A FEASIBILITY STUDY ON CLEAN DEVELOPMENT MECHANISM PROJECT FOR TRANSPORT SECTOR IN KHON KAEN UNIVERSITY, THAILAND: CASE STUDY OF CAMPUS SHUTTLE BUS

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ABSTRACT

This paper conducts a feasibility study to implement the Clean Development Mechanism project for transport sector in Khon Kaen University. Until now, there is no CDM project from transport sector has been registered by Thailand Greenhouse Gas Management Organization. One of causes is the costs for receiving the Certified Emission Reductions might be higher than the returns from selling of a carbon credit. To encourage CDM project for transport sector, it is feasible to start from the small scale CDM project in boundary and compacted area. The university has several accomplished conditions to implement the transportation project for CDM. The Khon Kaen University recently encounters a huge amount of traffic travelling inside campus that it causes many problems of traffic congestion, traffic accident as well as air pollution emission. To lessen these problems, the campus

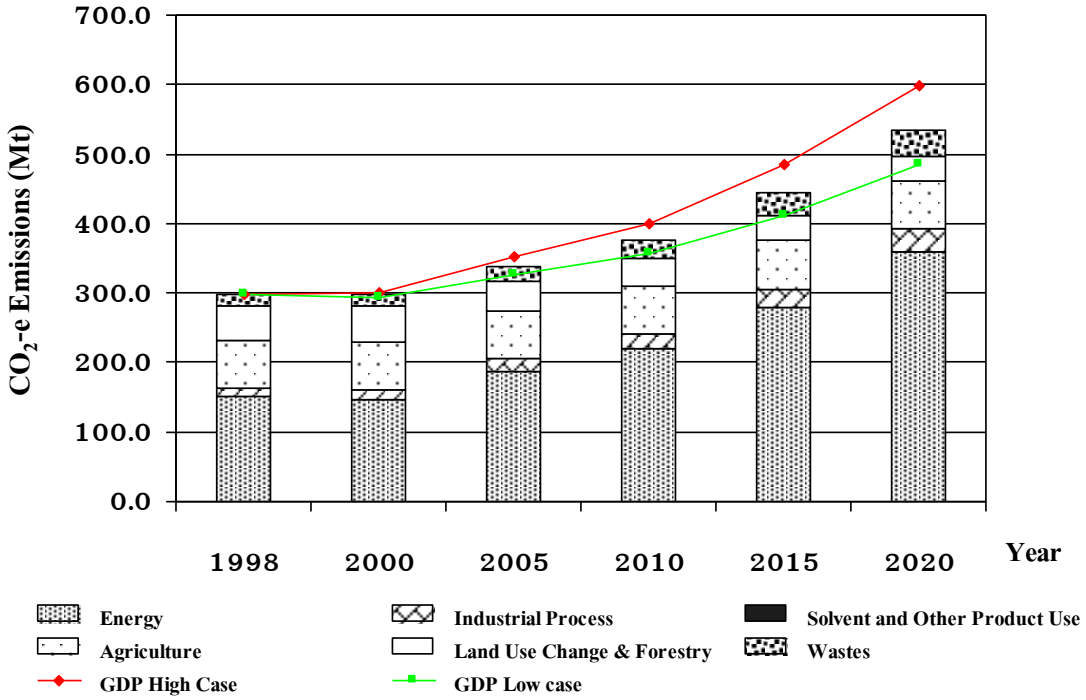
shuttle bus project has been planned to start to operate in this year. Therefore, this paper proposes the public transportation projects for Clean Development Mechanisms (CDM) to reduce Carbon Dioxide (CO2) emission in KKU. The proposed projects consist of 2 scenarios; 1) a substitution of Diesel usage of Song Thaew (a modified pickup truck), an existing public transportation, with alternative fuels and 2) a replacement of an existing Song Thaew by a campus shuttle bus project. To evaluate the proposed projects, the CO2 emissions in the future conditions from each scenario were estimated following the principle of CDM by comparison with a Baseline Case, a condition without proposed project. This study applied the demand foresting model, to analyze the existing traffic condition and to estimate the traffic volumes along KKU road network in future. The emission factors were applied to calculate the emissions. The evaluation results show that both proposed projects can reduce the CO2 emission, significantly a campus shuttle bus project. Hence, the proposed projects would be possibly considered to be implemented as a small scale CDM project inside KKU.

Keywords: Clean Development Mechanism, Carbon Dioxide Emission, Campus Shuttle Bus, Alternative Energies, Khon Kaen University

1. INTRODUCTION

1.1 Situation of CO2 Emission in Thailand

The CO2 emission of Thailand has been increasing 20% during 1994 – 2003. Its tendency has been forecasted to increase continuously as shown in Figure 1 (TGO, 2009). Especially, the emission from Energy sector is higher than other sectors.



