Title of Feasibility Study:
Introduction of fuel efficiency improvement technologies to motorcycle in Vietnam

Name of the Responsible Company
Pacific Consultants Co., Ltd.

1. Outline of the project

(1) Regarding the project

The CDM feasibility study of the project described below is conducted.
The purpose of the proposed project activity is to introduce the motorcycle maintenance techniques and to conduct maintenance and investigation in order to reduce the greenhouse gas emission (CO2) as well as air pollutants from existing motorcycles in Ho-Chi-Minh city, and specifically, following items are implemented.

1. Introduce the investigation equipments for exhaust gases,
2. Establish the system for motorcycle maintenance,
3. Educate the maintenance techniques for the improvement of fuel economy.

(2) Regarding the methodology

No applicable methodology has existed. Submit a new methodology to the UNFCCC.

2. Method of the survey

(1) Implementation structure of the survey

- Tamsui corporation : Measurement of motorcycle exhaust gas, support for the introduction of maintenance techniques
- Geo Viet : Local counterpart. Information gathering of Vietnam and coordination of meetings with institutions concerned in Vietnam.
- Vietnam Success Co., Ltd, Sakura Toso, Sato Sangyo Vietnam Co., Ltd: Provision of spaces for maintenances and motorcycles to be monitored.
- Mr. Tung : Support for coordination with Ho-Chi-Minh city and private maintenance shops

(2) Main issues

Following are the issues of the project activity.

1. Choice or development of a new applicable methodology to the CDM project activity.
2. Set a baseline and project scenario reflected the current situation
3. Considering of uncertainty about the project scenario and leakages.
4. Establishment of a system for ensuring MRVs and management of data.
5. Introduction of facilities and equipments for motorcycle maintenance. Considering of a system for education of maintenance techniques.
6. Opinion exchanges for prevalence of motorcycle maintenance techniques and equipments.
7. Review the status of an introduction of the regulation for motorcycle exhaust gas in Vietnam.

(3) Content of the survey

【At site visit】

Table.1 contents of the site visit

	Schedule	Contents / Visit
1st	29□31.Aug.2010	Meeting with local stakeholders (Department of Transport in Ho-Chi-Minh, Motorcycle manufacture)
2nd	02□14.Dec.2010	Measurement of motorcycle exhaust gas (1st)
3rd	07□21.Feb.2011	Measurement of motorcycle exhaust gas (2nd) and additional measurement for the past motorcycles.

At 2nd and 3rd site visits above, we measured exhaust gases and fuel efficiency of existing motorcycles in Vietnam, and provided maintenances of the project activity. From these data, we consider how much the intensity of exhaust gas and fuel efficiency are improved. Followings are the summary of the measurement of motorcycle exhaust gas.

< Contents >
Measure the 80 motorcycles' exhaust gas and their fuel efficiency before and after the maintenance activities.
Carbon monoxide (CO), Hydrocarbon (HC) and Carbon dioxide (CO2) are measured in the condition where motorcycle is idling.
Maintenances include exchange of engine oil, cleaning air element and cleaning spark plug.

<Summary of the results>
Data are shown in the Table-2. Fuel efficiency could not be measured in 23 motorcycles of the total due to the failure of their odometers. In addition, we except the data correspond to the following conditions. As a result, data of thirty-six (36) motorcycles are available to evaluate.

- The data which show significant worse fuel efficiency after the maintenance than that before. It is assumed to work other factors, e.g. unusual way of driving, between measurements of fuel efficiency.
- The data which show significant improvement of fuel efficiency, more than 50%, after the maintenance than that before. It is assumed to work other factors, e.g. failure of the measurement of the fuel efficiency.

Table.2 Results of measurement of exhaust gas before and after maintenance

	Fuel efficiency (km/l)	CO (vol%)	HC (volppm)	CO_2 (vol%)
Ave. before maintenance	40.34	0.77	468.67	1.81
Ave. after maintenance	51.88	0.40	171.97	1.79
Difference of the averages	+11.54	-0.37	-296.96	-0.02

Table.3 Summary of fuel efficiency measurement

Engine displacement	Sample	Ratio	Baseline fuel economy (km/l)		Project fuel economy (km/l)		Improvement range (km/l)	
			95% lower	95% upper	95% lower	95% upper	Minimum	Maximum
< 100cc	6	16.67%	43.93		57.10		13.17	
			37.55	50.32	52.67	60.65	2.36	23.10
100 - 125cc	30	83.33%	39.62		50.84		11.22	
			36.29	42.95	47.37	54.30	4.42	18.01

From these results, we adopt the figures in Table.4 as the improvement of fuel efficiency.

