A Study of CO_2 and PM_{10} Emissions from Public Transportation Projects in Khon Kaen University

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Background

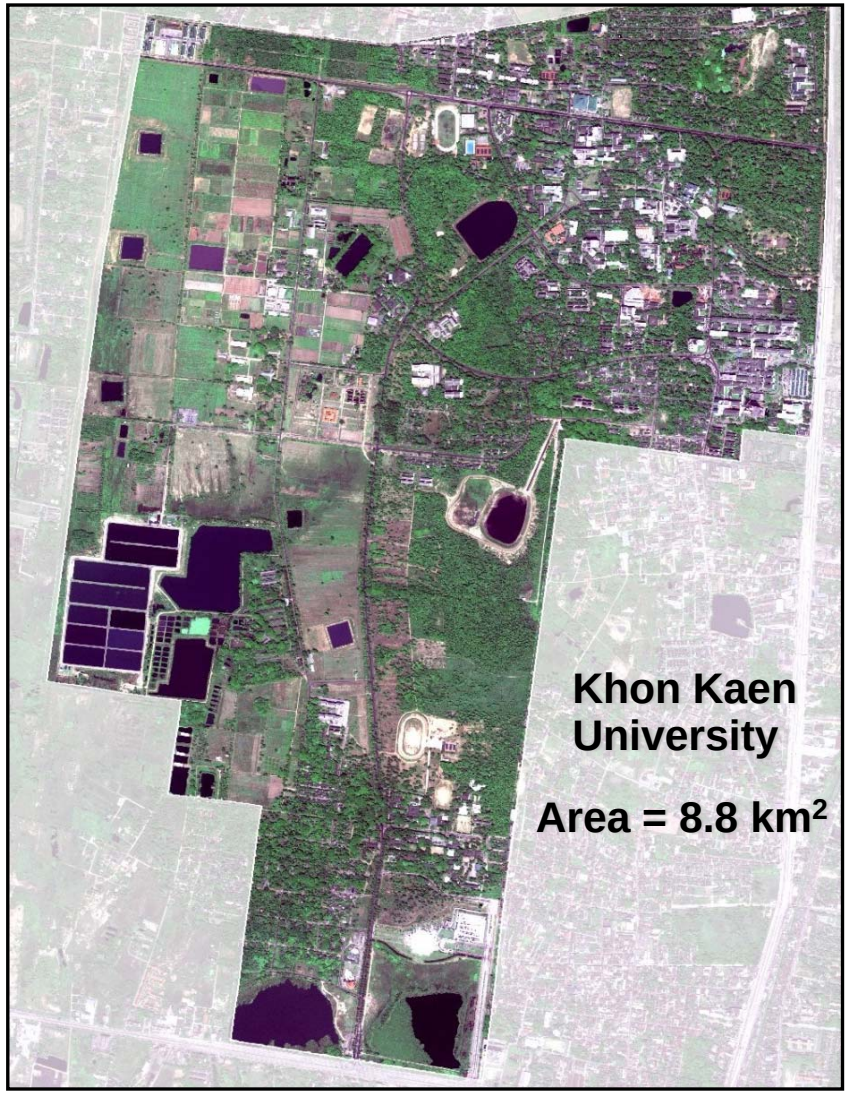
- Nowadays, the global climate has been turned to bad conditions.
- It affects to increase the surface temperature of the earth which caused by the human activities.
- Especially, the transportation sector emits the enormous amount of emission.



Objective

- To studies CO_2 and PM_{10} emissions from public transportation projects in Khon Kaen University.