Source: Thailand Greenhouse Gas Management Organization, 2009

Figure 1 – Tendency of CO2 Emission of Thailand

1.2 Existing Situation and Its Feasibility of CDM Project for Transport Sector in Thailand

Until present, there are 60 CDM projects that have been received the Letter Of Approval from Thailand Greenhouse Gas Management Organization. 59% of them are Biogas projects and 18% of them are Biomass projects. However, there is no CDM project from transport sector has been received the LOA (TGO, 2009). The difficulties are that the expenses for procedure to receive the Certified Emission Reductions (CERs) are costly. The costs for receiving CERs might be higher than the returns from carbon credit trading, especially for small scale project. The private transportation companies therefore may not be interested to encourage their projects being CDM projects. Moreover, in case of mega transportation project, e.g. the subway project reducing emission from deceasing of number of passenger cars and buses, it needs the huge budgets for data surveying as well as the comprehensive methodology for calculating CO2 emission reduction that causes from private car users shifting to use subway. Previously, there is no the proposed methodology to calculate CO2 emission reduction from subway project which have been approved by CDM Executive Board of United Nations Framework Convention on Climate Change.

To encourage the CDM project for transport sector in Thailand, it is feasible to start from a small-scale CDM project in a boundary and compacted area. The university has several conditions capable to implement the CDM project for transport sector. Its area is observable boundary. It could provide the budget for the expenses for the procedure receiving CERs. In extra addition, there are many various knowledge and skilled staffs in the university to accomplish the procedure of CDM project.

2. RESEARCH OBJECTIVES

The objectives of this paper are presented as following.

1. To consider the feasibility to implement the CDM transportation Project in university in order to promote the small scale CDM Project for Transport Sector in Thailand
2. To propose the public transportation projects for small scale CDM projects in Khon Kaen University

3. PUBLIC TRANSPORTATION PROJECTS FOR SMALL SCALE CDM PROJECTS IN KHON KAEN UNIVERSITY

This study selects the Khon Kaen University as the representative campus. Since there is a high growth rate of development and population, especially number of students, there are many people traveling inside campus more than 40,000 peoples per day, mostly traveling by private vehicles (SIRDC, 2007). Recently, it encounters a huge amount of traffic travelling inside campus that it causes many problems of traffic congestion, traffic accident as well as air pollution emission. Even, there are Song Thaew (a modified pickup truck) routes, an existing public transportation, operating inside KKU. Its service routes through KKU are presented in Figure 2. However, it is still not widely used by KKU population for traveling

inside the university since its service is not efficiency and effectiveness, e.g. ineffective schedule with unpunctual and long time waiting, unsafe and uncomfortable vehicle etc. Moreover, the service route still not covers the whole area of KKU, particularly the educational zone. Consequently, the private mode, especially motorcycle, still overcome public mode, being the most chosen mode for traveling inside the university (Piphay, C. 2000). To diminish these problems, the KKU has been planned to start to operate the campus shuttle bus project in this year.

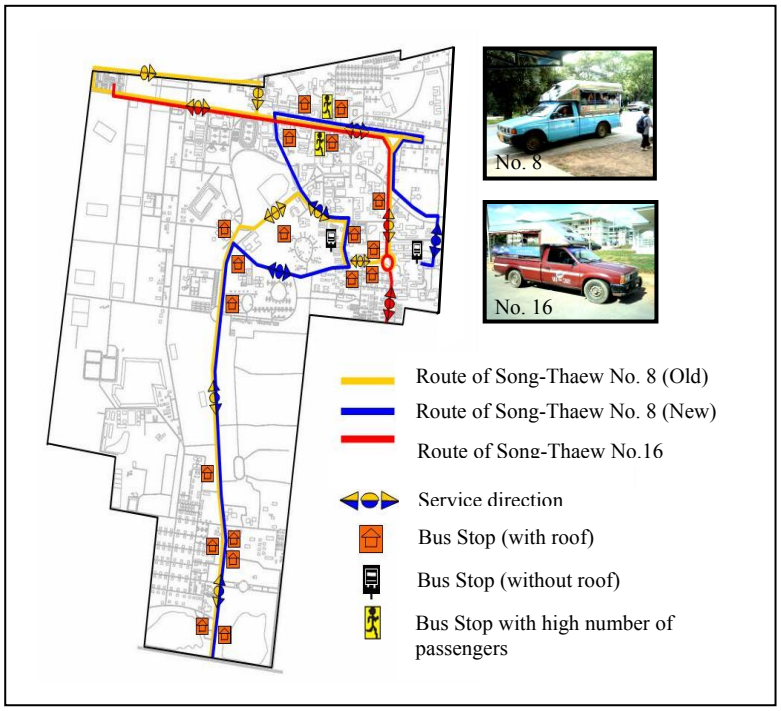


Figure 2 – Song Thaew routes servicing in Khon Kaen University

Therefore, this study proposes the public transportation projects to reduce the CO_2 emission inside KKU. The proposed projects consist of 2 scenarios; 1) a substitution of fuel usage of Song Thaew, a public Pickup Truck, from Diesel fuel to Compressed Natural Gas (CNG) and 2) a replacement of existing Song Thaew by a campus shuttle bus project. The CO_2 emission reductions of each proposed project are estimated by comparing with Baseline Case (an existing condition without project in present year, 2007) and 7 years later (in 2014) following the principle of CDM. The three scenarios are established as follows.

