ASEAN Valuers Association

กรมธนารักษ์
The Treasury Department

The Development of Land unit's Quality Score for Mass Valuation in Thailand

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Speaker Introduction

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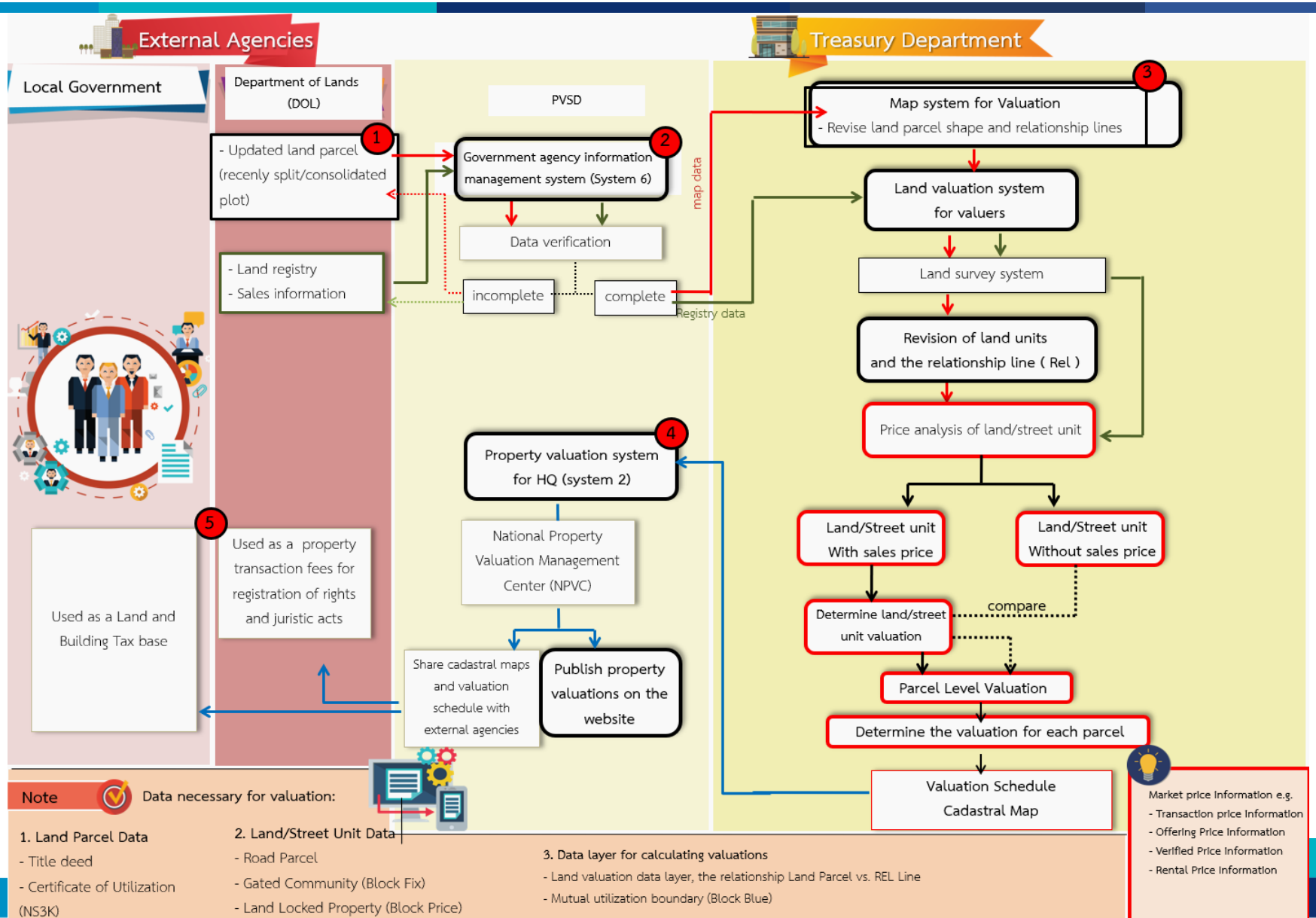
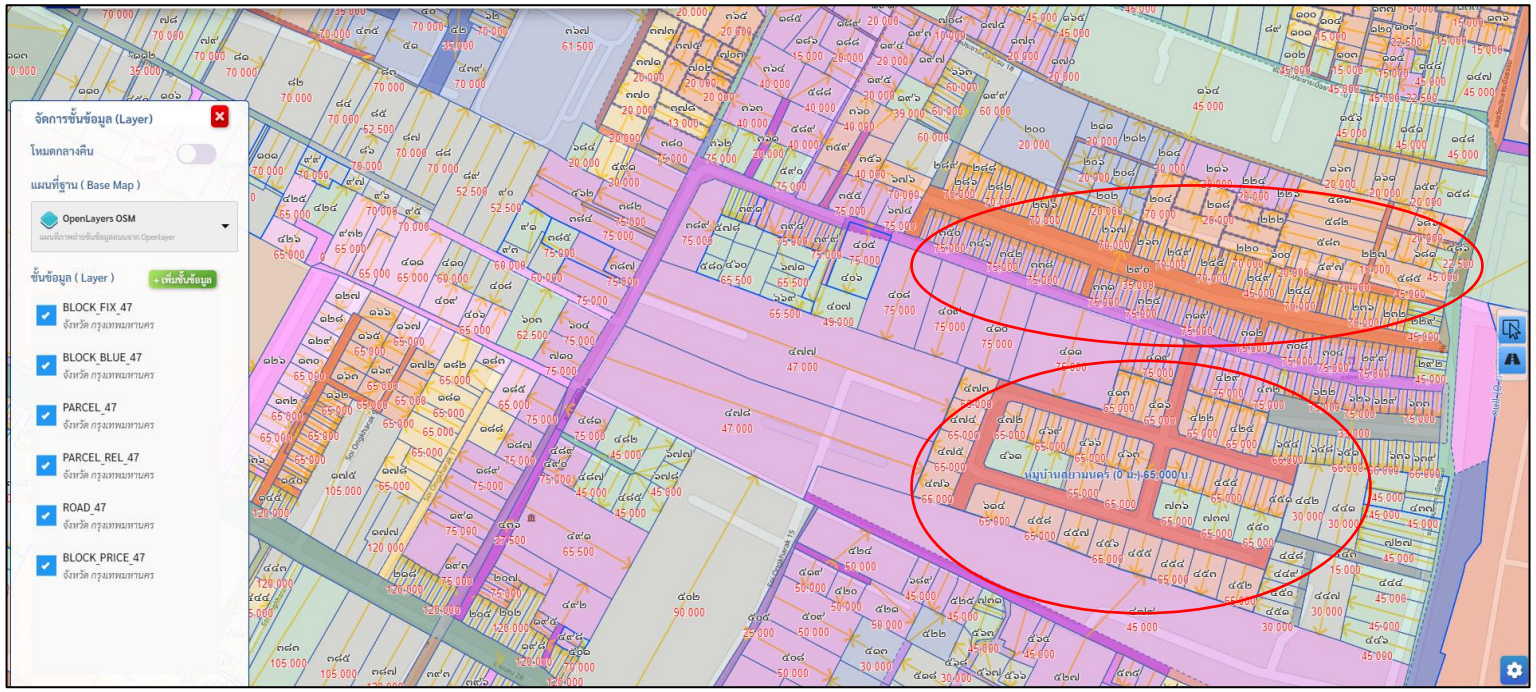
Overview of Property Valuation in Thailand

