DEVELOPMENT OF A BASIC INFRASTRUCTURE FOR THE SUCCESSFUL COMPLIANCE OF JEEPNEYS AND TRICYCLES TO THE PHILIPPINE CLEAN AIR ACT

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Abstract: A study was undertaken to promote the successful compliance of jeepneys and tricycles to the air quality standards in the Philippines. Initially, a survey was conducted among the stakeholders in order to ascertain actual needs and dispositions. Eventually, a basic package of support (including viable technology solutions) was developed; and available policies, guidelines and other infrastructure in the country were evaluated in terms of their adequacy to support the compliance of jeepneys and tricycles to the provisions of the law. A difficult compliance by jeepneys and tricycles to an immediate implementation of a Clean Air Act is indicated by the disparity between the basic infrastructure support package that emerged and the support components already operational/existing in the Philippines. Success may be achieved in the medium-term and through concerted efforts of the government and the non-government sectors.

Key Words: emissions, jeepneys and tricycles, Philippine Clean Air Act, compliance, support infrastructure

1. INTRODUCTION

The lure of modernization is economic benefit that is the requisite of the good life. Unscrupulous and/or irresponsible practices in industrialization and urbanization lead to the production of materials that are carried in exhaust gases from spray guns, burners and engines out to the ambient air. Such materials are called wastes. In spite of the facilities and viable management schemes that are already provided, most wastes remain outside the earth's natural ecosystem where one organism's waste is another organism's food or shelter. This results to considerable depletion of resources and to worsening damage to life and the environment.

Over the last decade, the Philippines has suffered serious environmental problems. The situation thus far caused the Filipino nation to take the necessary courses of action to sustain the carrying capacity of the environment and preserve the richness of the country's natural resources.

In 1998, the Philippine Congress passed a Clean Air Act (RA 8749). It was signed into law by the President of the Philippines in 1999. The law provides for the systematic elimination of existing pollution-promotion technologies (processes and products) and the prevention of the emergence of other sources of pollution that can adversely affect the quality of the air.

The land transport sector is a major contributor to air pollution in the Philippines. The 3,533,732 (Phil. Land Transportation Office1999) total registered vehicles contribute more than 50% of the non-methane hydrocarbons and nitrogen oxides in the atmosphere. Lead level in Metro Manila air averages 1408 ng/m^3 between 1991 and 1997 (Santos, F.L. *et. al.* 2000). This value is significantly higher than the 1000 ng/m^3 in most cities of the United States of America for the same period (U.S. EPA Office of Air and Radiation 1999). Lead in Canadian air has been below detectable limit since 1991 (Environment Canada 1998).

There are 177,222 registered jeepneys and 463,243 registered tricycles in the country (Phil. Land Transportation Office1999). Most jeepneys use 3000-3500 cc, four-stroke, compression-ignition, surplus engine from Japan, while most tricycles use 125 cc, two-stroke, single-cylinder, spark-ignition engine that are more often than not second-hand. Second-hand engines for jeepneys and tricycles are usually badly maintained because of the high costs of parts and services. Also, frequent problems in foreign exchange rates and the age of the engines make access to parts difficult. These limitations persist in the face of the stringent requirements of the Clean Air Act.

The satisfactory compliance of jeepneys and tricycles to the environmental standards is, therefore, incumbent upon the development of a basic, enabling package of policies, rules and regulations, standards, incentives, penalties, technology solutions, and information dissemination strategies.

2. OBJECTIVES

A number of components in such a basic, enabling package are long existing and can be identified. There is just a need to evaluate, supplement and harmonize the components into a comprehensive whole. The proposed program of study aims to

1. Conduct a survey among stakeholders in order to ascertain actual needs and dispositions;
2. Present a viability analysis of the available technology solutions to high level of emissions in jeepney and tricycle engines;
3. Develop a basic package (including viable technology solutions) that can support compliance to the Philippine air quality standards;
4. Evaluate the available policies, guidelines and other infrastructure in the country in terms of their adequacy to support the compliance of jeepneys and tricycles to the Clean Air Act;
5. Make recommendations to remedy any inadequacy found in the existing support infrastructure in the Philippines for the compliance of light transport units to the air quality standards.

3. SCOPE AND LIMITATIONS

The components of the basic infrastructure that is proposed herein are derived from the documents about current related practices in the world and the results of the survey that was undertaken.