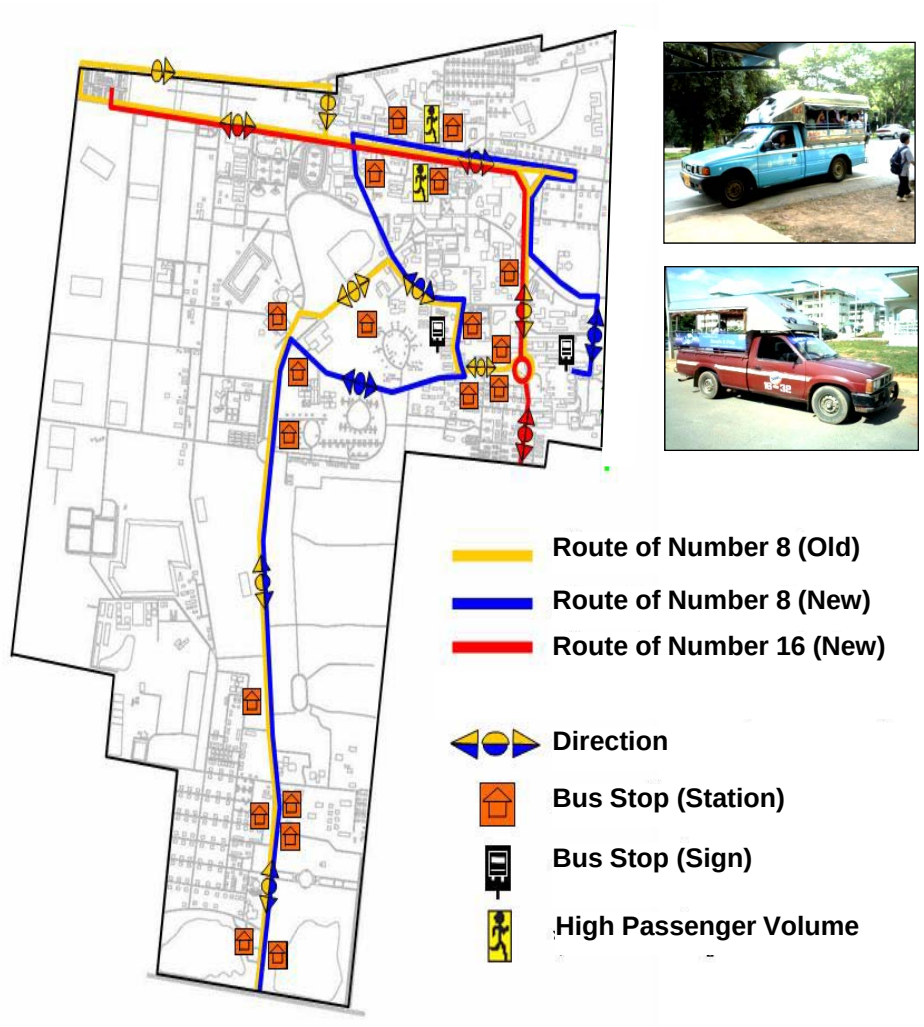
Study area



- KKU is high growth rate of population (6.9 % per year with student) and development.
- There are population about 39,940 persons in 2007.
- There are very much the peoples traveling in the university per day.
- This high demand of vehicle usage increases the fuel consumption.

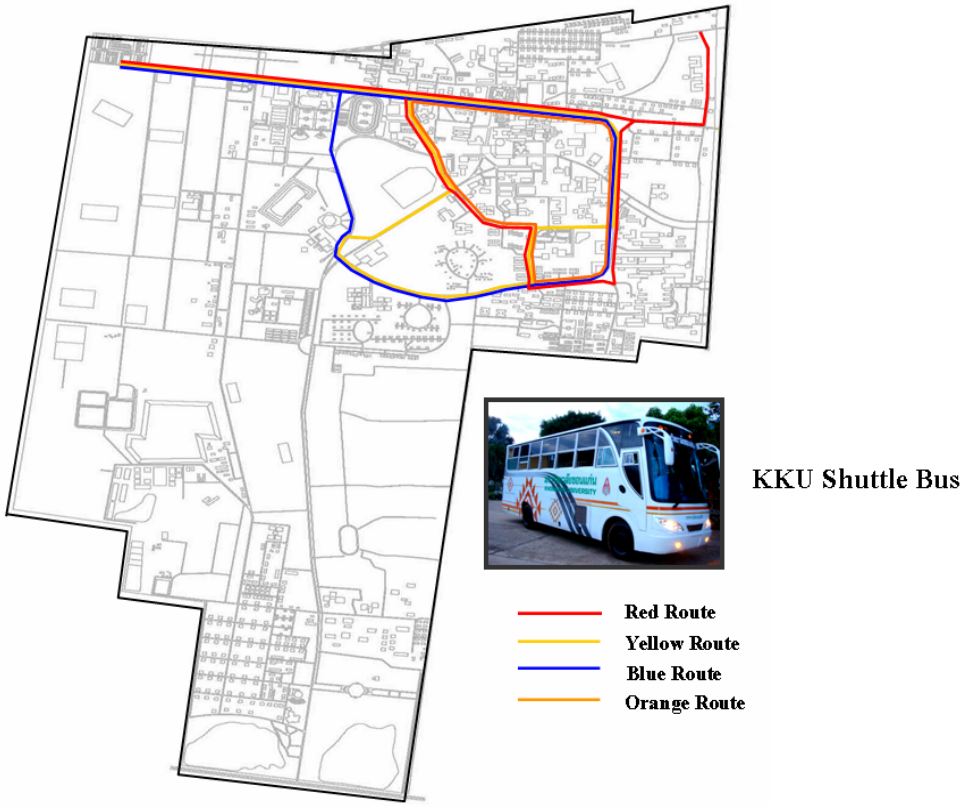
Problems in peak hour

- KKU have a lot of vehicles in peak hour. KKU also have high emission in peak hour.



Song Thaew routes inside Khon Kaen University

- Song-Thaew have 3 routes inside KKU which these routes are some part of total route service.
- To use Diesel fuel.
- Song-Thaew ‘s capacity about 13 for seat or 25 include the standing.
- Total of Song-Thaew have about 30 vehicles per peak hour.
- Characteristic of traveler are mostly come in or come out from KKU.



KKU Shuttle Bus

Shuttle bus routes inside Khon Kaen University

- Shuttle bus have 4 loop routes inside KKU.
- To use CNG fuel.
- Shuttle bus ‘s capacity about 40 include the standing.
- Total of Shuttle bus have 20 vehicles which bus are service working time (07:00-20:00).
- Average speed about 25 km/h.