- Mandated by Law : Property Valuation for the Public Interest Act 2019
- Assessment Cycle: : 4-year cycle, with periodic reviews for accuracy and fairness
- Property Type : Land, Buildings and structures, Condominium units
- Total Land Parcel : 37 millions
- Assessment Body: The Treasury Department

Valuation Process Overview

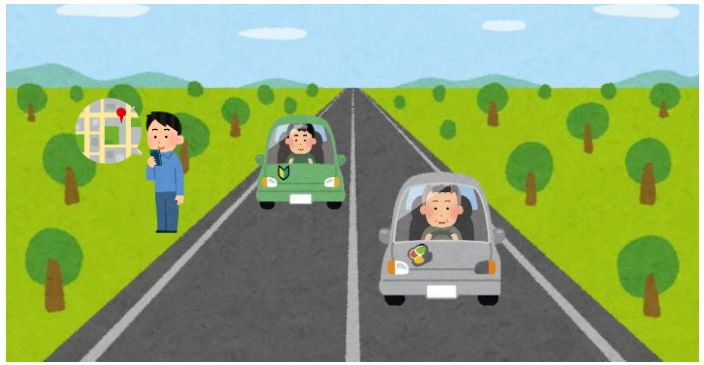


Key Challenges



Comparison Criteria?

One of the key challenges in Thailand's land valuation method is the assessment of land units without recorded sale prices. In such cases, the valuation must be based on comparisons with land units that do have sale prices. However, this process lacks a standardized methodology and largely relies on the judgment and experience of valuation officers.



Collaboration Project with JICA

“Project for Enhancement of Property Valuation Capacity in Thailand"
Technical Cooperation Project (TCP) between the Treasury Department and the Japan International Cooperation Agency (JICA)

Objectives

•To develop a property valuation framework and methodology in Thailand that reflects actual conditions and the real estate market in the assessed areas.

•To enhance the capacity of property valuation officers nationwide, enabling them to perform their duties more efficiently and effectively.

Project Duration: 3 years (November 2022 – November 2025)

Step 1: Stepwise Regression

We begin by collecting land unit data from our database, including attributes such as street name, land use, street width, and street value. Additionally, we enhance this dataset using GIS software to extract further attributes, such as the distance between each land unit and key public amenities, including public transportation, schools, hospitals, and department stores. In total, we consider 19 attributes.

Once the data is compiled, we apply stepwise regression analysis to identify the attributes that significantly influence land sale prices. This analytical approach ensures that only the most relevant factors are incorporated into the valuation model, enhancing its accuracy and reliability.

STREET_CODE	STREET_DEPTH	LAND_USE	STREET_TYPE	STREET_WIDTH	STREET_AREA	STREET_VALUE	STREET_RN	Road_Type	Road_Category
S139	40	Agriculture	Asphalt Road	4	4	800	360104513	6	0
S045	40	Residential	Asphalt Road	4	4	500	360099304	6	0
S045	40	Agriculture	Dirt Road	5	8	500	360107141	6	0
S071	40	Residential	Concrete Road	4	6	600	60183713	6	0
S045	40	Agriculture	Dirt Road	4	8	500	360100553	6	0
S044	40	Agriculture	Dirt Road	5	5	300	60187289	6	0
S001	40	Agriculture	Dirt Road	4	8	200	360101023	6	0
S001	40	Agriculture	หินคลุก	4	6	200	360107142	6	0
S044	40	Agriculture	Dirt Road	4	5	300	60025587	6	0
S001	40	Agriculture	หินคลุก	4	6	200	60036668	6	0
S001	40	Agriculture	หินคลุก	4	6	200	60033293	6	0
S044	40	Agriculture	Dirt Road	4	5	300	60024071	6	0
S044	40	Agriculture	Dirt Road	4	5	300	60184236	6	0
S002	40	Agriculture	Asphalt Road	4	6	250	60190600	6	0
S011	40	Residential	Concrete Road	5	8	300	60011266	6	0
S044	40	Agriculture	Dirt Road	5	6	300	60184680	6	0
S001	40	Agriculture	หินคลุก	4	6	200	360107143	6	0
S001	40	Agriculture	Asphalt Road	4	6	200	60183213	6	0
S001	40	Agriculture	หินคลุก	4	6	200	60184637	6	0
S049	40	Agriculture	Dirt Road	4	8	200	60184106	6	0
S044	40	Agriculture	Asphalt Road	5	5	300	10028648	6	0
S202	40	Residential	Concrete Road	5	6	600	60032776	0	0
S045	40	Agriculture	Dirt Road	4	8	500	60081409	6	0
S002	40	Residential	Asphalt Road	4	4	250	10027648	6	0
S002	40	Agriculture	หินคลุก	4	6	250	60103529	6	0
S044	40	Residential	Concrete Road	4	5	300	60186615	6	0
S044	40	Agriculture	Dirt Road	4	5	300	60011239	6	0
S045	40	Agriculture	Dirt Road	4	8	500	60186745	6	0
S044	40	Agriculture	Dirt Road	5	5	300	60009748	6	0
S044	40	Agriculture	Dirt Road	4	5	300	60022773	6	0
S049	40	Agriculture	Dirt Road	5	8	200	60186935	6	0
S045	40	Agriculture	Dirt Road	4	8	500	60186664	6	0
S208	40	Agriculture	หินคลุก	4	4	250	60136977	0	0
S044	40	Agriculture	Dirt Road	4	5	300	60016376	6	0
S044	40	Agriculture	Dirt Road	4	5	300	60186643	6	0