Table.4 Fuel efficiency improvement ratio (%)

Engine displacement	Ave. before maintenance [km / l] 95%confidence upper	Ave. after maintenance [km/ l] 95% confidence bottom	Fuel efficiency improvement ratio (%)
～100cc	50.32	2.36	**4.68**
100～120cc	42.95	4.42	**10.29**

The savings of fuel consumptions, i.e. reductions in greenhouse gases, in project motorcycles as whole are calculated as multiplying the ratio of each engine displacement class to the 36 motorcycles (>100cc: 16.7%, 100 to 120cc: 83.33%) to the number of project motorcycles.

The followings are found by the measurement of motorcycles monitored.
- Improvement of fuel efficiency of motorcycles by the maintenance.
- Reductions in the intensity of CO and HC in motorcycle exhaust gas.

<Results of the questionnaire to the motorcycle owners>

We conducted the questionnaire to the 80 motorcycle owners in order to recognize how local people use their motorcycles usually when we provided maintenances. Summary of the results is provided below.
- All respondents use their motorcycles almost everyday in the range from 30 minutes to five hours (2.4 hours on average).
- Principal uses of motorcycle are for commuting, leisure and shopping.
- Average distance driven per day has the range from six (6) km to 100 km (36 km on average).
- The ratio of the time spent on motorcycle driving in tandem is 46% (average). That is, many motorcycle owners spend times on their motorcycles in tandem. Driving with large baggage or goods is relatively low.
- Regular exchange of engine oil in order to improve fuel efficiency or engine-stop at signals is practiced by many owners.
- Usual road conditions are paved but bumpy or even, and always congested.

【Latest information collection about the regulation of motorcycle exhaust gas in Vietnam】

A prime minister decision of “909/QD-TTg” which is related to monitoring of motorcycle exhaust gas has been announced on 17 June, 2010. It plans to establish a system

for motorcycle maintenances by 2013 to satisfy an exhaust gas standard by 20% of motorcycle users in Hanoi and Ho-Chi-Minh city. It also plans to cover about 80 – 90 % of all motorcycle users to be met the standard in Hanoi and Ho-Chi-Minh between 2013 and 2015. However, we found that the policy was not progressed so far.

【Choice or development of a new applicable methodology to the CDM project activity】

Review CDM registered and proposed methodologies or methodologies at review about transportation and registered transportation CDM project activities. Methodologies which can be referred are summarized.

【Coordination of stakeholders】

Department of Transport in Ho-Chi-Minh city, the branch office of the Vietnam Register and the Investment and Trade Promotion Center are supposed to be stakeholders of the project activity with which stakeholder meetings should be held. In order to progress the project, we have requested the establishment of a conference to the Department of Transport in Ho-Chi-Minh city.

3. Result of the survey for implementing CDM project

(1) Setting baseline scenario and project scenario

【baseline scenario】

In Vietnam, no regulation for the investigation of motorcycle exhaust gas and the motorcycle maintenance has existed at present. Although the Vietnamese government has planned to introduce a regulation for several years ago, the details of it or even if it actually introduces or not, are uncertain. Furthermore, it is assumed that establishment of a compliance system is difficult in terms of costs and technologies even if it does. It is also assumed that appropriate maintenances are not provided due to the lack of knowledge and/or techniques about motorcycle maintenances.

Therefore, the baseline scenario is supposed to be a situation where motorcycles are continued to use without appropriate maintenances, which result in consuming more fossil fuel than that consumed in the project activity.

CO2 emissions in the baseline scenario is calculated with the number of motorcycles in each engine displacement class (<100cc, 100-120cc, >120cc), annual travel distance per motorcycle (km), the amount of fuel consumption (liter/km) and CO2 emission factor for fuel (t-CO2/MJ).