PUBLIC TRANSPORTATION PROJECTS

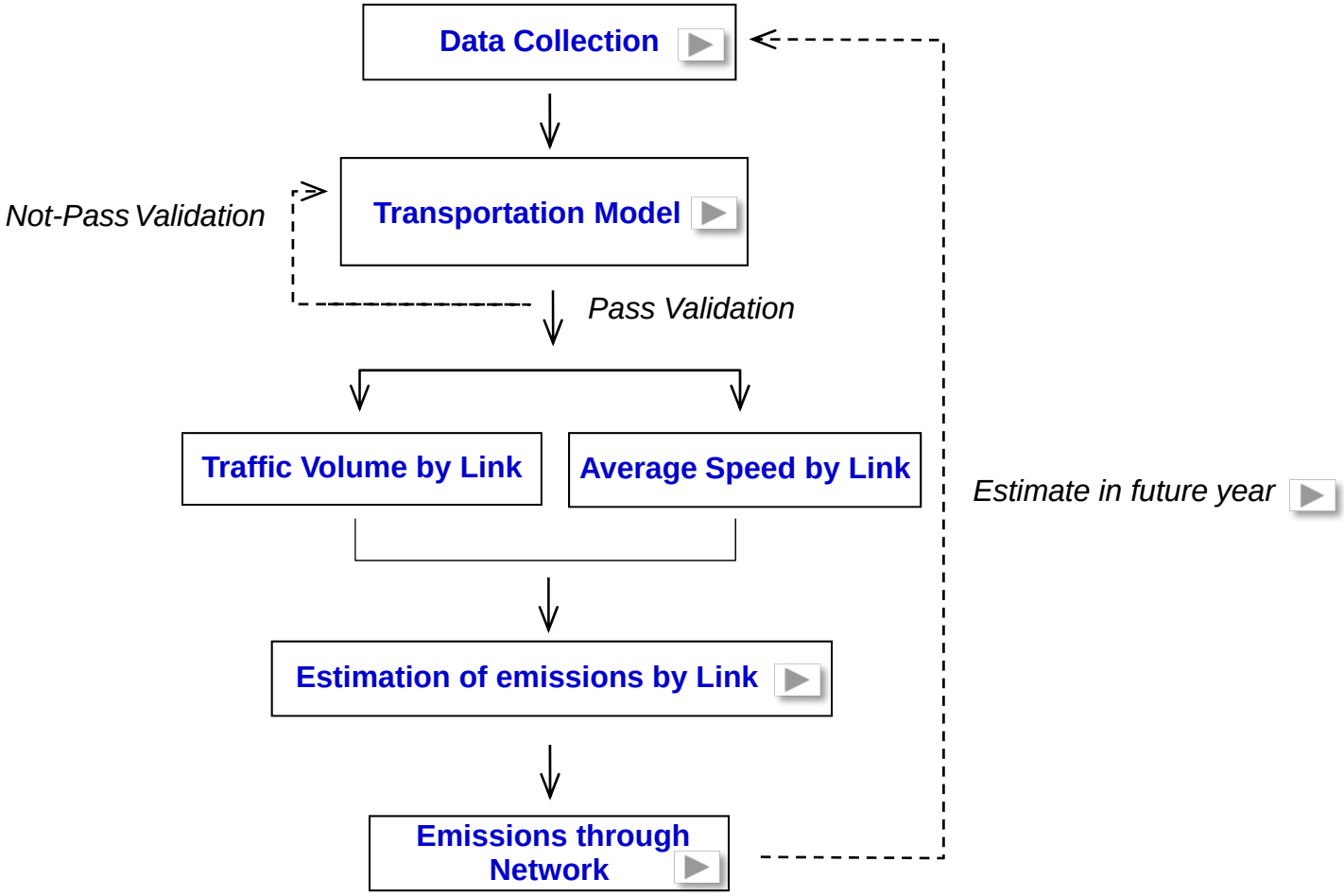
The three scenarios are established in 2014, as follows.

- Baseline Scenario : Do Nothing

- Scenario 1 : The project of substitution of fuel usage of Song Thaew operating inside KKU from Diesel to Compressed Natural Gas (CNG) and this mode has 3.15% of total mode share.

- Scenario 2 and Scenario 3 : The project of replacement of existing Song Thaew by a campus shuttle bus using CNG and these mode have 6.9% and 15% respectively, of total mode share.

METHODOLOGY



Step of Estimation of CO_2 and PM_{10} Emissions

Data Collection

This research collected both primary and secondary data.

Primary Data

This research have surveyed the service attributes of existing Song Thaew operating through KKU and Shuttle bus, as follows.

