



ABM in Pilot study



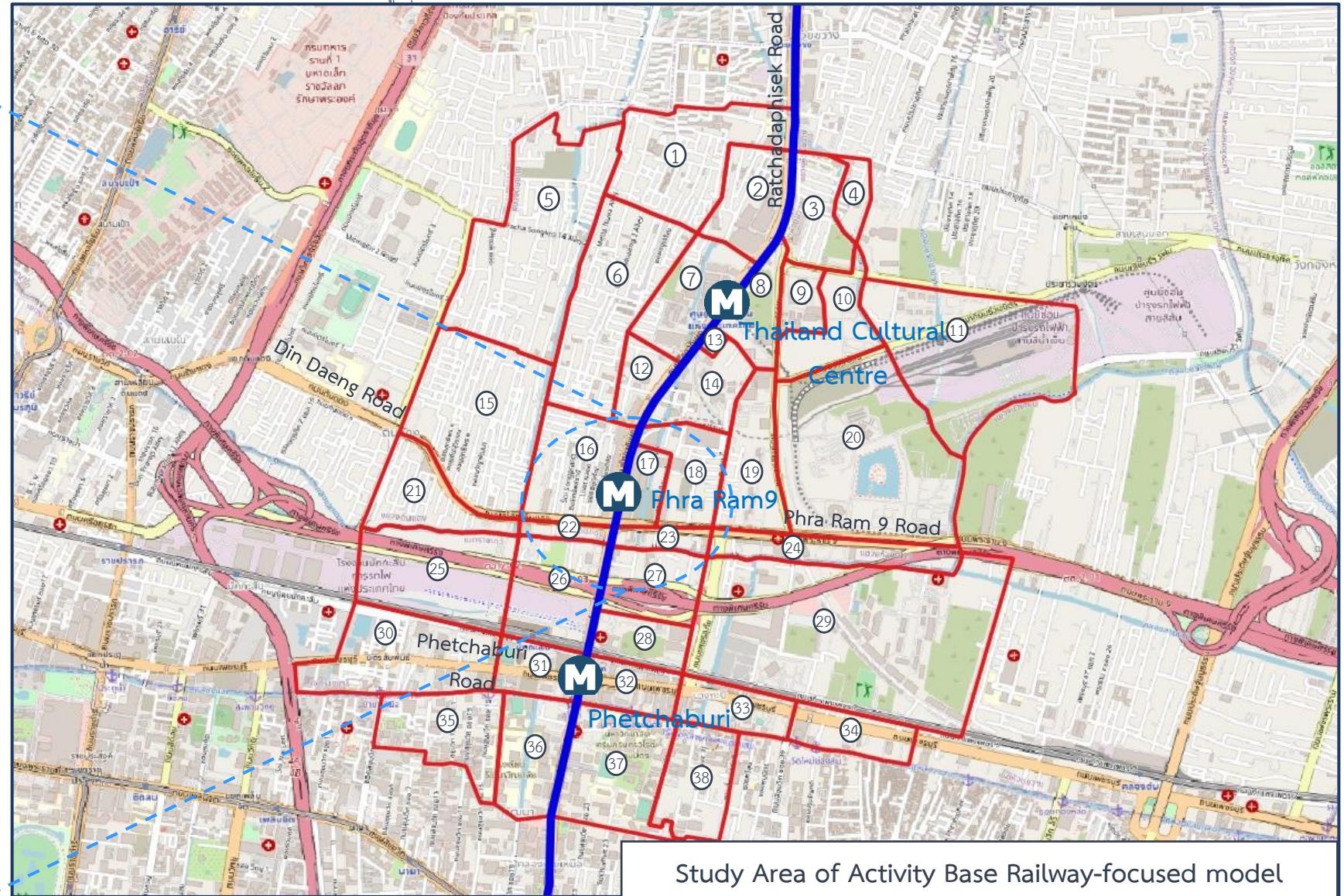
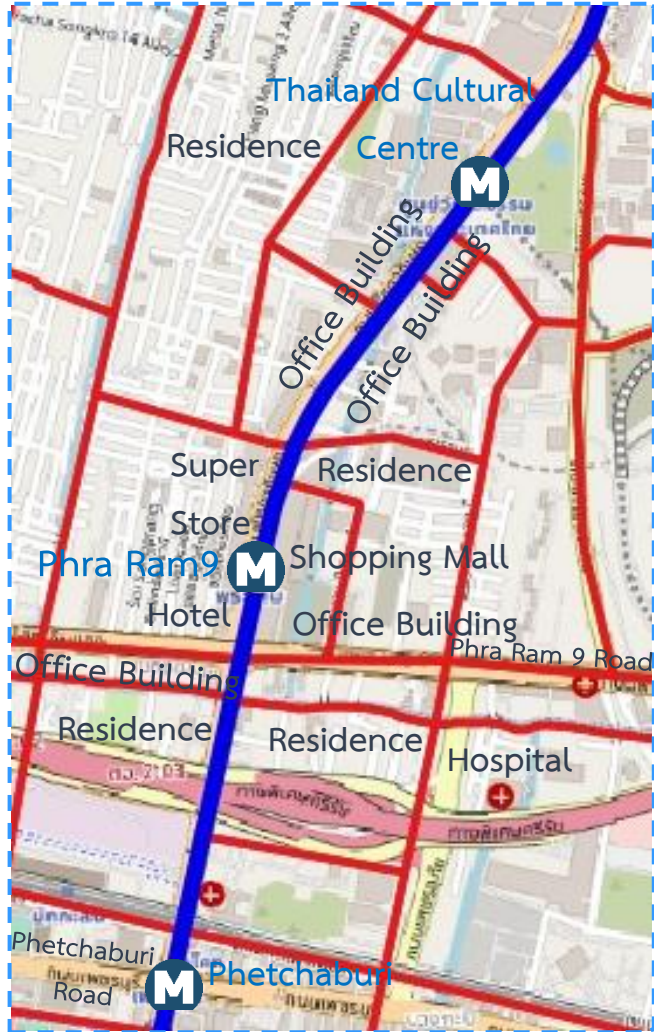
OBJECTIVES

- To study the processes, barriers, and possibilities of creating ABM in Thailand.



| (TOR 3.2.5) ศึกษาแนวทางการพัฒนาแบบจำลองความต้องการเดินทางด้วยระบบรางเชิงกิจกรรม (Railway Activity-Based Model) โดย Railway Activity-Based Model ให้จัดทำในรูปแบบโครงการนำร่อง (Pilot Project) อย่างน้อย 1 พื้นที่ โดยพิจารณาจำนวนตัวอย่างการสำรวจ และเก็บข้อมูลให้มีจำนวนเพียงพอตามหลักสถิติเพื่อให้เหมาะสมสำหรับการวิเคราะห์ข้อมูล |

Study Area



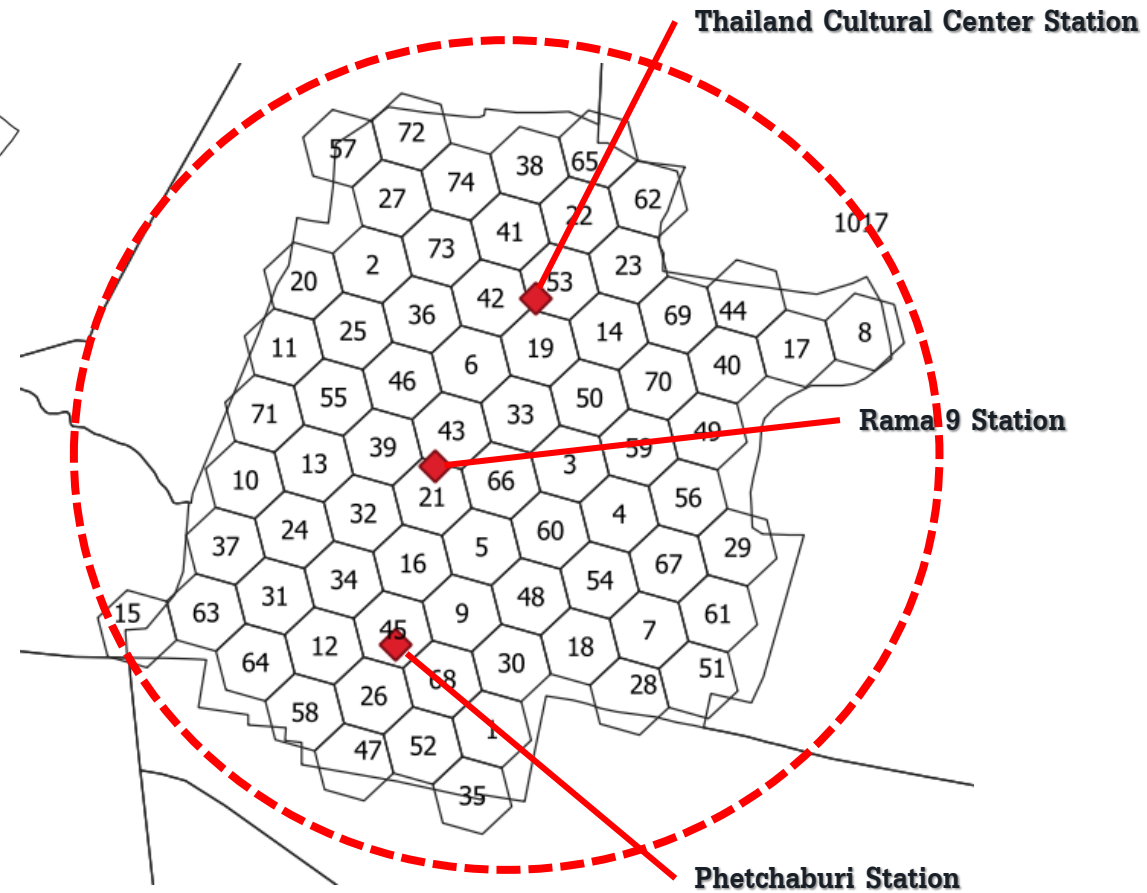
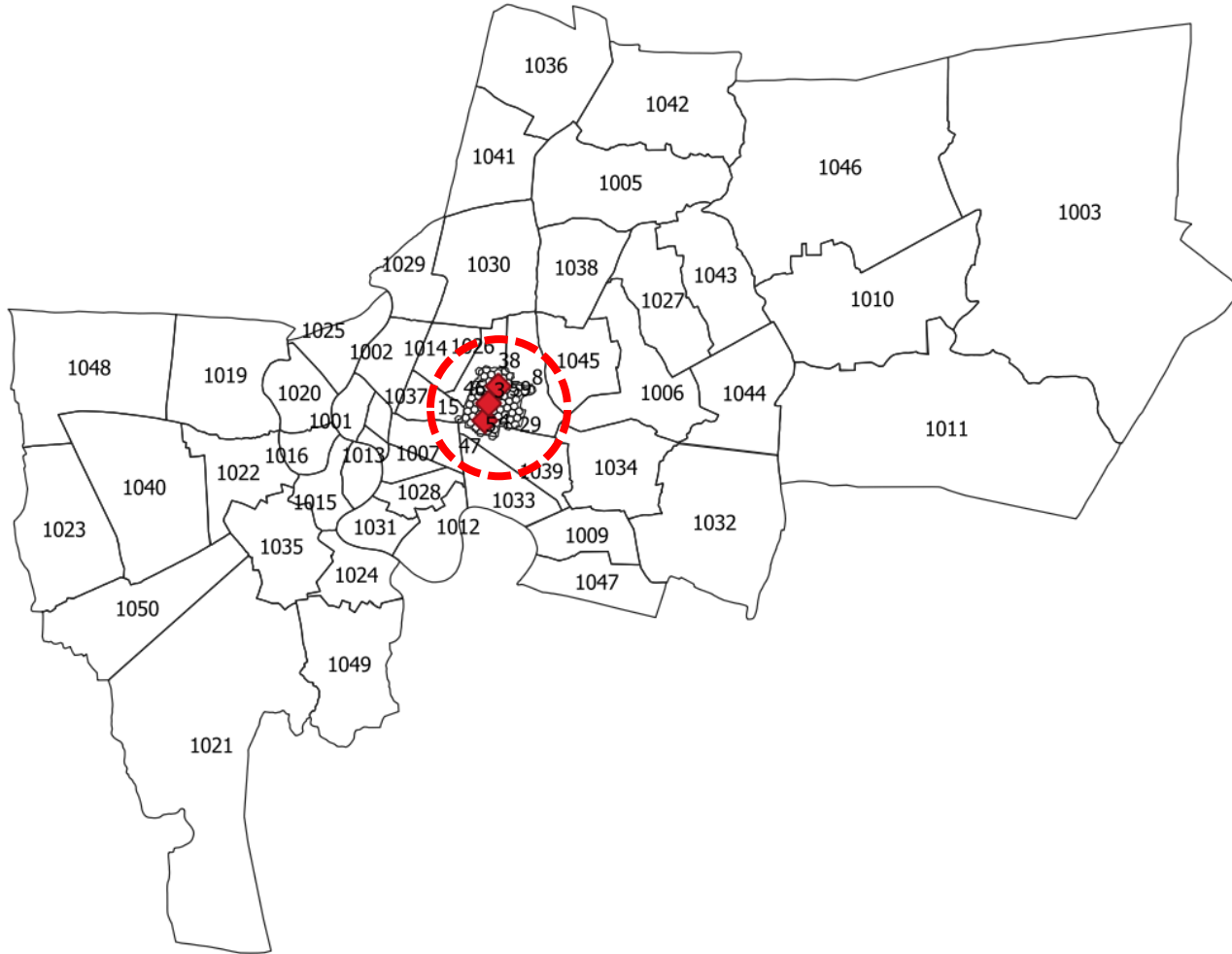
Study Area of Activity Base Railway-focused model



ABM Zonal System

74 Internal Zones (Study Area)

50 External Zones



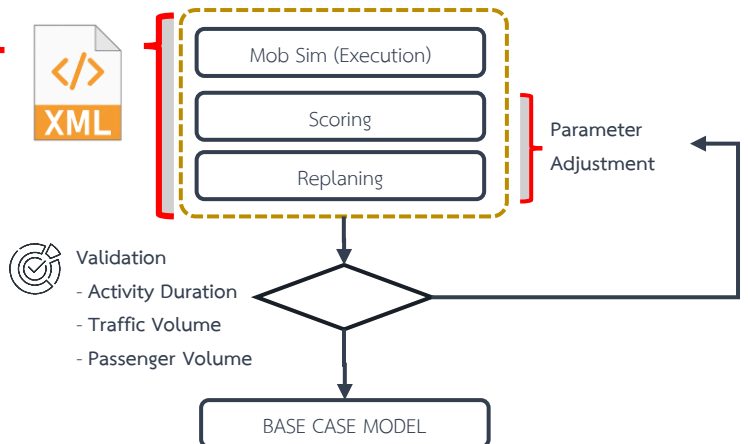


MAIN DATA SOURCES

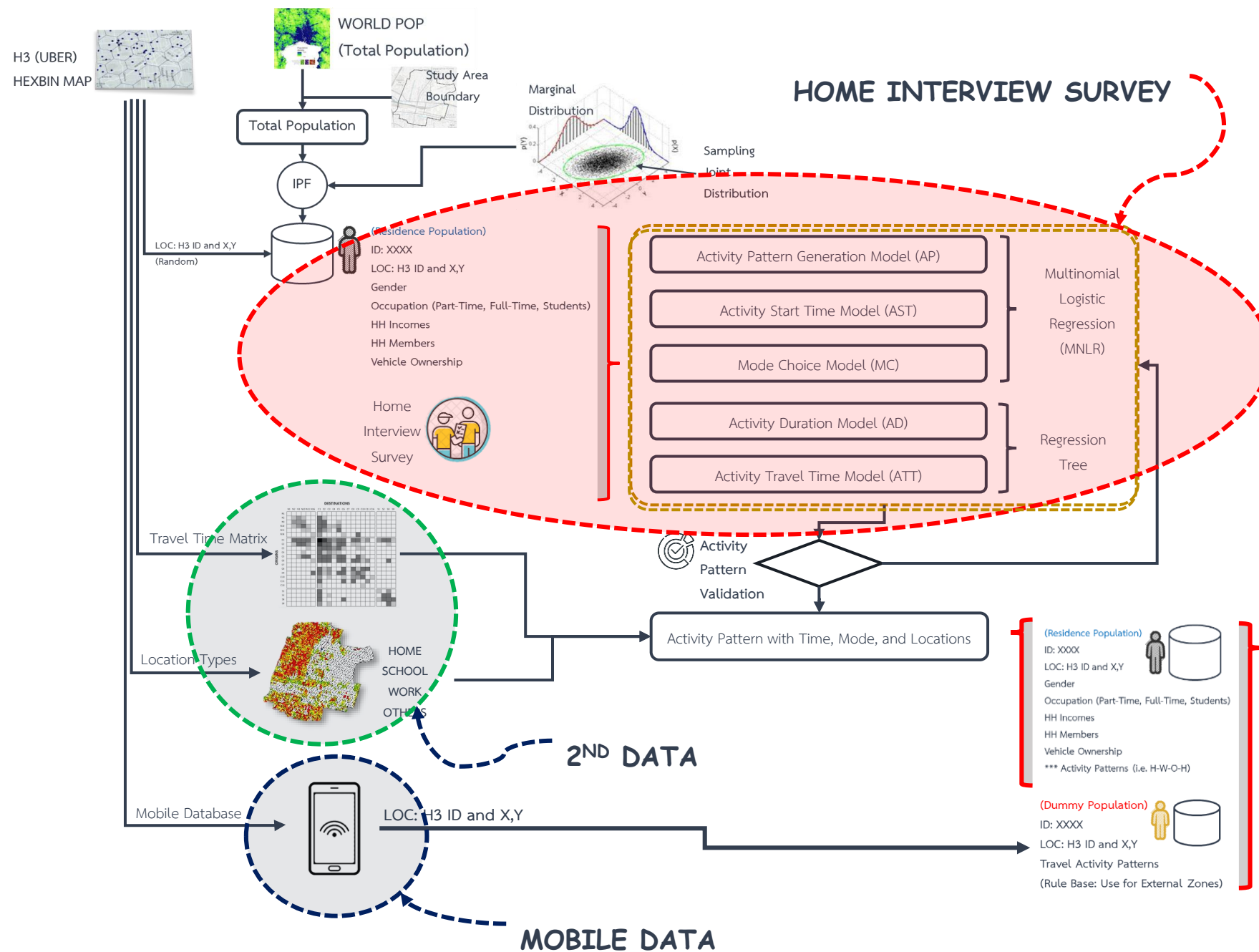
NOTE:

IPF (Iterative Proportional Fitting)

OSM (Open Street Map)

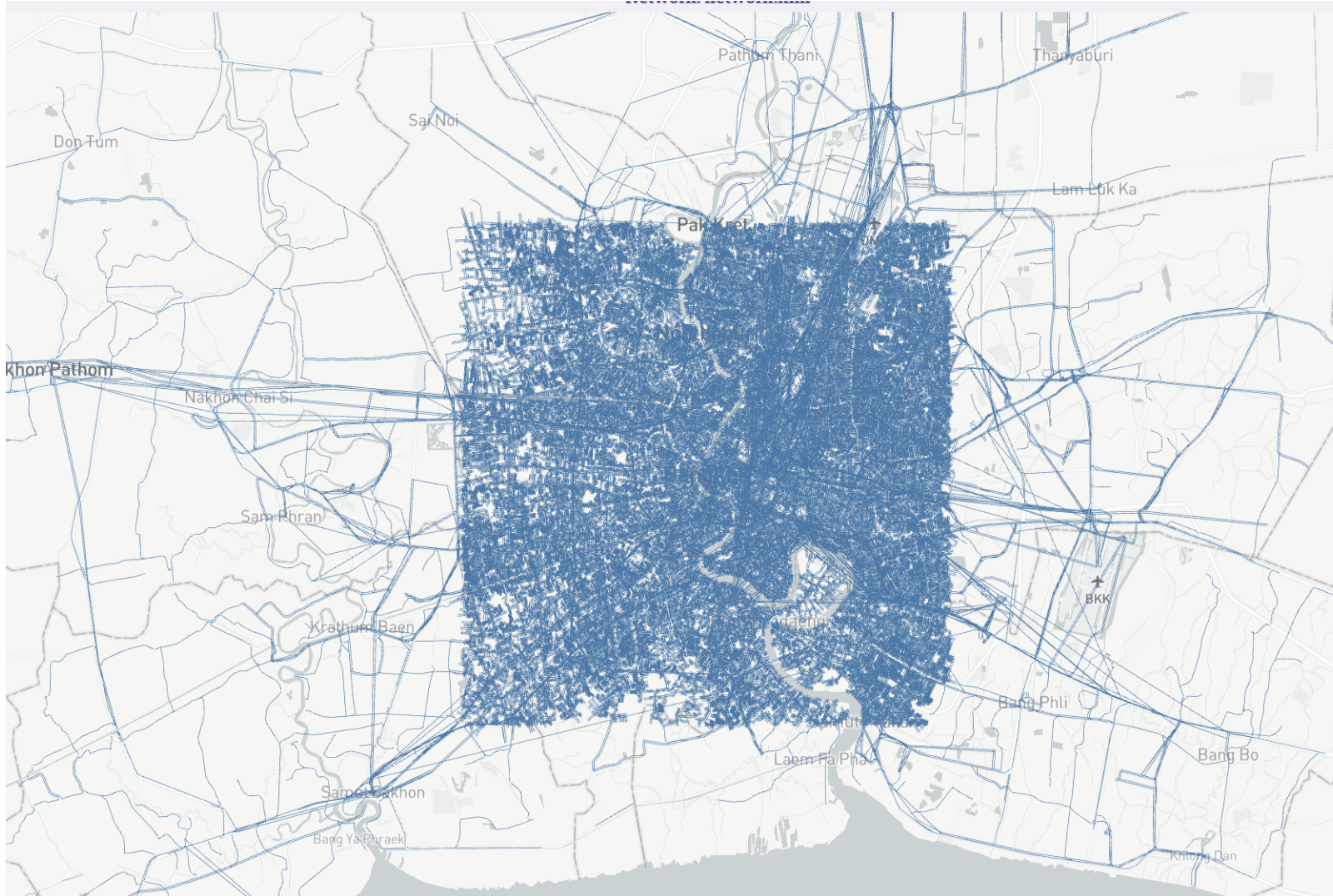


HOME INTERVIEW SURVEY





ABM Network Inputs (Road)



Notes:

Using OpenStreet Map (OSM) for Road Network Data, The detailed network was kept for the area inside Bangkok. To avoid problem of agents access the network in the study zone.



ABM Network Inputs (Public Transport: GTFS)



Notes:

Transit Stop Locations (Data from GTFS), Select only Rail Stations and Bus Stops for specific route that related to the study area.

- Not use for the pilot study
- Use for pilot study



INPUTS OF SKIM MATRIX RUNNING FROM GOOGLE MAP API

EXAMPLE OF SKIM MATRIX RUNNING FROM GOOGLE API

Sum of Distance_private	Column Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Row Labels		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1		0	5473	3574	3720	4418	4585	2935	5786	2903	4876	6622	3263	6700	5592	4180	3225	5798	3046	5884	6940	3681	5481	5147	5970	5089	1943	7928	3332	3977	2220	3697	3977	3682	3572	565	4961	7396
2		4990	0	2918	4124	2808	1377	7188	6412	6115	2859	1402	3252	1216	3033	4169	6240	6424	6802	3042	849	2526	2239	2588	2873	384	3205	1057	5437	5361	3834	3684	1960	2728	5523	4884	1332	5451
3		6055	4507	0	704	3873	3619	4322	2229	3745	5151	5025	4317	4839	1846	5234	4356	2240	3936	2138	4165	3038	1463	1401	6297	4123	4270	3372	6021	2374	4350	4749	3454	3240	4624	5949	3995	8173
4		5913	5013	2956	0	3947	4125	3618	2067	3041	4447	5940	4175	6796	4346	5092	3363	2078	3232	4637	6259	3221	3962	3901	5593	4629	4127	7882	5317	1670	3646	4607	3549	3210	4482	5954	4501	7469
5		3930	2813	903	1049	0	1925	2211	3115	1218	2248	3331	2192	3145	2922	3109	1540	3127	1825	3213	4061	1022	2822	2477	3395	2429	2144	4732	3437	2068	1835	2624	1349	1011	2499	3823	2301	6713
6		4220	1255	2600	2746	2037	0	3908	5562	2915	2992	1772	2482	1586	2183	3399	2520	5574	3522	2192	2452	1676	1389	1738	3038	871	2434	2930	4666	3765	3064	2914	2092	1879	2789	4113	742	5799
7		3817	4443	2533	2679	3377	3555	0	4745	1982	3691	5635	2079	5714	4551	2996	2304	4757	535	4843	5954	2651	4452	4106	4984	4059	2032	6941	1660	2756	1550	2511	2791	2641	2386	3859	3931	6410
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9		3046	3516	2425	2571	3269	2627	3095	4638	0	2919	4664	1308	7190	4444	2225	1420	4649	3205	4735	4983	1724	3524	3999	4013	3132	1260	5970	3492	2828	1890	1740	2020	2533	1615	2939	3003	5439
10		6436	3731	3579	4518	4253	3550	4918	6611	4341	0	1984	4698	2840	5241	4453	4736	6622	4532	5250	2303	2647	4447	4796	1637	3700	4651	3926	6548	4125	4946	4464	2942	3687	6946	6329	3926	4398
11		4700	1402	2628	3023	2518	1894	3936	6093	2943	2569	0	2962	926	3551	3879	3000	6104	3550	3560	1185	2781	2757	3105	1772	1018	2915	2172	5146	4260	3544	3394	1669	2736	3269	4593	1850	4533
12		2630	3030	2253	2399	3098	2142	2694	4466	1582	2434	4179	0	4257	3832	1021	1905	4478	2805	3841	4497	1238	3039	3387	3527	2646	845	5485	3091	2657	1489	1103	1534	2361	1129	2524	2518	4953
13		3917	1216	1845	1991	1734	1802	3153	4057	2160	1786	926	2179	0	3493	3096	2217	4069	2767	3502	1605	2040	2699	3048	2932	832	2132	2593	4363	3010	2761	2611	886	1953	2486	3810	1914	5693
14		5872	4325	3779	3552	3690	3436	5439	4119	4446	4170	4842	4134	4656	0	5051	4173	4131	5054	1955	3982	2855	1280	670	5317	3941	4087	3189	6666	4559	5064	4566	3271	3057	4441	5766	3812	9203
15		3548	4034	3171	3317	4015	3146	3611	5383	2500	3437	5182	1021	4994	4836	0	2822	5395	3722	4845	5501	2242	4042	4391	4531	3650	1762	6488	4009	3574	2406	807	2538	3279	2133	3441	3521	3254
16		6471	6809	7633	7448	8477	7594	8285	9845	7212	7886	5697	6047	5769	9652	5025	0	9857	7899	9943	6016	6691	8491	9206	9019	6630	8332	7003	9512	8162	7910	5832	6986	7741	6621	6325	7970	6837
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27		6236	1057	4164	4318	4054	4122	7382	7388	6309	4105	2162	4448	2640	3697	6529	6435	7400	6996	3737	1043	4077	3009	3252	3067	2675	4451	0	8608	5555	7006	5712	3206	4272	5718	6130	2385	5645
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30		2769	3253	1353	1499	2198	2365	1794	3566	682	2656	4401	1043	4480	3372	1960	1005	3577	1905	3663	4720	1461	3261	2927	3750	2869	983	5707	2191	1757	0	1477	1757	1461	1352	2662	2740	5176
31		3592	3227	2368	2514	2612	2339	3656	4580	2544	2631	4376	1066	4454	4029	833	2867	4592	3767	4038	4695	1435	3236	3584	3125	2843	1807	5682	4053	3619	2451	0	1731	2476	1326	3486	2715	3476
32		6998	4294	4142	5080	4816	4113	5480	7173	4903	1053	2547	5260	3402	5803	5016	5299	7185	5095	5812	2865	3209	5009	5358	2199	4263	5213	4488	7110	4687	5508	5027	0	4250	7509	6892	4488	4960
33		4066	2469	958	1104	1883	1581	2265	3170	1272	2385	2987	2328	2801	2976	3245	1595	3182	1880	3268	3666	999	2477	2531	3531	2085	2280	4387	3492	2123	1890	2760	1485	0	2635	3959	1956	6768
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Summary of paper-based survey for ABM