<Formula for calculation of baseline emissions>

$$BE_y = \sum BE_{dc,y}$$

Where:

BE_y : Total baseline emissions in year *y* (tCO2)

$BE_{dc,y}$: Total baseline emissions of motorcycles in engine displacement class *dc* in year *y*

$$BE_{dc,y} = SN_{p,dc,y} \times BFE_{dc,y} \times AD_{PL,commuting,p,y} \times EF_{CO2,j} \times NCV_j \times D_j$$

Where:

$SN_{p,dc,y}$: Statistical number of project motorcycles *p* in engine displacement class *dc* in year *y*

$BFE_{dc,y}$: Representative value of baseline fuel economy of motorcycle in each engine displacement class *dc* in year *y* (litre/km)

$AD_{PL,commuting,p,y}$: Average annual commuting distance of project motorcycles *p* in year *y* (km)
$EF_{CO2,j}$: CO2 emission factor of motor gasoline (tCO2/MJ)
NCV_j: Net calorific value of motor gasoline (MJ/t)
D_j : Density of motor gasoline (g/cm3) [1]

The parameter $BFE_{dc,y}$ shall be determined by statistical method based on $BFE_{sample,\ dc,\ y}$ obtained from baseline motorcycles in a sample survey and $BFE_{sample,\ dc,\ y}$ is calculated according to the following formula:

$$BFE_{sample,\ dc,\ y} = FC_{BL,\ sample,\ dc,\ y} / TD_{BL,\ sample,\ dc,\ y}$$

Where:
$FC_{BL,\ sample,\ dc,\ y}$:
Amount of fuel consumed by a sample un-maintained motorcycle in engine displacement class *dc* during sample survey in year *y*

This value is obtained by measuring the actual fuel consumption of a sample un-maintained motorcycle operating in comparable traffic conditions (i.e., in the same city) during the sample survey. It is measured based on the amount of fuel needed to fill the fuel tank after use of the motorcycle in a defined period, with the tank having been filled at the beginning of the sample survey.

$TD_{BL,\ sample,\ dc,\ y}$:
Travel distance of the sample un-maintained motorcycle with fuel consumption of $FC_{BL,\ sample,\ dc,\ y}$

This value is obtained by measuring the actual travel distances of the sample un-maintained motorcycle with fuel consumption of $FC_{BL,\ sample,\ dc,\ y}$. The travel distance is read from the odometer.

【Project boundary】
The project boundary is the physical, geographical location of the motorcycles with appropriate maintenances that are the main part of the project activity being provided. The project boundary includes the 300,000 motorcycles that will be conducted investigation and maintenance by the maintenance shops and mechanics who are introduced and educated by the project activity to retain capacity for investigation and maintenance.
CO2 emission from fuel consumption is the subject gas of the project activity.

(2) Project emissions
The project activity provides appropriate maintenances to motorcycles. It also improves condition of engine and saves fuel consumption per distance driven. As a result of the project activity, CO2 emissions are reduced with the improvement of fuel efficiency of motorcycles.
CO2 emissions in the project scenario is calculated with the number of motorcycles in each engine displacement class (<100cc, 100-120cc, >120cc), annual travel distance per motorcycle (km), the amount of fuel consumption (liter/km) and CO2 emission factor for fuel (t-CO2/MJ).

[1] http://www.iea.org/Textbase/work/2004/eswg/22_Oil%20Densities.pdf

<Formula for calculation of project emissions>

$PE_y = \sum PE_{dc,y}$

Where:
PE_y : Total project emissions in year *y* (tCO2)
$PE_{dc,y}$: Total project emissions of motorcycles in engine displacement class *dc* in year *y*.

$PE_{dc,y} = N_{p,dc,y} \times PFE_{dc,y} \times AD_{PL,commuting,p,y} \times EF_{CO2,j} \times NCV_j \times D_j$

$N_{p,dc,y}$: Number of project motorcycles *p* in engine displacement class *dc* in year *y*
$PFE_{dc,y}$: Representative value of improved fuel economy of project motorcycle *p* in engine displacement class *dc* in year *y* (litre/km)
$AD_{PL,commuting,p,y}$: Average annual commuting distance of project motorcycles *p* in year *y* (km)
$EF_{CO2,j}$: CO2 emission factor of motor gasoline (tCO2/MJ)
NCV_j : Net calorific value of motor gasoline (MJ/t)
D_j : Density of motor gasoline (g/cm3) [2]

The parameter $PFE_{dc,y}$ is determined by statistical method based on $PFE_{p,dc,y}$ obtained from project fuel economy survey and $PFE_{p,dc,y}$ is calculated according to the following formula:

$PFE_{p,dc,y} = FC_{PL,p,dc,y} / TD_{PL,p,dc,y}$

$FC_{PL,p,dc,y}$:
Amount of fuel consumed by a project motorcycle p in engine displacement class *dc* during a project fuel economy survey in year *y*.