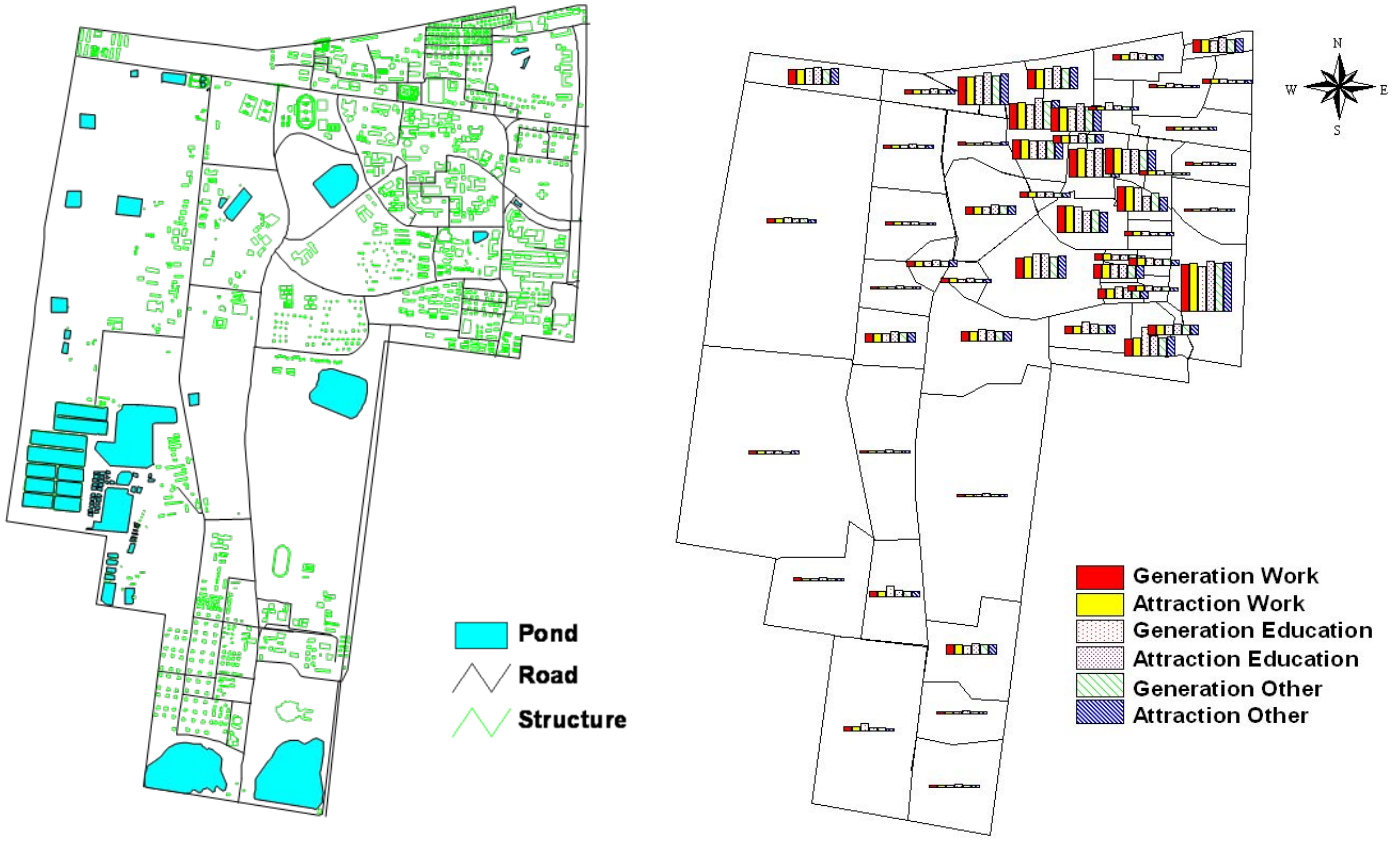
- ✓ Service route
- ✓ Frequency
- ✓ Volume
- ✓ Average speed by link
- ✓ Weight of vehicle
- ✓ Average number of passengers by link

Secondary Data

This research has been given the data from several sources. Data use in this method as follows;

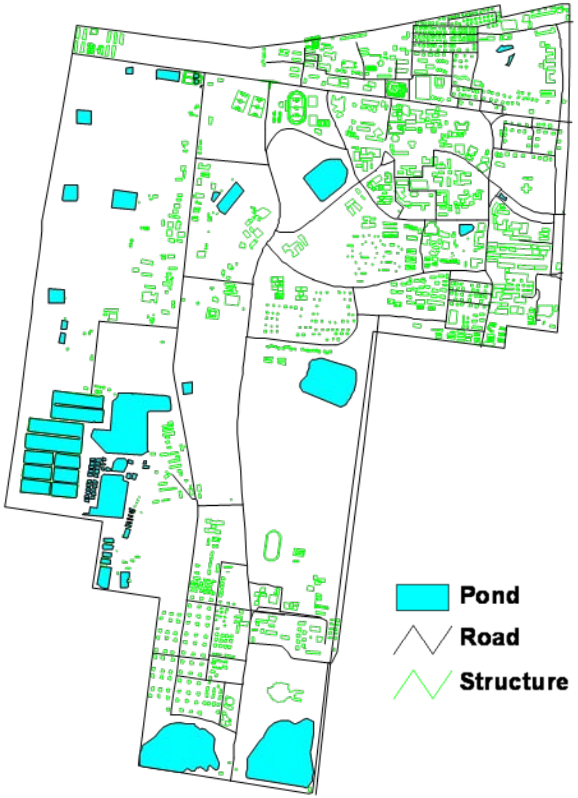
- ✓ Number of population and employment
- ✓ Road network
- ✓ Traffic volume on main road by mid block counting
- ✓ The existing and future travel behaviors (mode choice)
- ✓ The emission data of various speed by each vehicle type