Chatuchak

```
Removing Bus with p-value 0.9095147841342812
Removing Religious with p-value 0.4389472863325772
Removing STREET_TYP with p-value 0.2870236800008909
Removing BTS_MRT with p-value 0.2929492507070285 4
                            OLS Regression Results
==============================================================================
Dep. Variable:              STREET_VAL   R-squared:                       0.756
Model:                             OLS   Adj. R-squared:                  0.754
Method:                  Least Squares   F-statistic:                     420.0
Date:                 Fri, 08 Nov 2024   Prob (F-statistic):               0.00
Time:                         14:48:14   Log-Likelihood:                -13755.
No. Observations:                 1233   AIC:                         2.753e+04
Df Residuals:                     1223   BIC:                         2.758e+04
Df Model:                            9
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const      -1.607e+04   3191.909     -5.036      0.000   -2.23e+04   -9811.254
LAND_USE    1.656e+04   1043.396     15.874      0.000    1.45e+04    1.86e+04
STREET_WID  5704.0151    157.941     36.115      0.000    5394.149    6013.881
Count_500    288.1631    108.609      2.653      0.008      75.082     501.244
BTS_STATIO  2822.5918    350.552      8.052      0.000    2134.842    3510.342
Arterial     -13.8867      1.818     -7.637      0.000     -17.454     -10.320
Cemetery       2.4496      0.817      2.997      0.003       0.846       4.053
Store         -6.1377      1.073     -5.721      0.000      -8.243      -4.033
Park          -5.3021      0.846     -6.265      0.000      -6.963      -3.642
Prison         3.4884      0.500      6.984      0.000       2.508       4.468
==============================================================================
Omnibus:                      788.097   Durbin-Watson:                   1.790
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            47807.566
Skew:                           2.226   Prob(JB):                         0.00
Kurtosis:                      33.178   Cond. No.                     3.56e+04
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The condition number is large, 3.56e+04. This might indicate that there are
strong multicollinearity or other numerical problems.
```

Step 2: Scoring

Once we identify the attributes that significantly impact sale prices, we assign a score ranging from 1 to 5 to each attribute to further analyze their relative weight. For example, in the case of street width, a street wider than 8 meters receives the highest score of 5. If the width falls between 6 and 8 meters, it is assigned a score of 4, and the scoring continues in a similar manner down to a minimum score of 1. This structured scoring system ensures a more objective and systematic evaluation of land unit characteristics.

STREET_WID	Assign values based on conditions:
	- `5` if > 8
	- `4` if 6 ≤ value ≤ 8
	- `3` if 4 ≤ value < 6
	- `2` if 2 ≤ value < 4
	- `1` if < 2
RoadCate	Assign values based on conditions:
	- `5` if value = 1
	- `1` otherwise
Arterial	Assign values based on conditions:
	- `5` if < 500
	- `4` if 500 ≤ value ≤ 1000
	- `3` if 1000 < value ≤ 2000
	- `2` if 2000 < value ≤ 3000
	- `1` if > 3000

Step 3: Weight Percentage

After assigning scores, we conduct another regression analysis to determine the weight of each attribute. These weights are then converted into percentage values for better interpretability and application in the valuation model.