The survey was conducted in Metro Manila where the situation of air pollution is serious, and where large densities of jeepneys and tricycles can be found.

The key players that were surveyed are: (a) drivers and operators of jeepneys and tricycles;

(b) professionals with practices related to the promotion of air quality standards; (c) students taking courses in environmental engineering.

The evaluation of related technologies was focused on materials, units and systems that are commercially available and widely utilized.

In the evaluation of the sector readiness to implement the Clean Air Act, only those facilities or infrastructure components that are already in operation or in utilization were considered in existence.

4. RESEARCH DESIGN

The basic infrastructure for the successful compliance of jeepneys and tricycles to the Clean Air Act of the Philippines is composed of bodies of information, technology solutions and a functional organization of individuals and groups, both public and private, that undertakes related activities addressed to the common objectives. The development of such infrastructure is based on a need analysis with reference to the documented requisites in other countries implementing laws on clean air and the result of a survey among stakeholders in the Philippines. An evaluation of a number of technology solutions available worldwide is also done in order to specify the technology requirements in the support infrastructure.

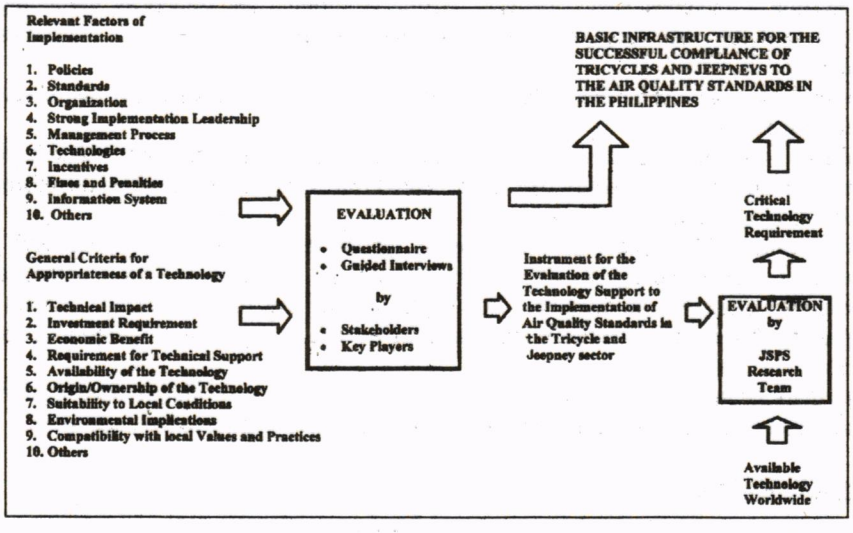

Figure 1. Research Design

Figure 1 shows the design of the study. The necessary questionnaires are constructed and validated, and then fielded to the various stakeholders as far as the compliance of jeepneys and tricycles to the air quality standards is concerned. The result of the survey becomes the basis of (a) a set of facilities that must be present in order to insure a successful compliance; and (b) an evaluation instrument for technology solutions applicable to the needs of the particular sector under consideration. Available technologies for the control of emissions in small engines are evaluated for inclusion to the basic infrastructure support for jeepneys and tricycles. The facilities already provided and in operation in the Philippines are checked

against the basic infrastructure. At any time that these two tally is a good time to implement the Clean Air Act in the jeepney and tricycle sector because there is a high probability of success.

5. SURVEY OF NEEDS

The survey of needs is done by fielding questionnaires and conducting interviews among the identified stakeholders. This provides an alternative avenue for information to filter down the grassroots and for the feedback to reach the planners.

5.1 Basis of Survey Instruments

The promotion of good air quality requires a total comprehensive system that can function as an effective support infrastructure in achieving the set environmental targets. In a functional system one finds the following components.

COMPONENTS OF A SUPPORT SYSTEM

Input

Information - Includes needs analysis, current solutions, and practices pertaining to air pollution and the necessary process reversal into an acceptable level of emissions in the ambient air.
Purpose/Direction - The clear statement(s) of intention(s) by the state and the private sector to clean the air.
Standards - A set of guides for the measurement of factors and parameters in terms of quantity, extent, value or quality that are accepted true, correct, or tolerable, therefore, can be a basis for a judgment or decision.
Organization - The functional structure of individuals and groups, public and private, cooperating and enduring for the common purpose of cleaning the ambient air, and undertaking collective activities based on organized patterns of relationship. An active lead group or agency in the structure is important for overall coordination, monitoring, recording, reporting, etc.
Technology Solutions - The products and processes that are available specifically for the control of air pollutants and the mitigation of their negative impact to the ecosystem.