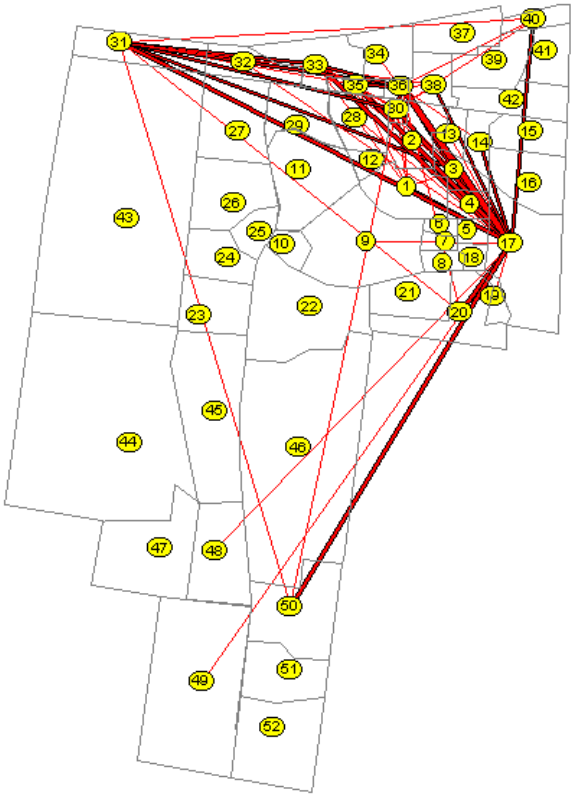
Trip Generation



Trip Production and Attraction by Purposes inside KKU (2007)

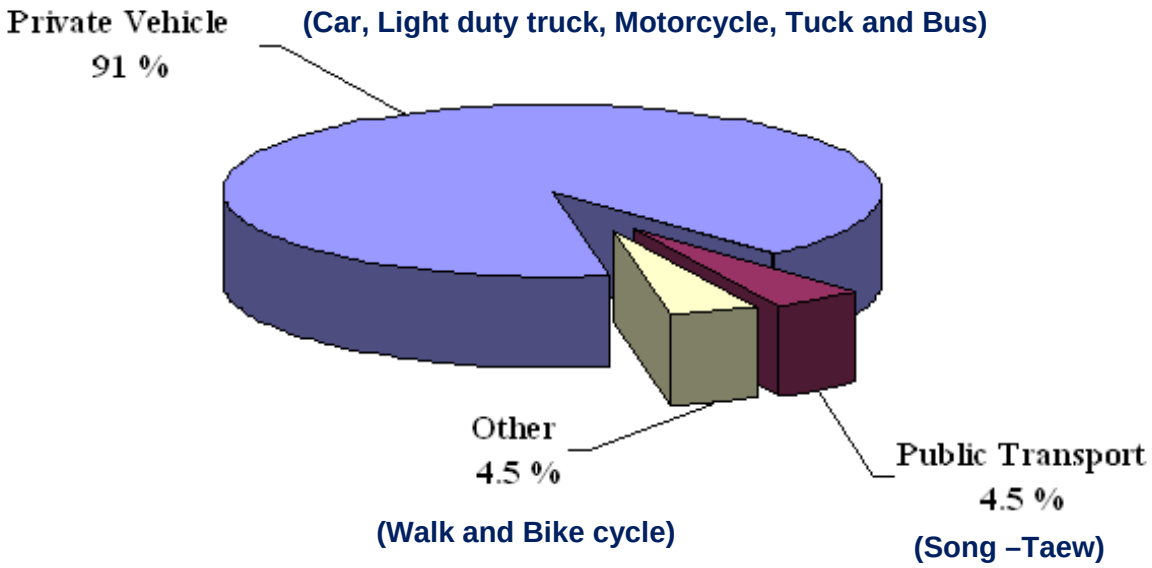
Trip Distribution





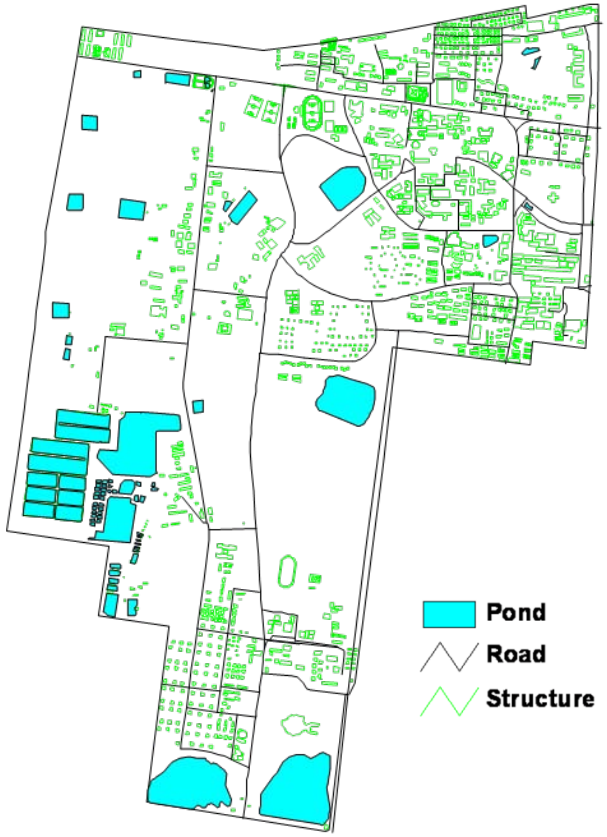
Trip Distribution inside KKU (2007)