OLS Regression Results

Dep. Variable:	STREET_VAL	R-squared:	0.677
Model:	OLS	Adj. R-squared:	0.675
Method:	Least Squares	F-statistic:	256.4
Date:	Tue, 26 Nov 2024	Prob (F-statistic):	1.45e-291
Time:	12:10:01	Log-Likelihood:	-13915.
No. Observations:	1232	AIC:	2.785e+04
Df Residuals:	1221	BIC:	2.791e+04
Df Model:	10		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-1.368e+05	6603.466	-20.720	0.000	-1.5e+05	-1.24e+05
LAND_USE	1.694e+04	1268.793	13.354	0.000	1.45e+04	1.94e+04
STREET_WID	1.217e+04	702.259	17.336	0.000	1.08e+04	1.36e+04
RoadCate	1.578e+04	929.074	16.985	0.000	1.4e+04	1.76e+04
Arterial	6108.4355	1028.656	5.938	0.000	4090.306	8126.565
Store	5002.6062	604.710	8.273	0.000	3816.220	6188.992
Park	3977.9398	574.000	6.930	0.000	2851.805	5104.075
Count_500	835.8121	508.756	1.643	0.101	-162.320	1833.945
BTS_STATIO	5131.5820	683.550	7.507	0.000	3790.520	6472.644
Cemetery	1216.8024	478.783	2.541	0.011	277.474	2156.130
Prison	5624.6763	862.619	6.520	0.000	3932.296	7317.057

Omnibus:	781.645	Durbin-Watson:	1.845
Prob(Omnibus):	0.000	Jarque-Bera (JB):	48274.855
Skew:	2.194	Prob(JB):	0.00
Kurtosis:	33.351	Cond. No.	110.

Percentage contribution of each coefficient:

LAND_USE	23.274995
STREET_WID	16.724431
RoadCate	21.676979
Arterial	8.391226
Store	6.872136
Park	5.464540
Count_500	1.148164
BTS_STATIO	7.049312
Cemetery	1.671535
Prison	7.726681