Scenario 0 (Baseline Case): Do Nothing

Scenario 1: Implementing the project of a substitution of fuel usage of Song Thaew operating inside KKU from Diesel to Compressed Natural Gas (CNG)

Scenario 2: Implementing the project of replacement of existing Song Thaew by a project of campus shuttle bus using CNG. This shuttle bus project consists of 4 designed routes as shown in Figure 3.

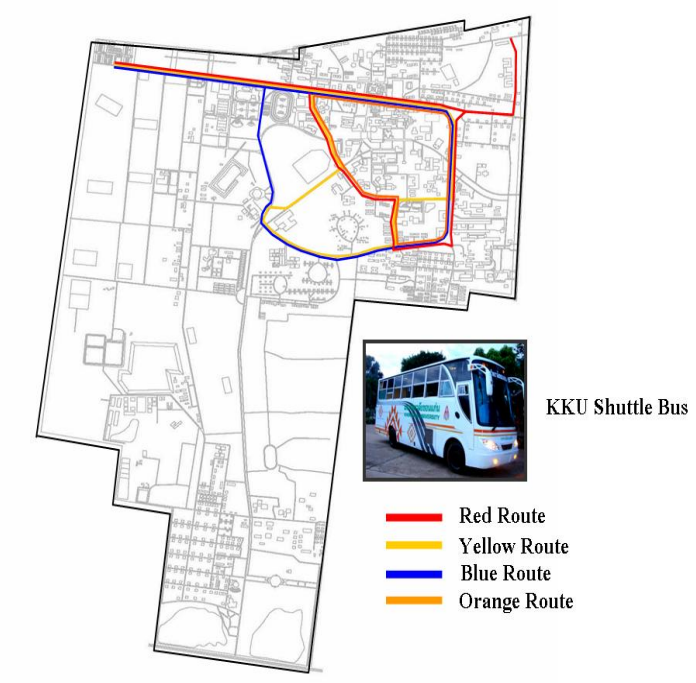


Figure 3 – KKU Shuttle Bus Routes

4. METHODOLOGY

This part describes the methodology for calculating Carbon Dioxide (CO2) emitted from transportation sector inside KKU. It summarizes all steps to calculate CO2 emission in a flow chart as shown in Figure 4. The first step of this flow chart is the data collection, including collecting primary and secondary data. The second step is an estimation of traffic volume by 4-step urban transportation planning model using JICA STRADA program, then validating the results, e.g. comparing the calculated traffic volume and average speed with surveyed those data by link). The last steps are calculating CO2 emission by link and by whole network. The same sequence will be repeat calculated for CO2 emission in future years.

4.1 Data Collection

This study collected both primary and secondary data for using in transportation model and CO2 emission estimation. The collected data is described in detail as follows.

4.1.1 Primary Data

This study has surveyed the service attributes of existing Song Thaew operating through KKU. The surveyed data includes service route, frequency, volume, average speed by link, weight of vehicle, average number of passengers per day, and etc.

4.1.2 Secondary Data

The study has been provided the data from several sources. The general data (such as number of population and employment), road network and transportation demand volumes of KKU were given by SIRDC (2007). It surveyed the existing traffic volume on main road by mid block counting. The existing and future travel behaviours (mode choice) of KKU population were surveyed by questionnaire interview. And, the emission data of various speeds by each vehicle type was given by MLIT-Japan (2004).

