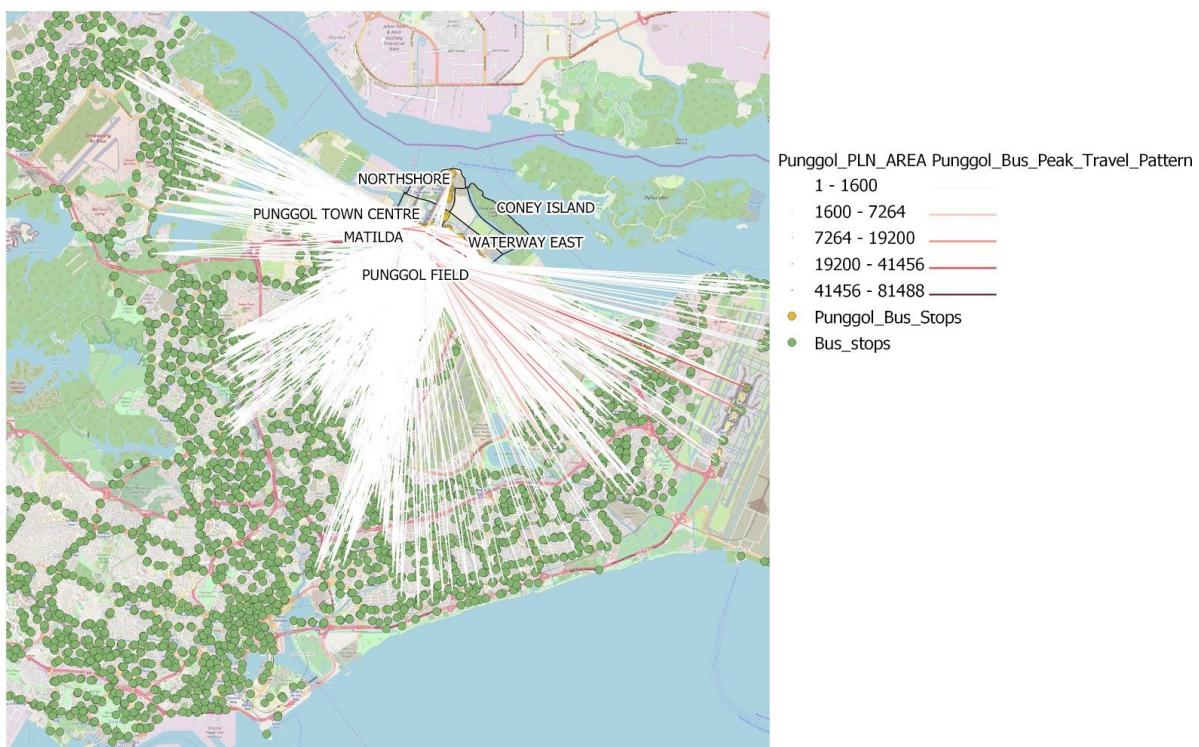
2. We manually plot the ‘X\_to’ and ‘Y\_to’ data point by indicating geometry expression with the following formula: “ make\_line( \$geometry, make\_point( “X\_to”, “Y\_to” ) ) ”
3. Next, we ‘Apply’ changes and select ‘TOTAL\_TRIPS’ and the object of graduated value visualisation.



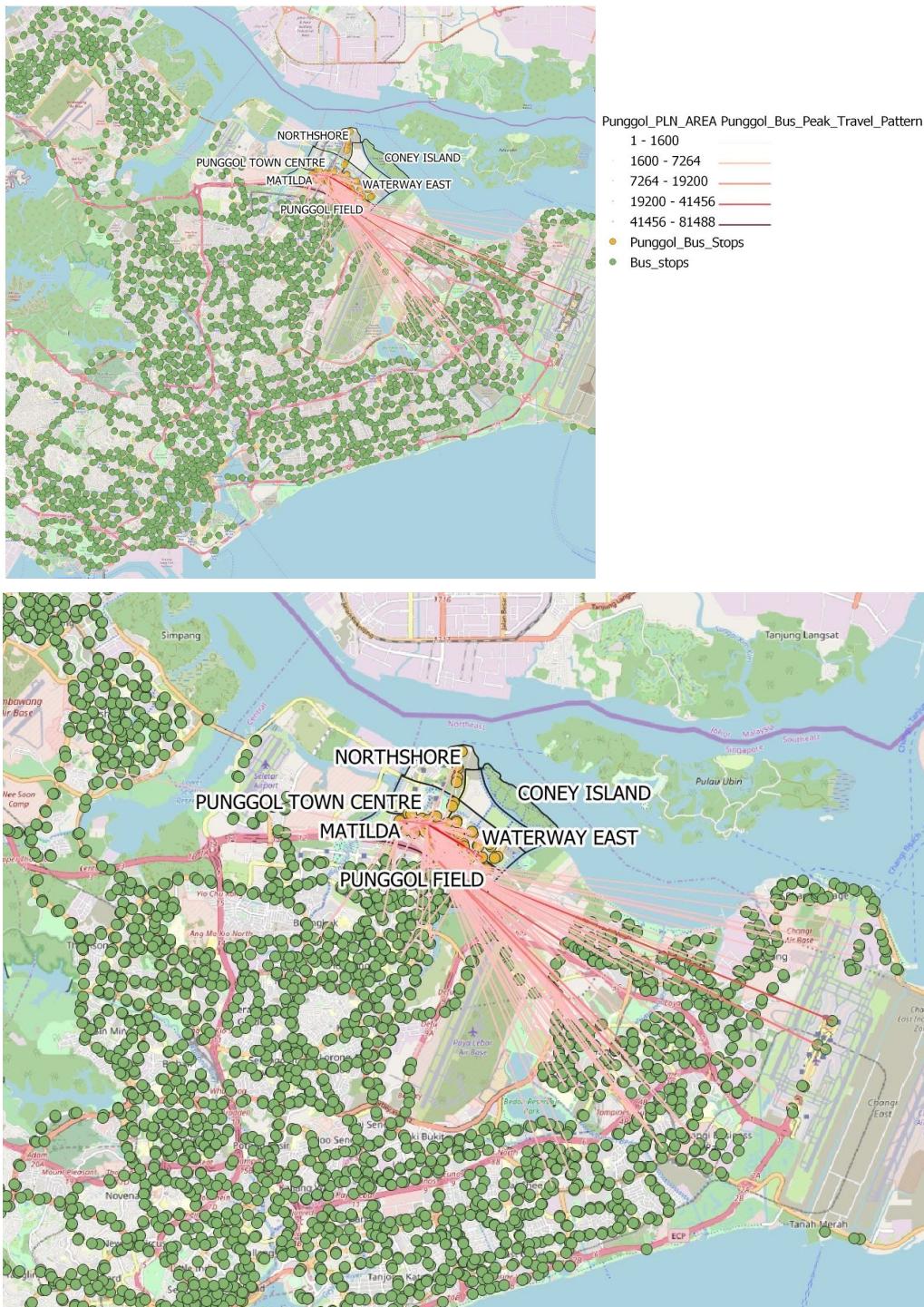
The above screenshot shows the created network layer based on the travel pattern data of public transportation. Next, we will analyse the results of the network map.