Step 4: Quality Score Calculation

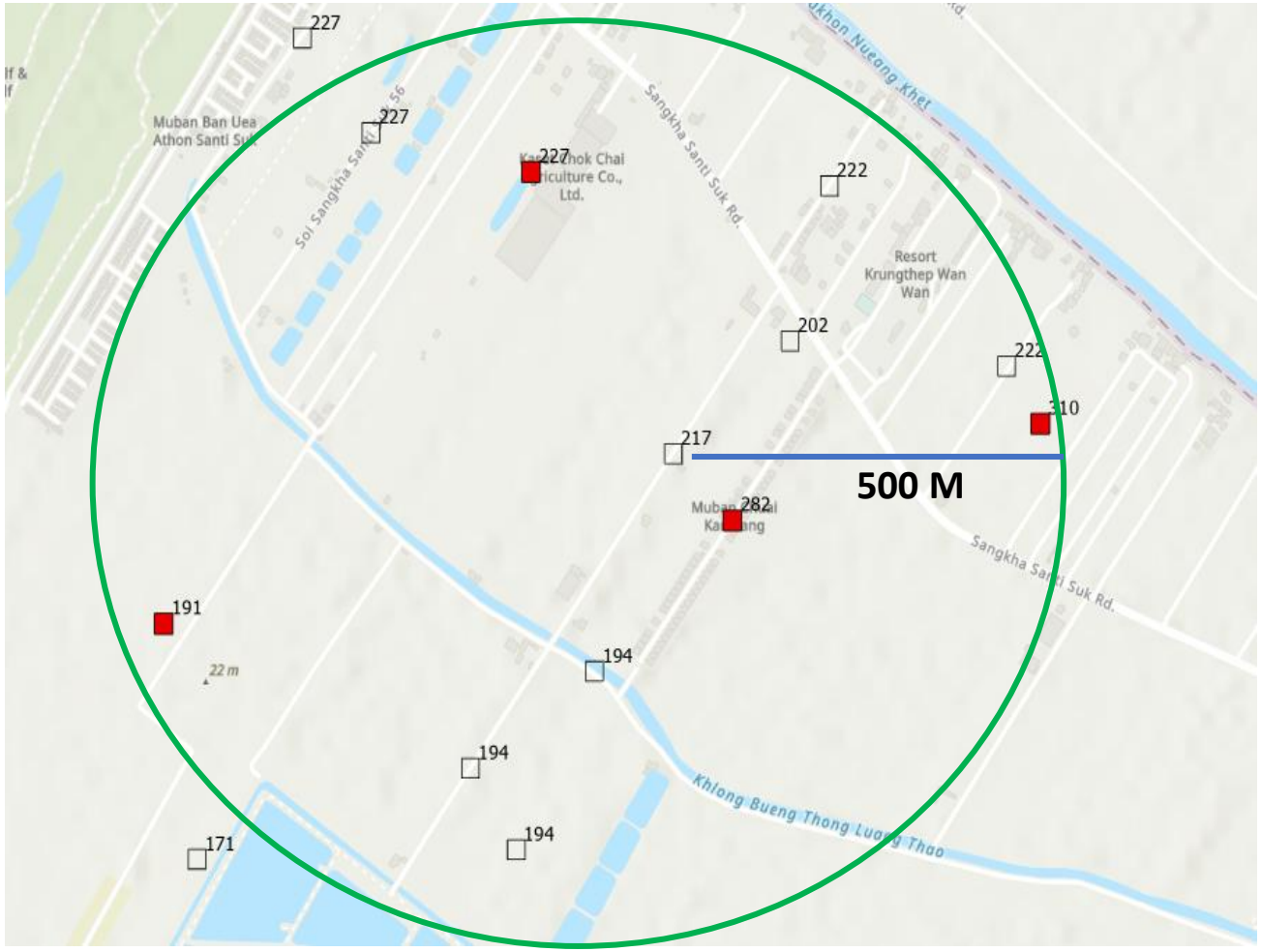
Once we obtain the percentage weight of each attribute, we calculate the individual attribute scores by multiplying the assigned score by its respective weight percentage. These weighted scores are then aggregated to derive the **quality score** for each land unit. The quality score serves as a comprehensive indicator of the overall quality and valuation potential of the land unit.

	LAND_USE	STREET_WID	RoadCate	Arterial	Store	Park	Count_500	STREET_VAL	Main_LU	STREET_RN	Quality_Score
0	120	80	17	15	15	20	30	10000	0	1000983136	297
1	120	80	17	12	15	20	10	8000	0	1000982333	274
2	80	60	17	12	20	20	10	3700	0	1000982151	219
3	80	60	17	12	10	10	10	3200	0	1000982127	199
4	80	60	17	9	10	15	10	3000	0	1000983105	201

Step 5 : Land Unit Comparison

LU without Sale Price (Sub LU)

LU with Sale Price (Main LU)



The **Working Group** has developed a **Python algorithm** designed to systematically identify the three closest land units with recorded sale prices within a **500-meter radius**. If fewer than three entries are found within this range, the search radius is incrementally expanded to **1 km, 1.5 km, 2 km, and up to a maximum of 20 km** until at least three comparable land units are located or the maximum radius is reached.

Once land units with sale price records are identified, the algorithm prioritizes and records the closest match based on **Quality Score**.

Additionally, two key criteria must be met when selecting comparable land units:

1.The **Quality Score difference** must not exceed **30%**.

2.The **Street Type** of the selected land unit must be the **same** as the target unit.

The identified matches are then systematically stored in a table, displaying the **Quality Score** and other relevant details.

(Refer to the next slide for a detailed table structure and results.)