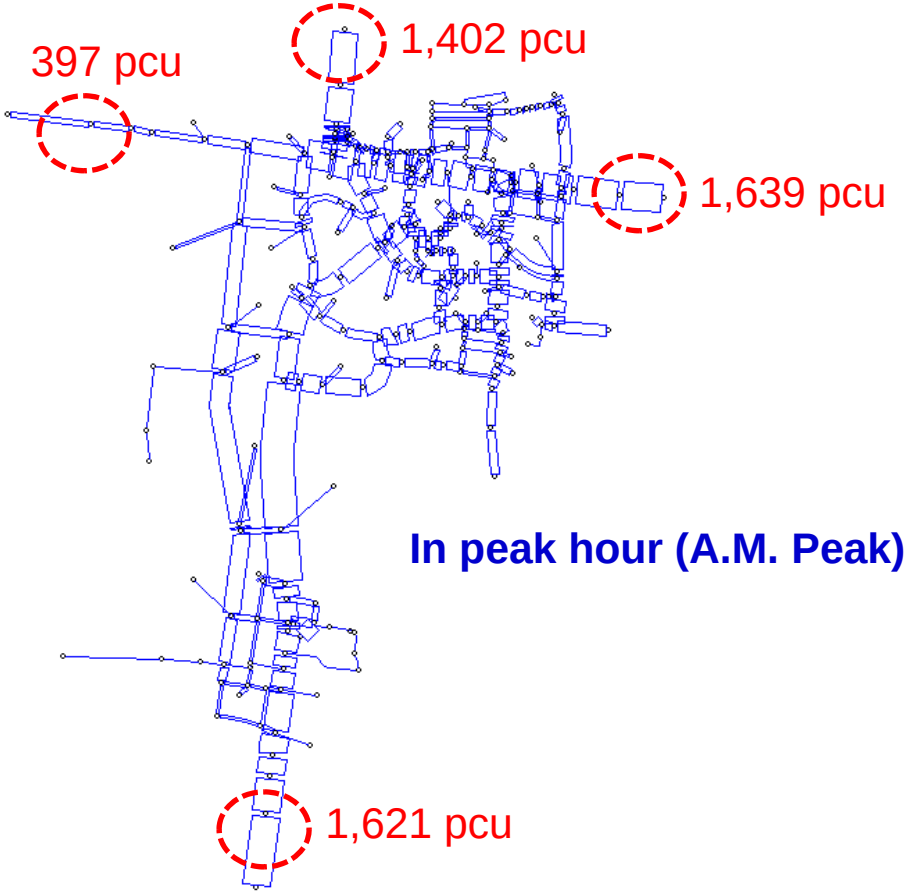
Modal Split



Mode Choice Data of KKU Population (2007)
by SIRDC (2008)