### Results: Bus Peak Hour Travel Pattern in Deriving Current Punggol Population's Workplace

**Network Map: Peak Hour Travel Data from Punggol Origin (Bus)**

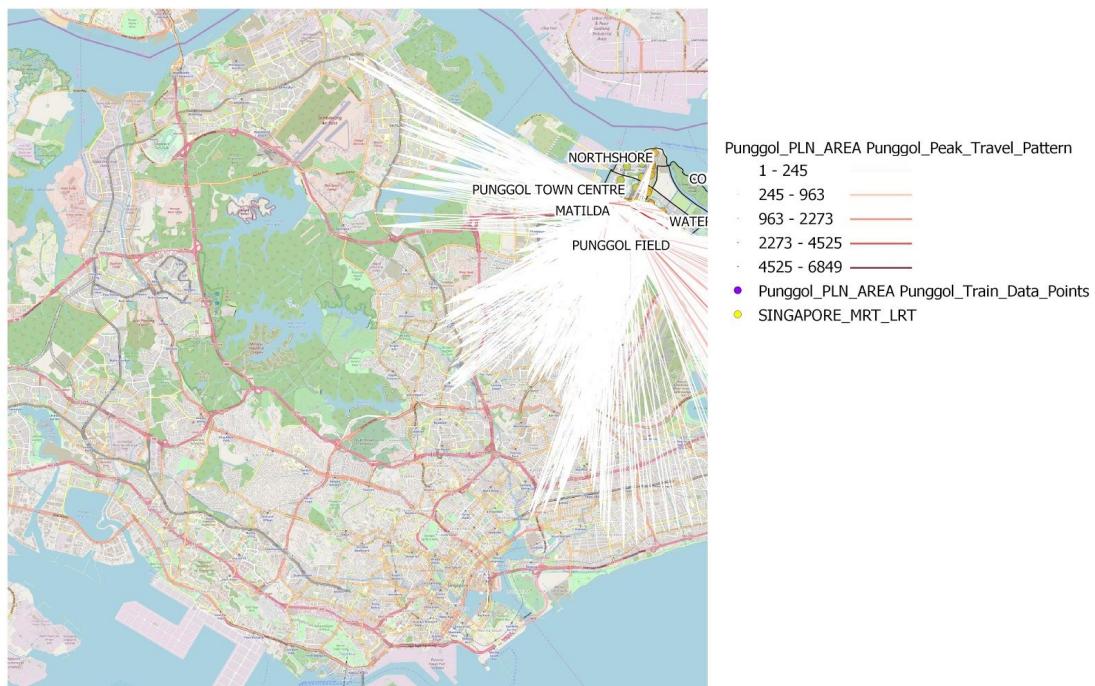


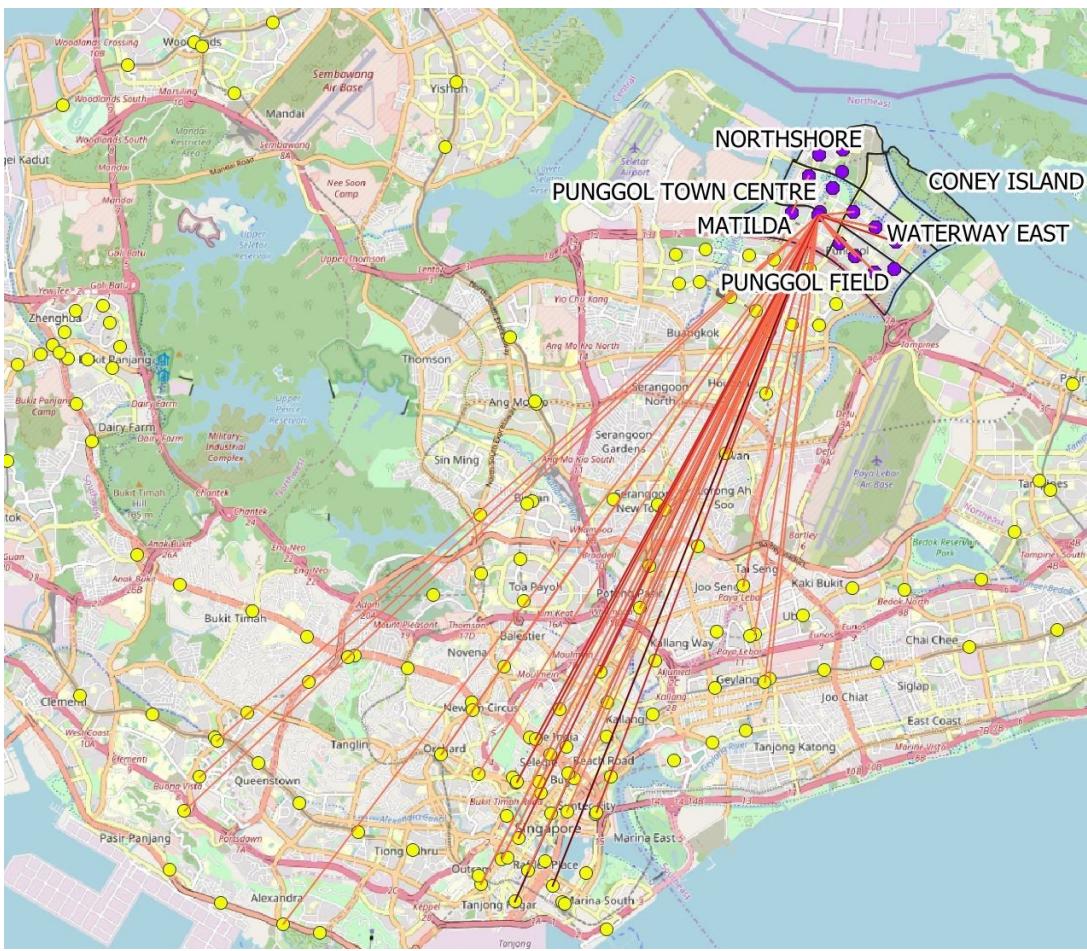
Network Map: Peak Hour Travel  
Data from Punggol Origin (Bus)