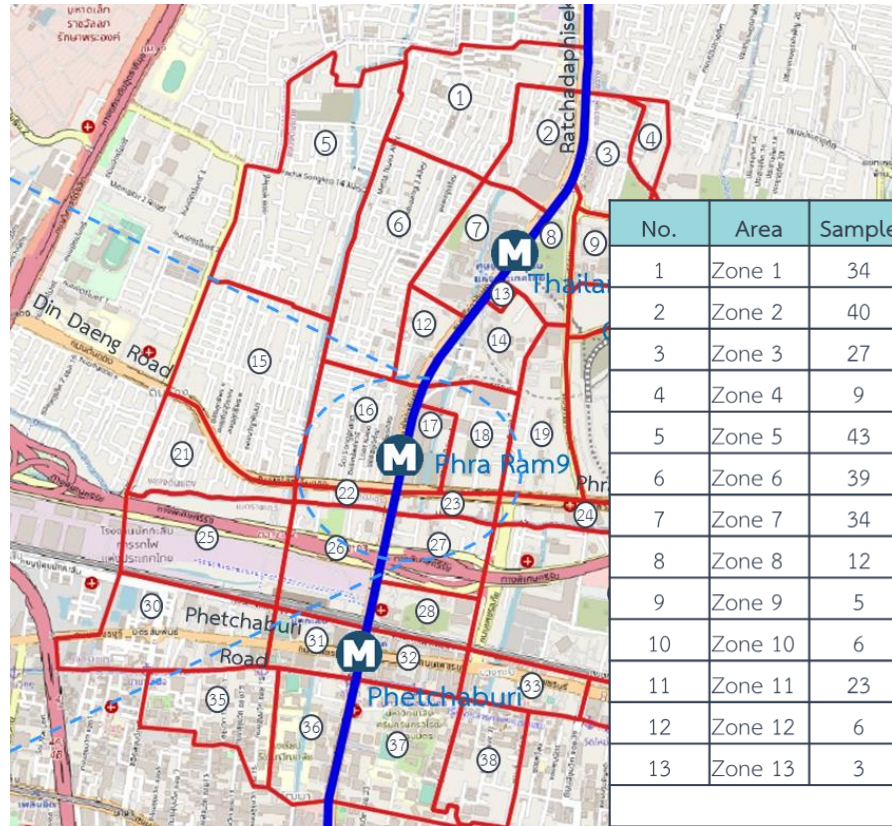
Travel Diary Survey (paper based survey)



Survey method: Interview survey

Number of samples: 925 samples(persons) - 65% live in study area

Survey period: 16/05/2022 - 20/06/2022



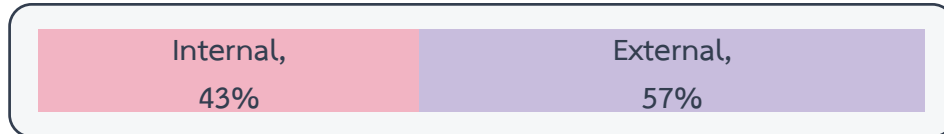
No.	Area	Sample	No.	Area	Sample	No.	Area	Sample
1	Zone 1	34	14	Zone 14	17	27	Zone 27	16
2	Zone 2	40	15	Zone 15	27	28	Zone 28	11
3	Zone 3	27	16	Zone 16	63	29	Zone 29	33
4	Zone 4	9	17	Zone 17	55	30	Zone 30	39
5	Zone 5	43	18	Zone 18	19	31	Zone 31	31
6	Zone 6	39	19	Zone 19	31	32	Zone 32	36
7	Zone 7	34	20	Zone 20	20	33	Zone 33	15
8	Zone 8	12	21	Zone 21	25	34	Zone 34	16
9	Zone 9	5	22	Zone 22	3	35	Zone 35	25
10	Zone 10	6	23	Zone 23	4	36	Zone 36	19
11	Zone 11	23	24	Zone 24	14	37	Zone 37	51
12	Zone 12	6	25	Zone 25	17	38	Zone 38	28
13	Zone 13	3	26	Zone 26	29			
Summary								925



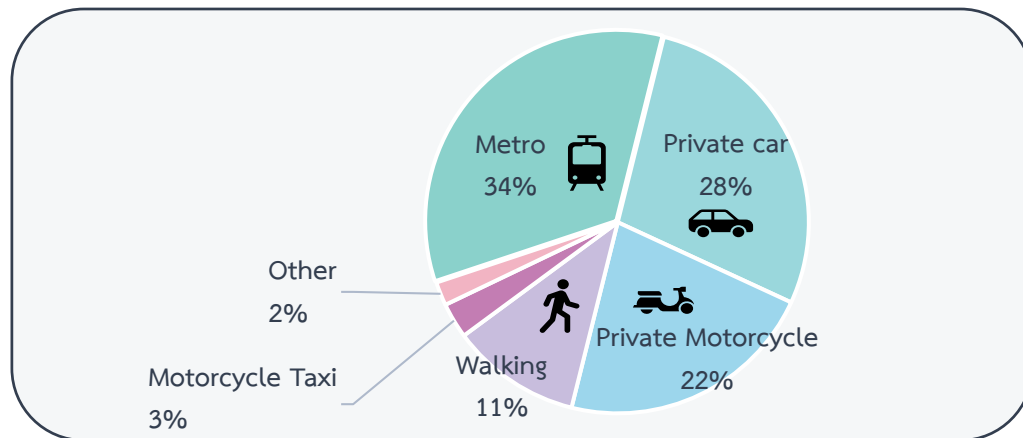
Proportion of survey samples by age



Proportion of trips



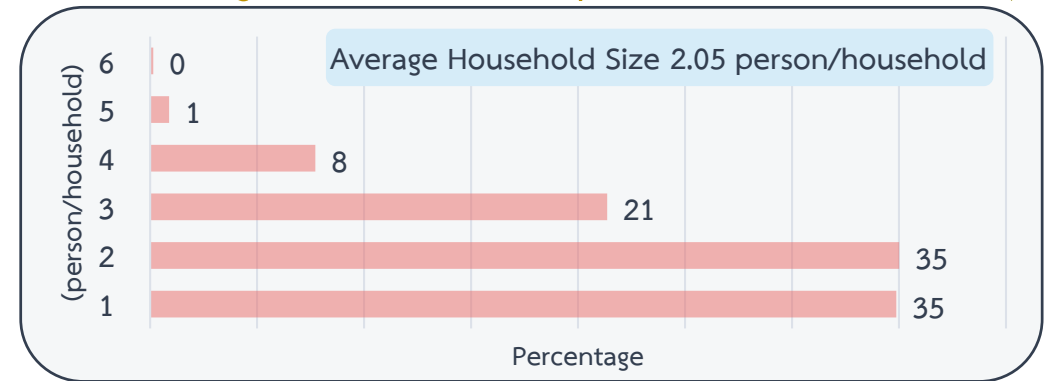
Travel Mode



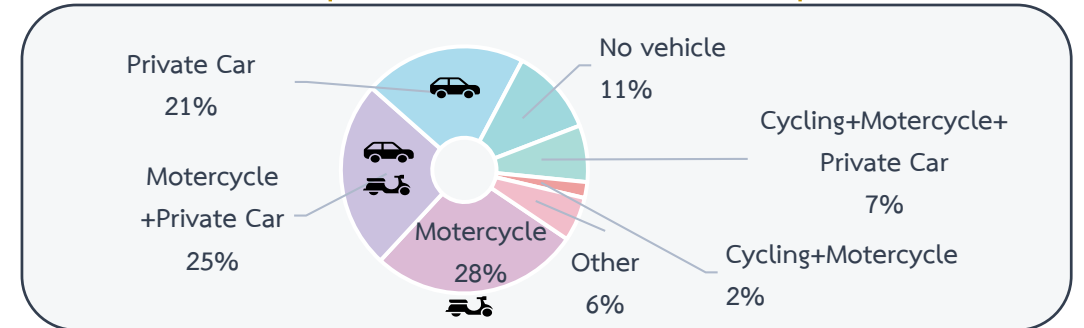
Summary of Travel time/Cost/Distance (per trip)

Trip rate (Trip/day)	Travel time (min/trip)	Distance (km./trip)	Cost (Bath/trip)
2.33	15.6	4.7	24.4

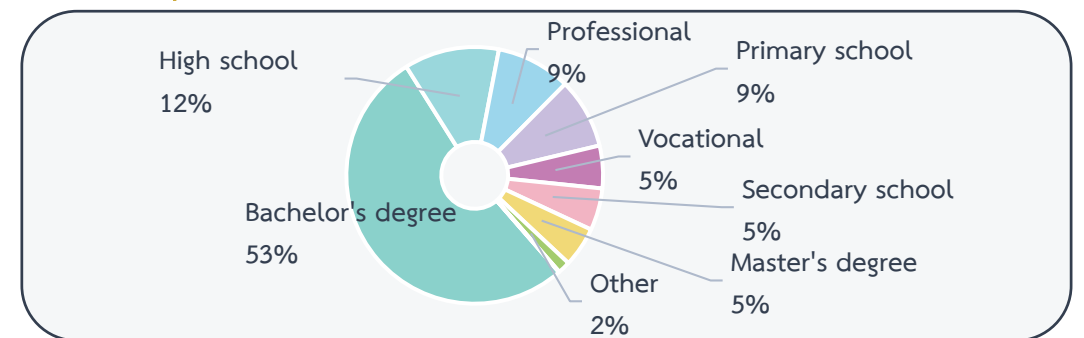
Average Household Size (person/household)



Proportion of vehicle ownerships



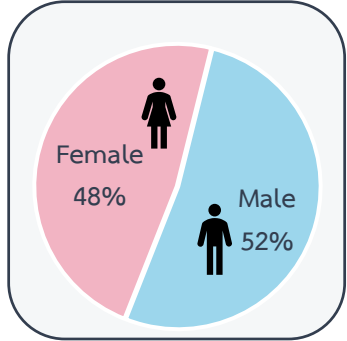
Proportion of the household member's education level



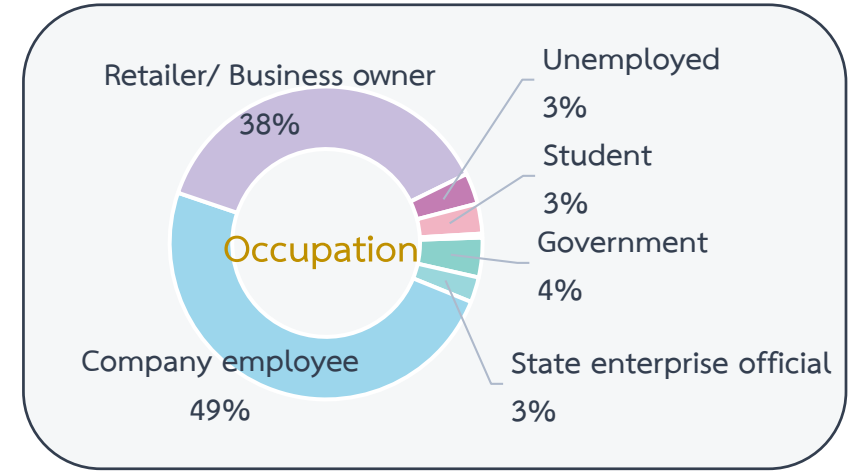
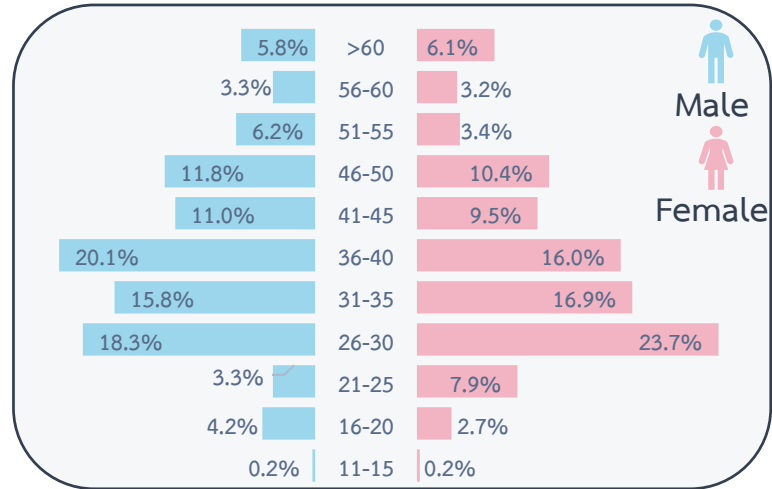
Details of respondents (persons)



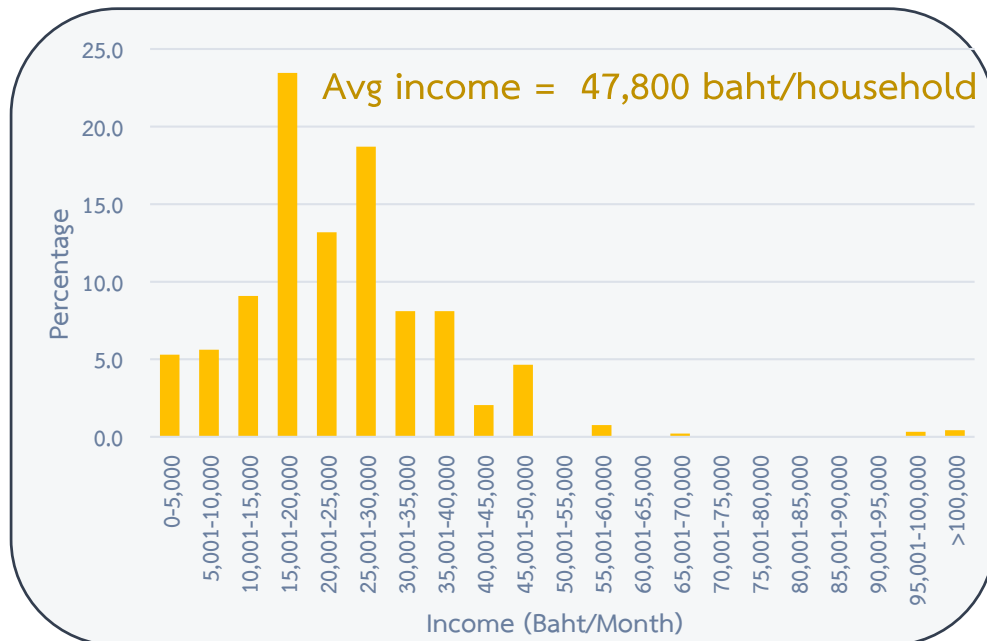
Sex



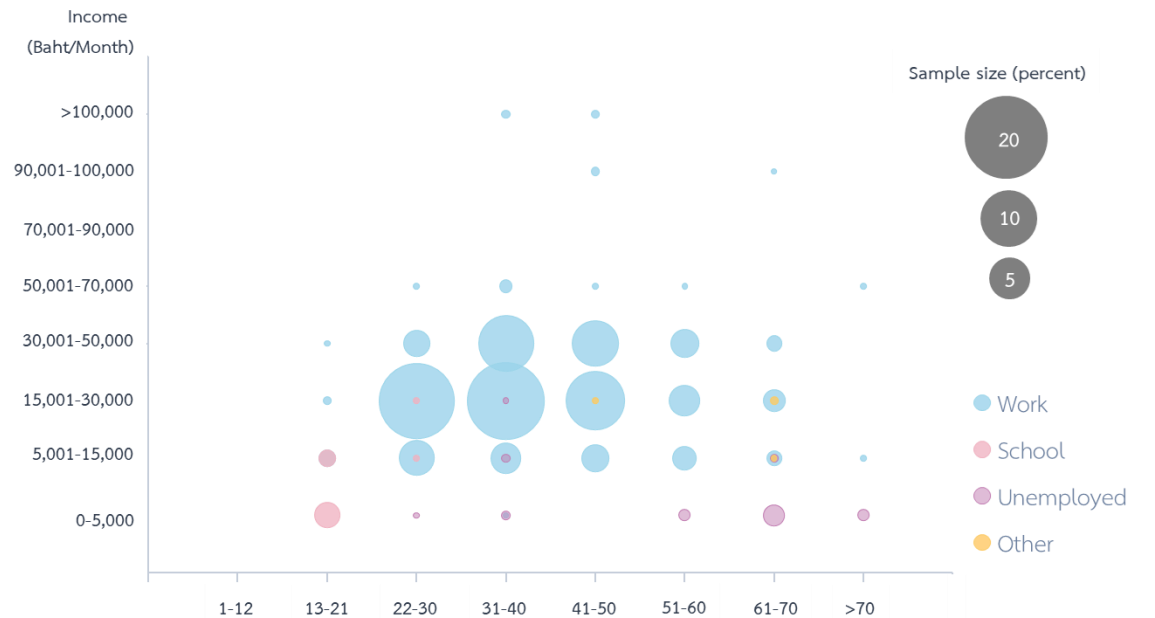
Gender and age of the sample



Income (Baht/Month)

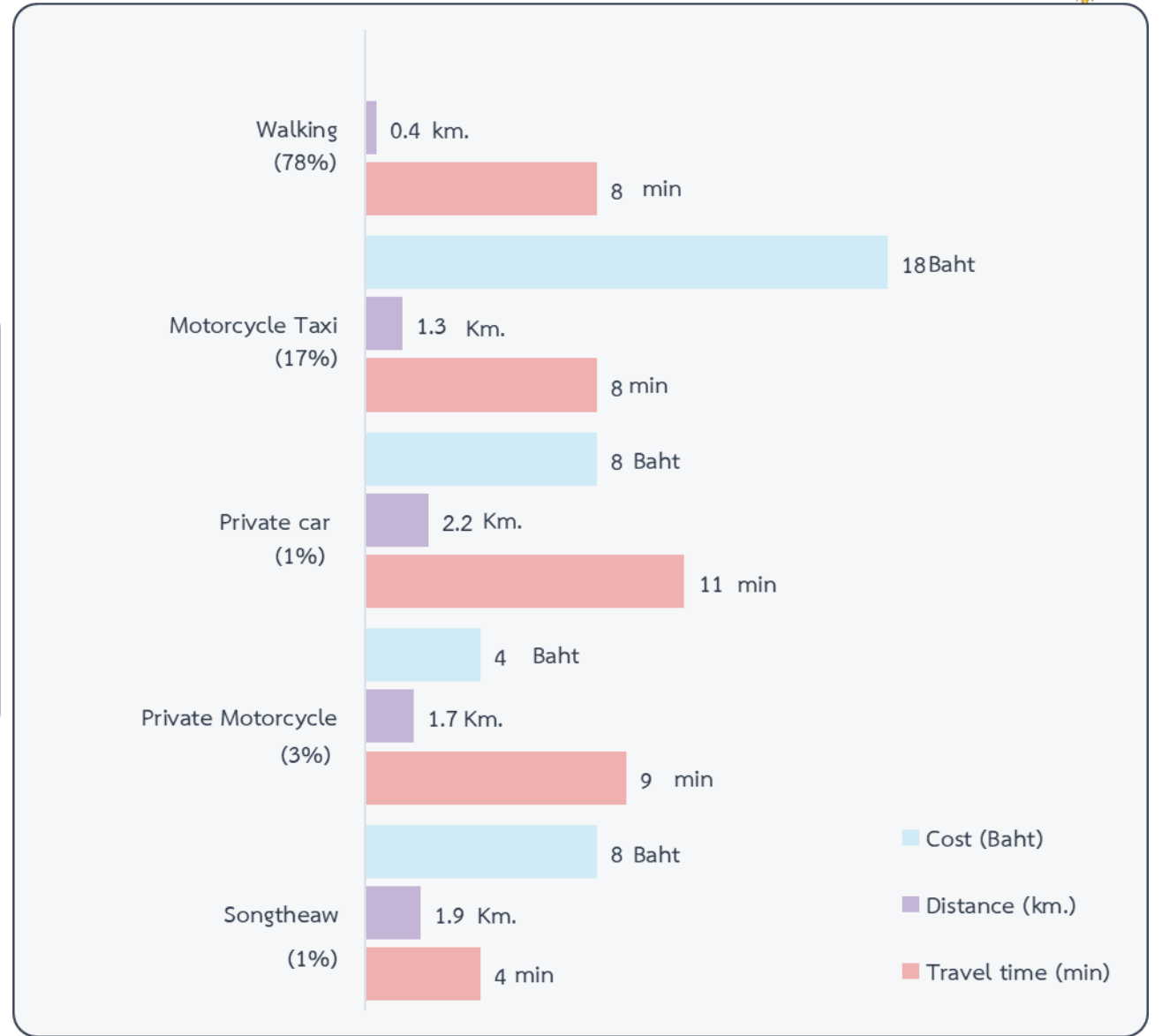
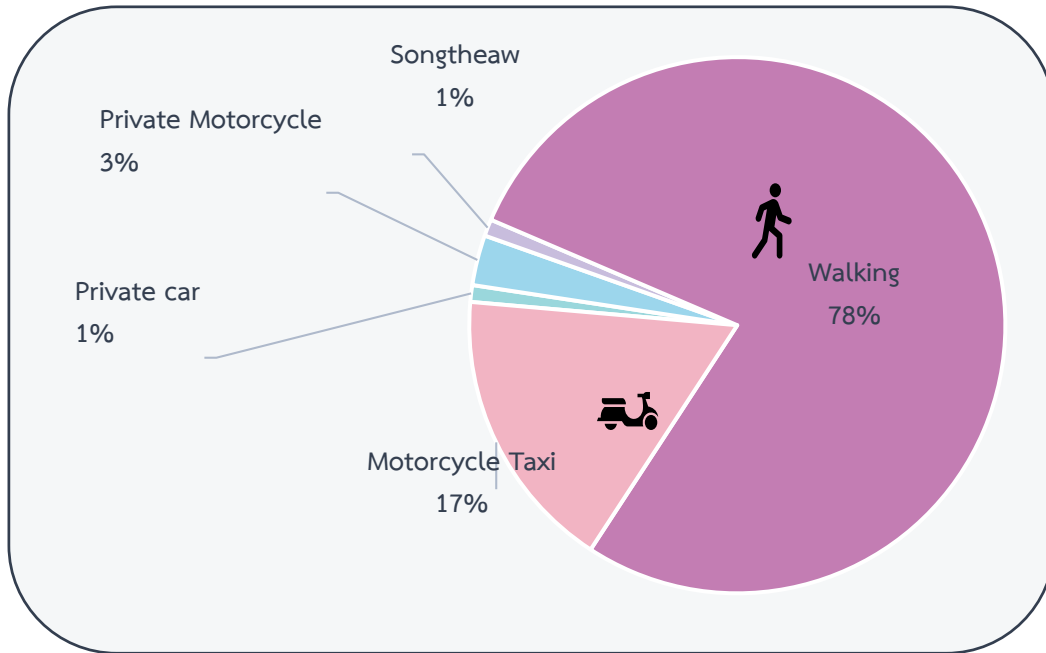


Sample distribution by income, occupation and age





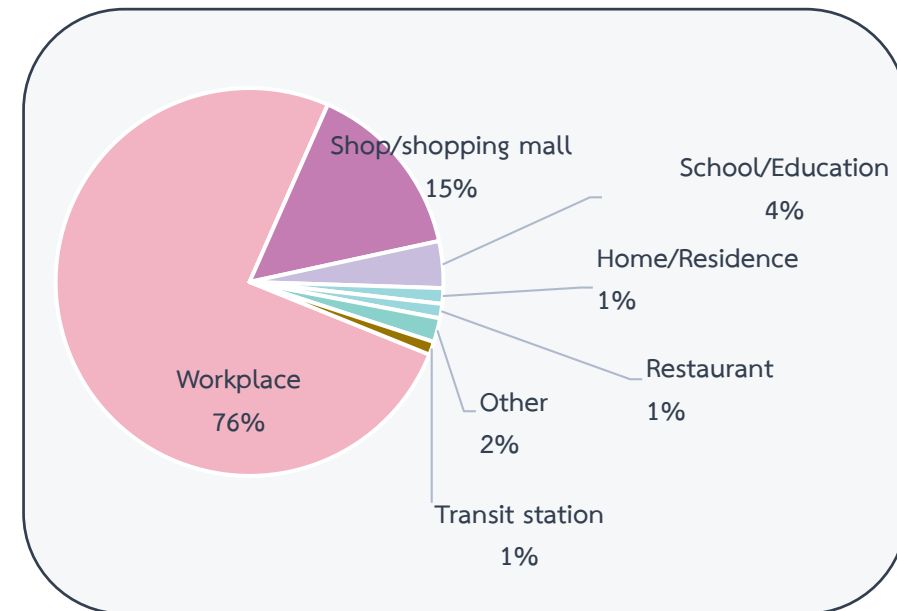
The travel mode to access the metro.



Proportion of activities done by respondents

Type of activity	Avg. Time (min)	Avg. Time (hr.)	% of activity types
Work full-time (Day Shift)	514	8.6	81.7
Errand	176	2.9	7.1
Study and other school activities	457	7.6	3.3
shopping	81	1.4	2.4
Purchase food	42	0.7	2.2
Drop-up passenger	7	0.1	1.2
Go to the doctor	273	4.6	0.4
Exercise	80	1.3	0.3
Social	150	2.5	0.2
Eat out	180	3.0	0.2
Stay home (no travel)	1440	24.0	0.2
Total			100

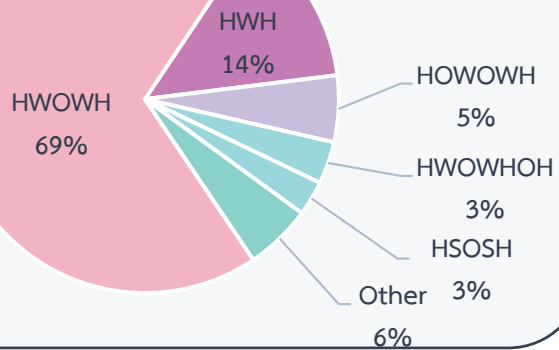
Proportion of the type of place used for the activities.