This value is obtained by measuring the actual fuel consumption of a project motorcycle during the project fuel economy survey in year *y* and measured based on the amount of fuel needed to fill the fuel tank after use of the motorcycle in a defined period, with the tank having been filled at the beginning of the sample survey.

$TD_{PL,p,dc,y}$:
Travel distances of the project motorcycle *p* in engine displacement class *dc* with fuel consumption of $FC_{PL,p,dc,y}$

This value is obtained by measuring the actual travel distances of the project motorcycle with fuel consumption of $FC_{PL,p,dc,y}$. The travel distance is read from the odometer.

【Leakage】

No leakage calculation is required.

Travel distances may increase with better fuel economy, resulting in additional CO2 emissions. The improvement of fuel economy due to the project activity would offset those increases, however, because better fuel economy would decrease the fuel consumption of

[2] http://www.iea.org/Textbase/work/2004/eswg/22_Oil%20Densities.pdf

motorcycles operated for uses other than commuting.

(3) Monitoring plan

Monitoring of the following items should be conducted in this project.

1. Not monitoring items (default value)

Data/parameter:	$EF_{CO2,j}$
Data Unit:	tCO2/TJ
Description	CO2 emission factor of the gasoline for vehicle
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Measurement procedure(if any):	Default value: 69.3（tCO2/TJ）

Data/parameter:	NCV_j
Data Unit:	TJ/Gg
Description	Net Calorific Value of the gasoline for vehicle
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Measurement procedure(if any):	Default value: 44.3（TJ/Gg）

Data/parameter:	D_j
Data Unit:	g/cm^3
Description	Average of density of the gasoline for vehicle
Source of data:	The Energy Statistics Working Group Meeting report of International Energy Agency
Measurement procedure(if any):	Default value: 0.7449（g/cm^3）

2. Para metered monitored

Data / Parameter:	$BFE_{dc,y}$
Data unit:	Litre/km
Description:	Baseline fuel economy in engine displacement class *dc* in year y
Source of data to be used:	Sampling survey
Value of data	The upper 95% confidence interval is taken.
Description of measurement methods and procedures to be applied:	Sample survey in year *y*. The fuel economy data based on the sample survey shall comply with the 90% confidence interval and 10% margin of error requirement, and the upper value of 95% confidence interval shall be taken in each engine displacement class *dc*.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$PFE_{dc, y}$
Data unit:	Litre/km
Description:	Project fuel economy in engine displacement class *dc* in year *y*
Source of data to be used:	Sampling survey
Value of data	The lower 95% confidence interval is taken.
Description of measurement methods and procedures to be applied:	Sample survey of project motorcycles in year *y*. The fuel economy data based on the sample survey shall comply with the 90% confidence interval and 10% margin of error requirement, and the lower value of 95% confidence interval shall be taken in each engine displacement class *dc*.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$AD_{PL, commuting, p, y}$
Data unit:	Km
Description:	Average annual commuting distance of project motorcycles in year *y*.
Source of data to be used:	Interview or questionnaire for the project motorcycle owners in year *y*.
Value of data	Average value is taken
Description of measurement methods and procedures to be applied:	Interview or questionnaire for the project motorcycle owners in year *y* when maintenance is provided to project motorcycles.
QA/QC procedures to be applied:	
Any comment:	

3. Monitoring plan

The monitoring survey of exhaust gas and fuel efficiency of project motorcycle shall be conducted at the periodical maintenance which will be done once in three months at the project maintenance center. All the monitoring data shall be stored electrically, and these data shall be kept storing at least two years after the last crediting period.

In order to specify the project motorcycles strictly, project participants shall require the owner of the motorcycle to provide the information useful for specified the user and project motorcycle at the monitoring.