## Results: Train Peak Hour Travel Pattern in Deriving Current Punggol Population's Workplace

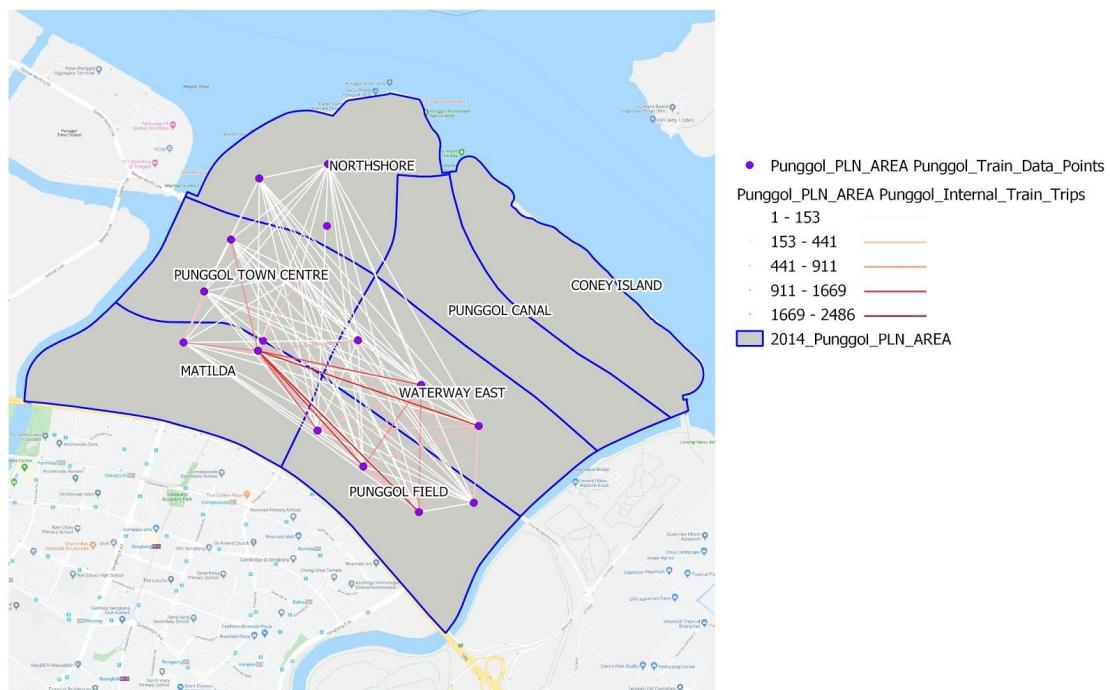
Network Map: Peak Hour Travel Data from Punggol Origin (Train)



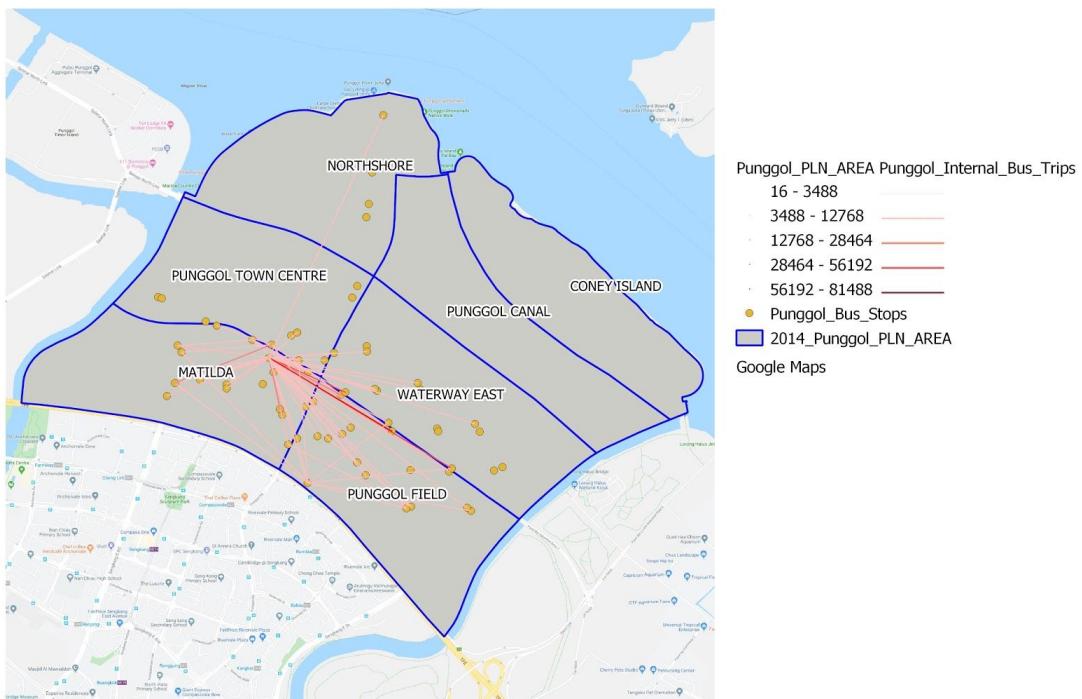


Results: Bus and Train Peak Hour Travel Pattern within Punggol Boundary

Internal Network Map: Peak Hour Travel Data within Punggol Region (Train)



Internal Network Map: Peak Hour Travel  
Data within Punggol Region (Bus)



### Analysis of the Bus and Train Peak Hour Travel Pattern in Deriving Current Punggol Population's Workplace

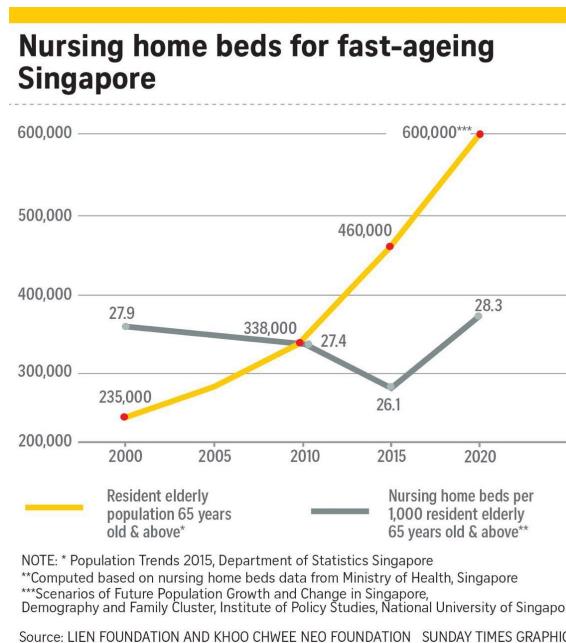
Based on the network analysis we have performed, we note that apparently most of Punggol citizens travel out of Punggol during peak hour. Firstly the Train Network map shows a rather spreading travel pattern out of Punggol all the way to Woodlands, Bishan, Ang Mo kio, and the East Region. Interestingly, when we review a rather small travel trips to of 1-963 in month September 2019, map revealed that many travel patterns are directed to the Buona Vista, One North, Labrador Park, Pasir Panjang, Paya Lebar, MacPherson, Tai Seng and of course CBD district including Tanjong Pagar, Downtown, Suntec, Promenade, City hall where most of the Big MNCs and well-performing startups and SMEs are currently located.

Additionally, from the predominant bus travel data during peak hour we can see that interestingly bus trips to the east including Changi Airport and Expo are directed to. It is believed that these 2 locations also provides the aviation industry sector and technology support for big companies such as IBM and DBS tech division and located at Expo.

To conclude this observation, I believe that the goal of creating Punggol Digital District can pose a challenge not just in terms of initiating the vision, but also getting on board companies who are willing to move over to the Punggol region where it is not really well-known as an office area. Looking from the Punggol citizen's perspective, Singapore's ease of transportation allows them to travel down to popular business districts pretty conveniently and thus citizens might not feel it is necessary to work within proximity. Truth is, people don't mind travelling just to be employed in a company they like. Next, global MNCs which most people prefer to work offers better competitive

benefits and salary which in turn becomes the preferable place to work instead of just proximity as priority.