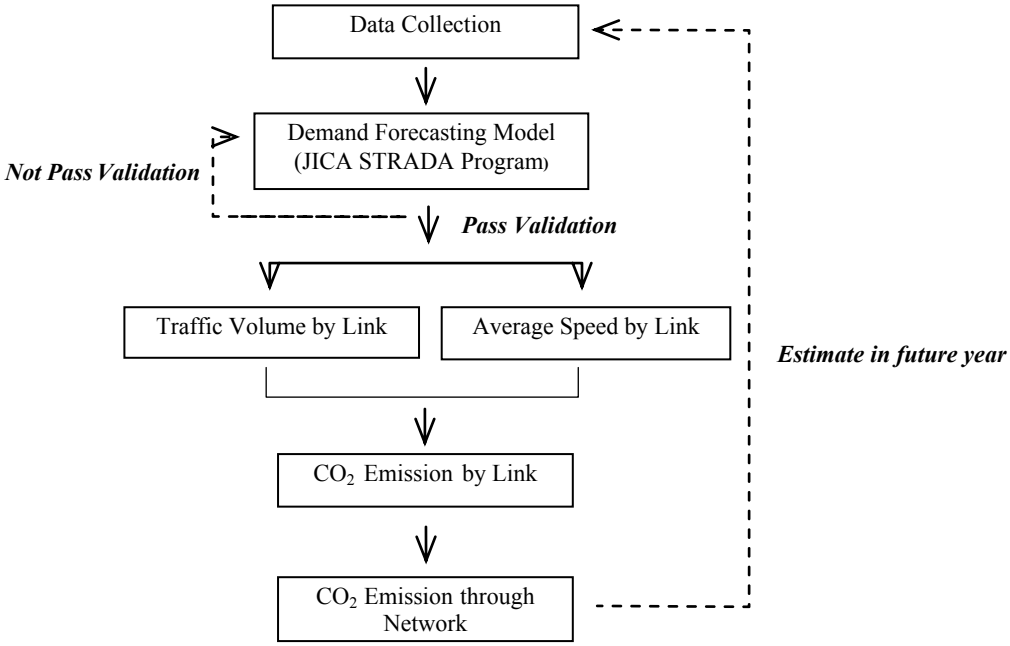


Figure 4 – Flow Chart of Calculating CO_2 Emission

4.2 Calculation of Traffic Volumes along Road Network

This study applied the 4-step urban transportation planning model through using JICA STRADA program to estimate exiting traffic volume in 2007 and future traffic volume in 2014 along KKU road network. These 4 steps consist of following steps.

4.2.1 Trip Generation

As the demand model developed by SIRDC (2007), the study area was separated into 52 internal zones and 7 external zones. The linear models were applied to estimate the trip generation of each zone by trip purposes. The results of trip generation models are displayed by zone and trip purpose as shown in Figure 5. There are totally about 13,820 trips (4,870 trips for education, 4,580 trips for work, and 4,370 trips for others) that were generated inside university during morning peak hour in 2007.

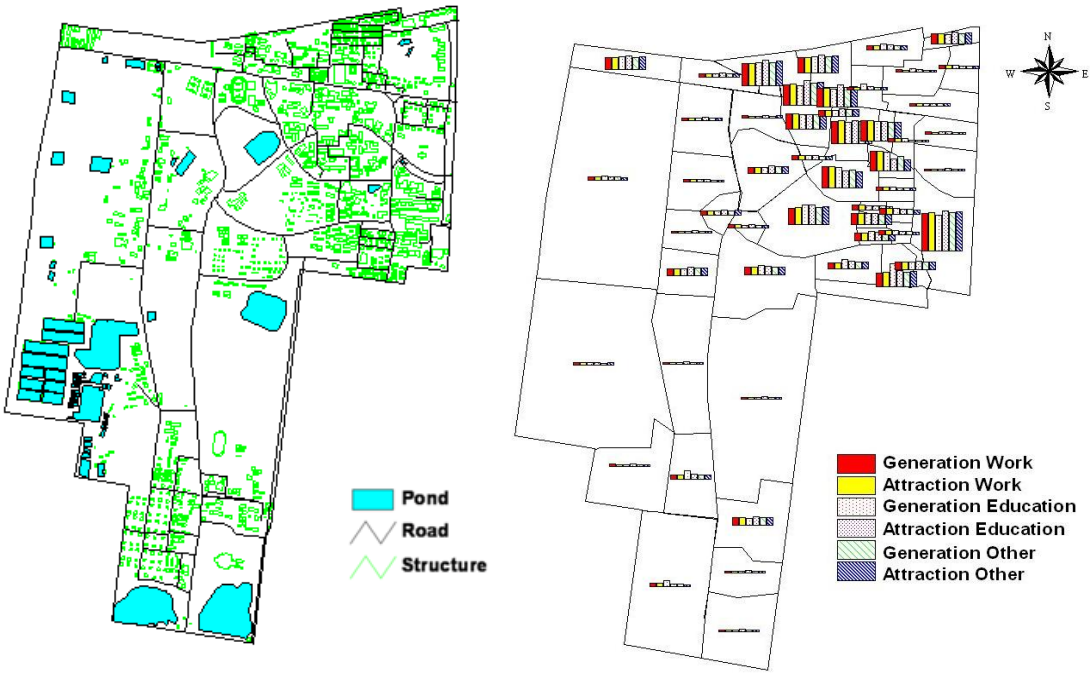


Figure 5 – Trip Production and Attraction by Purposes inside KKU

4.2.2 Trip Distribution

The Gravity models were applied to forecast the trip distribution from zone to zone by trip purpose. The results of trip distribution are presented as shown in Figure 6. There are about 16,770 trips that were distributed from zone to zone during morning peak hour in 2007.