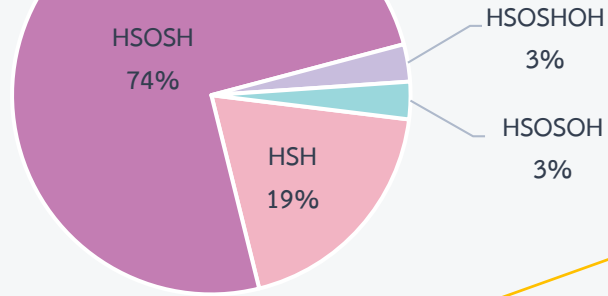
Activity Pattern



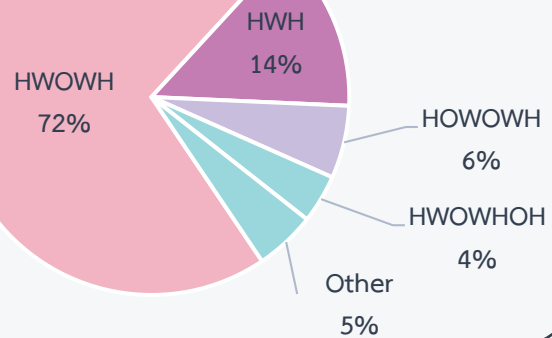
Overview



School



Work



Activity Pattern : HWOWH (Other)

Activity	Travel Mode	% workplace	% outside of workplace	Distance (km.)		Travel time (min)	
				workplace	outside of workplace	workplace	outside of workplace
Errand	Walking	0.2	-	0.10	-	2	-
Shopping	Private car (driver)	0.2	-	2.00	-	10	-
Eat out	Private car (driver)	1.0	7.4	0.52	1.25	6	8
Eat out	Private car (passenger)	0.4	-	0.35	-	5	-
Eat out	Private Motorcycle (driver)	1.5	7.4	0.38	0.60	5	8
Eat out	Private Motorcycle (passenger)	-	3.7	-	2.00	-	5
Eat out	Walking	95.8	81.5	0.19	0.34	5	6
Purchase food	Walking	1.0	-	0.26	-	5	-

Activity Pattern : HSOSH (Other)

Activity	Travel Mode	% School	% outside of School	Distance (km.)		Travel time (min)	
				School	outside of School	School	outside of School
Eat out	Walking	100	-	0.29	-	4.74	-

Activity Pattern (Overview)	%	Activity Pattern (Work)	%	Activity Pattern (ทำงาน)	%
HWOWH	68.9	HWOWH	71.7	HSOSH	74.2
HWH	13.6	HWH	14.2	HSH	19.4
HOWOWH	5.5	HOWOWH	5.8	HSOSHOH	3.2
HWOWHOH	3.5	HWOWHOH	3.7	HSOSOH	3.2
HSOSH	2.9	HWHOH	1.2	รวม	100
HWHOH	1.1	HWOH	1.0		
HWOH	1.0	HWOWOH	0.9		
HWOWOH	0.9	HOWH	0.4		
HSH	0.8	HOOWH	0.3		
HOWH	0.4	HOH	0.1		
HOOWH	0.3	HOHWOWOH	0.1		
HOH	0.1	HOWOH	0.1		
HOHWOWOH	0.1	HSOSH	0.1		
HOWOH	0.1	HSWH	0.1		
HSOSH	0.1	HSOSH	0.1		
HSOSHOH	0.1	HSOSHOH	0.1		
HSOSOH	0.1	รวม	100		
HSWH	0.1				
HOWOWOH	0.1				
HSWH	0.1				
รวม	100				



Results of travel analytics from mobile data



Mobile phone data (from TRUE)

Data attributes:

1. Person characteristics – sim id (unique_number), gender, age range, average voice in-out per month
2. Mobile phone information
 - cell sight tracked location (LAT, LON), time stamp, stop duration
 - probability of making some activities (initially analyzed by TRUE)
 - activity purposes including primary activity (home/work) and other activities (O)
 - mobile data including mobile users > 18 yrs. (Due to consent privacy policy)

Unique_number	probability	cluster	LAT	LON	first_par_datetime	province_district_th	sub_district	duration	last_par_datetime	subs_type	monthly_payment_TMH	gender	age_grp	location2	
Uq1		1	57	13.78112	100.5775	1/12/2019 0:00	กรุงเทพมหานคร	ห้วยขวาง	1440	2/12/2019 0:00	POST	3.Pay_200to599	female	19-25	home
Uq1		1	57	13.78112	100.5775	2/12/2019 2:00	กรุงเทพมหานคร	ห้วยขวาง	360	2/12/2019 8:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.035878181		60	13.76228	100.5688	2/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	0	2/12/2019 8:00	POST	3.Pay_200to599	female	19-25	work
Uq1		1	60	13.76228	100.5688	2/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	540	2/12/2019 18:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.003824092		57	13.78112	100.5775	2/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	0	2/12/2019 19:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.072657744		62	13.77789	100.5774	2/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	0	2/12/2019 19:00	POST	3.Pay_200to599	female	19-25	
Uq1		1	57	13.78112	100.5775	2/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	660	3/12/2019 7:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.058342624		60	13.76228	100.5688	3/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	0	3/12/2019 8:00	POST	3.Pay_200to599	female	19-25	work
Uq1		1	60	13.76191	100.5682	3/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	600	3/12/2019 19:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.277149709		57	13.78112	100.5775	3/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	0	3/12/2019 20:00	POST	3.Pay_200to599	female	19-25	home

3. Collect on 7-13 October 2019 for 2,500 mobile phone user (7 day) = about 1% of population

Mobile Data

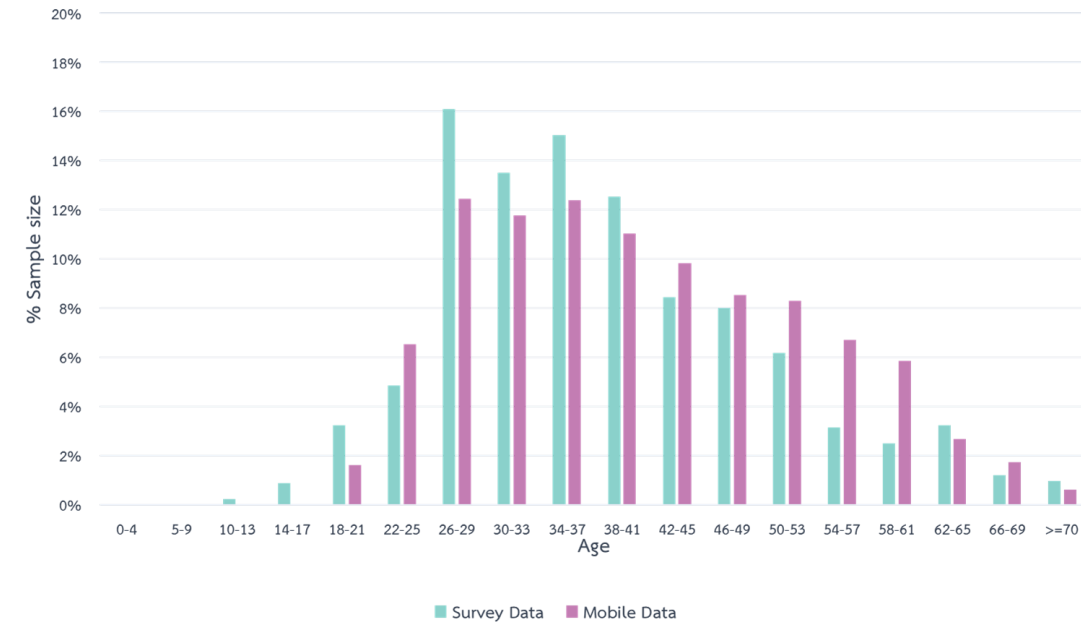
2,500 mobile phone data (7 days 7-13 from October 2019)
= about 1% of population.

Attributes of mobile data

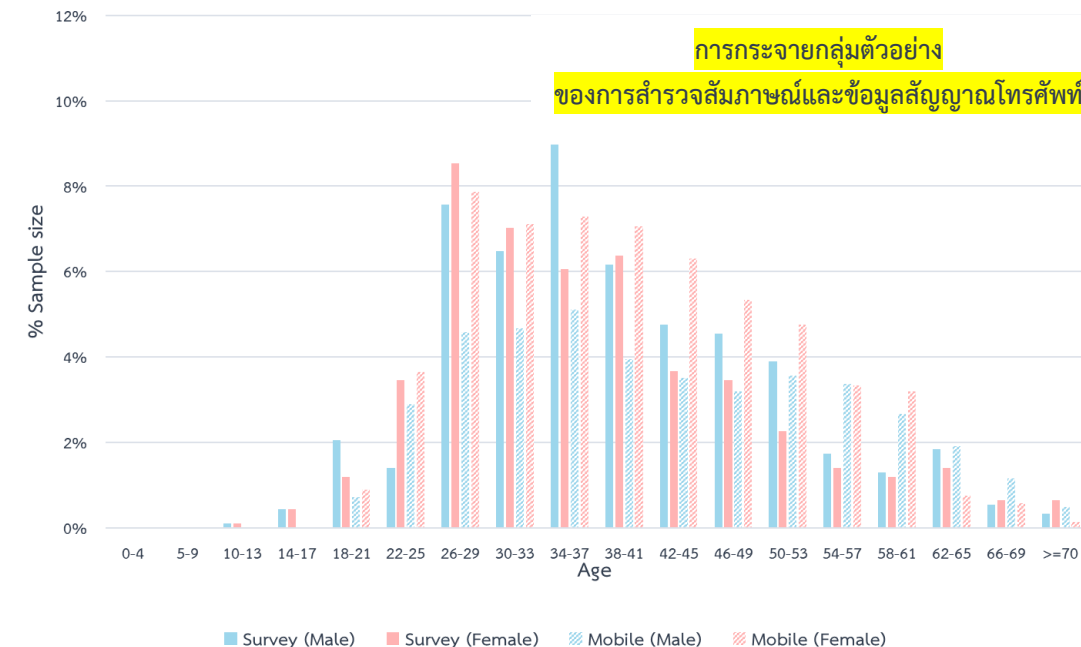
ข้อมูลตัวอย่างอายุ > 18 ปีขึ้นไป
และแบ่งช่วงอายุทุก 4 ปี

Field	Detail
Age	ช่วงอายุของกลุ่มตัวอย่าง
AVG Voice in per month	ค่าเฉลี่ยของการรับสายต่อเดือน
AVG Voice Out per month	ค่าเฉลี่ยของการโทรออกต่อเดือน
Date	วันที่ปรากฏตัว
Detail for Area Zone	Flag ลักษณะพื้นที่ศึกษาของกลุ่มตัวอย่าง
District	อำเภอ/เขต ของตำแหน่งที่ตัวอย่างปรากฏตัว
Flag_Location	Flag ตำแหน่งบ้านและที่ทำงาน ณ ตำแหน่งที่ปรากฏตัว Null : ตำแหน่งทั่วไป Home : ตำแหน่งบ้าน Home and Work : ตำแหน่งบ้านและที่ทำงาน Work : ตำแหน่งที่ทำงาน
Flag_study_zone_location	Flag พื้นที่ศึกษา ณ จุดที่ปรากฏตัว
Gender	เพศ
Hour	เวลาปรากฏตัว (ชั่วโมง)
Keys	Unique key for sample
Latitude	Latitude ที่ปรากฏตัว
Longitude	Longitude ที่ปรากฏตัว
No of actions	ตัวแบ่ง Action ที่เกิดขึ้น ณ ตำแหน่งนั้นๆ
Probability	ค่าความเป็นไปได้ของการใช้สัญญาณ ณ พื้นที่นั้นๆ
Province	จังหวัด ของตำแหน่งที่ตัวอย่างปรากฏตัว
Sub District	ตำบล/แขวง ของตำแหน่งที่ตัวอย่างปรากฏตัว
Subs Type	Prepay, Postpay

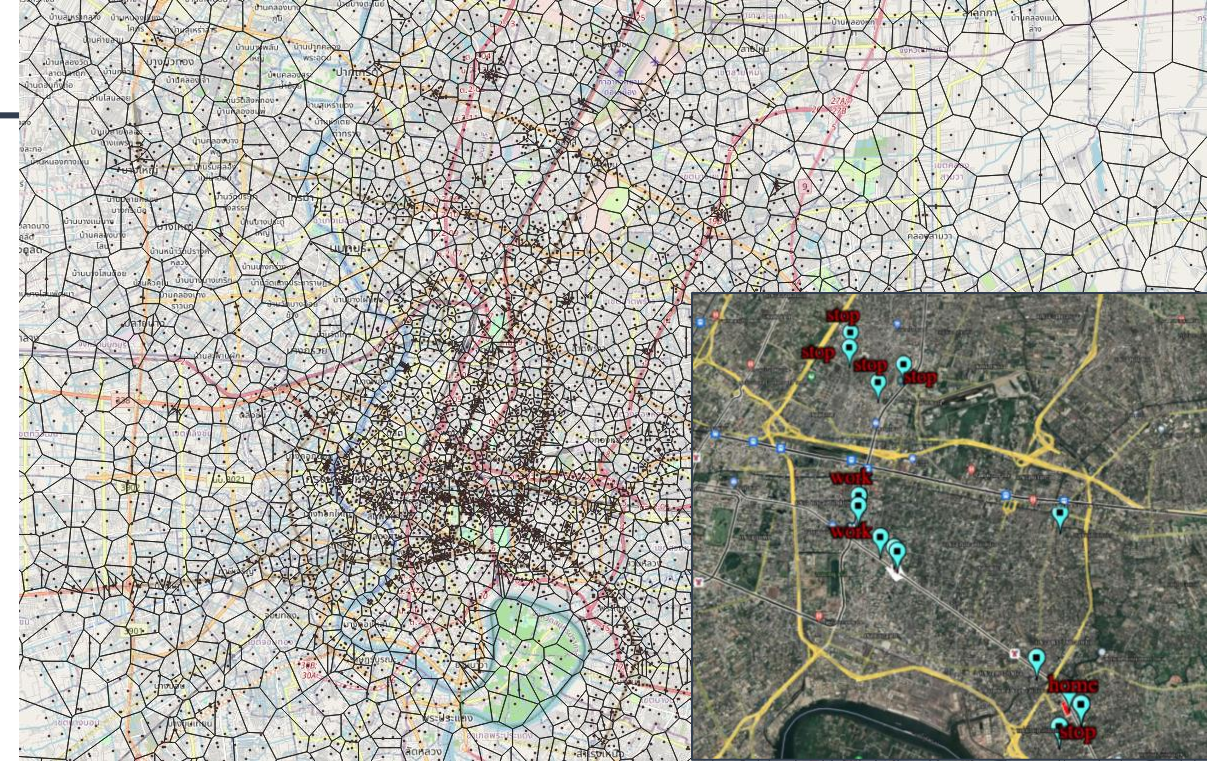
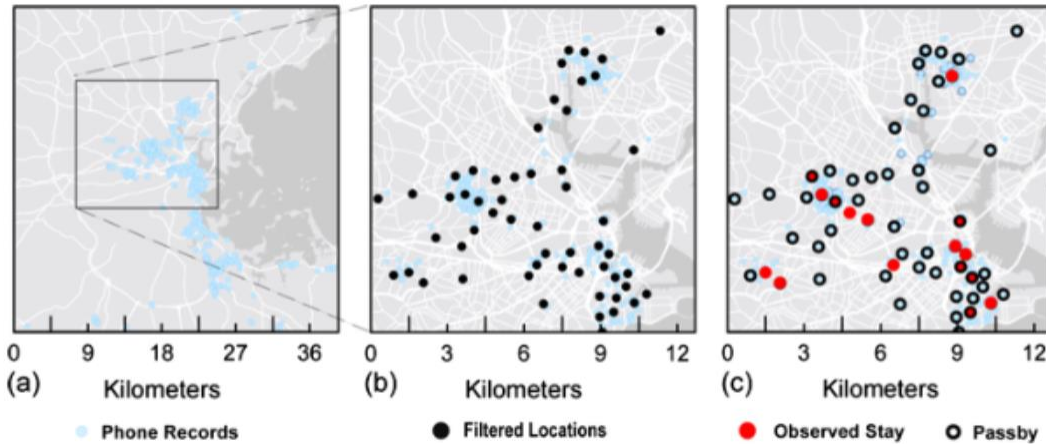
Samples Size of Survey and Mobile Data



Samples Size of Survey and Mobile Data



Sample of cellular data



Unique_n	probability	LAT	LON	first_par_datetime	province_th	district_th	sub_district_th	duration	last_par_datetime	subs_type	monthly_payment	gender	age_grp	location2	
Uq1		1	13.78112	100.5775	1/12/2019 0:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	1440	2/12/2019 0:00	POST	3.Pay_200to599	female	19-25	home
Uq1		1	13.78112	100.5775	2/12/2019 2:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	360	2/12/2019 8:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.035878181	1	13.76228	100.5688	2/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	2/12/2019 8:00	POST	3.Pay_200to599	female	19-25	work
Uq1		1	13.76228	100.5688	2/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	540	2/12/2019 18:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.003824092	1	13.78112	100.5775	2/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	2/12/2019 19:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.072657744	1	13.77789	100.5774	2/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	2/12/2019 19:00	POST	3.Pay_200to599	female	19-25	
Uq1		1	13.78112	100.5775	2/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	660	3/12/2019 7:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.058342624	1	13.76228	100.5688	3/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	3/12/2019 8:00	POST	3.Pay_200to599	female	19-25	work
Uq1		1	13.76191	100.5682	3/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	600	3/12/2019 19:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.277149709	1	13.78112	100.5775	3/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	3/12/2019 20:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.004841549	1	13.78112	100.5775	4/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 8:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.381956649	1	13.76191	100.5682	4/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 9:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.13877551	1	13.75874	100.5651	4/12/2019 10:00	กรุงเทพมหานคร	ดินแดง	ดินแดง	0	4/12/2019 10:00	POST	3.Pay_200to599	female	19-25	
Uq1	0.428571429	1	13.76225	100.5682	4/12/2019 10:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 10:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.325868504	1	13.75772	100.5648	4/12/2019 11:00	กรุงเทพมหานคร	ดินแดง	ดินแดง	0	4/12/2019 11:00	POST	3.Pay_200to599	female	19-25	
Uq1	0.999260355	1	13.75661	100.5667	4/12/2019 12:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	60	4/12/2019 13:00	POST	3.Pay_200to599	female	19-25	stop
Uq1	0.761406844	1	13.76225	100.5682	4/12/2019 14:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	240	4/12/2019 18:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.006334581	1	13.78112	100.5775	4/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 19:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.978661494	1	13.78112	100.5775	4/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	300	5/12/2019 1:00	POST	3.Pay_200to599	female	19-25	home
Uq1		1	13.78112	100.5775	5/12/2019 1:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	300	5/12/2019 6:00	POST	3.Pay_200to599	female	19-25	home
Uq1		1	13.78112	100.5775	5/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	240	5/12/2019 12:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.004610656	1	13.78112	100.5775	5/12/2019 13:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	5/12/2019 13:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.689140811	1	13.81618	100.5606	5/12/2019 14:00	กรุงเทพมหานคร	จตุจักร	จตุจักร	120	5/12/2019 16:00	POST	3.Pay_200to599	female	19-25	stop
Uq1		1	13.78112	100.5775	5/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	600	6/12/2019 6:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.5432	1	13.78112	100.5775	6/12/2019 7:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	6/12/2019 7:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.746196958	1	13.76191	100.5682	6/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	120	6/12/2019 10:00	POST	3.Pay_200to599	female	19-25	work
Uq1		1	13.76228	100.5688	6/12/2019 14:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	180	6/12/2019 17:00	POST	3.Pay_200to599	female	19-25	work
Uq1		1	13.78112	100.5775	6/12/2019 18:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	1020	7/12/2019 11:00	POST	3.Pay_200to599	female	19-25	home

Stay extraction:

- Consolidate points close in space using clustering algorithm (DBscan)
- Extract locations (lat,lon) between stay (duration > threshold) and passby

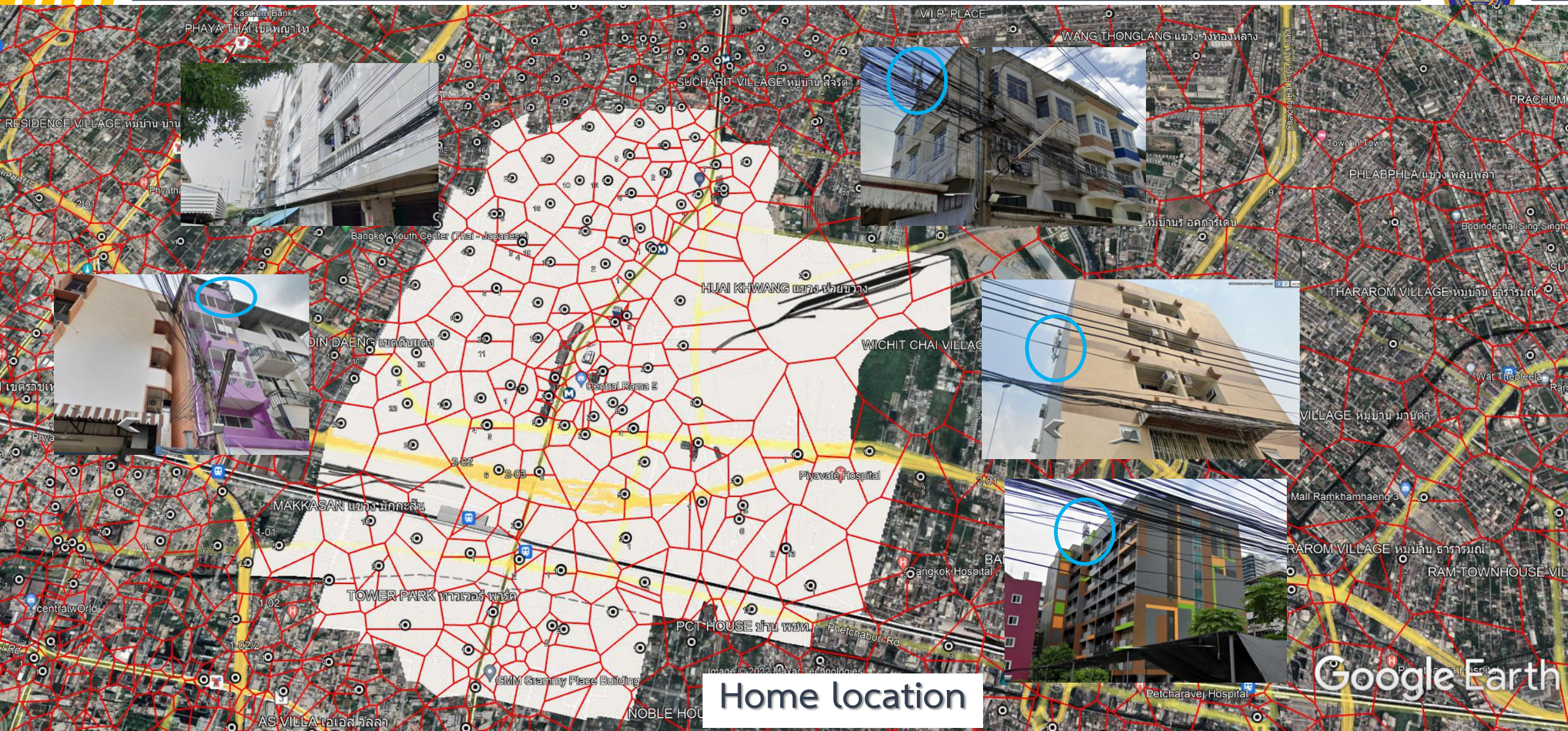
Activity inference:

- Home locations (H): most frequently visited on night time (e.g. alexander, 2015).
- Work locations (W): most frequently visited on day time on weekdays and max total distance from home (e.g. alexander, 2015).
- Other locations (O): the other cluster points of each users staying > threshold.

Trip estimation:

- Construct trip chain from inferred activities (E.g. Home(H)-Work(W))