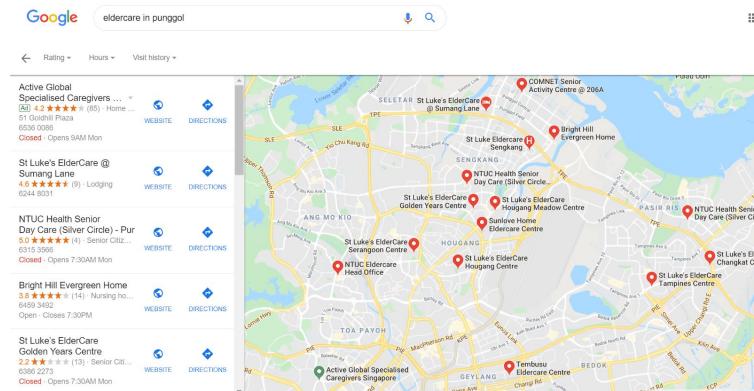
## 5. Looking out for the elderly of Punggol



Singapore is suffering from a silver tsunami, where more citizens are entering their golden ages. Nearly half a million people in Singapore are 65 and older today and their numbers are set to double by 2030 (Tai & Chuan, 2016). Years later, Punggol will too see a growing number of elderly. As such, there is a strong need for more eldercares to accommodate future generations of elderlies.

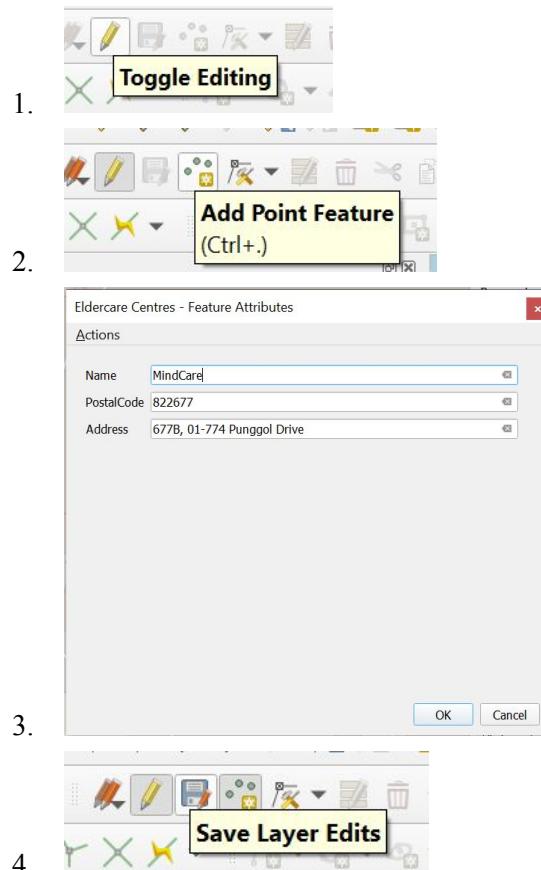
## Eldercare Centres in Punggol

To determine the location of eldercare in Punggol, we did a simple google search and drew up a list of centres.

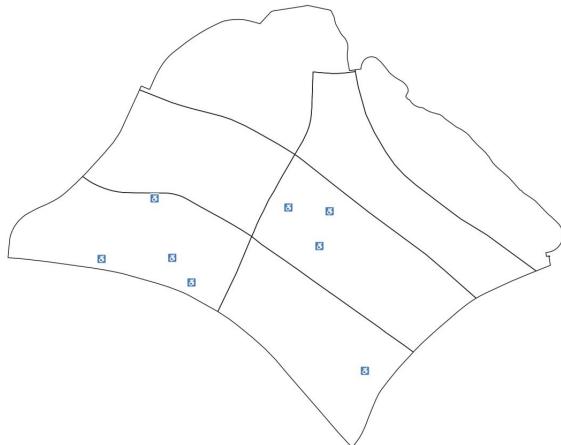


Using Google Maps to locate existing eldercare in Punggol

We extracted the name, address and postal code of each centre and added the geopoints to a new layer.



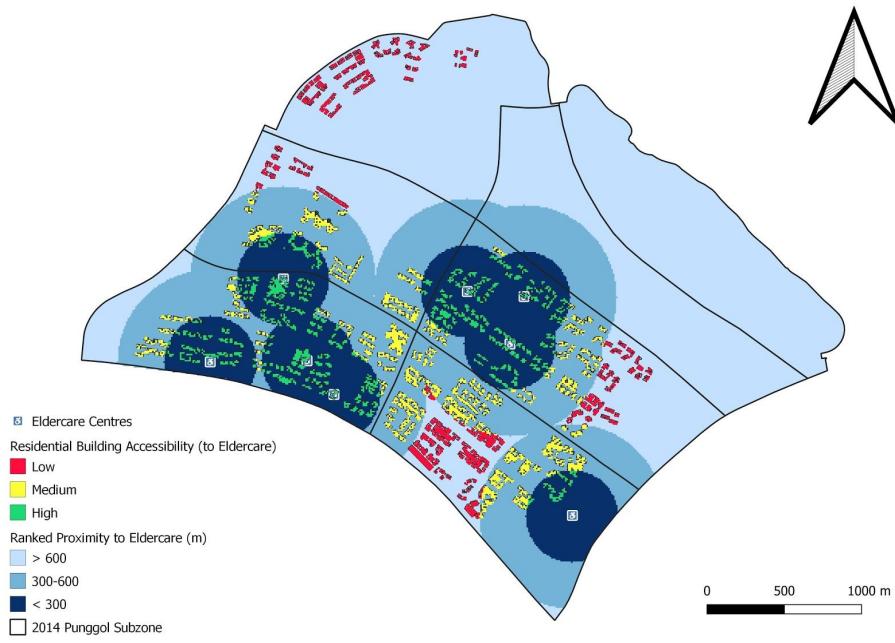
This resulted in the following layer:



Eldercare in Punggol

We then charted a proximity map from the eldercare to residential flats and houses. The following steps were taken:

To determine accessibility, we took into consideration that an average elderly will take 8.5 minutes to walk 300m, and classified this distance as **highly accessible**. For the next 300m, the eldercare would have **medium accessibility** and beyond 600m, the eldercare would be considered centres with **low accessibility**. We also classified the residential buildings according to its distance from the next nearest eldercare.



Proximity Map of Eldercare in Punggol

From our results, we can see that there are still multiple red residential areas that are too far away from eldercare centres. In this aspect, we propose building just one more eldercare be built to serve the unserved residents. To do so, we conducted a land suitability analysis.

## Land Suitability Analysis

First, we considered these factors when finding out which land is most suitable:

- Residential Convenience
  - The eldercare centres should be as close as possible to residential places. This allows for elderly to visit these nearby eldercare centres and allow for their family members to worry less since the facility is so accessible. The favourable distance is within 300m radius.
- Distance from existing centres
  - This ensures that the newly built centre overlaps least with the current areas that are already served. A favourable distance is beyond 600m of existing centres.
- Economic Factor
  - To ensure that it is inexpensive and easier for contractors to build the new eldercare, the slope of the land was taken into consideration. A ground with lower slope ( $< 15^\circ$ ) is favoured. This also ensures that construction periods do not overrun and disrupt residents' quality of living, especially when it is densely populated at Punggol.
- Accessibility to Bus Stops
  - In the case where the eldercare has a medium accessibility for someone, public transport becomes the alternative where the elderly can independently take safe rides to and from the eldercare. Hence, the eldercare centre should be closely located to bus stops.
- Accessibility to Roads
  - In the case where a family wants to send the elderly to the centre via car, eldercare centres should be placed by the roadside to decrease the time needed for families to send the elderly.
  - Moreover, allowing the eldercare centre to have a roadside view can provide a more inclusive environment rather than a deserted one, making the elder residents' feel less excluded.