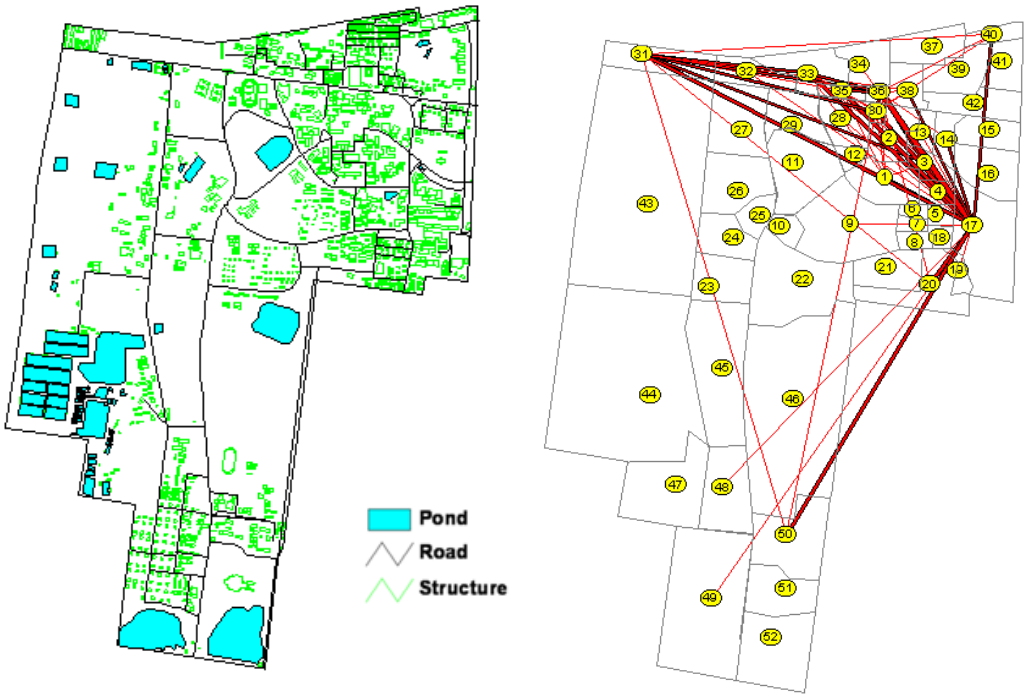


Figure 6 – Trip Distribution inside KKU

4.2.3 Modal Split

The Binary Logit models were applied to split between private and public modes for existing mode choice behaviour in 2007, Baseline Case condition. The results of mode split are presented as shown in Figure 7. And, in case that the campus shuttle bus project is implemented in the future, 2014, the mode choice behaviour was provided from the results of the questionnaire interview (SIRDC, 2007). The percent share of public mode increases from 4.5% to 6.9% of total trips.

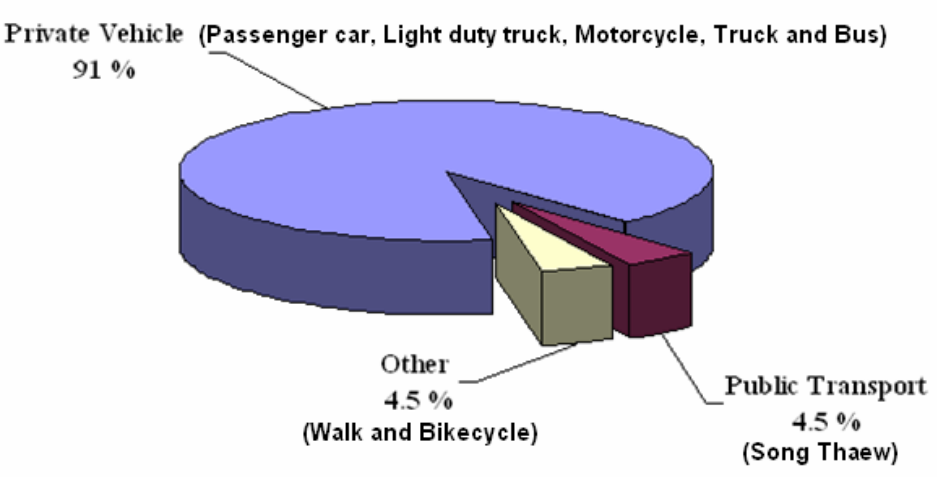


Figure 7 – Mode Choice of KKU Population in 2007

4.2.4 Traffic Assignment

The User Equilibrium Assignment model was applied to assign the traffic into the particular road link. The assigned traffic volumes along road network during morning peak hour are presented in Figure 8.