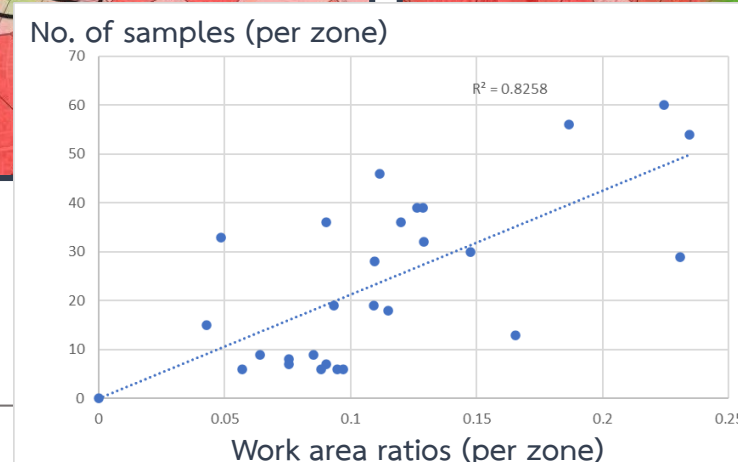
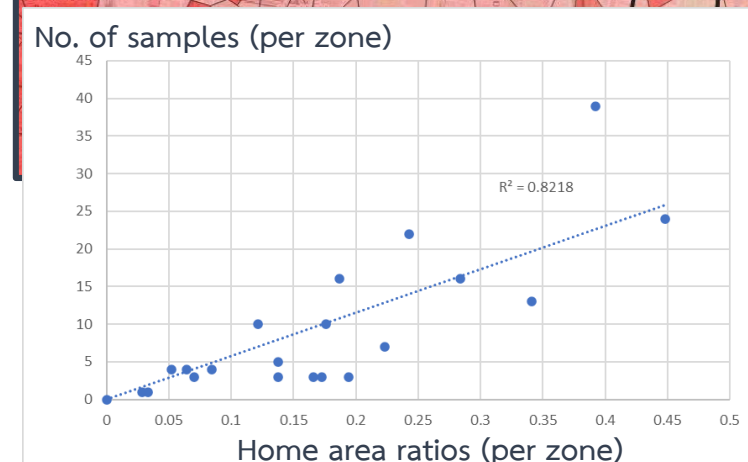
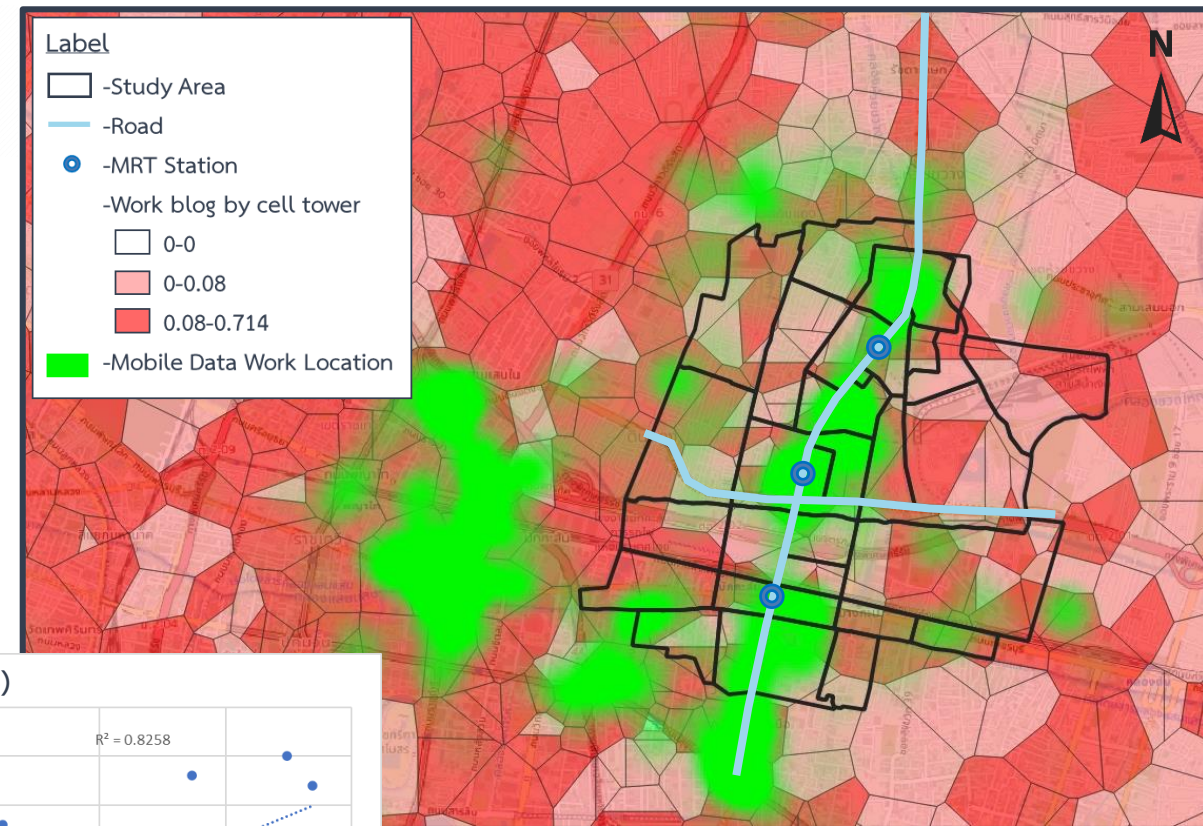
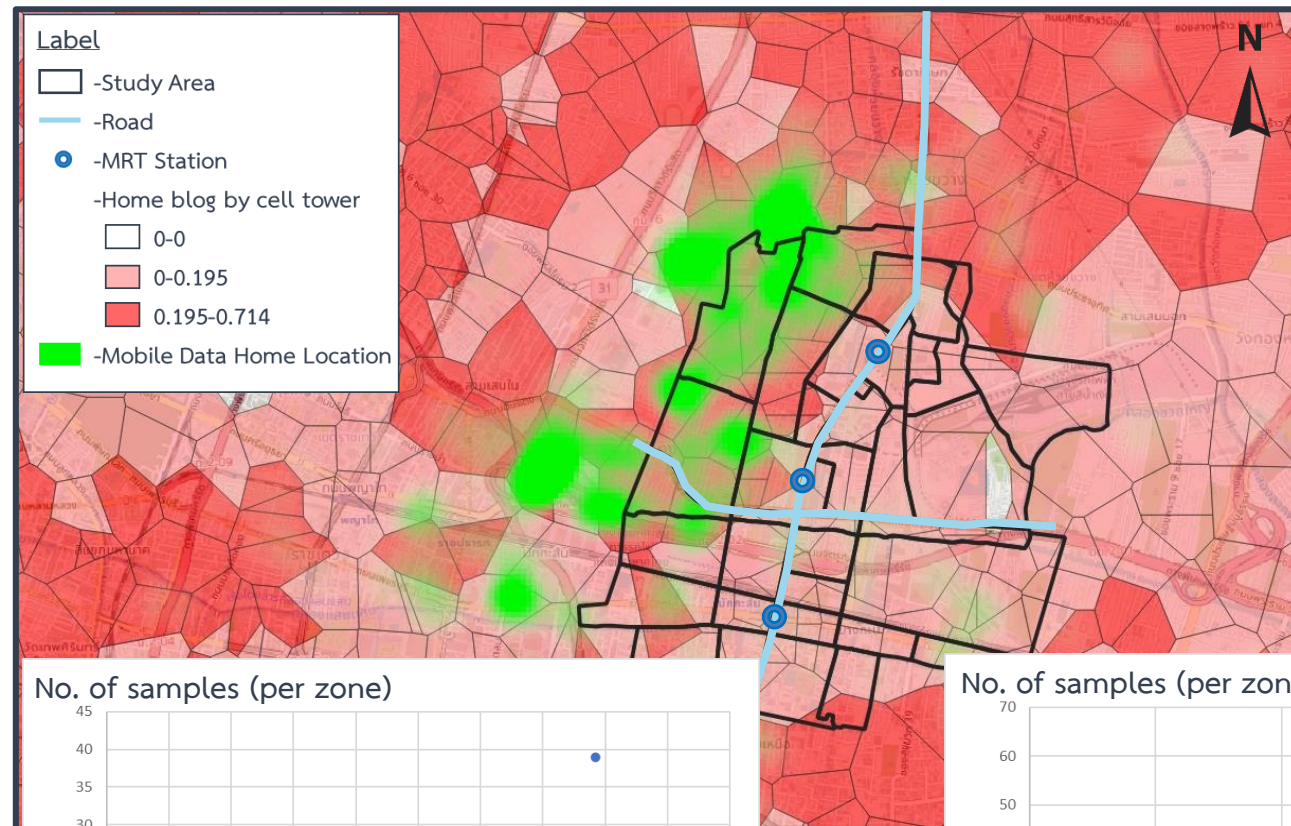
งานส่วนที่ 2 การพัฒนาแบบจำลองการคาดการณ์ความต้องการเดินทางด้วยระบบราง (Railway Demand Forecast Model)



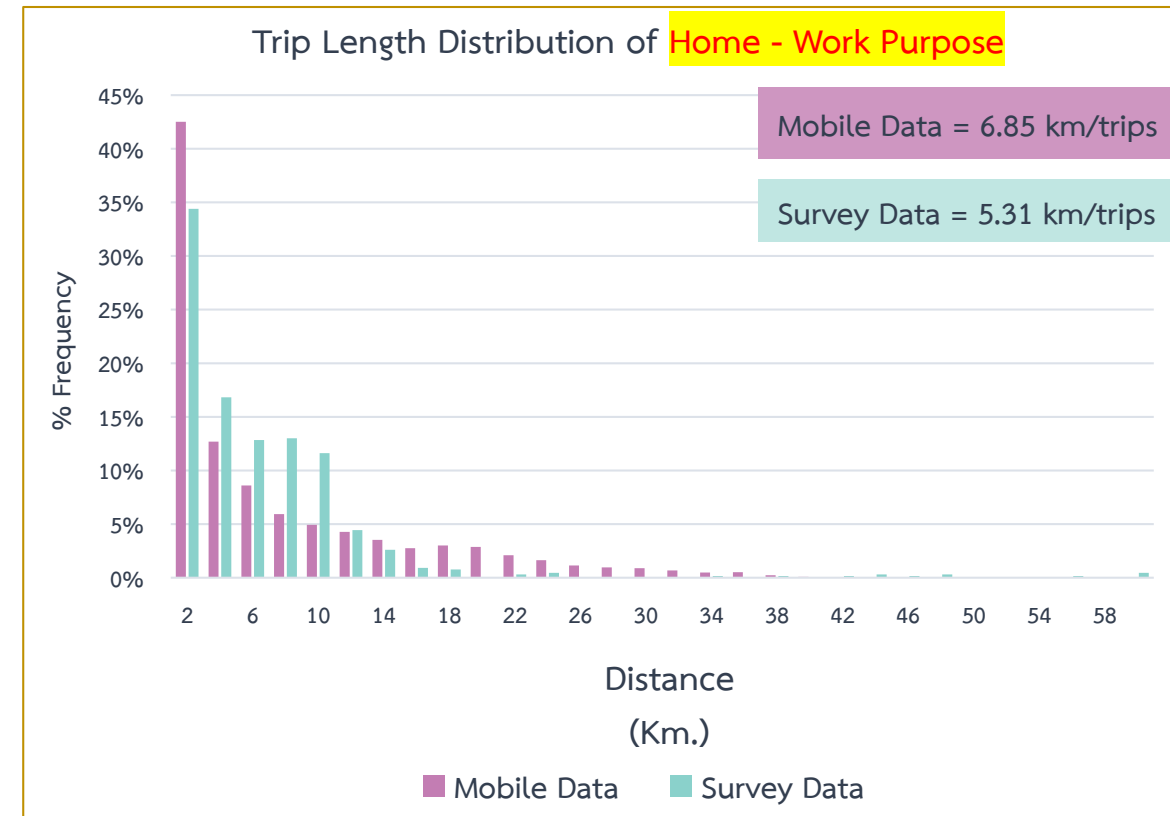
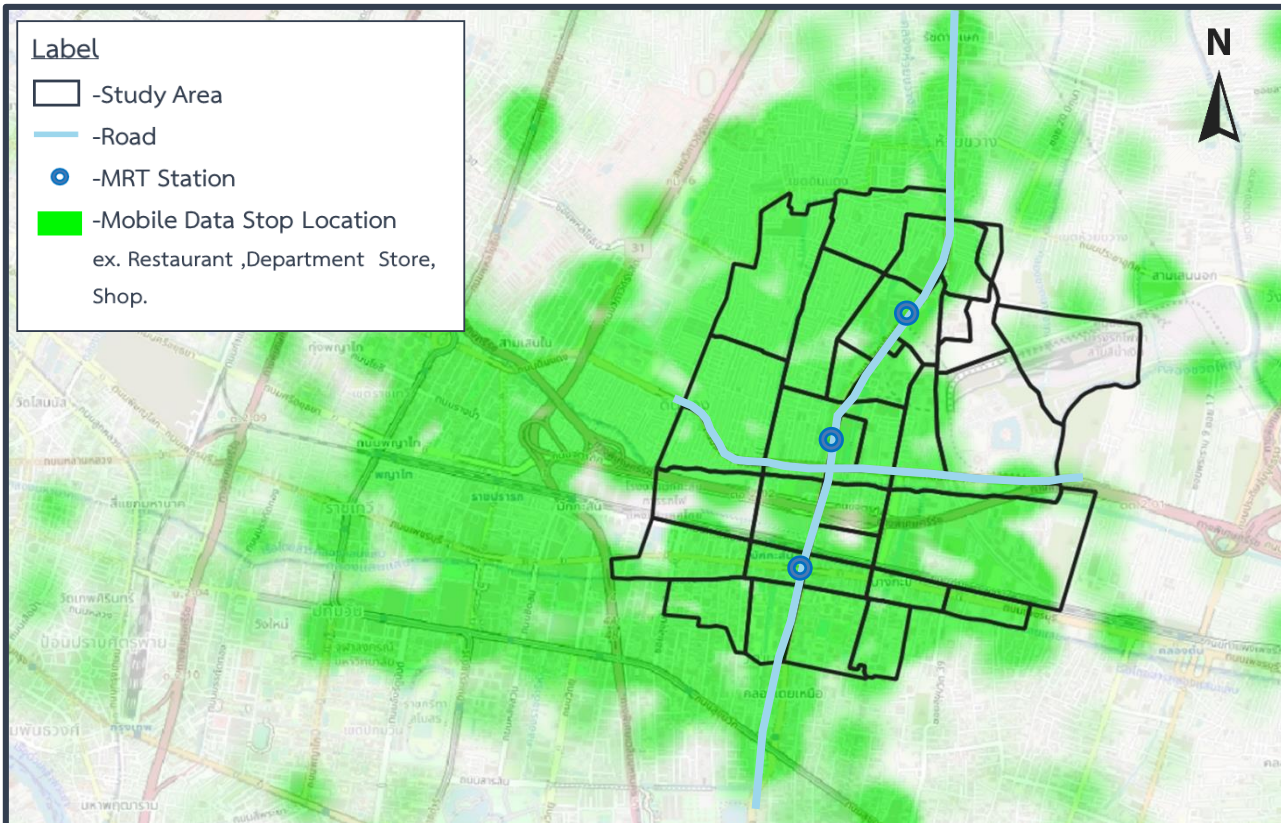
การกระจายตัวของผู้ใช้สัญญาณโทรศัพท์เกี่ยวกับการใช้พื้นที่และประเภทกิจกรรมหลัก

Mobile Data Home Location

Mobile Data Workplace Location

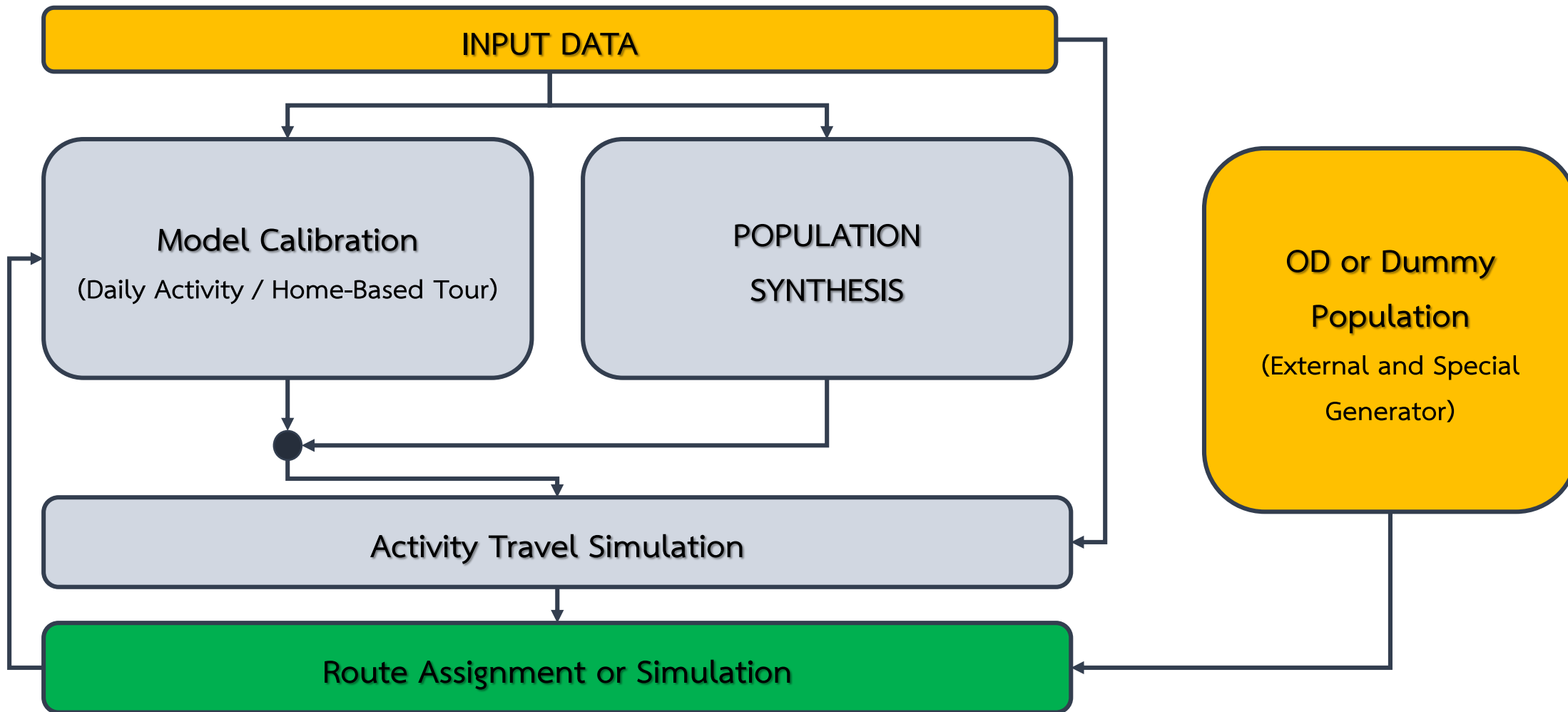


Non primary activity Location





Proposed ABM Modeling Concepts



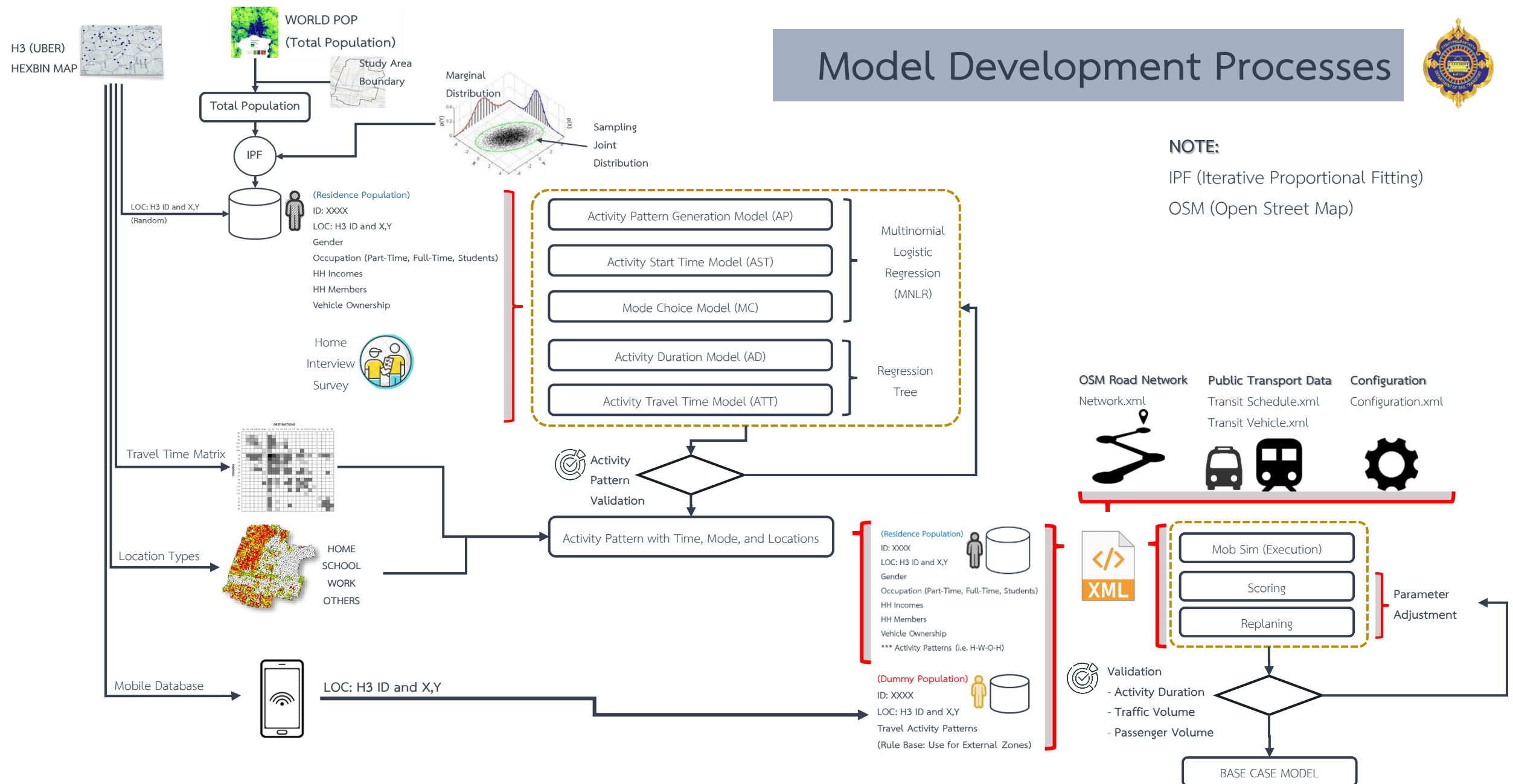


Model Development Processes

NOTE:

IPF (Iterative Proportional Fitting)

OSM (Open Street Map)

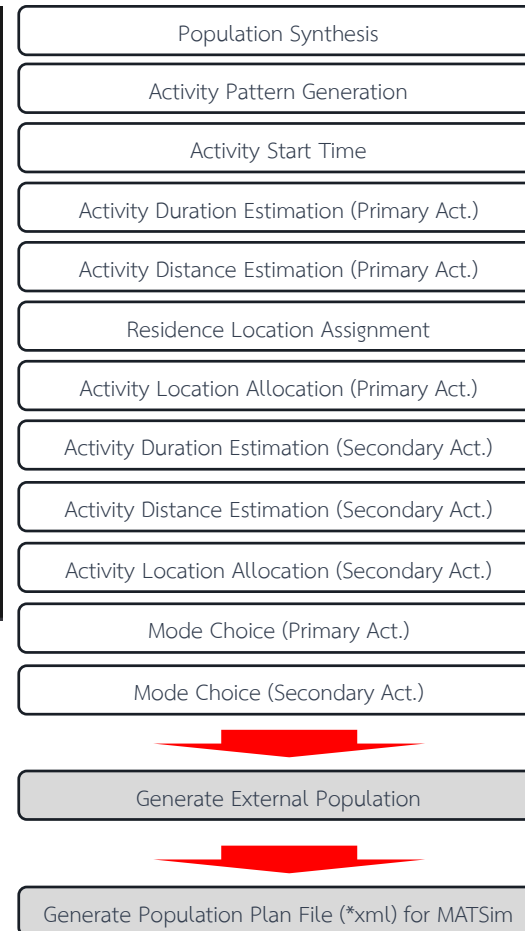




All Model Codes (ACTIVITY PATTERN GENERATION)

Population and Activity Schedule Synthetic Data:

- 01_populationSynthesis.py
- 02_activityPatternGen.py
- 03_activityStartTime.py
- 04_activityDurationPrimary.py
- 05_activityPrimaryDist.py
- 06_residentialLocationChoice.py
- 07_primaryActivityLocationChoice.py
- 08_activityDurationSecondary.py
- 09_activitySecondaryDist.py
- 10_secondaryActivityLocationChoice.py
- 11_primaryModeChoice.py
- 12_secondaryModeChoice.py
- 13_creatingPlanfile_xml.py
- 14_createExternalPop.py



id	Population ID
i	Gender
j	Occupation
k	Household Incomes
l	Household Size
m	Vehicle Ownership
pri_act	Primary Activities
sec_act	Secondary Activities
act_pattern	Activity Pattern
act_startperiod	Activity Start Time Period (AM, OFF AM, PM, OFF PM)
act_starttime	Activity Start Time
pri_act_dur	Primary Activity Duration
pri_tdist	Activity Travel Distance
res_loc	Residence Location
pri_loc	Primary Activity Location
pri_ttime_pri	Primary Travel Time (Private)
pri_ttime_pub	Primary Travel Time (Public) ** no data for some zones
pri_tdst_pri	Primary Travel Distance (Private)
pri_tdst_pub	Primary Travel Distance (Public)
sec_act_dur	Secondary Activity Duration
sec_tdist	Secondary Travel Distance
sec_loc	Secondary Activity Location
sec_ttime_pri	Secondary Travel Time (Private)
sec_ttime_pub	Secondary Travel Time (Public) ** no data for some zones
sec_tdst_pri	Secondary Travel Distance (Private)
sec_tdst_pub	Secondary Travel Distance (Public)
mode_pri	Primary Mode
mode_sec	Secondary Mode



RESULTS OF POPULATION SYNTHESIS

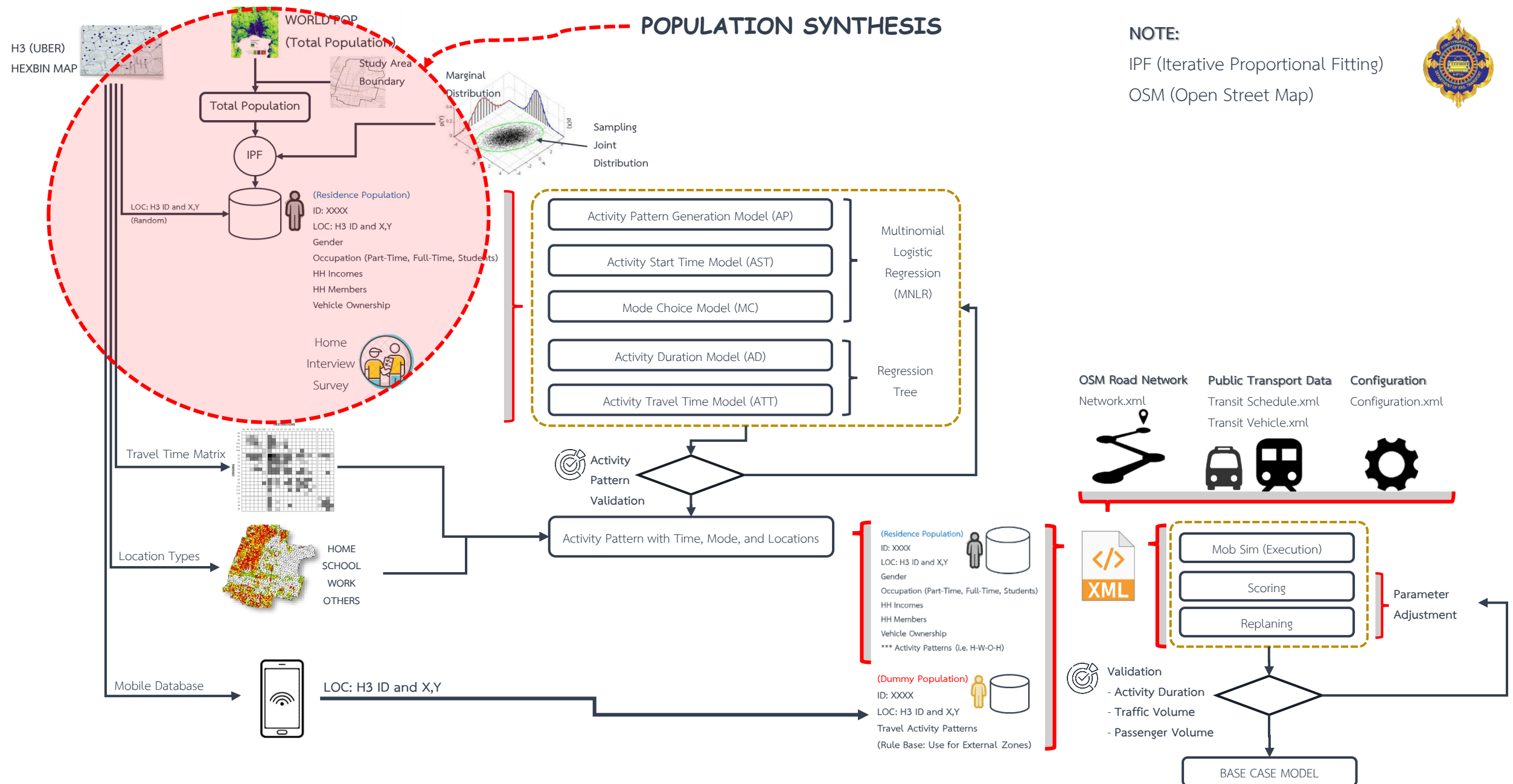


POPULATION SYNTHESIS

NOTE:

IPF (Iterative Proportional Fitting)

OSM (Open Street Map)