Main and Sub Land Unit Comparison Result Table

QS of sub LU

QS of Compare Main LU

Street_Rn of Compare Main LU

Street_Value of Compare Main LU

Radius that Main_LU were founded

Quality_Sc	geometry	centroid	QS_C_1	ST_RN_C_1	ST_VAL_C_1	QS_C_2	ST_RN_C_2	ST_VAL_C_2	QS_C_3	ST_RN_C_3	ST_VAL_C_3	scan_km
219	POLYGON ((699198.120 1523159.040, 699192.540 1...	POINT (699213.419 1523072.183)	209	1000983218	1700	237	1000983127	5500	237	1000983127	5500	[2.0, 2.0, 4.0]
201	POLYGON ((696818.724 1526194.609, 696814.992 1...	POINT (696692.876 1526286.254)	234	1000982481	8500	262	1000982389	7000	186	1000982582	3500	[2.0, 2.0, 4.0]
215	POLYGON ((705420.279 1524639.120, 705420.556 1...	POINT (705452.345 1524704.208)	207	1000983055	3700	199	1000982158	3000	231	1000983193	2800	[4.0, 4.0, 4.0]
350	POLYGON ((698535.250 1522494.496, 698525.617 1...	POINT (698404.431 1523535.285)	237	1000983127	5500	209	1000983218	1700	234	1000982481	8500	[2.0, 2.0, 4.0]
219	POLYGON ((708911.759 1526656.228, 708927.697 1...	POINT (708664.793 1526838.728)	227	1000982852	5000	231	1000983193	2800	237	1000983204	6000	[4.0, 4.0, 4.0]

Method 1: Adjusting Based on Closest Quality Score Difference

Quality_Sc	geometry	centroid	QS_C_1	ST_RN_C_1	ST_VAL_C_1	QS_C_2	ST_RN_C_2	ST_VAL_C_2	QS_C_3	ST_RN_C_3	ST_VAL_C_3	scan_km	method_1_val	method_2_val
219	POLYGON ((699198.120 1523159.040, 699192.540 1...	POINT (699213.419 1523072.183)	209	1000983218	1700	237	1000983127	5500	237	1000983127	5500	[2.0, 2.0, 4.0]	1,781	3,700
201	POLYGON ((696818.724 1526194.609, 696814.992 1...	POINT (696692.876 1526286.254)	234	1000982481	8500	262	1000982389	7000	186	1000982582	3500	[2.0, 2.0, 4.0]	7,301	5,343
215	POLYGON ((705420.279 1524639.120, 705420.556 1...	POINT (705452.345 1524704.208)	207	1000983055	3700	199	1000982158	3000	231	1000983193	2800	[4.0, 4.0, 4.0]	3,843	3,300
350	POLYGON ((698535.250 1522494.496, 698525.617 1...	POINT (698404.431 1523535.285)	237	1000983127	5500	209	1000983218	1700	234	1000982481	8500	[2.0, 2.0, 4.0]	8,122	5,456
219	POLYGON ((708911.759 1526656.228, 708927.697 1...	POINT (708664.793 1526838.728)	227	1000982852	5000	231	1000983193	2800	237	1000983204	6000	[4.0, 4.0, 4.0]	4,824	4,516

How It Works:

1. Identify the closest Main LU based on the smallest difference in **Quality Score** (`QS_C_1`).
2. Calculate the percentage difference between `sub_lu['Quality_Sc']` and `QS_C_1` :

$$\text{Percentage Difference} = \frac{\text{sub\_lu['Quality\_Sc']} - \text{QS\_C\_1}}{\text{QS\_C\_1}}$$

3. Adjust the value of `ST_VAL_C_1` based on this percentage difference:

$$\text{method\_1\_val} = \text{ST\_VAL\_C\_1} \times (1 + \text{Percentage Difference})$$

Example:

sub_lu['Quality_Sc']	QS_C_1	ST_VAL_C_1	Percentage Difference	method_1_val
219	209	1700	$\frac{219-209}{209} = 0.0478 = 4.78\%$	$1700 \times (1 + 0.0478) = 1781.26$

Explanation of Calculation:

1. The percentage difference is 4.78%, meaning `sub_lu['Quality_Sc']` is 4.78% higher than `QS_C_1` .
2. The value of `ST_VAL_C_1` is increased by 4.78% to compute `method_1_val` .