Since not all factors have equal importance, we weighed the factors against one another to determine the consistency weightage of each factor using the SAGA Analytical Hierarchical Process.

Criteria for New Eldercare Centre							
Pairwise Comparison Matrix		Furthest from Existing Convenience	Economic	Public Transport	Road Accessibility	Requirement-6	Requirement-7
Furthest from Existing		1	1/3	1	2	4	4
Convenience		3	1	4	4	5	4
Economic		1	1/4	1	2	3	4
Public Transport Accessibility		1/2	1/4	1/2	1	6	4
Road Accessibility		1/4	1/5	1/3	1/6	1	4

AHP		Consistency check	
1	0.183	18.3%	Consistency OK
2	0.460	46.0%	9%
3	0.164	16.4%	
4	0.142	14.2%	
5	0.052	5.2%	

As shown, the weightage for the factors are:

Residential Convenience = 0.460

Distance from existing centres = 0.183

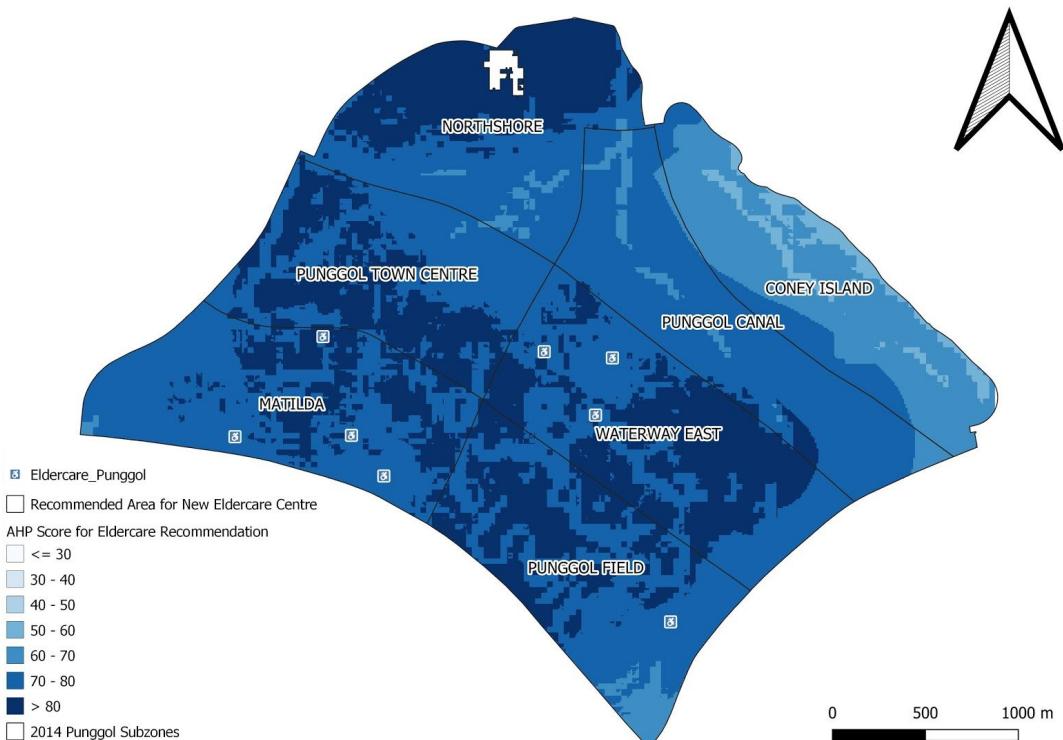
Economic Factor = 0.164

Public Transport Accessibility (Accessibility to Bus Stops) = 0.142

Road Accessibility = 0.052

The order of priority is thus determined - the higher the weightage, the higher the priority.

After weighing them, we multiple the score by 100 and resulted with a raster layer of values ranging from 20 - 90. Setting a threshold of 85, we obtained 3 plots of land with an area of at least 10,000m<sup>2</sup>. From there, we decided to select the area that is within residential blocks.



The recommended area is given as shown in the white space within Northshore subzone. There is a severe lack of eldercare centre there and despite the rising population of the economically active and the young, a new eldercare centre in Northshore can help to prepare for the future population.

In order that Punggol may become a place where all can work, live, learn and play, Punggol must first be equipped with relevant facilities that can support the growing population. With more available facilities, residents can avoid worrying about where their elder family members can spend their afternoons at and will increase the overall quality of living.

## 6. Polyclinic & CHAS Clinics in Punggol

Given that the overall population of Punggol will continue to rise and that more people will move in to reside in the new district, Punggol has to provide healthcare facilities in order to ensure good and affordable healthcare for the residents.

From the burgeoning economically active group, we might see a bigger number of them starting a new family and more younger populations seeking to get their healthcare needs met. This has inspired the opening of the Punggol Polyclinic in 2017 with the focus on women's and children's health services, whereby 11% of Punggol residents are children aged four and under in 2017, the highest proportion of children aged four and below in Singapore<sup>1</sup>.

Although there is only one polyclinic in Punggol, it is backed up by the numerous CHAS clinics which are private clinics that offer the Community Health Assistance Scheme (CHAS). There is also no hospital in Punggol but the clinics in Punggol are working closely with the Sengkang General and Community Hospitals<sup>2</sup>.

To determine the location of clinics in Punggol, we first looked up [CHAS Clinic Locators](#) online because we want to know where the family oriented and affordable clinics are. We searched by the keyword 'Punggol' and downloaded our search results.

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<sup>1</sup><https://www.channelnewsasia.com/news/singapore/punggol-polyclinic-healthcare-diabetes-new-mothers-10260194>

<sup>2</sup><https://polyclinic.singhealth.com.sg/news/patient-care/singhealth-polyclinics-opens-new-punggol-polyclinic-at-oasis-terraces>