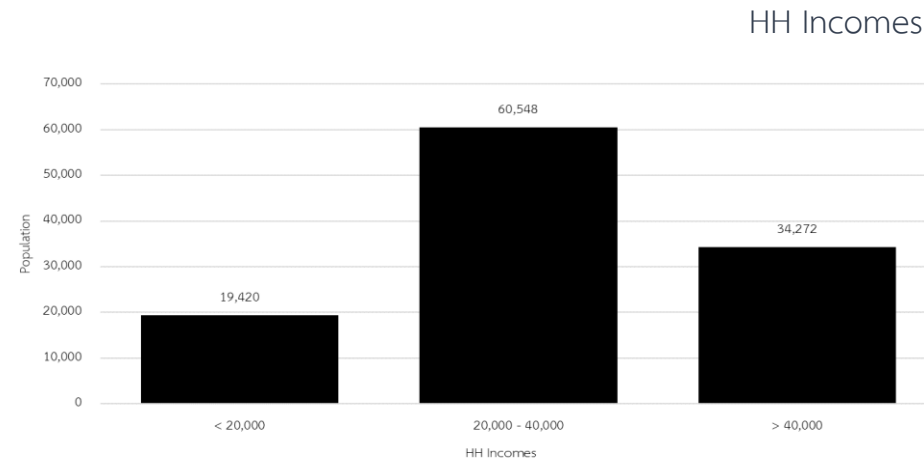
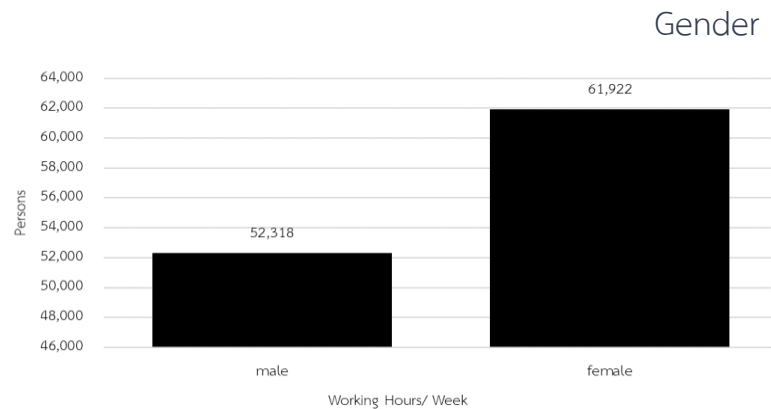
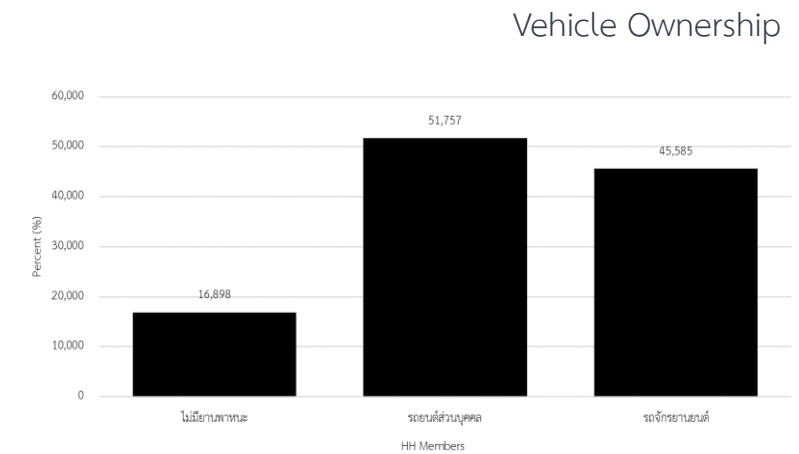
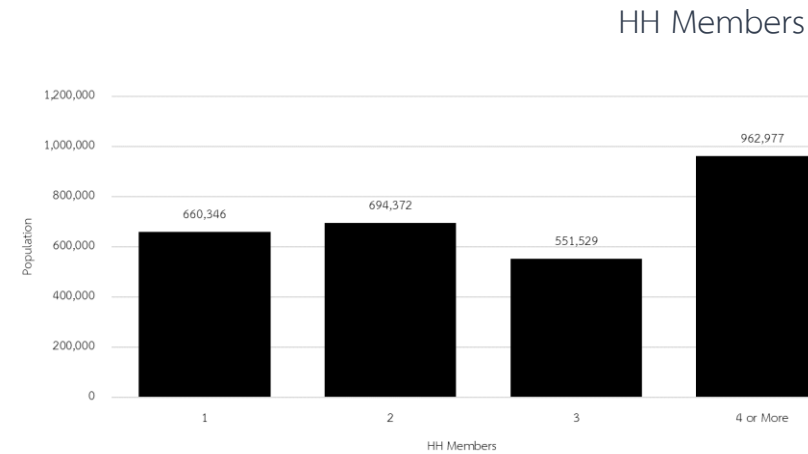
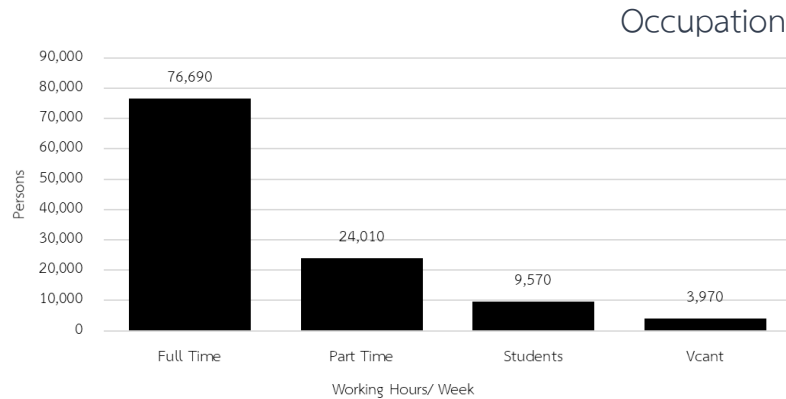
Characteristics of the sample population surveyed in the project

Attributes		PROPORTION	TOTAL
Gender	Male	0.48	380
	Female	0.52	415
Occupation	Part-Time	0.01	4
	Full-Time	0.84	668
	Student	0.08	65
	Unemployment	0.07	58
Household Size	1 person	0.12	95
	2 persons	0.45	354
	3 persons	0.28	222
	4 persons and more	0.16	124
Household Incomes	< 20,000	0.07	57
	20,000 - 40,000	0.30	242
	> 40,000	0.62	496
Vehicle Ownership	No Vehicle	0.10	83
	Car	0.62	496
	Mortorcycle	0.28	216



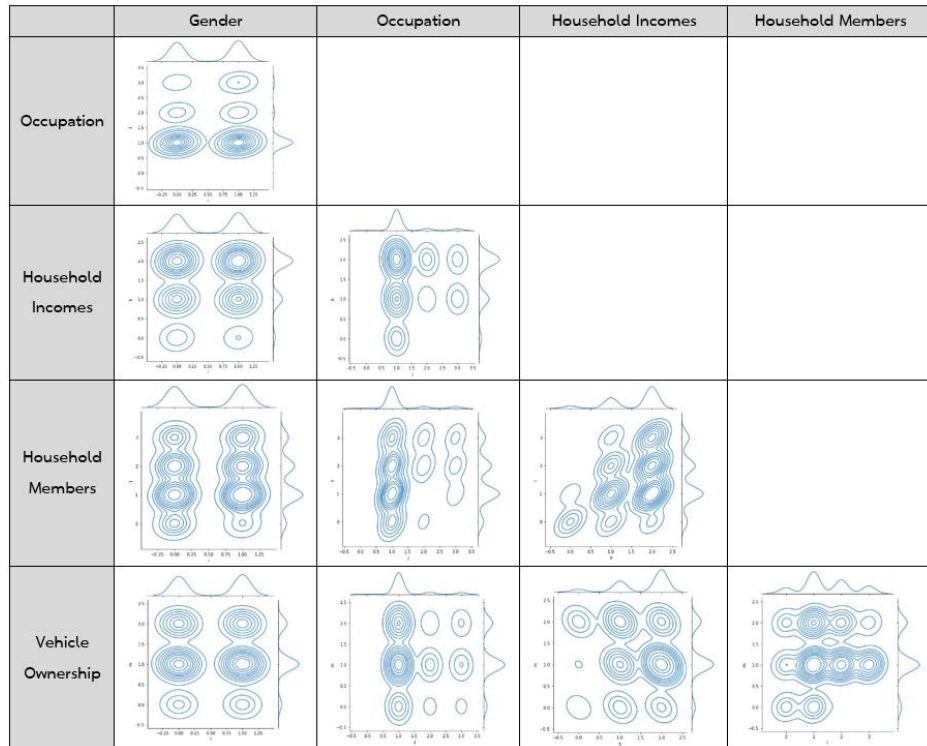
2019 : Total 110,270 Population
(Full Time / Part Time / Students)

Marginal Distribution Data: Vehicle Ownership

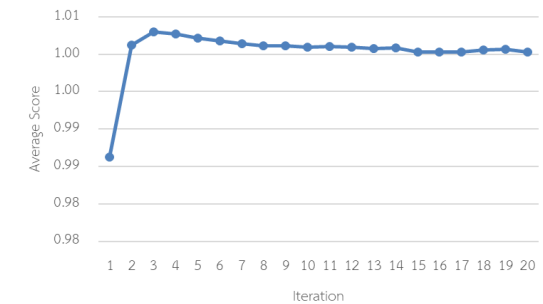
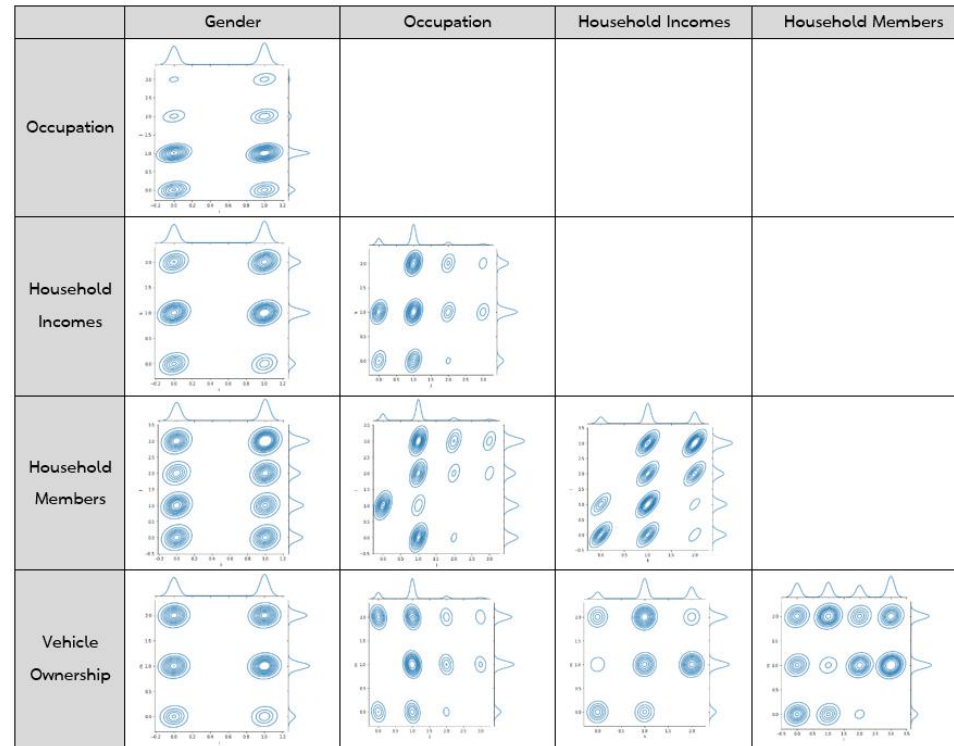


Population Joint distribution (Survey vs Model)

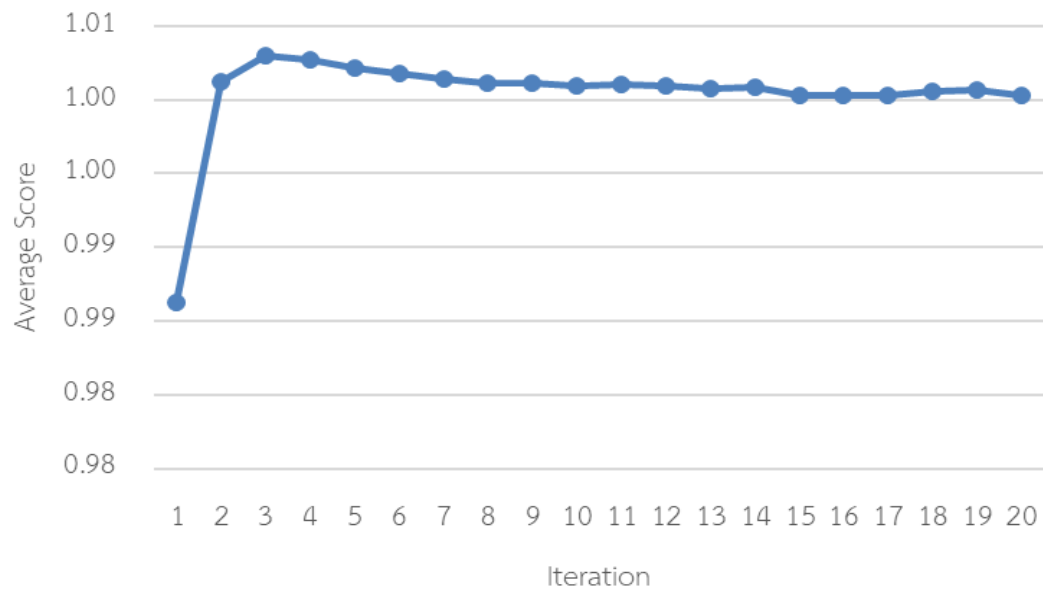
Survey



Model



Population Joint distribution (Survey vs Model)



Calibration Results from the IPF Steps (adjustment of the joint distribution data to the marginal distribution data)

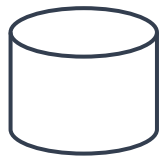
ID	gender	occ	hh_mem	hh_inc	veh_own
0	0	1	2	2	1
1	1	1	2	2	1
2	1	2	2	2	1
3	0	1	2	1	1
4	1	1	2	1	1
5	0	1	2	2	1
6	1	1	2	2	1
7	1	1	2	2	1
8	0	1	2	1	1
9	1	1	2	1	1
10	0	1	2	1	1

Examples of synthetic population databases created in the project



Secondary Data : Zonal Data and Land Type Indicators

Building Use Data: Residences (Production Base)



(Residence Population)

ID: XXXX

LOC: H3 ID and X,Y

Gender

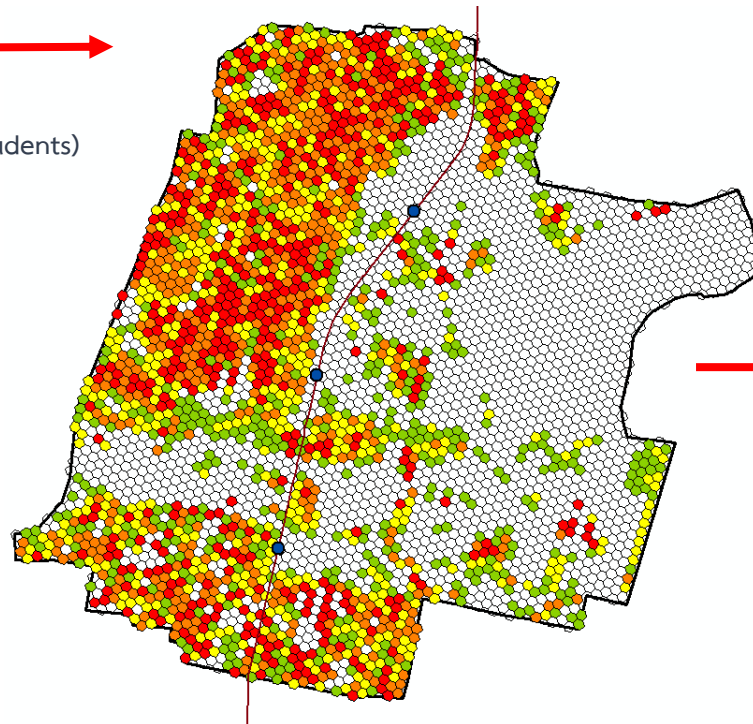
Occupation (Part-Time, Full-Time, Students)

HH Incomes

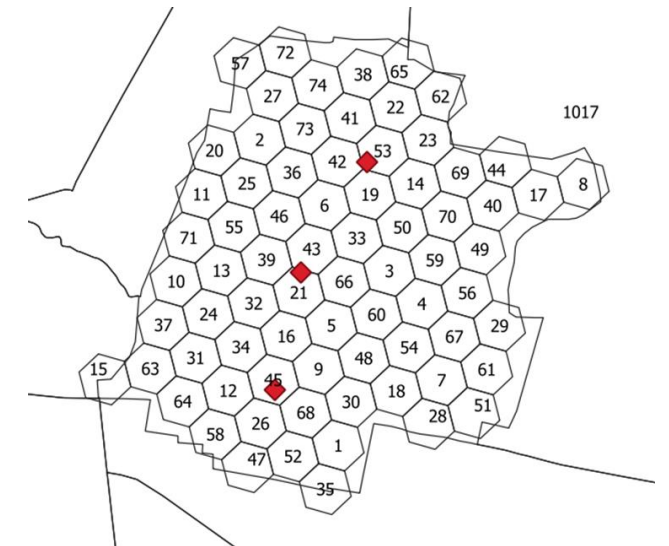
HH Members

Vehicle Ownership

Mapping
With H3
+ Floor Area Data



H3 Zone was leveled up to be more aggregate zone based on the problem of limited budgets for Google API (Skim Line Data Generation)





ACTIVITY SCHEDULE GENERATION



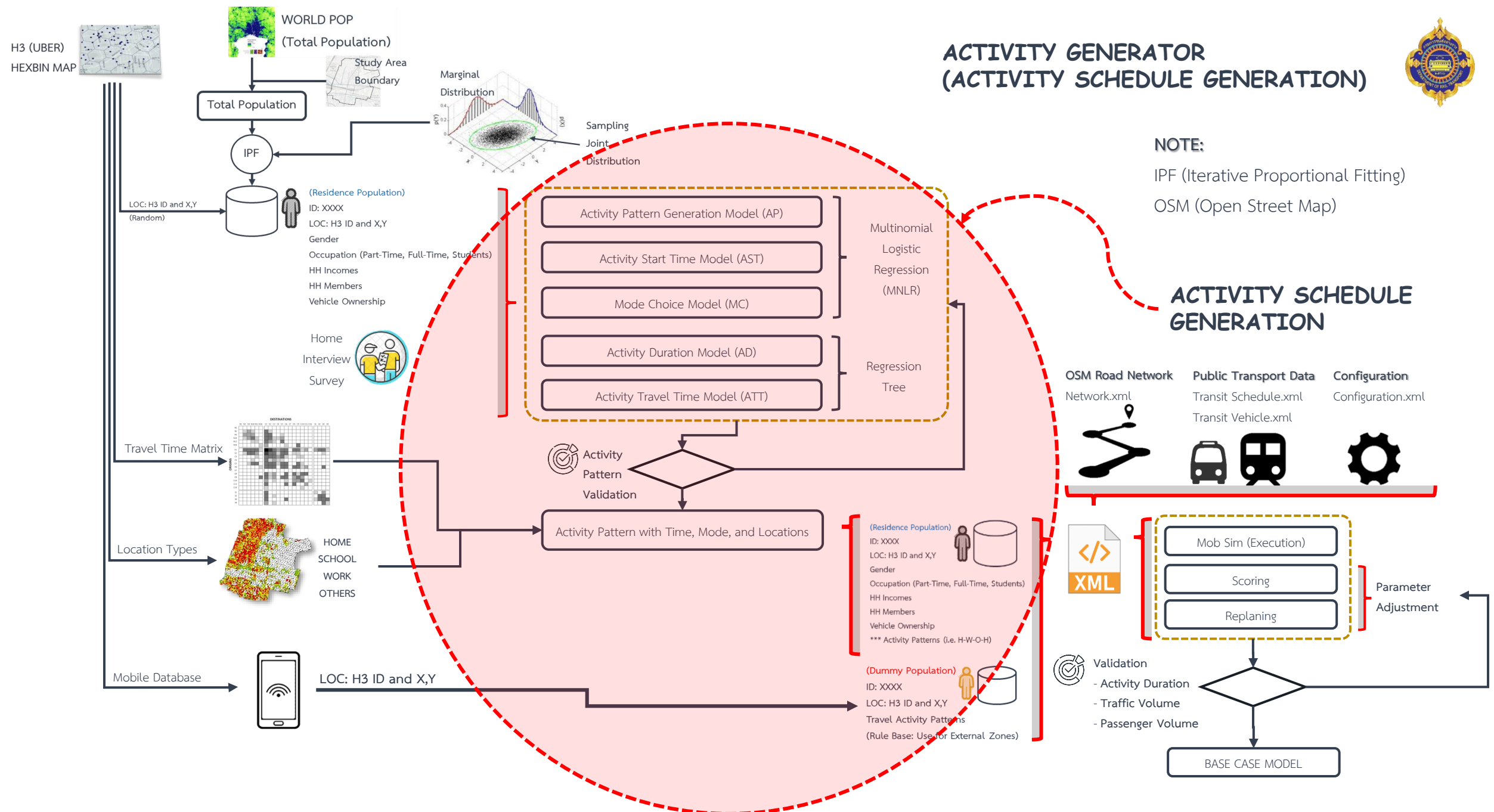
ACTIVITY GENERATOR (ACTIVITY SCHEDULE GENERATION)

NOTE:

IPF (Iterative Proportional Fitting)

OSM (Open Street Map)

ACTIVITY SCHEDULE GENERATION





Example of XML inputs for MATSIM

```
<population>
  <person id="1">
    <plan>
      <act type="home" x="5.0" y="8.0" end_time="08:00:00" />
      <leg mode="car" />
      <act type="work" x="1500.0" y="890.0" end_time="17:30:00" />
      <leg mode="car" />
      <act type="home" x="5.0" y="8.0" />
    </plan>
  </person>
  <person id="2">
    ...
  </person>
</population>
```

1. Activity Pattern Generation
2. Activity Start Times
3. Mode Choice

Notes:

Type : activities

Mode : traveling modes

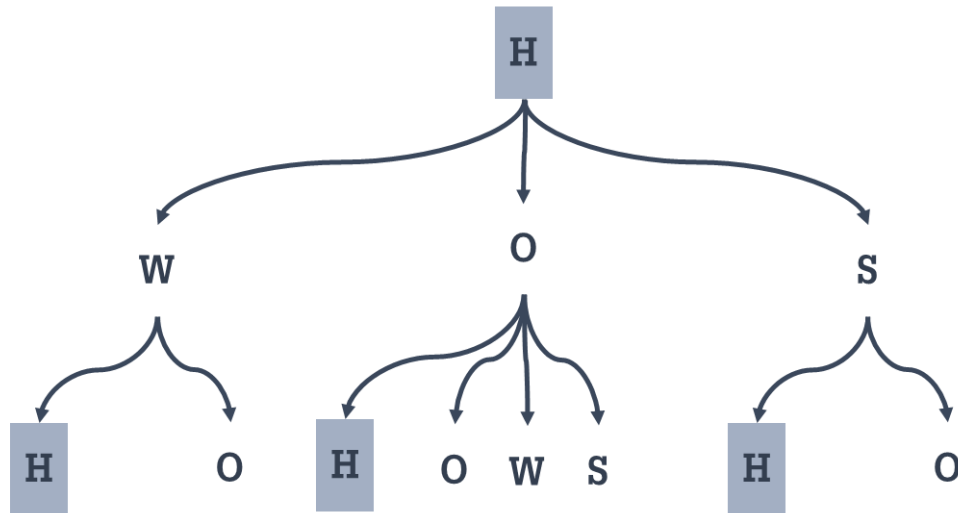
x : x coordinate

y : y coordinate

end_time : activity end time

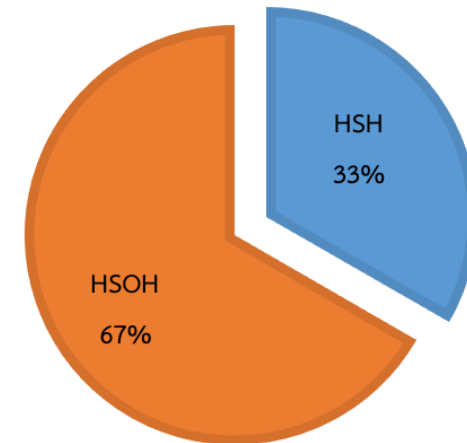
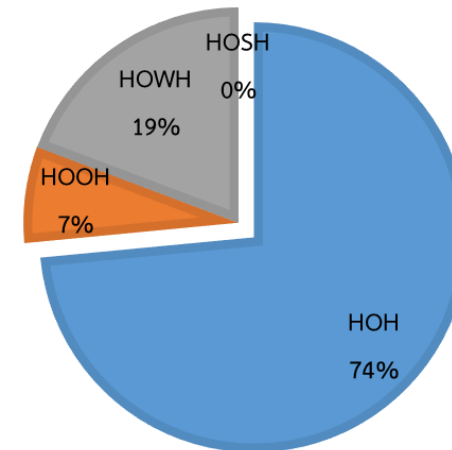
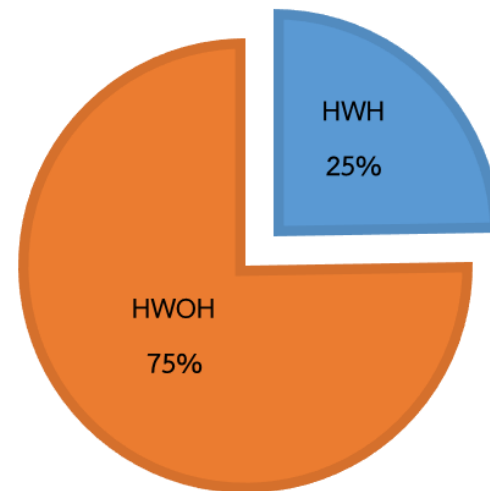
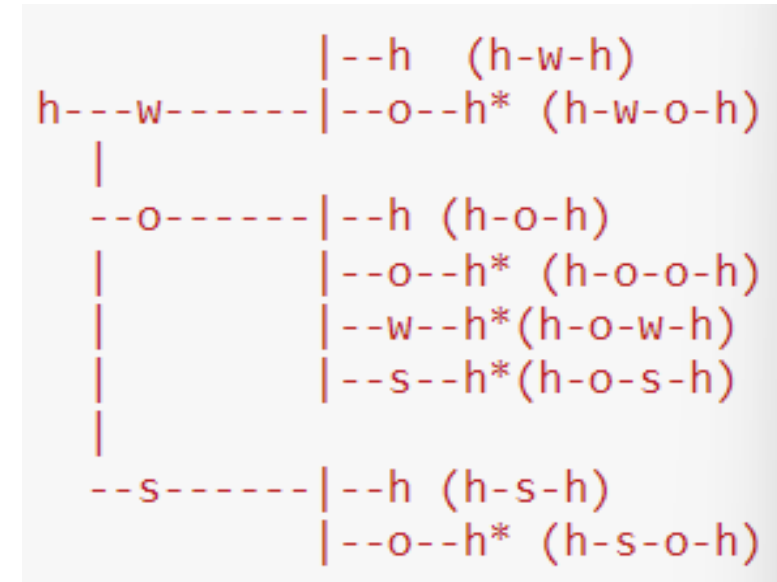


Activity Pattern Model



Notes:

H: Home, W: Work, S: School, O: Others



* In case the secondary activity is not home, the next activity will be assumed to be home as the ending activity in the pattern.