Method 2: Weighted Average Based on All Matches

Quality_Sc	geometry	centroid	QS_C_1	ST_RN_C_1	ST_VAL_C_1	QS_C_2	ST_RN_C_2	ST_VAL_C_2	QS_C_3	ST_RN_C_3	ST_VAL_C_3	scan_km	method_1_val	method_2_val
219	POLYGON ((699198.120 1523159.040, 699192.540 1...	POINT (699213.419 1523072.183)	209	1000983218	1700	237	1000983127	5500	237	1000983127	5500	[2.0, 2.0, 4.0]	1,781	3,700

How It Works:

1. Consider all three closest matches: `QS_C_1`, `QS_C_2`, and `QS_C_3`.
2. For each match, calculate the similarity weight:

$$\text{Weight} = \frac{1}{|\text{sub\_lu['Quality\_Sc']} - \text{QS\_C}| + 1e-6}$$

   Adding a small constant ($1e-6$) ensures numerical stability and avoids division by zero.

3. Normalize the weights so they sum to 1:

$$\text{Normalized Weight} = \frac{\text{Weight}}{\sum \text{Weights}}$$

4. Calculate the weighted value:

$$\text{method\_2\_val} = \sum(\text{Normalized Weight} \times \text{ST\_VAL\_C})$$

Calculation for Method 2:

1. **Weight Calculation:**
   - For each match, calculate the weight as the inverse of the absolute difference in Quali Score plus a small constant to avoid division by zero ($1e-6$).

$$\text{Weight}_1 = \frac{1}{|219-209|+1e-6} = \frac{1}{10+1e-6} \approx 0.1$$

$$\text{Weight}_2 = \frac{1}{|219-237|+1e-6} = \frac{1}{18+1e-6} \approx 0.0556$$

$$\text{Weight}_3 = \frac{1}{|219-237|+1e-6} = \frac{1}{18+1e-6} \approx 0.0556$$

2. **Normalize Weights:**

$$\text{Total Weight} = 0.1 + 0.0556 + 0.0556 = 0.2112$$

$$\text{Normalized Weight}_1 = \frac{0.1}{0.2112} \approx 0.473$$

$$\text{Normalized Weight}_2 = \frac{0.0556}{0.2112} \approx 0.263$$

$$\text{Normalized Weight}_3 = \frac{0.0556}{0.2112} \approx 0.263$$

3. **Weighted Average:**
   - Multiply the weights by their respective `ST_VAL_C` values and sum them:

$$\text{method\_2\_val} = (0.473 \times 1700) + (0.263 \times 5500) + (0.263 \times 5500)$$

$$\text{method\_2\_val} = 803.1 + 1446.5 + 1446.5 = 3696.1$$

Rounded to match the example format: **3700**.

Step 6: Compare with with Standard Criteria

Finally, after obtaining results from both methods, we will compare the outcomes against international standards, such as those set by the International Association of Assessing Officers (IAAO). To evaluate the accuracy and fairness of the model, we will calculate key statistical measures, including the Coefficient of Dispersion (COD) and the Price-Related Differential (PRD). These values should fall within the recommended ranges of 5 to 25 for COD and 0.98 to 1.03 for PRD. At present, we are actively addressing data inconsistencies and refining the valuation model as necessary to enhance accuracy and ensure more reliable results.

Pilot Area	Method 1						Method 2					
	COD			PRD			COD			PRD		
	Before	After	% Change	Before	After	% Change	Before	After	% Change	Before	After	% Change
Nakhon Sawan	102.13	26.65	75.48	3.14	1.04	2.10	102.13	25.94	76.19	3.14	1.00	2.15
Rayong	37.91	24.26	13.65	0.86	1.03	-0.17	37.91	24.11	13.80	0.86	1.01	-0.15
Chachoengsao	36.55	24.22	12.33	1.09	1.00	0.09	36.55	22.19	14.36	1.09	1.03	0.06
Nong Chok	31.04	23.65	7.39	0.92	1.02	-0.10	31.04	19.06	11.98	0.92	1.02	-0.10
Chatuchak	27.12	22.38	4.74	0.98	1.01	-0.03	27.12	18.02	9.10	0.98	1.01	-0.03

Q & A