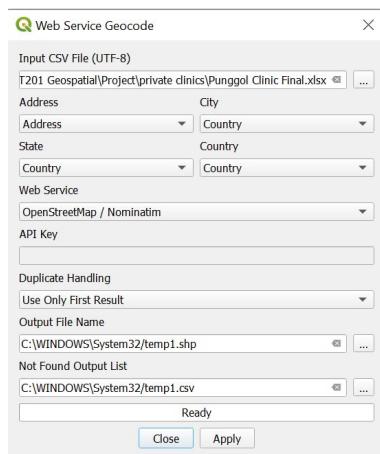


www.chas.sg

Name	Address	Telephone	Website	Type	Pap Test Services
Caring Dental Punggol	665a Punggol Drive, #01 - 02, Singapore - 821665	64816833		Medical	No
Etern Medical Clinic	79 Punggol Central, #01 - 05, Punggol MRT Station, Singapore - 828985	64259935		Medical	No
EXTERN MEDICAL CLINIC (PUNGGOOL SUMANG LRT)	368A PUNGGOOL WALK, #01 - 302, WATERWAY TERRACES I Singapore - 823308	62467288		Medical	No
HEALTHBRIDGE FAMILY CLINIC	615A EDGEFIELD PLAINS, #01- 328, PUNGGOOL SPRING, Singapore - 821615	64897495		Medical	No
Healthmark Medical Clinic	639 Punggol Drive, #01 - 06, Singapore - 828939	68756696		Medical	Yes
HEALTHWAY MEDICAL	658 PUNGGOOL EAST, #01 - 04, Singapore - 820568	68178267		Medical	No
Healthway Punggol Clinic	168 Punggol Field #02 - 07A, Singapore - 820568	63153493	www.healthwaymedical.com/	Medical	No
KENNETH TAN MEDICAL CLINIC	658 PUNGGOOL EAST, #01 - 07, Singapore - 820568	63124589		Medical	No
Lifeline Punggol Medical Clinic	198 Punggol Field #02 - 03, Singapore - 820568	63155428		Medical	No
MEDI HEALTHCARE CLINIC (PUNGGOOL)	218 SUMANG WALK, #01 - 02, Singapore - 820218	66948238		Medical	No
MINMED CLINIC (PUNGGOOL)	83 PUNGGOOL CENTRAL #02 - 15, Singapore - 828761	63399339		Medical	No
Mutual Healthcare Medical Clinic (Punggol)	106A Punggol Field, #01 - 546, Singapore - 821106	63155036		Medical	No
My Family Clinic (Punggol Central)	301 Punggol Central, #01 - 02, Singapore - 820291	686537351	www.alliancehealthcare.com.s	Medical	No

### Search result of clinics in Punggol

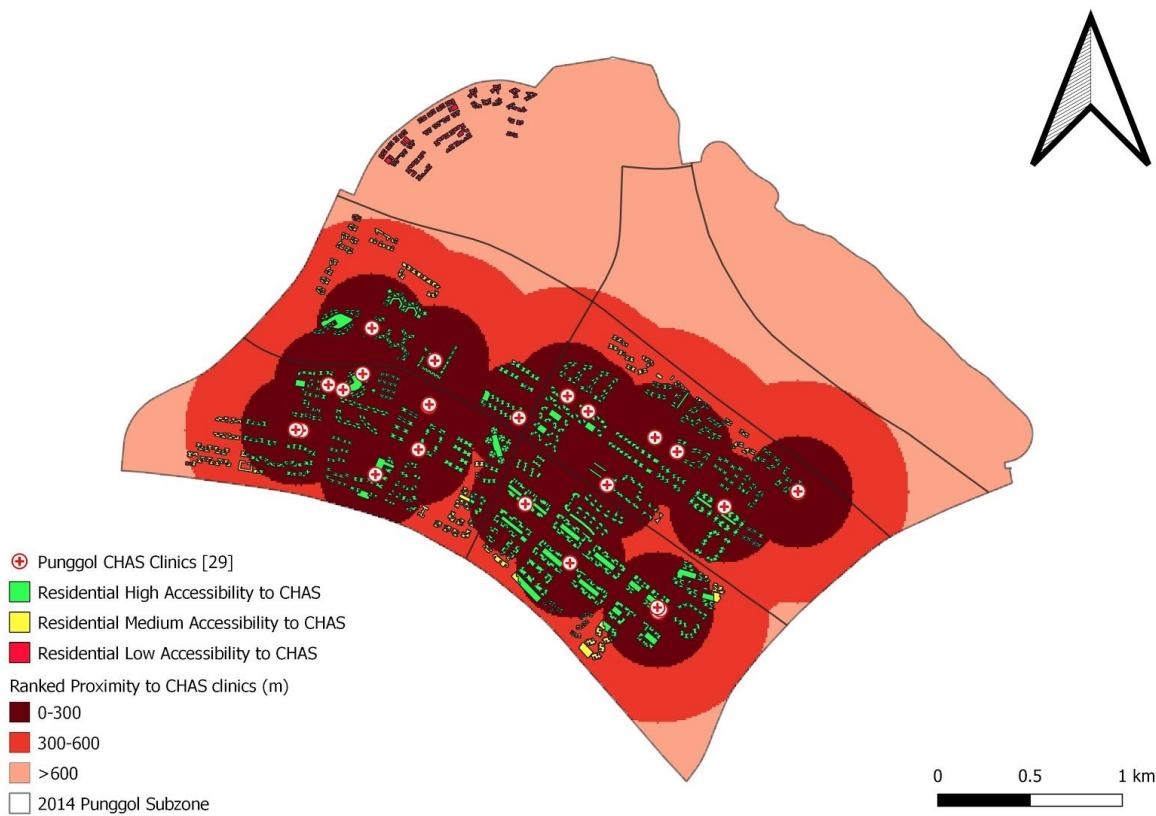
From there, we extracted all the information into a proper excel sheet. We had to add an extra column for Country so that we were able to geocode the addresses.



Geocoding Punggol Clinics

After geocoding, we realized not all the locations were geocoded correctly. This could happen when the Web Service Geocode do not have the proper x y coordinates. The point features were then manually shifted, and checked against google maps.

Next, we did a ranked proximity map of the CHAS clinics and categorize the residential buildings according to their proximity to the CHAS clinics in Punggol to find out whether residents have high accessibility to healthcare facilities.



## Land Suitability Analysis

- Accessibility factor
  - The new CHAS clinic needs to be accessible and inclusive so it's better for it to be near footway and service roads, which we quantify as less than or equal to 200m
  - The stated roads are extracted from the OSM roads layer which contains various types of roads
- Pollution factor
  - The new CHAS clinic also needs to be away from the vehicle emissions, and most of the vehicle will travel along the primary and secondary roads
  - The stated roads are extracted from the OSM roads layer which contains various types of roads
- Public transport accessibility factor
  - For people staying outside Punggol, we need to make the new CHAS clinic travel-friendly and thus build it in close proximity to the MRT or LRT
  - We want the clinic to be within 200m of the nearest MRT or LRT
- Hospital proximity factor
  - Since Punggol has no hospital currently, the clinic might not be able to handle high-level medical surgery or treatments and in case of emergencies, it's good to have the clinic in close proximity to a hospital outside Punggol
  - The new CHAS clinics needs to be in the range of 1 km to the nearest hospitals

- Residential proximity factor
  - The new CHAS clinics also needs to be relatively close to residential areas because it's built to serve the residents so we cannot have it faraway from the residential areas even though it is near the MRT or LRT
  - It needs to be within 500m of residential areas

After reclassifying the table for the layers stated above, different layers must have different scale so we standardized the value using the min-max method

- Min-Max

$$MM(x_{ij}) = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}}$$

We use SAGA's Analytical Hierarchical Process to rank the importance of the factors relevant to the building of new CHAS clinic to get the weights of each factor.