Results of Activity Pattern Generation (H-WOS)

Variable	Value	Std err	t-test	p-value	Definition
asc_o_female_hhinc20k40k***	1.0596	0.1542	6.8736	0.0000	Other, Female, Household Incomes 20k-40k
asc_o_female_hhincl20k***	-0.6809	0.3115	-2.1856	0.0288	Other, Female, Household Incomes < 20k
asc_o_female_hhincm40k***	1.6316	0.1303	12.5255	0.0000	Other, Female, Household Incomes > 40 k
asc_o_male_hhinc20k40k***	1.0418	0.1551	6.7193	0.0000	Other, male, Household Incomes 20k-40k
asc_o_male_hhincl20k***	-0.7863	0.3270	-2.4046	0.0162	Other, male, Household Incomes < 20k
asc_o_male_hhincm40k***	1.7701	0.1258	14.0685	0.0000	Other, male, Household Incomes > 40 k
asc_s_female_hhinc20k40k***	-1.5972	0.4800	-3.3276	0.0009	School, Female, Household Incomes 20k-40k
asc_s_female_hhincl20k***	-2.2897	0.6726	-3.4045	0.0007	School, Female, Household Incomes < 20k
asc_s_female_hhincm40k***	-1.5972	0.4800	-3.3276	0.0009	School, Female, Household Incomes > 40 k
asc_s_male_hhinc20k40k***	-2.2897	0.6726	-3.4045	0.0007	School, male, Household Incomes 20k-40k
asc_s_male_hhincl20k***	-1.1917	0.3954	-3.0142	0.0026	School, male, Household Incomes < 20k
asc_s_male_hhincm40k***	-2.2897	0.6726	-3.4045	0.0007	School, male, Household Incomes > 40 k
asc_w_female_hhinc20k40k***	0.7301	0.1728	4.2258	0.0000	Work, Female, Household Incomes 20k-40k
asc_w_female_hhincl20k***	-0.6809	0.3115	-2.1856	0.0288	Work, Female, Household Incomes < 20k
asc_w_female_hhincm40k***	1.1909	0.1478	8.0578	0.0000	Work, Female, Household Incomes > 40 k
asc_w_male_hhinc20k40k***	0.9483	0.1600	5.9274	0.0000	Work, male, Household Incomes 20k-40k
asc_w_male_hhincl20k**	0.1946	0.2126	0.9150	0.3602	Work, male, Household Incomes < 20k
asc_w_male_hhincm40k***	1.2506	0.1451	8.6197	0.0000	Work, male, Household Incomes > 40 k

Note: *less significant, **Significant, ***Strongly Significant



Results of Activity Pattern Generation (W-HO)

Variable	Value	Std err	t-test	p-value	Definition
asc_h_female_hhinc20k40k*	-0.2936	0.1837	-1.5986	0.1099	Home, Female, Household Incomes 20k-40k
asc_h_female_hhincl20k***	-1.8335	0.3779	-4.8522	0.0000	Home, Female, Household Incomes < 20k
asc_h_female_hhincm40k*	-0.0149	0.1628	-0.0918	0.9268	Home, Female, Household Incomes > 40 k
asc_h_male_hhinc20k40k*	-0.0705	0.1667	-0.4229	0.6723	Home, male, Household Incomes 20k-40k
asc_h_male_hhincl20k***	-0.8533	0.2368	-3.6038	0.0003	Home, male, Household Incomes < 20k
asc_h_male_hhincm40k*	0.1583	0.1514	1.0459	0.2956	Home, male, Household Incomes > 40 k
asc_o_female_hhinc20k40k*	0.1353	0.1528	0.8854	0.3759	Other, Female, Household Incomes 20k-40k
asc_o_female_hhincl20k***	-1.2279	0.2824	-4.3485	0.0000	Other, Female, Household Incomes < 20k
asc_o_female_hhincm40k***	0.7930	0.1184	6.6971	0.0000	Other, Female, Household Incomes > 40 k
asc_o_male_hhinc20k40k*	0.1583	0.1514	1.0459	0.2956	Other, male, Household Incomes 20k-40k
asc_o_male_hhincl20k***	-0.9868	0.2520	-3.9159	0.0001	Other, male, Household Incomes < 20k
asc_o_male_hhincm40***	1.0185	0.1095	9.3007	0.0000	Other, male, Household Incomes > 40 k

Note: *less significant, **Significant, ***Strongly Significant



Results of Activity Pattern Generation (O-HOWS)

Variable	Value	Std err	t-test	p-value	Definition
asc_h_female_hhinc20k40k*	0.418731	1.247649	0.335616	0.73716	Home, Female, Household Incomes 20k-40k
asc_h_female_hhincl20k*	-0.63103	1.281304	-0.49249	0.622372	Home, Female, Household Incomes < 20k
asc_h_female_hhincm40k*	0.75523	1.242389	0.607885	0.543264	Home, Female, Household Incomes > 40 k
asc_h_male_hhinc20k40k*	0.467551	1.246773	0.375009	0.707654	Home, male, Household Incomes 20k-40k
asc_h_male_hhincl20k*	-0.27435	1.265881	-0.21673	0.828422	Home, male, Household Incomes < 20k
asc_h_male_hhincm40k*	0.824217	1.241511	0.663882	0.506766	Home, male, Household Incomes > 40 k
asc_o_female_hhinc20k40k**	1.483462	1.235555	1.200644	0.229889	Other, Female, Household Incomes 20k-40k
asc_o_female_hhincl20k*	-0.27435	1.265881	-0.21673	0.828422	Other, Female, Household Incomes < 20k
asc_o_female_hhincm40k**	1.987367	1.233021	1.611787	0.107008	Other, Female, Household Incomes > 40 k
asc_o_male_hhinc20k40k**	1.354845	1.236433	1.095769	0.27318	Other, male, Household Incomes 20k-40k
asc_o_male_hhincl20k*	-0.01194	1.257497	-0.0095	0.992422	Other, male, Household Incomes < 20k
asc_o_male_hhincm40k*	2.123499	1.232528	1.722881	0.08491	Other, male, Household Incomes > 40 k
asc_s_female_hhinc20k40k*	-9.3406	28.19809	-0.33125	0.740456	School, Female, Household Incomes 20k-40k
asc_s_female_hhincl20k**	-2.57733	1.558133	-1.65411	0.098105	School, Female, Household Incomes < 20k
asc_s_female_hhincm40k**	-1.47887	1.347776	-1.09726	0.272527	School, Female, Household Incomes > 40 k
asc_s_male_hhinc20k40k**	-2.57733	1.558133	-1.65411	0.098105	School, male, Household Incomes 20k-40k
asc_s_male_hhincl20k**	-1.88395	1.403274	-1.34254	0.179422	School, male, Household Incomes < 20k
asc_s_male_hhincm40k**	-1.88395	1.403274	-1.34254	0.179422	School, male, Household Incomes > 40 k

Note: *less significant, **Significant, ***Strongly Significant



Results of Activity Pattern Generation (O-HOWS)

Variable	Value	Std err	t-test	p-value	Definition
asc_w_female_hhinc20k40k*	0.467551	1.246773	0.375009	0.707654	Work, Female, Household Incomes 20k-40k
asc_w_female_hhincl20k*	-1.19026	1.319038	-0.90237	0.366861	Work, Female, Household Incomes < 20k
asc_w_female_hhincl40k*	1.033938	1.23918	0.834372	0.404071	Work, Female, Household Incomes > 40 k
asc_w_male_hhinc20k40k*	0.718851	1.242877	0.578377	0.56301	Work, male, Household Incomes 20k-40k
asc_w_male_hhincl20k*	-0.09223	1.259839	-0.0732	0.941644	Work, male, Household Incomes < 20k
asc_w_male_hhincl40k*	1.086581	1.238667	0.877218	0.380368	Work, male, Household Incomes > 40 k

Note: *less significant, **Significant, ***Strongly Significant



Results of Activity Pattern Generation (S-HO)

Variable	Value	Std err	t-test	p-value	Definition
asc_h_female_hhinc20k40k***	10.5380	0.6893	15.2883	0.0000	Home, Female, Household Incomes 20k-40k
asc_h_female_hhinc<20k***	9.8449	0.9443	10.4252	0.0000	Home, Female, Household Incomes < 20k
asc_h_female_hhinc>40k***	9.8449	0.9443	10.4252	0.0000	Home, Female, Household Incomes > 40 k
asc_h_male_hhinc20k40k***	10.5380	0.6893	15.2883	0.0000	Home, male, Household Incomes 20k-40k
asc_h_male_hhinc<20k***	10.5380	0.6893	15.2884	0.0000	Home, male, Household Incomes < 20k
asc_h_male_hhinc>40k***	9.8449	0.9444	10.4250	0.0000	Home, male, Household Incomes > 40 k
asc_o_female_hhinc20k40k***	9.8449	0.9444	10.4250	0.0000	Other, Female, Household Incomes 20k-40k
asc_o_female_hhinc<20k***	9.8449	0.9443	10.4253	0.0000	Other, Female, Household Incomes < 20k
asc_o_female_hhinc>40k***	11.6366	0.4442	26.1952	0.0000	Other, Female, Household Incomes > 40 k
asc_o_male_hhinc20k40k***	9.8449	0.9444	10.4250	0.0000	Other, male, Household Incomes 20k-40k
asc_o_male_hhinc<20k***	11.2312	0.5165	21.7444	0.0000	Other, male, Household Incomes < 20k
asc_o_male_hhinc>40k***	10.5380	0.6893	15.2884	0.0000	Other, male, Household Incomes > 40 k

Note: *less significant, **Significant, ***Strongly Significant



Activity Start Time Model

1. AM Peak (amPeak): before 10:00 am
2. AM OFF PEAK (amOff) : 10:00 am. to 12:00 pm
3. PM Peak (pmPeak) : 12:00 pm to 14:00 pm.
4. PM OFF PEAK (pmOff) : after 14:00 pm. to 17:00 pm.

Significant Variable in the model:

- Age less than 20
- Captive Household
- Gender (Male, Female), and
- Household Incomes (<20k, 20k to 40k, and >40k)
- Primary Activities (Other, School, Work)

Variable	Value	Note
asc_amOff***	-8.83E-01	(amPeak)
asc_amPeak***	1.70E+00	(amOff)
asc_pmOff***	-1.16E+00	(pmPeak)
asc_pmPeak***	-9.11E-01	(pmOff)
b_agel20***	7.18E+00	Age less than 20 years old
b_captive***	0.00E+00	Household with no vehicles (Captive)
b_female***	-3.34E-16	Female
b_hhinc20k40k***	-2.27E-16	Household incomes 20k to 40k
b_hhincl20k***	-1.97E-16	Household incomes less than 20k
b_hhincm40k***	-2.70E-16	Household incomes more than 40k
b_male***	-3.60E-16	Genders
b_other***	-4.06E-17	Primary Activity (Others)
b_school***	-2.14E-16	Primary Activity (Shool)
b_work***	-4.40E-16	Primary Activity (Work)

Note: *less significant, **Significant, ***Strongly Significant



Mode Chocie Model

Modes	กิจกรรมหลัก (Primary Trip)	กิจกรรมรอง (Secondary Trip)
ยานพาหนะส่วนบุคคล (private-veh)	O	O
การเดินเท้าหรือจักรยาน (private-nmt)	X	O
รถจักรยานยนต์รับจ้างสาธารณะ (mc_taxi)	O	O
รถยนต์รับจ้างสาธารณะ (taxi)	O	X
รถสองแถว (songtaew)	X	O
รถโดยสารสาธารณะ (bus)	O	X
ระบบขนส่งมวลชน-รถไฟฟ้า (metro)	O	O

Significant Variable in the model:

- Cost of Travel
- Time of Travel
- Gender (Male, Female), and
- Household Incomes (<20k, 20k to 40k, and >40k)



Mode Choice Model (Primary Trips)

Variable	Value	Std err	t-test	p-value	Definition
asc_bus***	-4.70E+00	3.07E-01	-1.53E+01	0.00000	Bus
asc_mcTaxi***	-2.78E+00	1.74E-01	-1.60E+01	0.00000	Motorcycle Taxi
asc_metro***	-6.24E-01	1.43E-01	-4.36E+00	0.00001	Metro
asc_private_veh***	-3.25E-01	1.42E-01	-2.29E+00	0.02204	Car
asc_taxi***	-5.68E+00	4.68E-01	-1.21E+01	0.00000	Taxi
b_cost_scaled***	-2.13E-14	9.19E-18	-2.31E+03	0.00000	Traveling costs (Baht)
b_tt_scaled***	-2.24E-13	5.78E-18	-3.87E+04	0.00000	Traveling times (Minutes)
b_female***	9.47E-12	7.46E-17	1.27E+05	0.00000	Female
b_male***	-2.50E-11	1.56E-16	-1.60E+05	0.00000	Male
b_hhinc20k40k***	-1.84E-11	2.41E-16	-7.64E+04	0.00000	Household incomes 20k-40k
b_hhincl20k***	2.92E-12	1.98E-18	1.48E+06	0.00000	Household incomes < 20k
b_hhincm40k***	-8.48E-14	1.20E-17	-7.05E+03	0.00000	Household incomes > 40k



Mode Choice Model (Secondary Trips)

Variable	Value	Std err	t-test	p-value	Definition
asc_mcTaxi***	1.13E+00	1.28E-01	8.870873	0.00E+00	Motorcycle-Taxi
asc_metro***	-2.30E+00	3.64E-01	-6.308655	2.81E-10	Metro (Rail)
asc_private_nmt***	2.63E+00	1.15E-01	22.800403	0.00E+00	Non-Motorize (Walk and Bike)
asc_private_veh***	6.17E-01	1.38E-01	4.485983	7.26E-06	Private Vehicle (Car)
asc_songtaew***	-1.51E+00	2.59E-01	-5.824896	5.71E-09	SongTaew
b_cost_scaled***	-1.30E-13	5.69E-19	-229042.7954	0.00E+00	Cost of Travel (Baht)
b_tt_scaled***	5.72E-13	1.07E-16	5362.638259	0.00E+00	Time of Travel (Minute)
b_female***	-5.39E-15	6.63E-17	-81.376704	0.00E+00	Female
b_male***	-8.10E-16	6.73E-17	-12.028724	0.00E+00	Male
b_hhinc20k40k***	-3.57E-15	1.13E-16	-31.510873	0.00E+00	Household Incomes 20k-40k
b_hhincl20k***	-4.46E-16	1.26E-17	-35.483134	0.00E+00	Household Incomes less than 20k
b_hhincm40k***	-2.19E-15	7.81E-18	-279.999315	0.00E+00	Household Incomes More than 40k

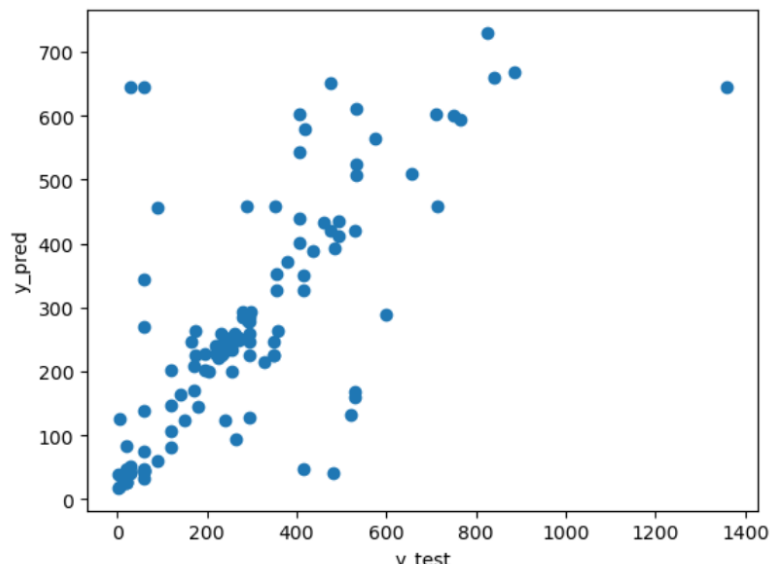


Activity Duration Model (Primary Trips)

Notes:

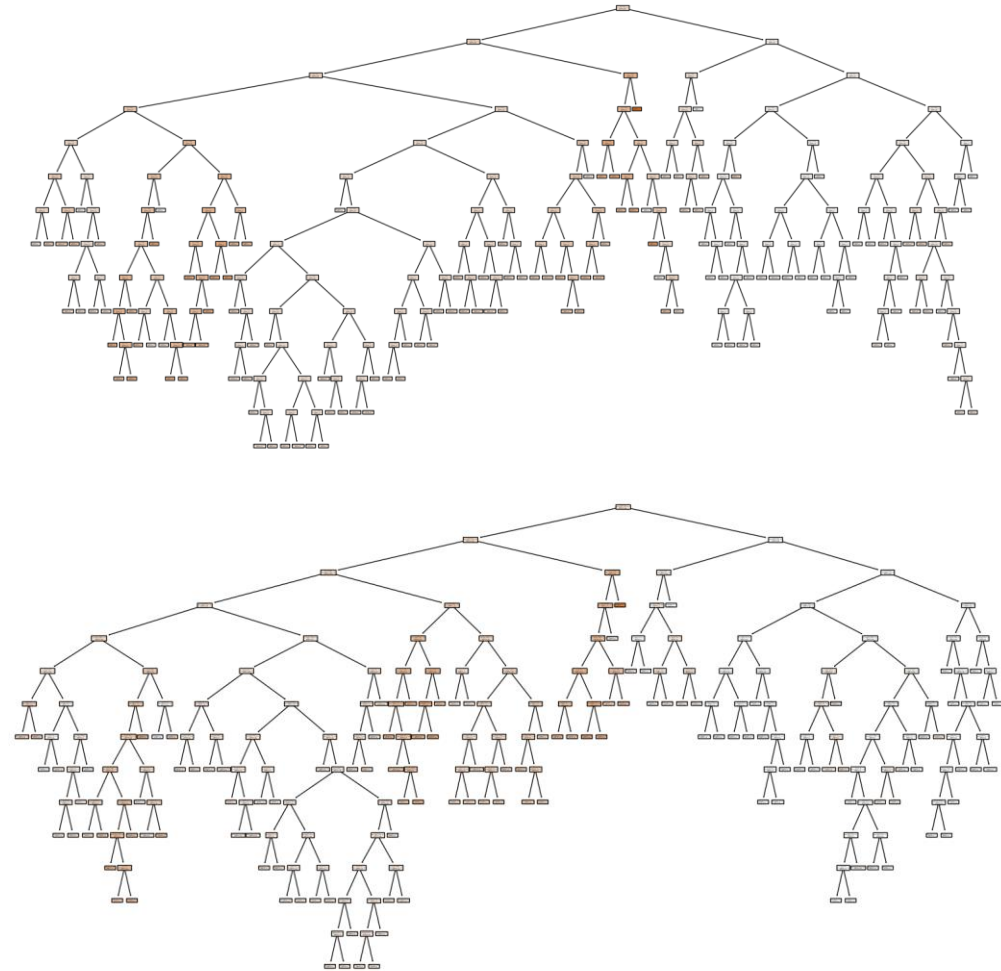
Making results from the activity duration model more accurate,

the model was changed from a single regression tree to a random forest tree model (100 trees were created for the model).



*** Testing Samples (30%) Training Samples (70%)

Examples of Tree Structures Create from The model (2 out of 100 Trees)

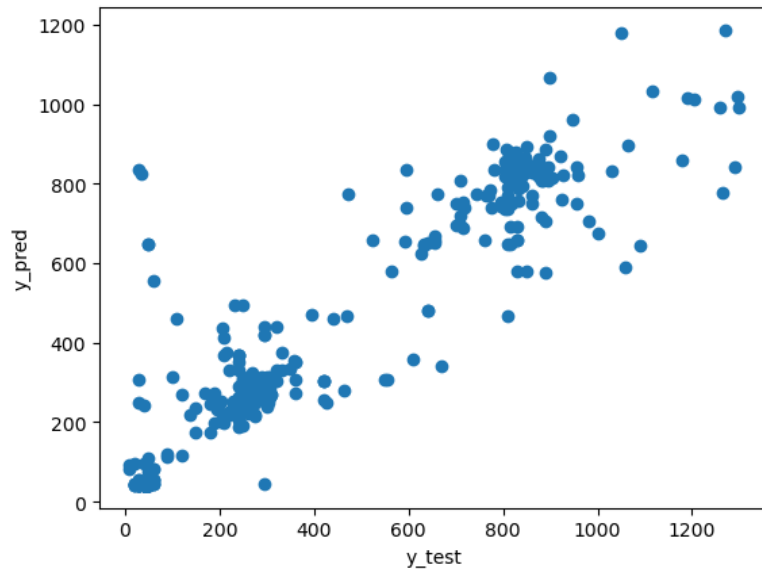




Activity Duration Model (Secondary Trips)

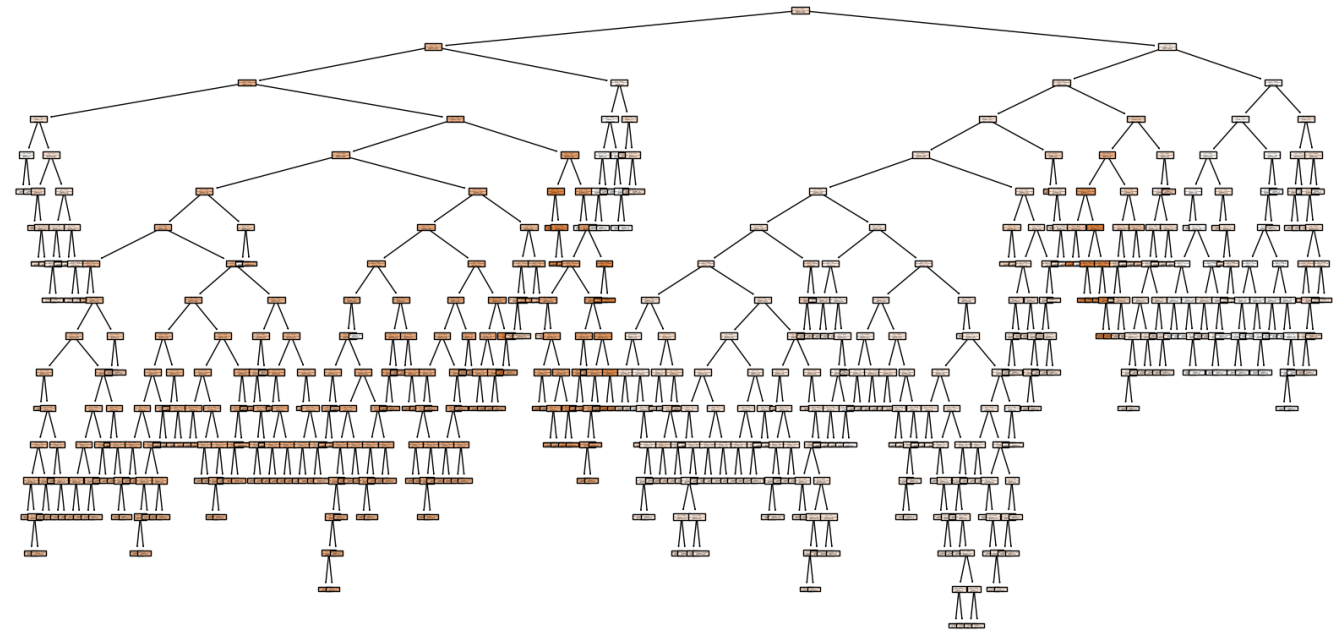
Notes:

Making results from the activity duration model more accurate, the model **was changed from a single regression tree to a random forest tree model (100 trees were created for the model).**



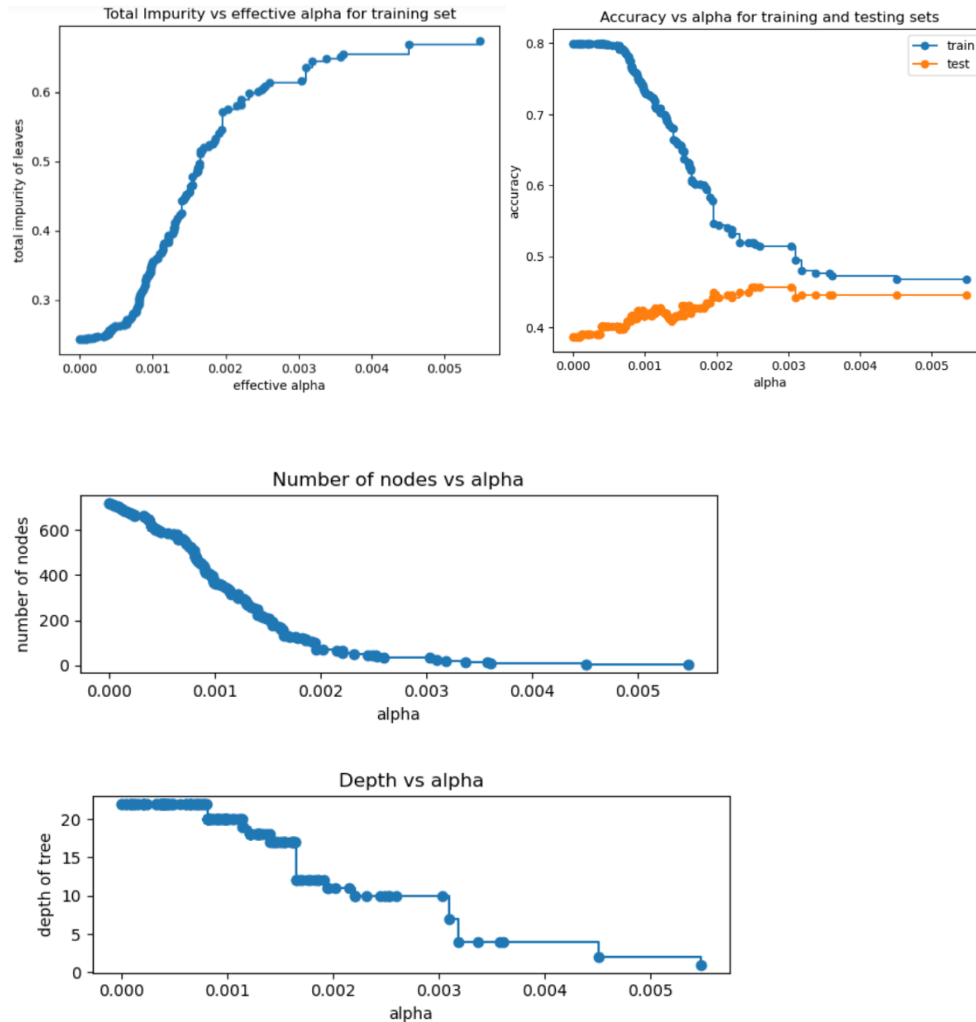
*** Testing Samples (30%) Training Samples (70%)

Examples of Tree Structures Create from The model (1 out of 100 Trees)

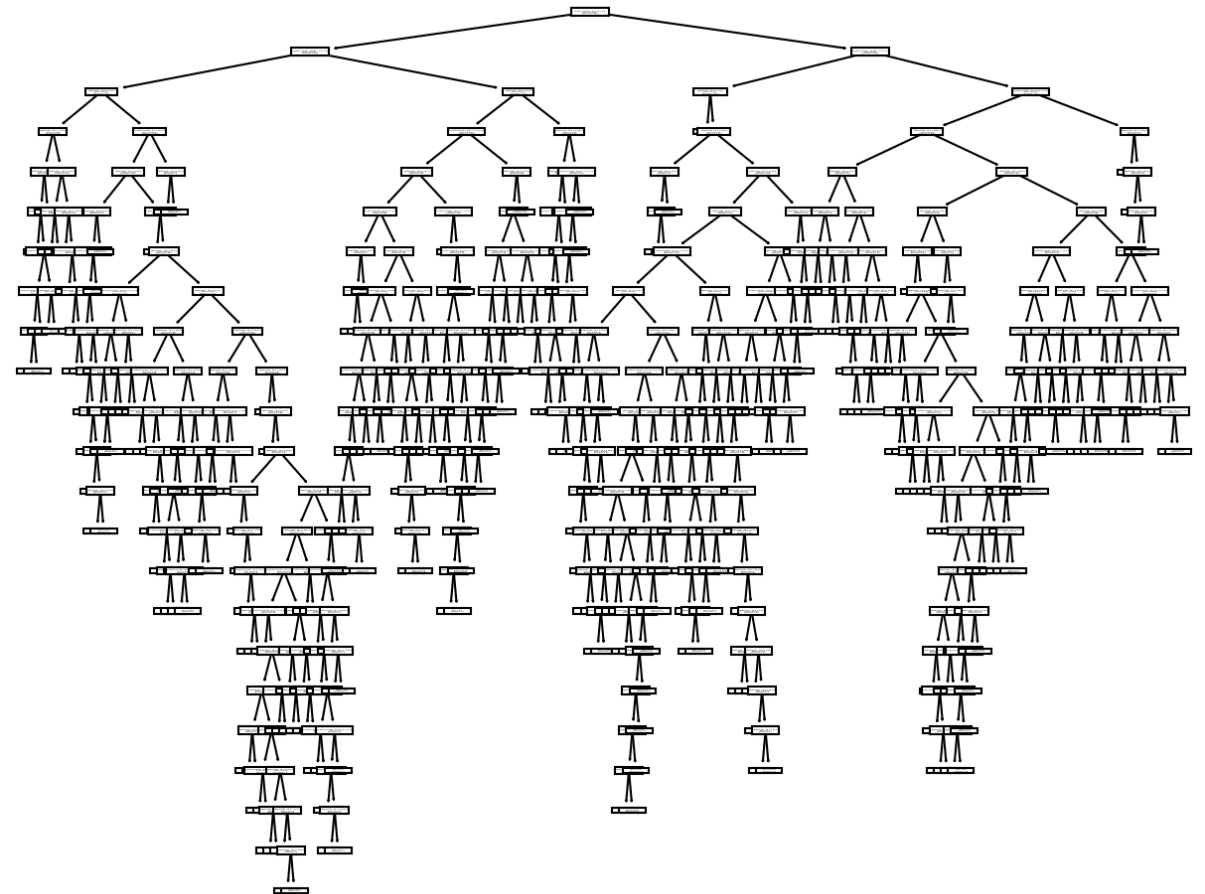




Activity Travel Distance Model



X: "tp": time pocket, "gender": gender, "hhincc": household incomes,
"Dc": Destination Activity
Y: Distance Travel for Activities