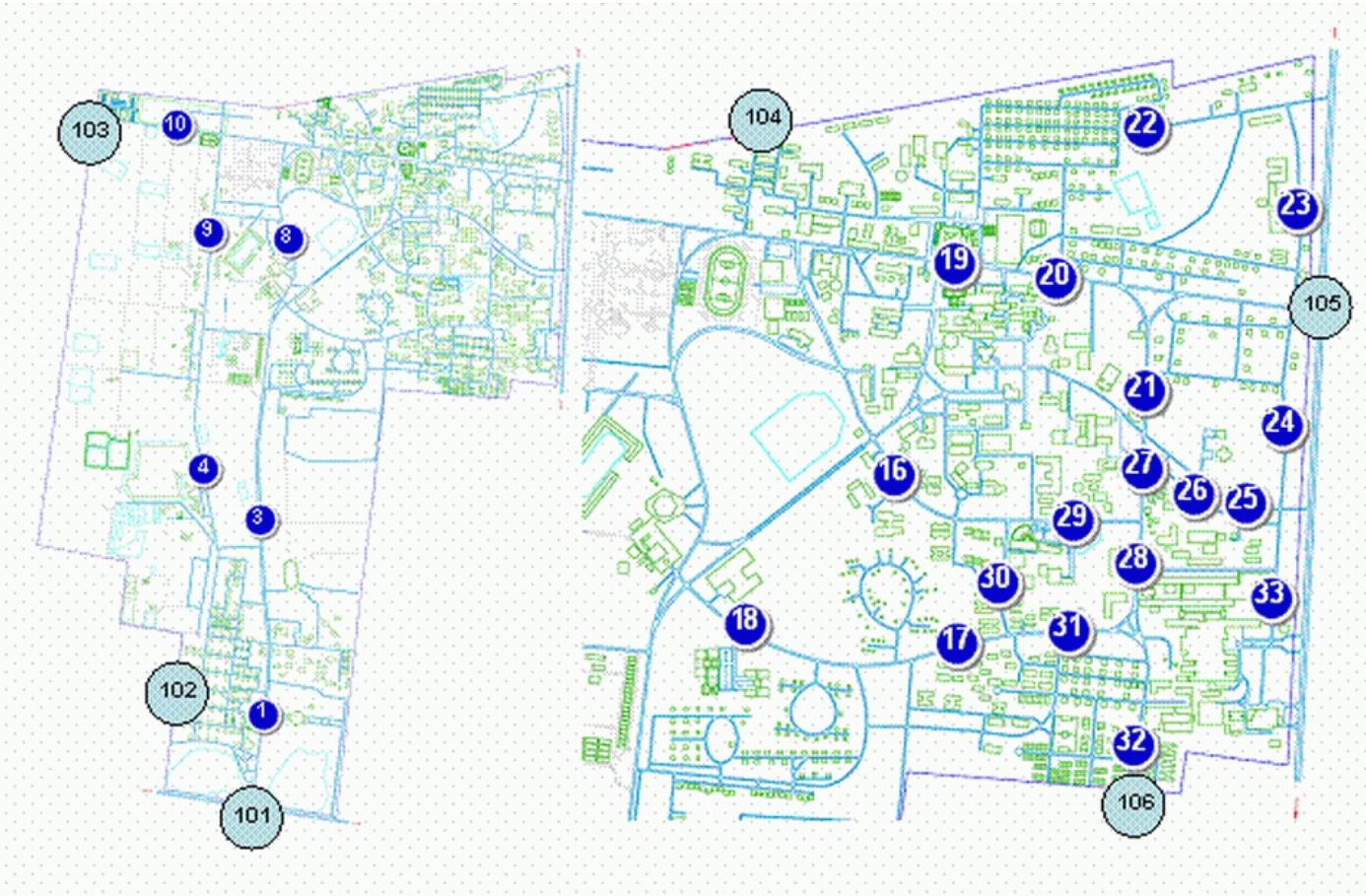
Traffic Assignment





Traffic Volume along KKU Road Network (2007)

Model Validation



Survey points of traffic data inside KKU

Maximum Acceptable ERROR

Traffic Volume (PCU/day)	Max. Acceptable (%)
0 - 5,000	± 36
5,000 - 10,000	± 29
10,000 - 25,000	± 25
25,000 - 50,000	± 22
> 50,000	± 21

Source: Federal Highway Administration, U.S. Department of Transportation (1997)

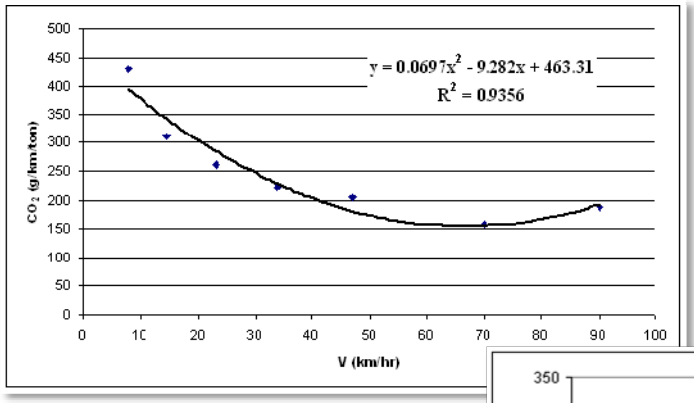
Estimation of Emissions

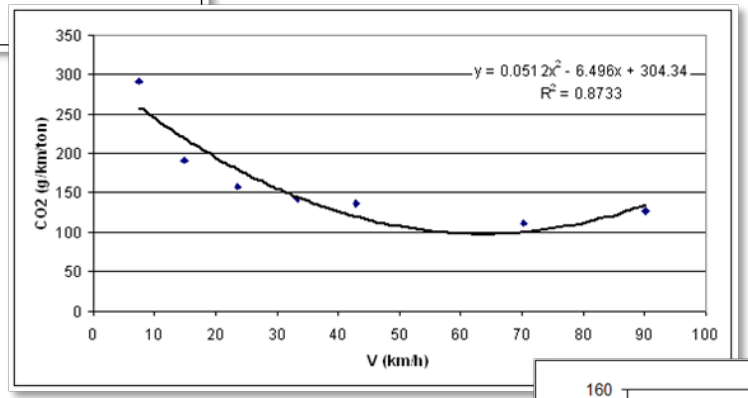
$$Emission\ of\ Link = \sum_{k}\sum_{i} D_k \times T_{ki} \times Ef_{ki} \times WT_i$$

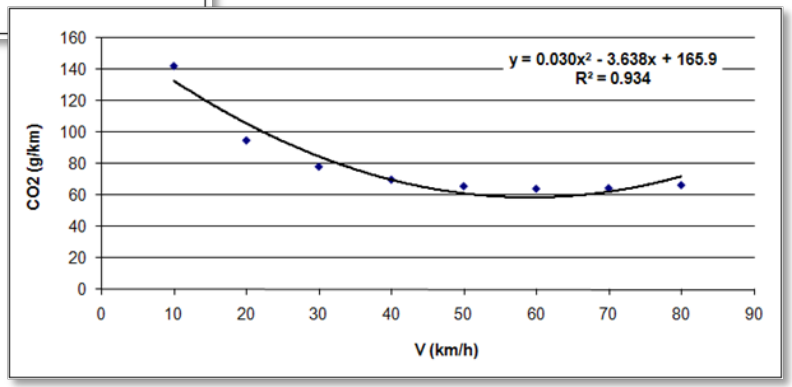
Where

k	=	Link number
i	=	Vehicle type (Car, Light Duty Truck, Motorcycle, Truck and Bus)
D_k	=	Link length (km)
$T_{k,i}$	=	Traffic volume in link k of vehicle type i (Vehicle)
Ef_{ki}	=	Amount of Emissions on link k of vehicle type i (g/km/Ton)
WT_i	=	Weight of vehicle type i (Ton)