Land Suitability Analysis for new CHAS clinic/hospital					
Pairwise Comparison Matrix					
	Footway accessibility	Pollution	Public transport	Hospital proximity	Residential proximity
Footway accessibility	1	5	3	4	1/2
Pollution	1/5	1	1/3	1/2	1/6
Public transport accessibility	1/3	3	1	1/2	1/3
Hospital proximity	1/4	2	2	1	1/5
Residential proximity	2	6	3	5	1

	AHP		Consistency check	
	Value	Percentage	Consistency OK	
1	0.294	29.4%	Consistency OK 7%	
2	0.054	5.4%		
3	0.114	11.4%		
4	0.116	11.6%		
5	0.422	42.2%		

So the final raster calculation (in percentage) according to the weights:

```
(( "Standardized_footwayroad_proximity @1" * 0.294) + ( "Standardized_primaryroads_proximity@1" * 0.054) + ( "Standardized_MRTandLRT_proximity@1" * 0.114) + ( "Standardized_hospital_proximity@1" * 0.116) + ( "Standardized_residential_proximity@1" * 0.422 ))*100
```

As shown, the weightage for the factors are based on the highest priority are:

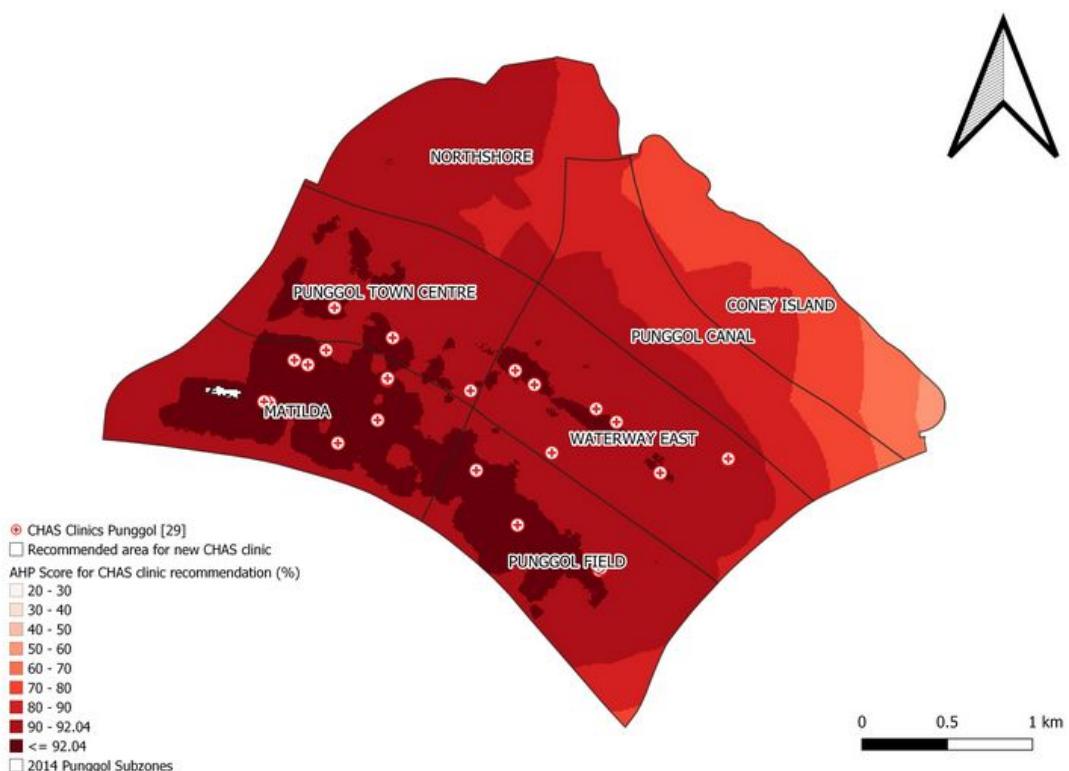
Residential proximity = 0.422

Footway accessibility = 0.294

Hospital proximity = 0.116

Public transport proximity = 0.114

Pollution = 0.054



The AHP gives us several plots of land ranging from 100m<sup>2</sup> to above 10000 m<sup>2</sup>, since the clinic does not need to occupy such a large space and because Punggol is now currently undergoing development, we chose a plot of land that is approximately 8000m<sup>2</sup> in the Matilda subzone because it has the fastest growing population and is the closest to the hospitals in Sengkang area.

Future works might be developed in the northshore area which is going to house the Punggol Digital District (PDD) but looking at the population growth now, it is not suitable to house the new CHAS clinic and will be more beneficial if located in Matilda even though Matilda has the highest number of CHAS clinic. In the future, hospitals might also need to be built in Punggol to accommodate the growing economically active group.

## Webmaps

[Webmap of Punggol Land Use Changes between 2008 and 2014](#)

[Webmap of Punggol Planning Area](#)

[Webmap of Land Suitability Analysis for new Pre and Primary School](#)

[Webmap of Land Suitability Analysis for new Eldercare Centre](#)

[Webmap of Land Suitability Analysis for new CHAS clinic in Punggol](#)

# Final Poster

SMT201 AY2019-2020, T1

# Paradisiacal Punggol

OBSERVING LANDUSE CHANGES AND ENSURING PHYSIOLOGICAL NEEDS OF PUNGOL RESIDENTS THROUGH GEOSPATIAL ANALYTICS

by Erika Aldisa Gunawan, Jerry Tohvan, Renata Dharma. Special thanks to Professor Kam Tin Seong for the guidance.

## LANDUSE CHANGE ANALYSIS (2008-2014)

## ISSUES, MOTIVATION, APPROACH

- Based on our landuse change detection above, it can be seen that more way has been made for residential area. However, we observed that Punggol lacks the basic amenities to serve the incoming residents, which poses a threat to their physiological needs. To obtain greater details, we cleaned the population data from SingStats, and conducted the analysis of demographics via graph visualisation in R.
- Even as Punggol aims to be the next digital district, it should always seek to address residents' basic needs first.
- When we first conducted proximity analysis, we realized there were residential areas that were highly unserved. Hence, we conducted multiple land suitability analysis to determine the most suitable place to plant new education, eldercare and clinical facilities. We made use of the SAGA Analytical Hierarchical Process to simulate and ensure the consistency weightage, which is dependent on suggested factors.

## RESULTS & RECOMMENDATIONS BY AGE GROUP NEEDS

### the Young

With the current figure of the economic active population, there is a possibility that the younger group might still spike due to family plans. Additionally, as there is a high demand and low supply preschools in the Punggol region we can see the building of preschools as an open job opportunity for new teachers thus tackling Punggol as a place to play-work-learn-live. The suggested criteria considered are: children risks avoidance, residential proximity factor, economic factor, public transport accessibility factor, road accessibility factor and favourable objects proximity factor in that order. [Map 1]

### the Elderly

As the demographics suggests, Punggol population is predicted to increase even further. In a few years time, the need for elderly care centres will be higher. We decided to uncover areas currently served by eldercare centres (within an accessible radius of 600m) [Map 2]. From there, we found the next most suitable area for a new eldercare centre, with criteria like residential convenience, distance from existing centres, economic factor, accessibility to bus stops and roads, prioritized in that order. [Map 3]

### Economy Class

With a denser population, there is a need to accommodate incoming residents, with special attention to children and women. A proximity map was drawn [Map 4] to find out which areas were unserved. From there, a land suitability analysis for a new clinic was conducted, the criteria considered being the residential proximity factor, accessibility factor, hospital proximity factor, public transport accessibility factor and pollution factor, in that order of priority. [Map 5]