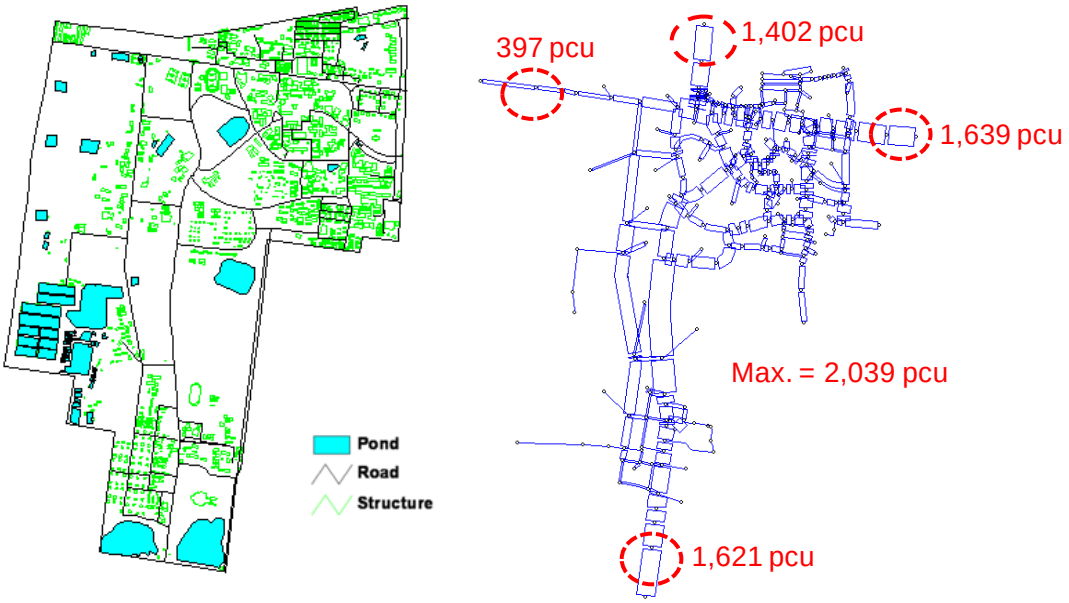


Figure 8 – Traffic Volume along KKU Road Network

4.3 Model Validation

After completing a running of a demand forecasting model, the traffic volume on each road link resulted from a model was compared with the surveyed traffic volume by specific link to validate the reliability of the model. The traffic volume inside KKU was surveyed by SIRDC (2007). The result of validation reveals that approximate 80% of traffic volumes resulted from the model are matched with the existing traffic volumes as shown in Figure 9.

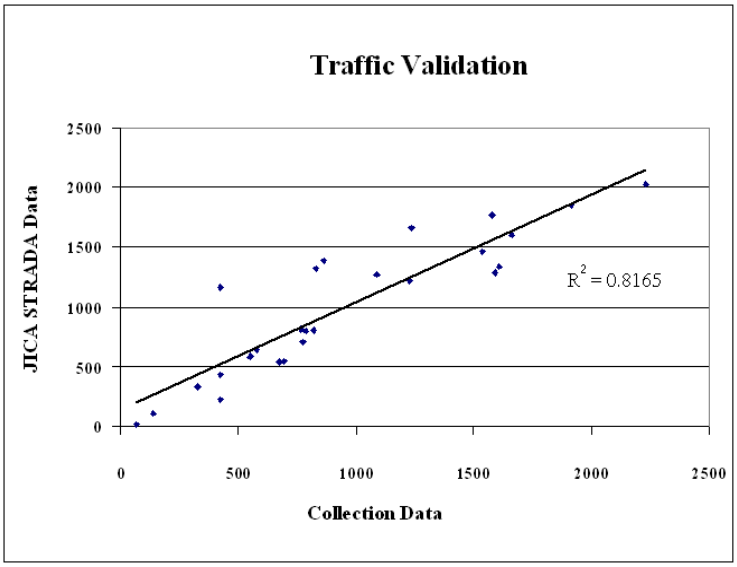


Figure 9 – Comparison between Surveyed and Modelled Traffic Volume

4.4 Estimation of CO2 Emission

After the estimated traffic volumes by link were accepted. There results from traffic assignment model, including traffic volume and average speed by link, would be further applied to estimate the CO2 emission by link by applying the Equation 1. The Emission factor in the equation is given by the project of MLIT-Japan (2004). This project applied the emission rates of each vehicle type in Bangkok that is similar to the vehicle type used in KKU. Table 1 displays the illustrative results of calculation of CO2 emission by link in 2007.

$$Emission\ of\ Link = \sum_{k}\sum_{i} D_k \times T_{ki} \times Ef_{ki} \times WT_i \qquad (1)$$

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 CO2 Emission on link k of vehicle type i (g/km/Ton)
WT_i	=	Weight of vehicle type i (Ton)