Emission Factor



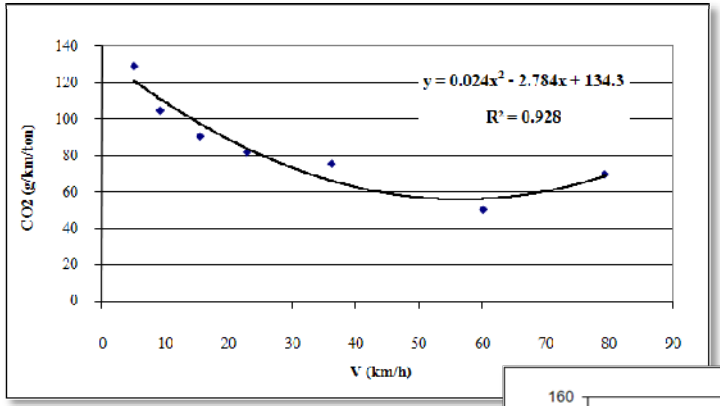


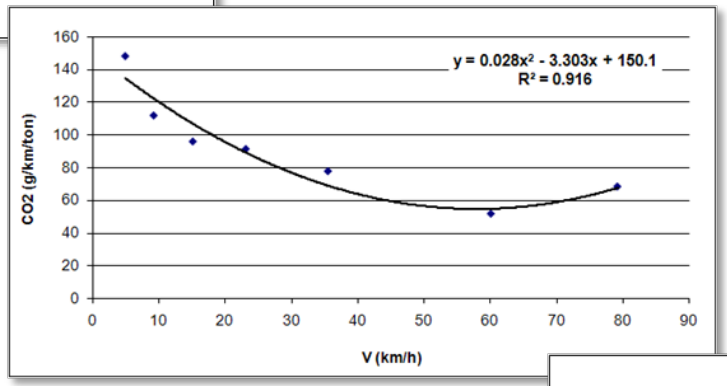


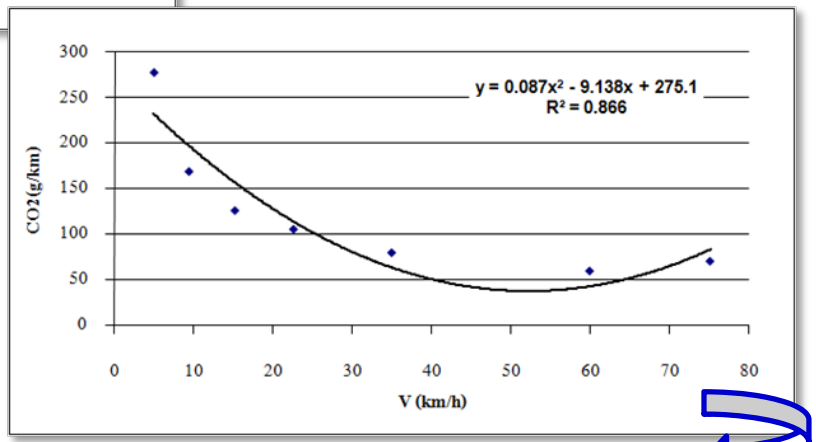
**** Vehicles were tested in laboratory in Bangkok under the typical driving cycles.**

Source: MLIT - Japan (2004)

Emission Factor







Source: MLIT - Japan (2004)

Illustrative Results of Estimation of Emissions by link in 2007 (Base Year)

No.	Link Name	Distance (km)	CO_2 (Ton/year*)	PM_{10} (Ton/year*)
1	L317	0.52	998.580	0.157
2	L309	0.28	426.178	0.072
3	L304	0.43	642.167	0.108
4	L299	0.10	151.318	0.024
5	L288	0.14	188.913	0.033
…	…	…	…	….
199	L336	0.11	34.710	0.003
200	L292	0.51	160.927	0.013
Total		38.10	23,287.727	3.190

Note: * total 248 weekdays per year

Results of Estimation of Emissions in 2014

Scenario No.	CO_2 (Ton)	PM_{10} (Ton)
Do nothing	32,979	4.18
1	32,759	4.02
2	31,163	3.91
3	27,166	3.44

Emissions Reduction Comparing with Baseline Scenario in 2014

Scenario NO.	CO_2 emission reduction (Ton)	PM_{10} emission reduction (Ton)
1	220	0.16
2	1,816	0.27
3	5,812	0.74

SUMMARY

- Scenario 2 & 3 (Shuttle bus) will reduce emissions more than first scenario, because these scenarios have percent of mode share and capacity per trip more than first scenario.

- If shuttle bus project have other policy which that join in project such as ban private vehicle zone, to charge fee of parking, first year student are not allow use private vehicle in working time etc, So those policies can increase percent of shift mode.


Thank you for your attention
Khon Kaen University