## DEMOGRAPHICS

### PAST & PREDICTED PUNGOL POPULATION

### DATA SOURCE

"PASSENGER VOLUME BY ORIGIN DESTINATION BUS STOPS", Month Sep 2019, <http://datamall2.mytransport.sg/fiatservice/PVODBus> | "PASSENGER VOLUME BY ORIGIN DESTINATION TRAIN STATIONS", Month Sep 2019, <http://datamall2.mytransport.sg/fiatservice/PVODTrain> | Train data points: <https://www.mytransport.sg/content/dam/datamall/datasets/Geospatial/TrainStation.zip>. Bus stop data points: <https://www.mytransport.sg/content/dam/datamall/datasets/Geospatial/BusStopLocation.zip>. DataMail API: [https://www.mytransport.sg/content/dam/datamall/datasets/UTA\\_DataMail\\_API\\_User\\_Guide.pdf](https://www.mytransport.sg/content/dam/datamall/datasets/UTA_DataMail_API_User_Guide.pdf) | AHP Template from SGB Associates | Master Plan 2014 Subzone Boundary from URA, Childcare Centres, Schools: [https://www.sgb.gov.sg/media/Corporate\\_Resources/Publications/Skyline/Skyline-PDPs/Skyline-issue-11.pdf](https://www.sgb.gov.sg/media/Corporate_Resources/Publications/Skyline/Skyline-PDPs/Skyline-issue-11.pdf) | ASTER Global Digital Elevation Model (GDEM) dataset jointly prepared by NASA and METI, Japan: <https://search.earthdata.nasa.gov/search?m=-7.17525,3.937211&0.0942C2> | Population Growth Trend & Forecast: <https://www.singstat.gov.sg/media/microdata/statistics/>

## Data Source

“PASSENGER VOLUME BY ORIGIN DESTINATION BUS STOPS”, Month Sep 2019,  
<http://datamall2.mytransport.sg/ltaodataservice/PV/ODBus>

“PASSENGER VOLUME BY ORIGIN DESTINATION TRAIN STATIONS”, Month Sep 2019,  
<http://datamall2.mytransport.sg/ltaodataservice/PV/ODTrain>

Train data points:

<https://www.mytransport.sg/content/dam/datamall/datasets/Geospatial/TrainStation.zip>

Bus stop & MRT data points:

<https://www.mytransport.sg/content/dam/datamall/datasets/Geospatial/BusStopLocation.zip>

DataMall API:

[https://www.mytransport.sg/content/dam/datamall/datasets/LTA\\_DataMall\\_API\\_User\\_Guide.pdf](https://www.mytransport.sg/content/dam/datamall/datasets/LTA_DataMall_API_User_Guide.pdf)

Live-Work-Play in Punggol:

<https://www.ura.gov.sg/-/media/Corporate/Resources/Publications/Skyline/Skyline-PDFs/Skyline-issue-11.pdf>

Master Plan 2014 Subzone Boundary from URA:

<https://data.gov.sg/dataset/master-plan-2014-subzone-boundary-web>

Roads, buildings, land use data from OpenStreetMap (OSM) data sets:

<https://download.bbbike.org/osm/bbbike/Singapore/>

Child Care Data:

<https://data.gov.sg/dataset/child-care-centres-capacity-and-enrolment-annual>

AHP Template from SCB Associates

Master Plan 2014 Subzone Boundary from URA, Childcare Centres, Schools:

<https://www.data.gov.sg>

CHAS Clinic Locator: [https://www.chas.sg/clinic\\_locator.aspx?id=90](https://www.chas.sg/clinic_locator.aspx?id=90)

Eldercare Centres in Punggol:

[https://www.google.com/search?rlz=1C1CHZL\\_enSG805SG805&sxsrf=ACYBGNTuWNROT1WRH-VEgrOSQJfj0\\_6qGQ:1574527817770&q=eldercare+in+punggol&npsic=0&rflfq=1&rlha=0&rllag=1389781,103901698,1949&tbo=lcl&ved=2ahUKEwjbnPGa5YDmAhXnzDgGHXq6BPoQjGp6BAGLEI&tbs=lrf:!1m4!1u3!2m2!3m1!1e1!1m4!1u2!2m2!2m1!1e1!1m4!1u16!2m2!16m1!1e1!1m4!1u16!2m2!16m1!1e2!2m1!1e2!2m1!1e3!2m1!1e16!3sIAE,lrf:1,lf\\_ui:14&rldoc=1#rlfi=hd;si:;mv:\[1.4120332,103.9698978999999\],\[1.314682299999999,103.8417530999999\]\];tbs:lrf:!1m4!1u3!2m2!3m](https://www.google.com/search?rlz=1C1CHZL_enSG805SG805&sxsrf=ACYBGNTuWNROT1WRH-VEgrOSQJfj0_6qGQ:1574527817770&q=eldercare+in+punggol&npsic=0&rflfq=1&rlha=0&rllag=1389781,103901698,1949&tbo=lcl&ved=2ahUKEwjbnPGa5YDmAhXnzDgGHXq6BPoQjGp6BAGLEI&tbs=lrf:!1m4!1u3!2m2!3m1!1e1!1m4!1u2!2m2!2m1!1e1!1m4!1u16!2m2!16m1!1e1!1m4!1u16!2m2!16m1!1e2!2m1!1e2!2m1!1e3!2m1!1e16!3sIAE,lrf:1,lf_ui:14&rldoc=1#rlfi=hd;si:;mv:[1.4120332,103.9698978999999],[1.314682299999999,103.8417530999999]];tbs:lrf:!1m4!1u3!2m2!3m)

[1!1e1!1m4!1u2!2m2!2m1!1e1!1m4!1u16!2m2!16m1!1e1!1m4!1u16!2m2!16m1!1e2!2m1!1e2!2m1!1e3!2m1!1e16!3sIAE,lf:1,lf\\_ui:14](#)

Hospitals near Punggol:

<https://www.healthhub.sg/directory/hospitals>

ASTER Global Digital Elevation Model (GDEM) dataset jointly prepared by NASA and METI, Japan: <https://search.earthdata.nasa.gov/search?m=-7.175!25.59375!1!1!0!0%2C2>

Population Growth Trend & Forecast:

[https://www.singstat.gov.sg/-/media/files/find\\_data/population/statistical\\_tables/singapore-residents-binary-planning-areasubzone-age-group-sex-and-type-of-dwelling-june-20112019.zip](https://www.singstat.gov.sg/-/media/files/find_data/population/statistical_tables/singapore-residents-binary-planning-areasubzone-age-group-sex-and-type-of-dwelling-june-20112019.zip)

## References

Tai, J., & Chuan, T. Y. (2016, November 10). Growing old: Should you be worried? Retrieved from <https://www.straitstimes.com/singapore/growing-old-should-you-be-worried>.

Hao, Z. (2018, October 16). 6 Ways Preschools Under HDB Blocks Create the Kampung Spirit. Retrieved from

<https://goodyfeed.com/6-facts-about-preschools-under-hdb-blocks-besides-the-fact-that-theyre-everywhere/>