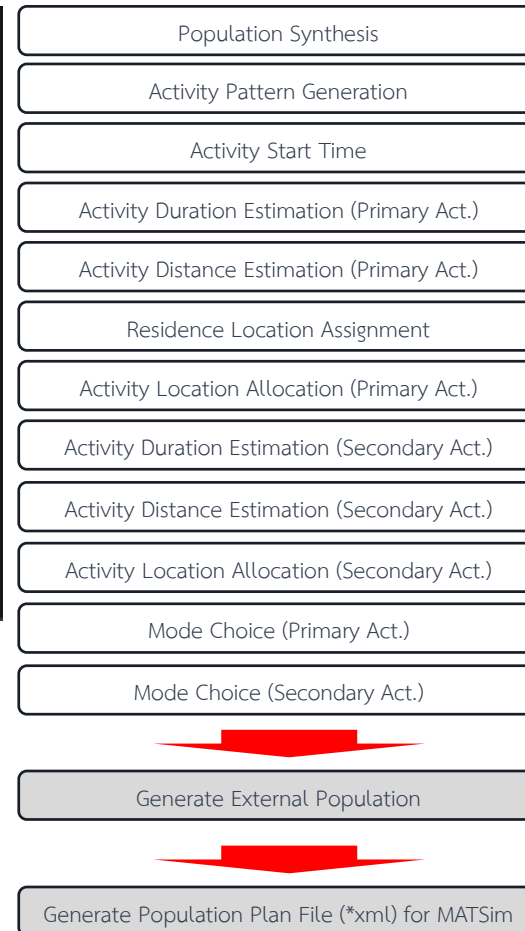




All Model Codes (ACTIVITY PATTERN GENERATION)

Population and Activity Schedule Synthetic Data:

- 01_populationSynthesis.py
- 02_activityPatternGen.py
- 03_activityStartTime.py
- 04_activityDurationPrimary.py
- 05_activityPrimaryDist.py
- 06_residentialLocationChoice.py
- 07_primaryActivityLocationChoice.py
- 08_activityDurationSecondary.py
- 09_activitySecondaryDist.py
- 10_secondaryActivityLocationChoice.py
- 11_primaryModeChoice.py
- 12_secondaryModeChoice.py
- 13_creatingPlanfile_xml.py
- 14_createExternalPop.py



id	Population ID
i	Gender
j	Occupation
k	Household Incomes
l	Household Size
m	Vehicle Ownership
pri_act	Primary Activities
sec_act	Secondary Activities
act_pattern	Activity Pattern
act_startperiod	Activity Start Time Period (AM, OFF AM, PM, OFF PM)
act_starttime	Activity Start Time
pri_act_dur	Primary Activity Duration
pri_tdist	Activity Travel Distance
res_loc	Residence Location
pri_loc	Primary Activity Location
pri_ttime_pri	Primary Travel Time (Private)
pri_ttime_pub	Primary Travel Time (Public) ** no data for some zones
pri_tdst_pri	Primary Travel Distance (Private)
pri_tdst_pub	Primary Travel Distance (Public)
sec_act_dur	Secondary Activity Duration
sec_tdist	Secondary Travel Distance
sec_loc	Secondary Activity Location
sec_ttime_pri	Secondary Travel Time (Private)
sec_ttime_pub	Secondary Travel Time (Public) ** no data for some zones
sec_tdst_pri	Secondary Travel Distance (Private)
sec_tdst_pub	Secondary Travel Distance (Public)
mode_pri	Primary Mode
mode_sec	Secondary Mode



OUTPUTS FROM SCHEDULE GENERATION

Notes:

Residences in the study area: 114,224 persons

External Population: 80,000 persons (only those traveling by metro)

	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1	id	i	j	k	l	m	pri_act	sec_act	act_pattern	act_startperiod	act_starttime	pri_act_dur	pri_tdist	res_loc	pri_loc	pri_ttime_pri	pri_ttime_pub	pri_tdst_pri	pri_tdst_pub	sec_act_dur	sec_tdist	sec_loc	sec_ttime_pri	sec_ttime_pub	sec_tdst_pri	sec_tdst_pub	mode_pri	mode_sec
2	0	0	0	0	1	0	work	none	h-w-h	amP	9:42:00	618.6	1	64	47	8.516666667	17.78333333	1858	1410	0	1	64	9.116666667	17.25	2667	1410	car	car
3	1	0	0	0	1	0	work	none	h-w-h	amP	9:06:00	579	2	53	4	7.7	31.61666667	3052	2510	0	2	53	6.716666667	32.61666667	3592	2716	metro	metro
4	2	0	0	0	1	0	work	none	h-w-h	amP	8:12:00	407.7	3	53	1007	20.3	46.3	7011	7566	0	3	53	19.1	47.2	12488	7474	metro	metro
5	3	0	0	0	1	0	work	none	h-w-h	amP	8:12:00	407.7	3	27	1007	19.41666667	44.7	7126	8207	0	3	27	20.13333333	50.43333333	7386	6577	metro	metro
6	4	0	0	0	1	0	work	none	h-w-h	amP	9:06:00	579	2	53	1017	5.116666667	27.31666667	2157	2855	0	2	53	5.5	28.86666667	2629	3618	car	car
7	5	0	0	0	1	0	work	none	h-w-h	amP	8:54:00	579	2	36	1017	9.916666667	40.61666667	3887	4590	0	2	36	12.05	42.33333333	5532	5268	metro	metro
8	6	0	0	0	1	0	work	none	h-w-h	amP	9:18:00	586.5	2	9	44	12.65	42.75	4817	6861	0	2	9	10.16666667	45.26666667	3731	3788	metro	metro
9	7	0	0	0	1	0	work	none	h-w-h	amP	9:00:00	579	2	67	17	7.983333333	33.61666667	3298	2685	0	2	67	8.283333333	33.68333333	3292	2685	metro	metro
10	8	0	0	0	1	0	work	none	h-w-h	amP	8:00:00	408.3	3	53	1030	13.06666667	49.86666667	8172	8426	0	3	53	18.1	44.25	12298	7658	songtaew	songtaew
11	9	0	0	0	1	0	work	none	h-w-h	amP	8:18:00	281.3	3	32	8	14	50.25	7173	3702	0	3	32	10.58333333	53.13333333	3782	3478	metro	metro
12	10	0	0	0	1	0	work	none	h-w-h	amP	8:48:00	534.6	2	43	44	6.933333333	33.21666667	3045	5328	0	2	43	10.75	31.7	4308	3038	metro	metro
13	11	0	0	0	1	0	work	none	h-w-h	amP	9:00:00	579	2	26	28	8.183333333	19.55	3070	1818	0	2	26	5.983333333	14.73333333	1742	1757	metro	metro
14	12	0	0	0	1	0	work	none	h-w-h	amP	10:00:00	388.1	1	4	70	2.45	10.1	839	838	0	1	4	3.366666667	10.35	893	838	metro	metro
15	13	0	0	0	1	0	work	none	h-w-h	amP	9:06:00	579	2	4	8	4.7	23.45	2067	1931	0	2	4	5.466666667	23.38333333	2121	1931	metro	metro
16	14	0	0	0	1	0	work	none	h-w-h	amP	9:00:00	579	2	56	1026	12.56666667	55.96666667	4406	4489	0	2	56	14.9	55.13333333	5533	4406	metro	metro
17	15	0	0	0	1	0	work	none	h-w-h	amP	7:54:00	501.7	1	56	8	4.483333333	22.3	1776	1828	0	1	56	4.45	22.08333333	1776	1828	metro	metro
18	16	0	0	0	1	0	work	none	h-w-h	amP	9:30:00	618.6	1	56	4	2.2	5.533333333	511	449	0	1	56	1.066666667	5.433333333	456	449	walk	walk
19	17	0	0	0	1	0	work	none	h-w-h	amP	8:54:00	579	2	4	33	8.25	14.1	3210	1104	0	2	4	3.966666667	14.03333333	1104	1104	metro	metro
20	18	0	0	0	1	0	work	none	h-w-h	amP	8:42:00	408.9	1	24	43	5.75	17.4	1738	1342	0	1	24	7.616666667	17.2	2861	1342	mcTaxi	mcTaxi
21	19	0	0	0	1	0	work	none	h-w-h	amP	9:54:00	389.3	1	34	1037	9.733333333	49.28333333	4729	4224	0	1	34	8.216666667	45.23333333	3990	3900	metro	metro
22	20	0	0	0	1	0	work	none	h-w-h	amP	8:36:00	408.9	1	50	43	7.233333333	32.46666667	1976	2362	0	1	50	8.716666667	35.36666667	4666	2074	metro	metro
23	21	0	0	0	1	0	work	none	h-w-h	amP	9:06:00	579	2	6	5	8.016666667	27.81666667	2037	1706	0	2	6	6.066666667	30.3	1925	1730	mcTaxi	mcTaxi
24	22	0	0	0	1	0	work	none	h-w-h	amP	9:36:00	618.6	1	28	66	7.35	22.71666667	1915	1935	0	1	28	10.33333333	24	3322	2172	metro	metro
25	23	0	0	0	1	0	work	none	h-w-h	amP	8:54:00	579	2	14	1017	6.35	24.18333333	2107	2465	0	2	14	8.55	30.08333333	3383	3727	metro	metro
26	24	0	0	0	1	0	work	none	h-w-h	amP	9:24:00	676.6	2	53	51	11.03333333	37.53333333	4280	4380	0	2	53	9.866666667	27.83333333	3864	4430	car	car
27	25	0	0	0	1	0	work	none	h-w-h	amP	9:36:00	618.6	1	73	1026	6.116666667	21.6	1814	1757	0	1	73	6.583333333	21.56666667	2008	1757	metro	metro
28	26	0	0	0	1	0	work	none	h-w-h	amP	8:24:00	290.8	1	53	44	2.933333333	21.71666667	1164	1722	0	1	53	5.533333333	19.51666667	2378	1502	metro	metro
29	27	0	0	0	1	0	work	none	h-w-h	amP	8:06:00	408.3	3	68	1014	19.36666667	47.7	9786	12736	0	3	68	19.36666667	47.7	9786	12736	metro	metro
30	28	0	0	0	1	0	work	none	h-w-h	amP	8:18:00	281.3	3	33	1014	13.53333333	44.26666667	7701	12809	0	3	33	13.53333333	44.26666667	7701	12809	metro	metro
31	29	0	0	0	1	0	work	none	h-w-h	amP	7:36:00	564.3	1	53	44	2.933333333	21.71666667	1164	1722	0	1	53	5.533333333	19.51666667	2378	1502	metro	metro
32	30	0	0	0	1	0	work	none	h-w-h	amP	8:36:00	408.9	1	30	21	4.55	17.63333333	1461	1733	0	1	30	4.55	17.63333333	1461	1733	metro	metro

*** Example for the first 30 population in the database

*** Example for the first 30 population in the database



OUTPUT PLANFILE FOR MATSIM (TRANSFORM FROM GENERATED ACTIVITY SHCHEDULE DATA)

```
<population>
  <person id="1">
    <plan>
      <act type="home" x="5.0" y="8.0" end_time="08:00:00" />
      <leg mode="car" />
      <act type="work" x="1500.0" y="890.0" end_time="17:30:00" />
      <leg mode="car" />
      <act type="home" x="5.0" y="8.0" />
    </plan>
  </person>
  <person id="2">
    ...
  </person>
</population>
```

Notes:

Type : activities

Mode : traveling modes

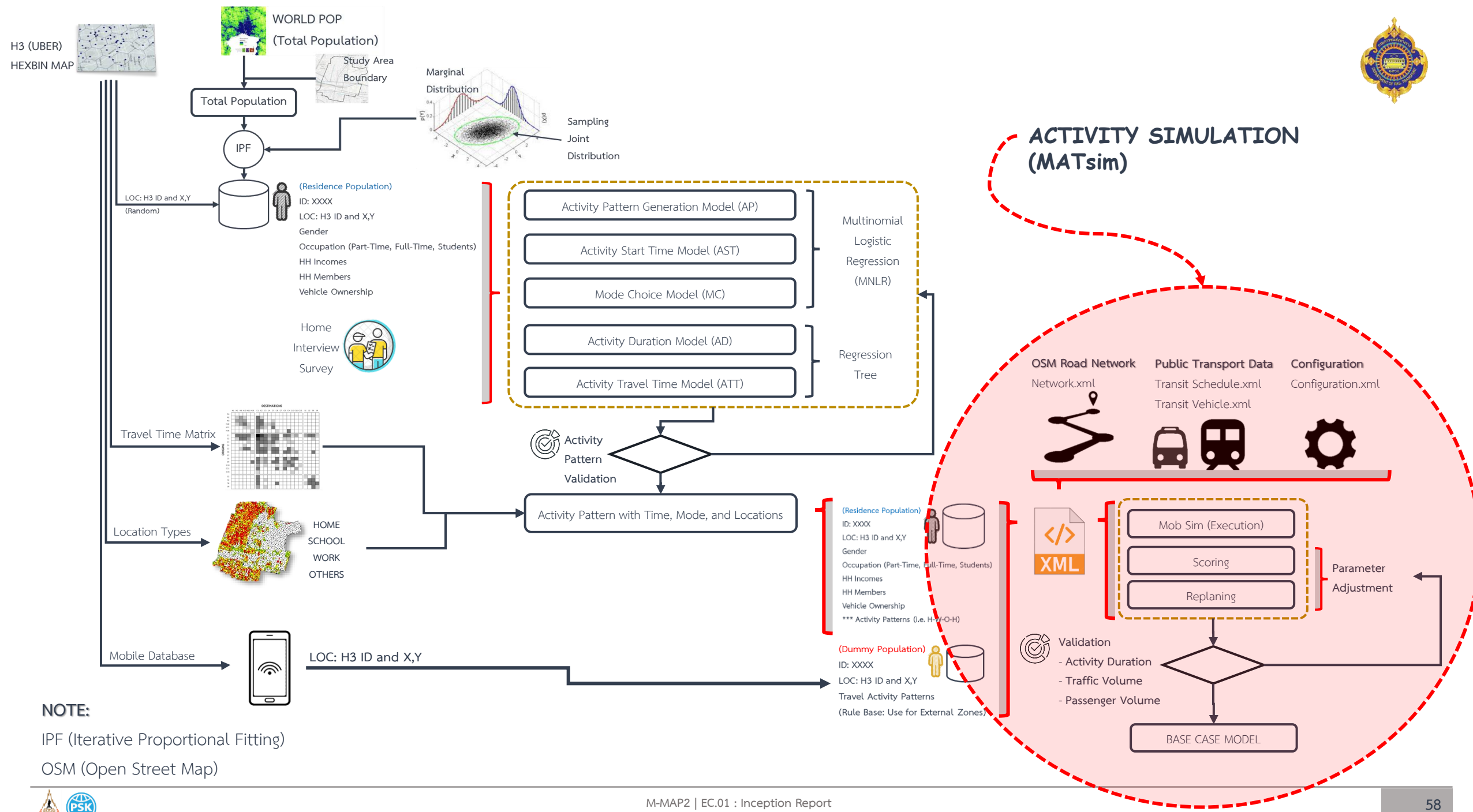
x : x coordinate

y : y coordinate

end_time : activity end time

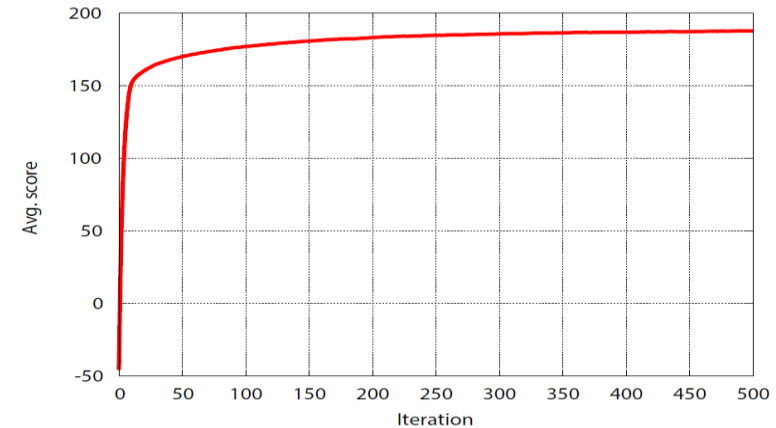
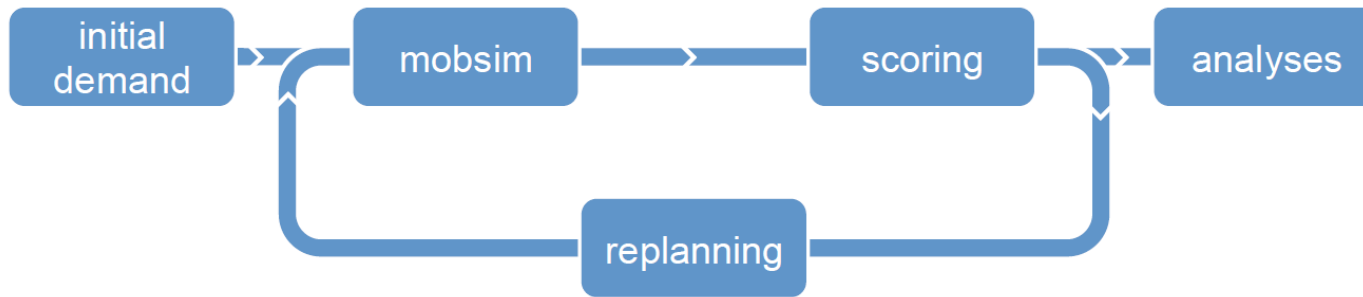
Residences in the study area: 114,224 persons

External Population: 80,000 persons (only those traveling by metro)





REVIEW OF MATsim Processes



- For each iteration, the Replanning process will suggest the best-modified schedule (schedule with the best score) and keep it in the agents' memory.
- Replanning in MATsim will change "mode", "travel time (activity location), and "route".
- The overall process will be stopped after converging (average score)
- Hence, the output schedule will be the best suggests after modified from several iterations.
- The final schedule and link volume (car and passengers) will be validated with the survey data.
- Scoring and Replanning will be manually adjusted (as needed), then model execution will be run again



SCORING

● = use in this project

$$S_{plan} = \sum_{q=0}^{N-1} S_{act,q} + \sum_{q=0}^{N-1} S_{trav,mode(q)}$$

$$S_{act,q} = S_{dur,q} + S_{late.ar,q}$$

$$S_{trav,q} = C_{mode(q)} + \beta_{trav,mode(q)} \cdot t_{trav,q} + \beta_m \cdot \Delta m_q$$



SCORING

● = use in this project

$$S_{act,q} = S_{dur,q} + S_{late.ar,q}$$

$$S_{dur,q} = \beta_{dur} \cdot t_{typ,q} \cdot \ln(t_{dur,q}/t_{0,q})$$

$S_{dur,q}$ is the utility of performing activity q , where opening times of activity locations are considered. $t_{dur,q}$ is the performed activity duration, β_{dur} is marginal utility of time as a resource (same value for all activities), and $t_{0,q}$ is the duration when utility starts to be positive.

$$S_{late.ar,q} = \begin{cases} \beta_{late.ar} \cdot (t_{start,q} - t_{latest.ar,q}), & \text{if } t_{start,q} > t_{latest.ar,q} \\ 0, & \text{else} \end{cases}$$

$S_{late.ar,q}$ specifies the late arrival penalty, where $t_{start,q}$ is the activity q starting time and $t_{latest.ar,q}$ is the latest possible penalty-free activity starting time (for example, the starting time of the office core hours, an opera or theater performance).



REPLANNING



Note: 0.2,0.1,0.1,0.7 is the initial weight set up as default (recommended by the guide line) for the replanning processing



MATSim Program and its file structure



Model Configuration File

- Base.xml
- Base_Alt1.xml
- mode-vehicles.xml
- network.xml
- network_new.xml
- populationAllv4.xml
- transitSchedule_NOSRTv2.xml
- transitVehicle.xml
- transitVehicle_NOSRT.xml

ITERS	5/7/2023 10:30 AM	File folder
tmp	5/6/2023 11:37 PM	File folder
logfile.log	5/7/2023 12:29 AM	Text Document
logfileWarningsErrors.log	5/7/2023 12:29 AM	Text Document
modestats.txt	5/7/2023 12:28 AM	Text Document
output_allVehicles.xml.gz	5/7/2023 12:29 AM	GZ File
output_config.xml	5/7/2023 12:29 AM	XML File
output_config_reduced.xml	5/7/2023 12:29 AM	XML File
output_counts.xml.gz	5/7/2023 12:29 AM	GZ File
output_events.xml.gz	5/7/2023 12:28 AM	GZ File
output_facilities.xml.gz	5/7/2023 12:29 AM	GZ File
output_households.xml.gz	5/7/2023 12:29 AM	GZ File
output_legs.csv.gz	5/7/2023 12:28 AM	GZ File
output_network.xml.gz	5/7/2023 12:29 AM	GZ File
output_persons.csv.gz	5/7/2023 12:29 AM	GZ File
output_plans.xml.gz	5/7/2023 12:29 AM	GZ File
output_transitSchedule.xml.gz	5/7/2023 12:29 AM	GZ File
output_transitVehicles.xml.gz	5/7/2023 12:29 AM	GZ File
output_trips.csv.gz	5/7/2023 12:28 AM	GZ File
output_vehicles.xml.gz	5/7/2023 12:29 AM	GZ File
ph_modestats.txt	5/7/2023 12:28 AM	Text Document
pkm_modestats.txt	5/7/2023 12:28 AM	Text Document
scorestats.txt	5/7/2023 12:28 AM	Text Document
stopwatch.txt	5/7/2023 12:28 AM	Text Document
traveldistancestats.txt	5/7/2023 12:28 AM	Text Document



config.xml

```
C:\Users\Admins\Desktop\matsim-13.0\examples\pt-simple\config.xml - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
config.xml x
1 <?xml version="1.0" ?>
2 <!DOCTYPE config SYSTEM "http://www.matsim.org/files/dtd/config_v2.dtd">
3 <config>
4
5   <module name="global">
6     <param name="randomSeed" value="4711" />
7     <param name="coordinateSystem" value="gk3" />
8   </module>
9
10  <module name="network">
11    <param name="inputNetworkFile" value="network.xml" />
12  </module>
13
14  <module name="plans">
15    <param name="inputPlansFile" value="population.xml" />
16  </module>
17
18  <module name="transit">
19    <param name="useTransit" value="true" />
20    <param name="transitScheduleFile" value="transitschedule.xml" />
21    <param name="vehiclesFile" value="transitVehicles.xml" />
22    <param name="transitModes" value="pt" />
23  </module>
24
25  <module name="TimeAllocationMutator">
26    <param name="mutationRange" value="7200.0"/>
27  </module>
28
29  <module name="controler">
30    <param name="firstIteration" value="0" />
31    <param name="lastIteration" value="0" />
32    <param name="eventsFileFormat" value="xml" />
33    <param name="writeEventsInterval" value="1" />
34    <param name="writePlansInterval" value="50" />
35  </module>
36
37  <module name="qsim">
```

eXtensible Markup Language file length : 4,093 lines : 121 Ln : 1 Col : 1 Pos : 1 Unix (LF) UTF-8 INS



network.xml

C:\Users\Admins\Desktop\matSim-13.0\examples\pt-simple\network.xml - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?



network.xml

```
1 <?xml version="1.0" encoding="utf-8"?>
2 <!DOCTYPE network SYSTEM "http://matSim.org/files/dtd/network_v1.dtd">
3 <network>
4   <nodes>
5     <node x="0.0" y="0.0" id="1" />
6     <node x="10.0" y="0.0" id="2" />
7     <node x="20.0" y="0.0" id="3" />
8     <node x="2000.0" y="0.0" id="4" />
9     <node x="2010.0" y="0.0" id="5" />
10    <node x="2020.0" y="0.0" id="6" />
11  </nodes>
12
13  <links capperiod="10:00:00">
14    <link id="1-2" modes="pt" permlanes="1" capacity="2000" freespeed="22" length="10" to="2" from="1"/>
15    <link id="2-3" modes="pt" permlanes="1" capacity="2000" freespeed="22" length="10" to="3" from="2"/>
16    <link id="3-4" modes="pt" permlanes="1" capacity="2000" freespeed="22" length="1980" to="4" from="3"/>
17    <link id="4-5" modes="pt" permlanes="1" capacity="2000" freespeed="22" length="10" to="5" from="4"/>
18    <link id="5-6" modes="pt" permlanes="1" capacity="2000" freespeed="22" length="10" to="6" from="5"/>
19  </links>
20 </network>
21
```

population.xml

```
C:\Users\Admins\Desktop\matsim-13.0\examples\pt-simple\population.xml - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
[Icons]
population.xml x
1  <?xml version="1.0" encoding="utf-8"?>
2  <!DOCTYPE plans SYSTEM "http://www.matsim.org/files/dtd/plans_v4.dtd">
3  <plans>
4    <person employed="no" age="12" id="1">
5      <plan selected="yes">
6        <act end_time="05:01:00" y="10" x="0" type="home"/>
7        <leg mode="pt"/>
8        <act end_time="12:35:00" y="10" x="2015" type="home"/>
9      </plan>
10   </person>
11 </plans>
12
```

transitschedule.xml

```
C:\Users\Admins\Desktop\matim-13.0\examples\pt-simple\transitschedule.xml - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
transitschedule.xml x
1  <?xml version="1.0" encoding="UTF-8"?>
2  <!DOCTYPE transitSchedule SYSTEM "http://www.matsim.org/files/dtd/transitSchedule_v1.dtd">
3  <transitSchedule>
4  <transitStops>
5    <stopFacility id="192" x="05" y="0" linkRefId="1-2"/>
6    <stopFacility id="293" x="15" y="0" linkRefId="2-3"/>
7    <stopFacility id="495" x="2005" y="0" linkRefId="4-5"/>
8    <stopFacility id="596" x="2015" y="0" linkRefId="5-6"/>
9  </transitStops>
10 <transitLine id="gelb">
11   <transitRoute id="gelb_1">
12     <transportMode>pt</transportMode>
13     <routeProfile>
14       <stop refId="192" departureOffset="00:00:00" arrivalOffset="00:00:00" awaitDeparture="true"/>
15       <stop refId="293" departureOffset="00:00:30" arrivalOffset="00:00:30" awaitDeparture="true"/>
16       <stop refId="495" departureOffset="00:30:00" arrivalOffset="00:30:00" awaitDeparture="true"/>
17       <stop refId="596" departureOffset="00:30:30" arrivalOffset="00:30:30" awaitDeparture="true"/>
18     </routeProfile>
19     <route>
20       <link refId="1-2"/>
21       <link refId="2-3"/>
22       <link refId="3-4"/>
23       <link refId="4-5"/>
24       <link refId="5-6"/>
25     </route>
26     <departures>
27       <departure id="1000" departureTime="05:05:00" vehicleRefId="1000"/>
28     </departures>
29   </transitRoute>
30 </transitLine>
31 </transitSchedule>
32
```



transitVehicles.xml

*C:\Users\Admins\Desktop\matSim-13.0\examples\pt-simple\transitVehicles.xml - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?