Table 1 – Illustrative Results of Calculation of CO2 Emission by link in 2007

No.	Link Name	Distance (km)	Traffic Volume (PCU/hr)	Aver. Speed (km/hr)	CO2 (Ton/year*)
1	L317	0.52	1621	20.80	998.580
2	L309	0.28	1390	25.00	426.178
3	L304	0.43	1371	25.30	642.167
4	L299	0.10	1277	21.60	151.318
5	L288	0.14	1276	27.00	188.913
…	…	…	…	…	…
199	L336	0.11	272	34.60	34.710
200	L292	0.51	272	34.60	160.927
Total		**38.10**	**603**	**27.09**	**23,287.727**

Note: *total 248 weekdays per year

5. RESULTS AND DISCUSSIONS

As the results from emission calculation, the transportation activities inside KKU emit CO2 about 23,300 Ton-CO2 in 2007. The proportion of CO2 emission by mode is illustrated in Figure 10. It shows that almost emission is emitted by private modes, especially, motorcycle since most of KKU students travel inside KKU by motorcycle.

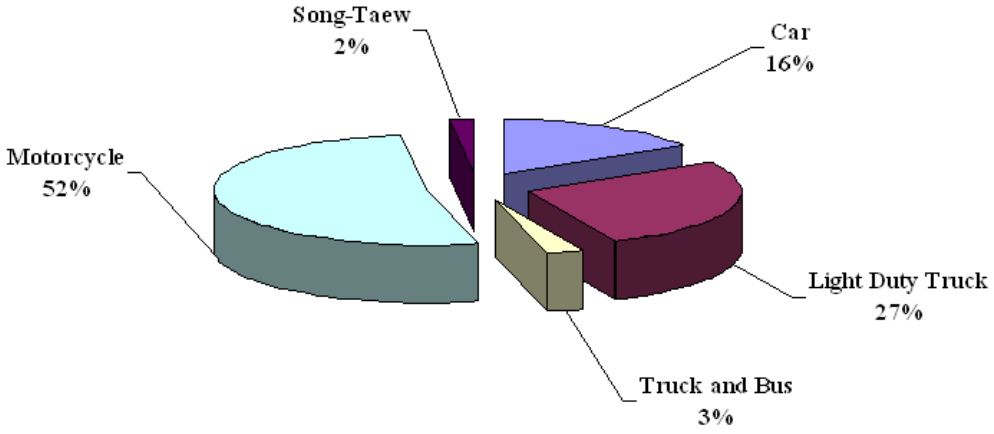


Figure 10 – CO2 Emission by Vehicle Type in 2007

Furthermore, if there is no implementation of proposed projects to reduce CO2 emission in the future. Amount of CO2 emitted by transportation activity is increased to 31,890 Ton-CO2 in 7 years later (in 2014). Because the number of KKU population, i.e. students and staffs, increases about 6.9 % and 1.1 % per year respectively (SIRDC, 2007), it therefore causes increasing of traffic volume inside KKU.

However, if there is an implementation of proposed public transportation project in the future whether a substitution of fuel usage of Song Thaew operating inside KKU from Diesel to Compressed Natural Gas (CNG) (Scenario 1) or a replacement of existing Song Thaew by a campus shuttle bus project using CNG (Scenario 2). The CO2 emissions in 2014 consequently are decreased to 31,670 (Scenario 1) and 30,220 (Scenario 2) Ton-CO2,

respectively. The reductions of CO_2 emission comparing with Baseline Case (Scenario 0) are presented in Table 2. The CO2 emission reductions are displayed by link in Figure 11.

Table 2 - CO2 Emission Reduction Comparing with Baseline Case

Scenario No.	CO2 Emission in 2014 (TonCO2)	CO2 Emission Reduction in 2014 (TonCO2)
0	31,890	-
1	31,670	220
2	30,220	1,670