(4) GHG emission reduction

From the survey result which have been conducted to 50 motorcycles at the site, it has been figured out the change of density of CO2 and fuel efficiency in exhaust gas before and after. The average fuel efficiency of pre project is 45.83km/liter, and the value of 95% confidence interval is 41.14 to 50.52 km/liter. And after project, the average fuel efficiency has been improved to 53.79 km/liter (+7.96 km/liter), the range of the 95% confidence interval of fuel improvement is 4.00 to 11.91 km/liter.

From these results, fuel efficiency has been improved at least 4.00 km/liter (lower value

of 95% confidence interval) from the upper limit of fuel efficiency (50.52 km/liter), which means fuel efficiency has been improved from 50.52 (km/liter) to 54.52 (km/liter) with the project activity. And the annual average travel distance (7,744km) have caught by the data of purchasing date and accumulate travel distance. The estimation of emission reduction by project activity are as follows;

Table.3 GHG emission reduction (t-CO2/year)

Year	Estimation of project activity emissions(tCO_2e)	Estimation of baseline emissions(tCO_2e)	Estimation of leakage emissions(tCO_2e)	Estimation of overall emission reductions(tCO_2e)
2012	147,622	161,556	0	13,934
2013	147,622	161,556	0	13,934
2014	147,622	161,556	0	13,934
2015	147,622	161,556	0	13,934
2016	147,622	161,556	0	13,934
2017	147,622	161,556	0	13,934
2018	147,622	161,556	0	13,934
2019	147,622	161,556	0	13,934
2020	147,622	161,556	0	13,934
2021	147,622	161,556	0	13,934
Total	**1,476,220**	**1,615,560**	0	**139,340**

(5) Project period/Crediting period

Fixed time period for ten (10) years are set to the project period. This is because it seems that the technologies for fuel efficiency or maintenance techniques for motorcycles would be improved with time and the situation of transportation of the county would be changed in the future.

The starting date of the project is set to August, 2010. This is why that the feasibility study of this project has been conducted since August, 2010. In addition, it is considered the announce of this feasibility study which were submitted by GEC and the minutes of the meeting with HCMC could be used as the documents for the prior consideration. And the submission of prior consideration of this project to UNFCCC were submitted on January, 2011.

(6) Environmental effect, other indirect effect

There are clear clarification for implementation of environmental assessment by the Environmental law which were revised and adopt on 2005 in Vietnam. And on the appendix of the government decree, “No. 80/2006/ND-CP of August 9, 2006”, they show clearly the list of the business which shall make the environmental assessment report. In this list, the establishment of the maintenance center like this project is not included. And the benefit of the implementation of this project are emission reduction of air pollution, such as carbon monoxide and hydrocarbon and nitrogen oxide, and they are positive effect for the environment. Therefore, basically, it is not necessary to implement the environment assessment.

(7) Comment from stakeholders

To implement this project, the following organizations are considered as stakeholders of this project for which prior consultation should be done.

- Department of Transportation HMCM
- Vietnam Register
- The center of investment

However, the official prior consultation with these organizations have not been conducted yet. In order to have prior consultation between them, request for establishing the commission have been submitted, and after the establishment of the committee, the comments from the stakeholders for this project should be collected.

(8) Implementation scheme of this project

Tamusu, Vietnam that are established by Japanese private company, Tamsui Co.,Ltd., would be the project participant in this project. Tamsui, Vietnam will implement the maintenance of motorcycle and check exhaust gas, therewith, they will form an alliance with local maintenance companies and implement technology transfer of maintenance techniques and equipment to other maintenance companies.