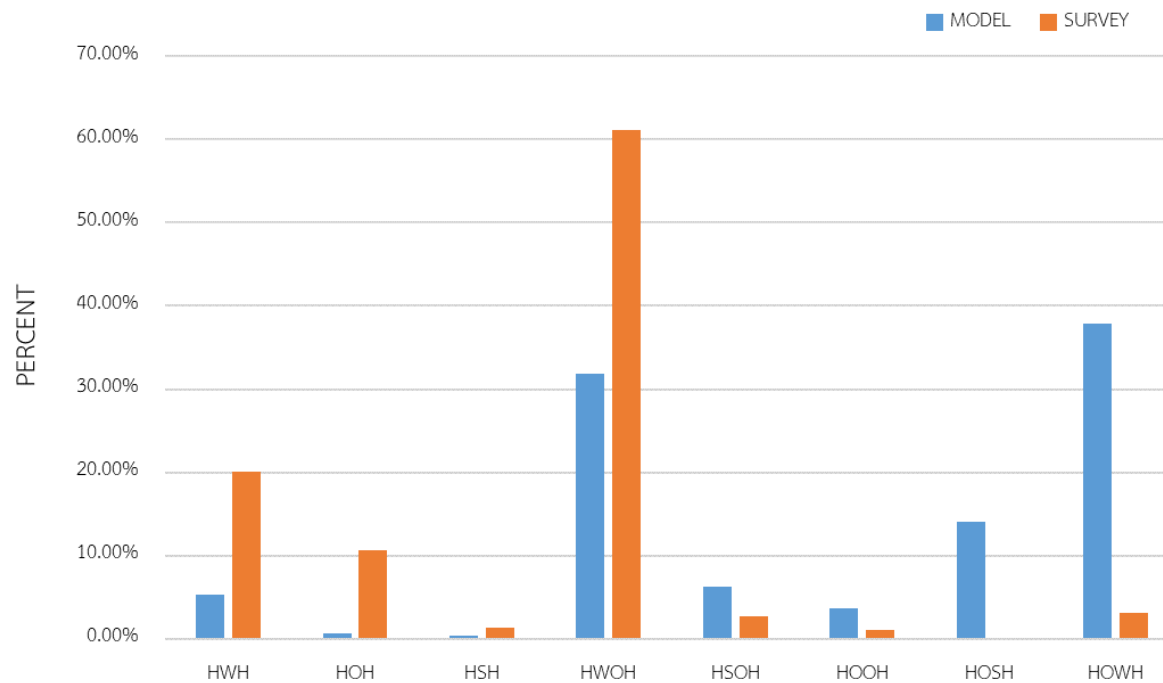
```
transitVehicles.xml x
1  <?xml version="1.0" encoding="UTF-8"?>
2  <vehicleDefinitions xmlns="http://www.matsim.org/files/dtd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
3  xsi:schemaLocation="http://www.matsim.org/files/dtd http://www.matsim.org/files/dtd/vehicleDefinitions_v1.0.xsd">
4  <vehicleType id="1">
5      <description>pt</description>
6      <capacity>
7          <seats persons="50"/>
8          <standingRoom persons="100"/>
9      </capacity>
10     <length meter="12"/>
11 </vehicleType>
12 <vehicle id="1000" type="1"/>
13 </vehicleDefinitions>
14
```



RESULTS OF MODEL (MATSIM) VALIDATIONS

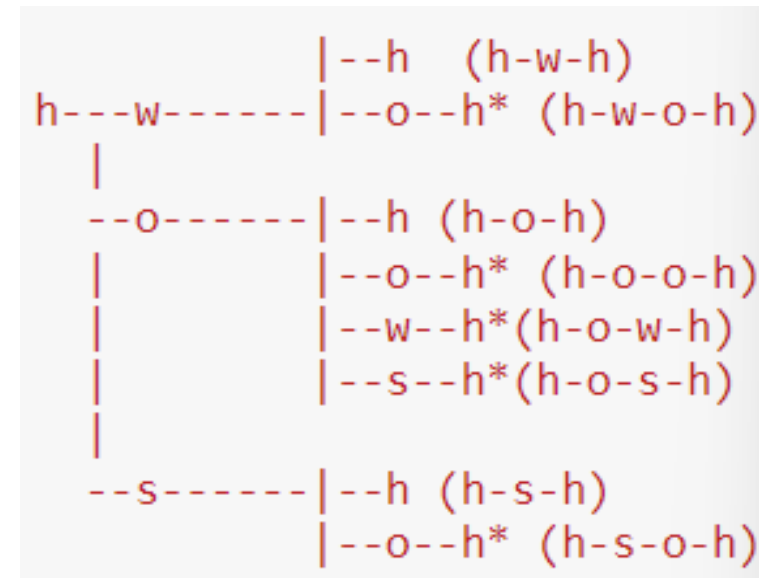


ACTIVITY PATTERNS



Notes:

The activity patterns of the population were adjusted based on the MATSIM simulation. The schedule will be different from those generated in the “Schedule Generation” Step present in the prior slides.





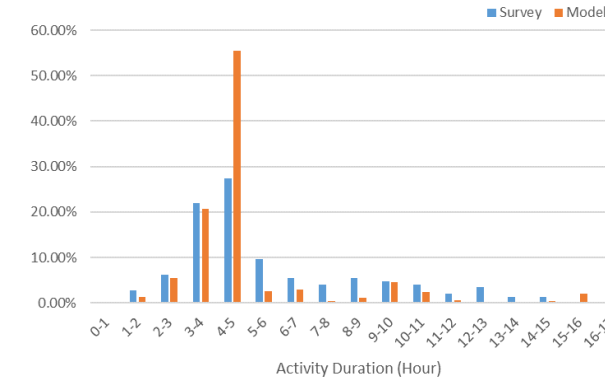
ACTIVITY DURATIONS (Hours)

Activity	Survey		Model	
	Average	SD	Average	SD
Work	5.86	3.03	5.00	2.40
School	4.12	2.15	2.68	0.69
Other	2.14	2.16	3.73	4.59

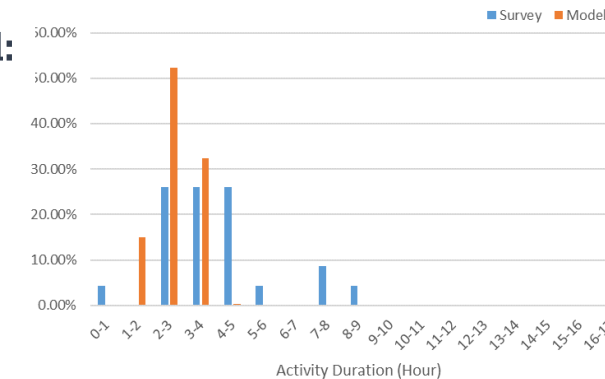
Notes:

School activity duration from the output plan file (generated from MATSIM simulation) is lesser than the survey. It found that patterns generated for the MATSIM for school trips are mostly involved with “Other” trip activities.

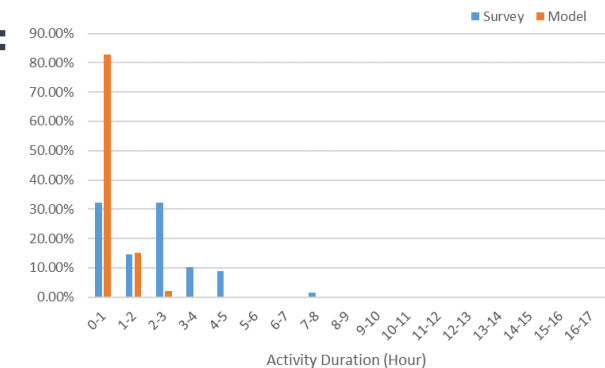
Work:



School:

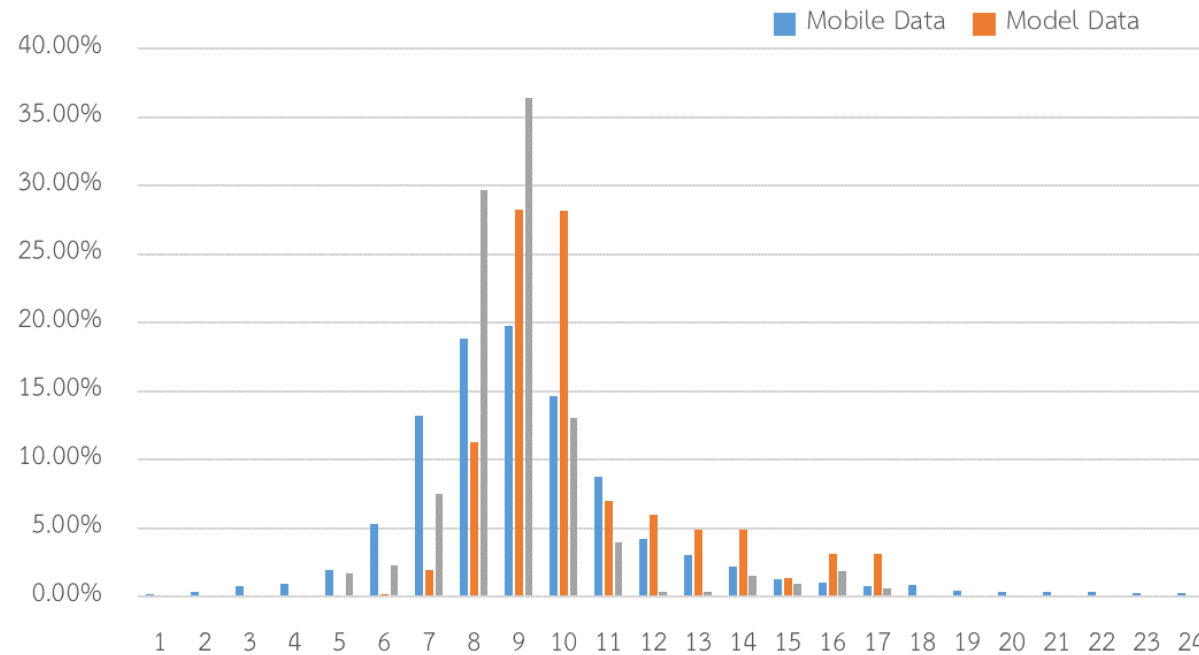


Other:





ACTIVITY START TIME (START TIME TO GO TO WORK FROM HOME)

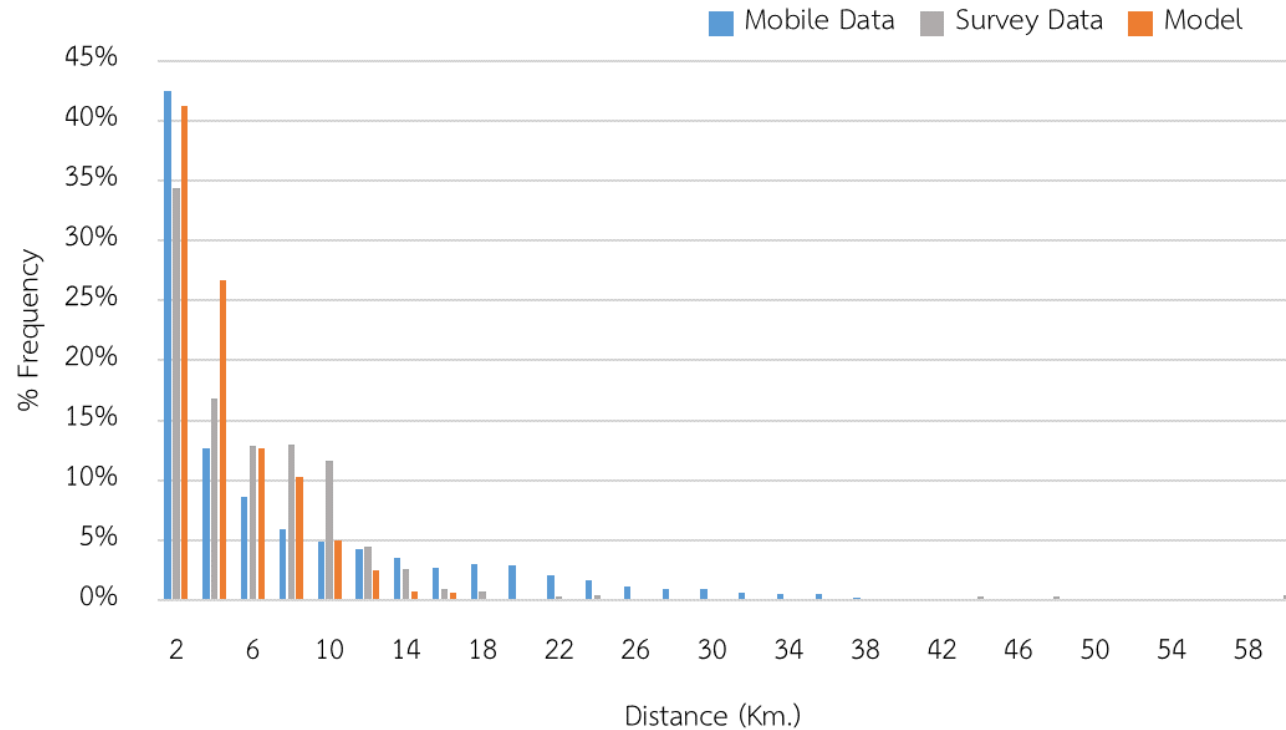


Notes:

Activity start times were caught up from the simulation and compared with both mobile data and survey data.



TRIP LENGTH DISTRIBUTION FOR WORK

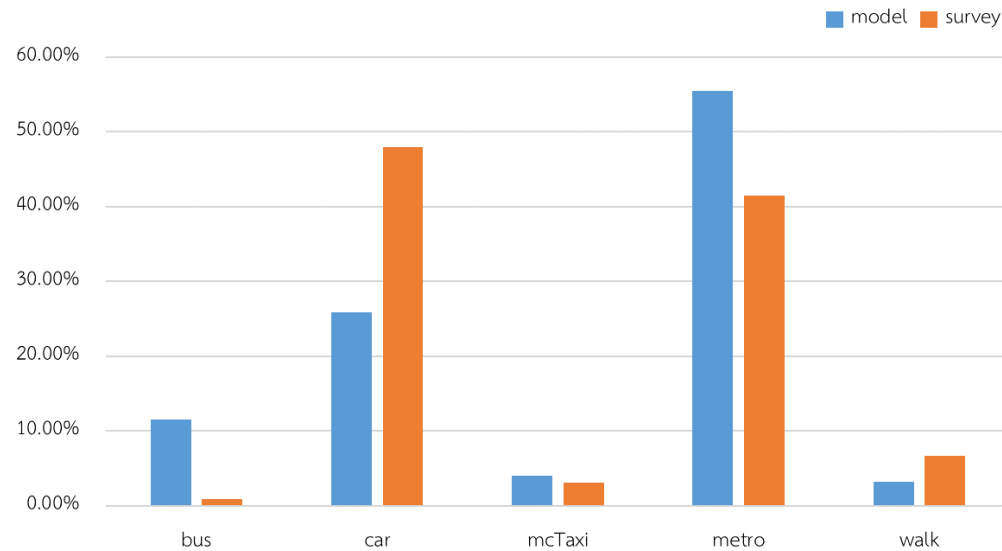


Notes:

Survey, Simulation (model), and Mobile Data results were comparable for trip length distribution for work.



MODE AND NUMBER OF PASSENGER ACCESS AND EGRESS THE STATIONS IN THE AREA



Data	Access	Egress	Total
Statistic in 2019	74,901	75,427	150,328
Model	76,805	73,825	150,630

Data	Thailand Cultural Center		Rama 9		Phetchaburi		Total
	Access	Egress	Access	Egress	Access	Egress	
Statistic in 2019	21,069	22,540	26,429	27,164	27,403	25,723	150,328
Model	42,146	33,763	23,055	28,312	11,604	11,750	150,630



CASE STUDY: Increasing Marginal Utility of Car (Mode)

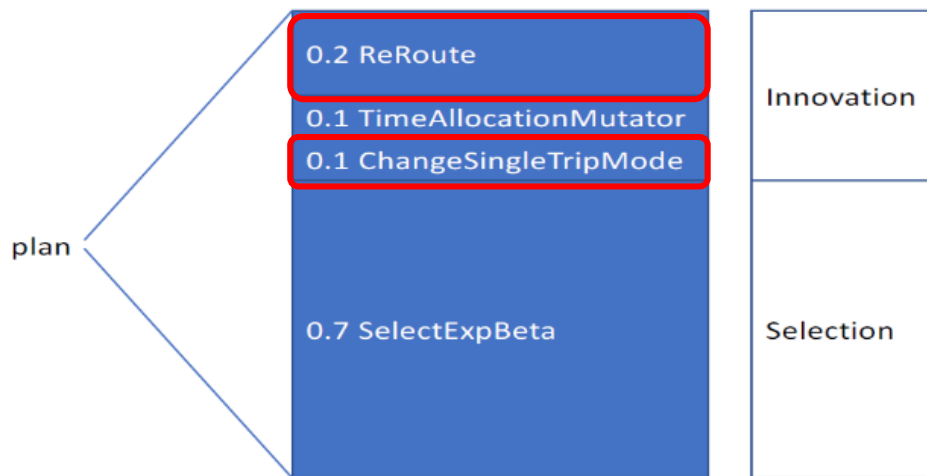


CASE STUDY: SHIFT MODE FROM CAR TO METRO

$$S_{trav,q} = C_{mode(q)} + \left[\beta_{trav,mode(q)} \cdot t_{trav,q} \right] + \beta_m \cdot \Delta m_q$$

Notes:

Testing the Policy which increasing the marginalUtilityOfTraveling for the private mode (for example the area pricing or cost of traveling by private vehicle).



Notes:

Setting MATSim to Consider only Reroute (0.4) and ChangeSingleTripMode (0.6) for the Replanning processes.



EXAMPLE OF SIMULATION OUTPUT FROM SIMWRAPPER

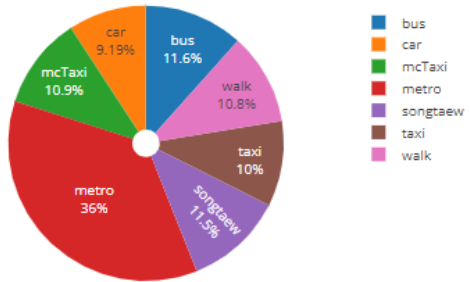


Summary Statistic

ABM Results Summary

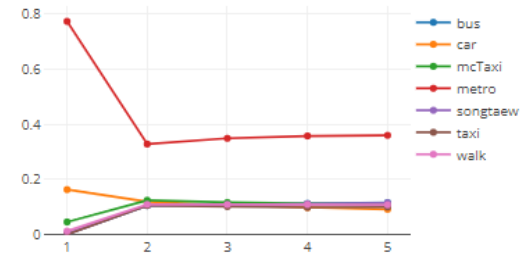
mode shares

By iteration



Mode Share vs. Iteration

For all modes in modstats.txt

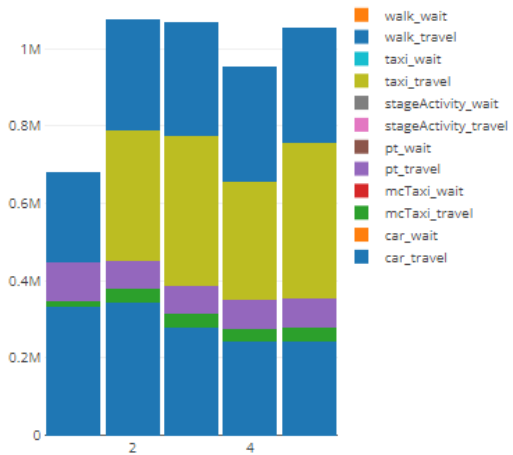


Notes:

Graph compares results for each iteration.

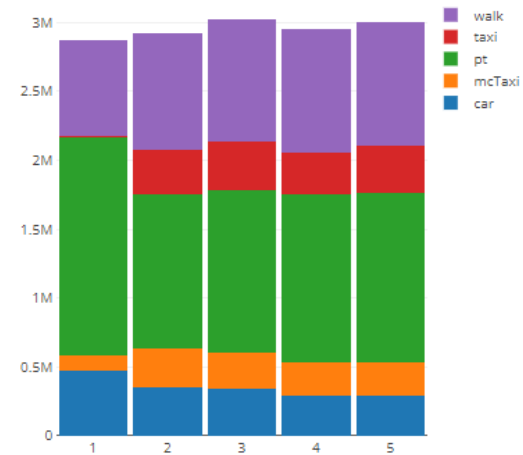
Passenger-hours traveled per mode

For all modes in modstats.txt



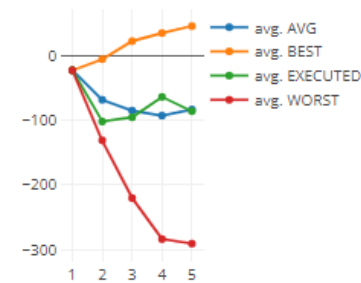
Passenger-kilometers traveled per mode

For all modes in modstats.txt



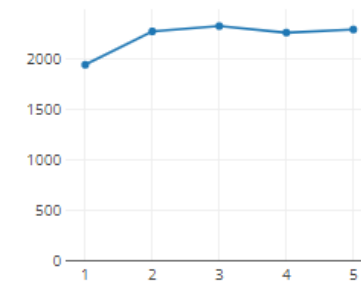
Score statistics

by iteration



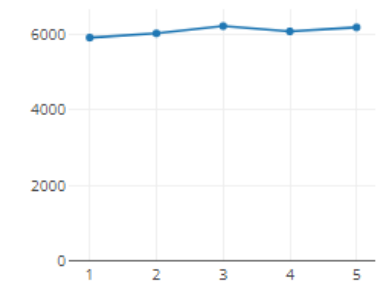
Leg travel distance statistics

avg. Average Leg distance



Trip travel distance statistics

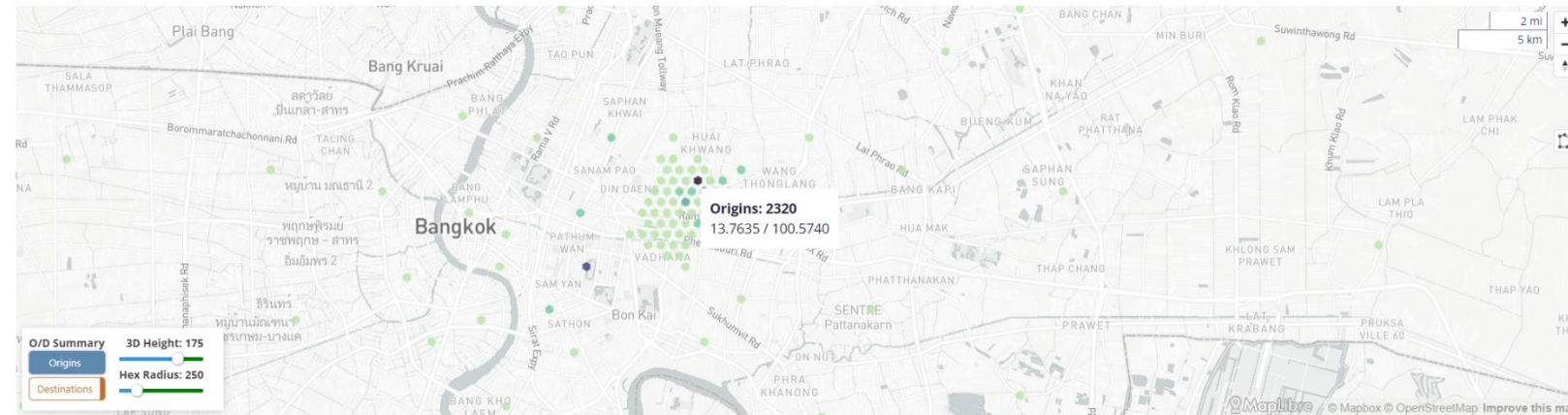
avg. Average Trip distance



Maps Etc

Origin - Destination for ABM Pilot Study Location

Total origins/destinations by zone

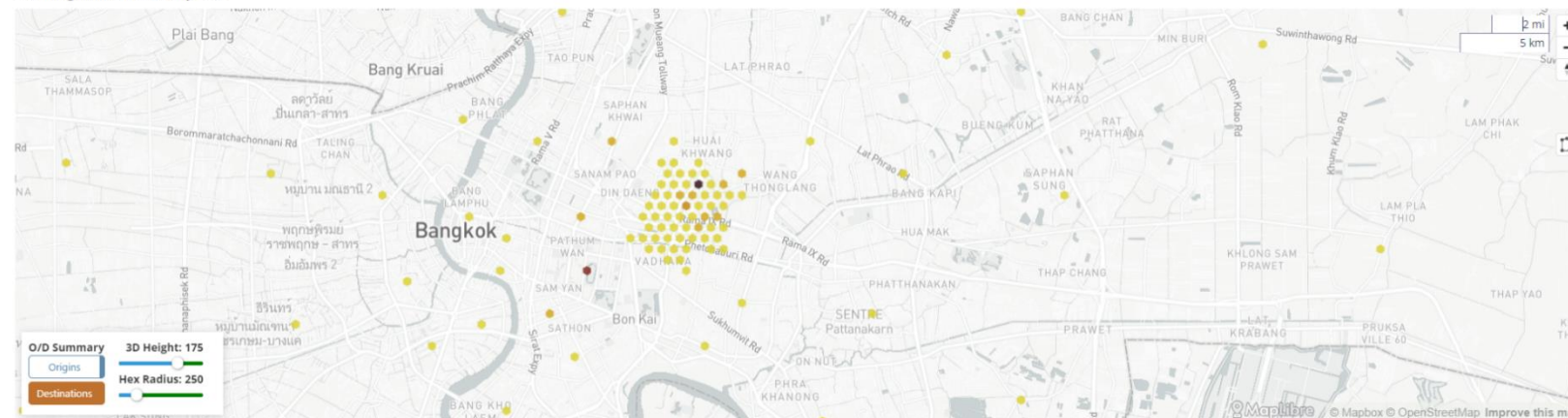


Notes:

Presenting the Number of Origin-Destination Trips in Each Zone from the Model

Origin - Destination for ABM Pilot Study Location

Total origins/destinations by zone





EXAMPLE OF SIMULATION OUTPUT FOR THE HOME WORK HOME AGENTS



Test Run:
10 agents