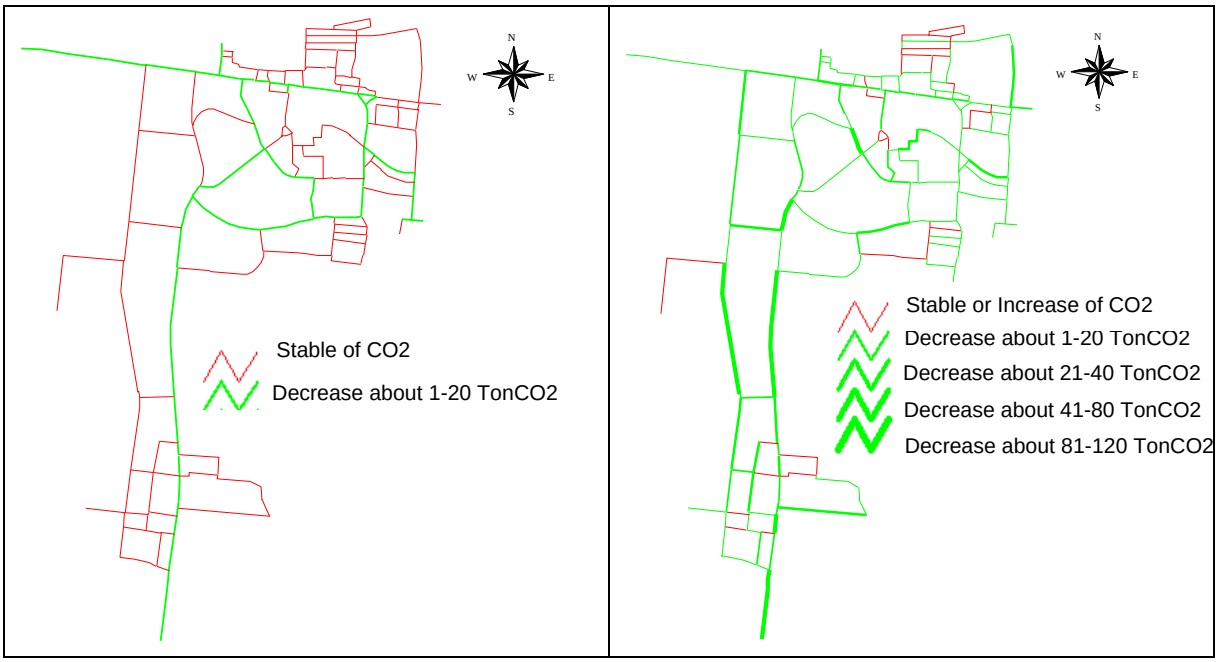


Figure 11 – CO2 Emission Reduction along KKU Network by Scenario 1 and Scenario 2

As all results, it can explain that the CO2 emission reduction from Scenario 1 causes from CNG emitting CO2 less than Diesel although the proportion selecting Song Thaew for travelling inside KKU is unchanged. On the other hand, the CO2 emission reduction from Scenario 2 causes from replacing Song Thaew using Diesel with the campus shuttle bus using CNG and also switching of some private vehicle users to shuttle bus. It results in decreasing of some CO2 emitted by private vehicles. The CO2 emissions by vehicle type of each scenario are displayed as shown in Figure 12.

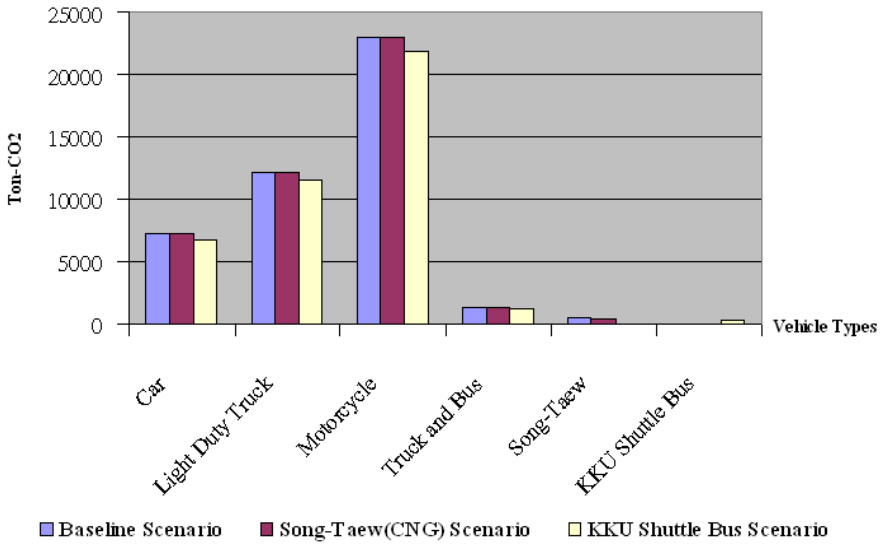


Figure 12 – Comparison of CO2 Emission of each Scenario by Vehicle Type

6. SUMMARY AND RECOMMENDATION

The both proposed public transportation projects can reduce significantly the CO2 emission in KKU, especially, the project of shuttle bus. Hence, the proposed projects would be possibly considered to be implemented for CDM in Khon Kaen University. Even the proposed project can reduce a small scale of CO2 emission. And, its revenue from carbon credit trading might not cover the expenses for procedure to receive CERs. Nevertheless, the profits could come from the social benefits from achieving liveable university and resolving global warming.

As the recommendation for future study, the additional policies, such as cover way construction, vehicle ban zone, campaign, and etc., should be considered in order to promote the implementation of shuttle bus project. The more private mode users switching to use shuttle bus the more CO2 emission reduction.

7. ACKNOWLEDGEMENT

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