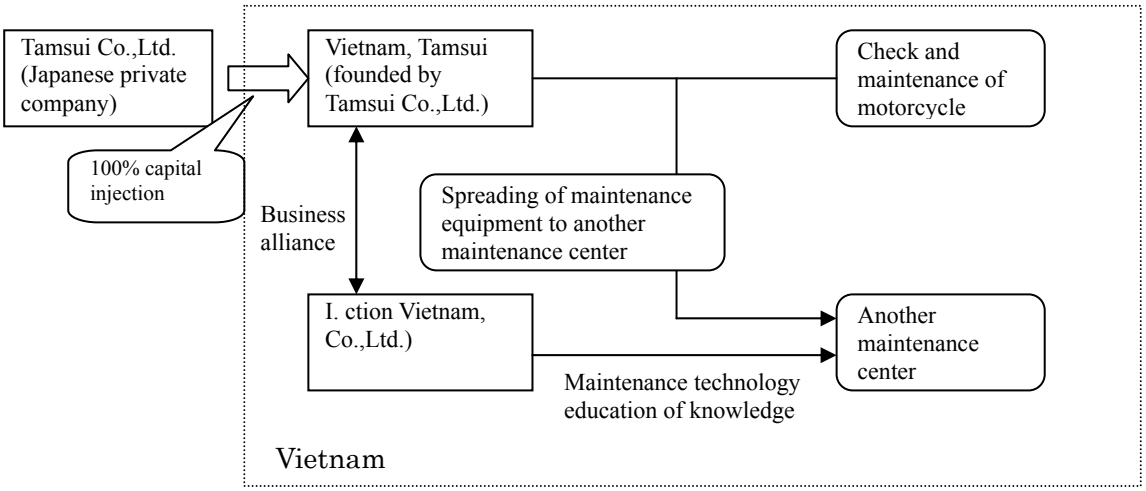

Fig.1 Scheme of project implementation

(9) Financial planning

This project could be important countermeasure for air pollution control in Ho Chi Minh City (hereafter HCMC). Therefore, in order to request HCMC to provide public fund to this project, continuous consultation with HCMC should be done. However, the prospect of the funding from Ho Chi Minh City is not in sight at this stag. Therefore, the own fund of Tamsui Co., Ltd. and the borrowing from the commercial bank would be the main source of fund to implement the project at this stage.

(10) Economical analysis

Investment condition for this project is as follows;

- Total project cost: 0.8 Million USD (own fund: 0.13Million USD)
- Maintenance cost: 0.98 Million USD (without CDM)
  1.16 Million USD (with CDM)

It is assumed that benchmark IRR is 13.5%, 1.5 times of official discount rate 9.0% of the Vietnamese central bank, in the case of benchmark analysis using EIRR as a index.

When the project would be done without CDM, EIRR would be 7.78%, that are lower than benchmark IRR, it means that this project is not economical attractive for the project owner. On the other hand, if the project would be done as a CDM project and the economical benefit, 13 million USD, would be included for the benefit from the project, the EIRR would be 15.34%. It means that EIRR would be above benchmark index and this project with CER benefits has economical attractive for the project owner.

(11) Demonstration of additionality

Additionality of this project would be demonstrated by Investment analysis, Barrier analysis, and Common practice analysis.

1. Investment analysis

As mentioned at economical analysis, if the project would be done without CDM, this project would not have economical attractive for the project owner. However, if the project would be done with CER benefit, this project would have economical attractive for the project owner.

2. Barrier analysis

The level of maintenance technology for motorcycle in Vietnam is low. This is because that most of the maintenance service are provided by small private company. And these service providers have not appropriate techniques and knowledge. Therefore, there is a technological barrier for the appropriate maintenance. In order to overcome this barrier, technological transfer from Japan would be necessary.

3. Common practice analysis

Demonstrating the appropriate maintenance of motorcycle is not common practice in Vietnam. Current common practice is only the simple maintenance by small private service provider, and that would not be succeed with new regulation for exhaust gas from motorcycle.

(12) Prospective of getting in operation

Preparation has been implemented for a business operation, establishing a local corporation in Ho Chi Minh City on November, 2010. And the consultation with Investment and Trade Promotion Center which manage the foreign capital company and department of transport of HCMC has been conducted continuously, on the other hand, the consultation with Japanese business counterpart which could support this project has been conducted, too.

After the establishing of committee with department of transport of HCMC, making a prospect for the early stage of ensuring the place for maintenance field, introducing the maintenance and checking equipment, holding of the technical class for the maintenance engineer will be done as soon as possible to make start the project as soon as possible considering the status of approving the methodology,

(13) Issues were extracted by this feasibility study

Issues were extracted by this feasibility study and the countermeasure for these issues is as follows,

1) Thorough training/education for the local engineer

As for the training / education for the local engineer at the field, improvement of the technical level of the local engineer while operating measurement equipment and using the manual which are written in Vietnamese with calling of the Japanese engineer.

However, considering the real measurement results, they include many irregular values (especially at the first exhaust gas test). It is because that local engineer could not justify these values as irregular value so that some action should be done for these issues.

Therefore, in the case of conducting the maintenance or exhaust gas test, the training or education is necessary.

2) Considering incentive of periodical maintenance enforcement for the motorcycle user

It seems that some incentives for the motorcycle user should be considered to make periodical maintenance enforcement and GHG emission reduction continuously, such as discount system of the fee for maintenance. However, these kind of incentives may suppress profit side of the project participant. Therefore, serious consideration shall be done before implementing these

incentives.

3) Consideration expansion of the maintenance item
In this feasibility study, three maintenance items (oil exchange, air element cleaning, sparking plug cleaning) had been done as a maintenance for motorcycle. The effect of these items have not continued for a long time and decreased during the first and second exhaust gas test period. Therefore, in order to promote these items as countermeasure for GHG emission reduction and air pollution control, it seems that the periodical maintenance once a three month is necessary. However, from the realistic point of view, it is difficult to make the user understand the periodical maintenance once a three month. In addition, ensure the effect of fuel efficiency improvement, the above three maintenance items are not enough. Therefore, new maintenance item or some component replacement should be considered. As for possible candidate, replacement the sparking plug to higher performance sparking plug. Furthermore, holding the appropriate air pressure of tire is considered as another possible candidate.

4. Result of Co-benefit

(1) Evaluation index

Carbon monoxide and hydrocarbon that are used as regulation for the transportation system, such as motorcycle and car, are used as evaluation index of Co-benefit. Carbon monoxide is known well that it has extremely toxic consequences. And hydrocarbon is known well that it would be cause of air pollution that generate oxidize smog.

(2) Baseline scenario/Project scenario

The baseline scenario is that the motorcycles which do not have the appropriate maintenance continues being used, and an incomplete combustion of the gasoline continues, and the continuous emitting of carbon monoxide and one of the cause of the air pollution material would continue. The project scenario is that emission density of carbon monoxide and hydrocarbon would be lowered by improving the situation of an incomplete combustion of the gasoline because of conducting the appropriate maintenance.

(3) Evaluation of baseline and monitoring

The density regulation is general for a regulation of the measurement of carbon monoxide and hydrocarbon. Then the density regulation for both of carbon monoxide and hydrocarbon are set as a evaluation index of Co-benefit in this project.
As for the evaluation method of baseline, sampling survey shall be conducted to a certain number of the project motorcycles in order to measure the density of carbon monoxide and hydrocarbon before the maintenance. After the maintenance, the measuring of these gases shall be conducted as well as pre maintenance. By taking the difference of the average of these sampling data, reductions of density of these gases are evaluated as co-benefit of the project.

(4) Process of the calculation for estimation (quantitative) and the result

The result of the estimation for pre project using the result of exhaust gas examination is as follows. The quantification method that assumed a hydrocarbon an evaluation index is as follows.

(Calculation formula of emission reduction of hydrocarbon density)

$$ER_{HC,ave} = BE_{HC,ave} - PE_{HC,ave}$$

where

$ER_{HC,ave}$ Emission reduction of hydrocarbon density (ppm)
$BE_{HC,ave}$ Hydrocarbon density on baseline scenario (ppm)

$PE_{HC,ave}$ Hydrocarbon density on project scenario (ppm)

(Calculation formula of hydrocarbon density in exhaust gas on baseline scenario)

$$BE_{HC,ave} = \sum (EC_{HC,BL,y}) / N_y$$

where

$EC_{HC,BL,y}$ Density of hydrocarbon of project motorcycles in baseline (ppm)

$N_{,y}$ Number of project motorcycles

(Calculation formula of hydrocarbon density in exhaust gas on project scenario)

$$PE_{HC,ave} = \sum (EC_{HC,P,y}) / N_y$$

where

$EC_{HC,p,y}$ Density of hydrocarbon of project motorcycles in project (ppm)

$N_{,y}$ Number of project motorcycles

表-4 Result of Exhaust gas examination（Average）

	CO (vol%)	HC (volppm)
Average date before maintenance	0.77	468.67
Average date after maintenance	0.40	171.97
Difference	-0.37	-296.96