Process/Procedure

Monitoring - The process(es) by which critical information pertaining to air quality can be obtained, recorded and reported precisely and regularly. This can include procedures of sampling, testing, and calculation for the desired values of factors and parameters.
Control - The set of procedures that regulate practices so that the identified objectives can be achieved.
Coordination - The communication among individuals and groups for the harmonization of their functions and delineation of responsibilities.

Target Results

These include, in the short-term, mostly the extent of compliance on fuel properties and the

quality of exhaust gases tested from specific sources, assuming strict implementation of monitoring procedures. In the long-term, it is best to focus on impacts to the ambient air quality and the state of people's health.

There are precedents in the advocacy for clean air. Models of infrastructure existing in other countries can be compared on the basis of their relative efficiency and effectiveness.

5.2 The Instruments

There are three (3) instruments as there are three respondent groups. The instruments differ only in the contents of Part I. This part captures items of information about the respondent such as average family income per month, access to information and technology, and gender. The two other parts are common to the instruments. Part II includes thirty-three support components with a provision for the accommodation of additional items that may be recommended by the respondent. The particulars of this part of the instrument are designed to specify the basic infrastructure (technology solutions are identified in terms of applications) required for the successful compliance of jeepneys and tricycles to the air quality standards in the Philippines. The last part (III) pertains to the desirable characteristics of the technology solutions, and intends to provide guidelines in the development of another instrument called the **Technology Information and Evaluation Sheet**.

Working on the hypothesis that the basic requirements for the successful implementation of the air quality standards do not differ from sector to sector nor from country to country, part II of the questionnaires is developed. Initially, the facilities present in the countries that successfully implement the air quality standards are appraised. Those that are established/provided during the early period of implementation are identified. These are the same facilities presented in the questionnaires for the consideration of the respondents. Detailed evaluation and addition of item requisites are facilitated.

The items in part II are rated according to the respondent's perceived need for them as requisites of the successful compliance of jeepneys and tricycles to the air quality standards. The ratings range from 0-not needed, 1-slightly needed, 2-needed, 3-much needed, to 4-very much needed.

5.3 The Respondents

Questionnaires are distributed among the identified stakeholders. The drivers and operators are primarily responsible for keeping the condition and operation of their engines well within the prescribed standards. The professionals are engaged in activities related to the promotion of good air quality. The students are enrolled in reputable institutions of higher education (centers of excellence/development in engineering) in Metro Manila, and have taken courses or related courses in environmental engineering.

All the respondents benefit from the improvement of the air quality. The drivers (in many cases, the operators/owners also) of jeepneys and tricycles are the most affected by the bad air quality. The Metro Manila Development Authority (MMDA) estimates that 190,000 public utility drivers have 8-24 hours per day exposure to air pollutants. A study by the College of Public Health at the University of the Philippines shows that chronic lung diseases are more common among jeepney drivers relative to the general public. The students and the

professionals are among the riding public who are highly dependent on the jeepneys and tricycles not withstanding their contribution to the deterioration in the quality of the ambient air.

The drivers and the operators are subject to monitoring and control processes that are necessary in order to observe the limitations set on the levels of engine emissions. These people have to spend for technology solutions in order to insure compliance to standards. There is also probability of being fined/penalized for non-compliance to rules and regulations. While this group has a major role in the implementation of the law, it has the least access to information and technology.

The provisions for monitoring and control nor the limitations on emission levels do not directly affect the students and the professionals unless they become operators and drivers. They can be affected as riding public should the number of units dwindle because of difficult compliance to the law. Basically these people are agents of change through research, education and training. These are the informed groups with better access to technology. They can help speed up initial implementation of the law and help sustain compliance by providing for the continuous flow of information and the generation of vital indigenous technologies.

The group of drivers and operators know what they need presently; the group of students and professionals know what are needed based on available facts. Their combined inputs should provide more than adequate information to develop a good infrastructure support for the implementation of the Clean Air Act.

5.4 Data Processing

The mean and standard deviation of the ratings for each component item are calculated for all respondents. The results are expected to indicate the central tendency of the ratings and how the individual response varies from such central tendency.

A **correlation analysis** is made between the ratings and the independent variables (a) access to information and technology, (b) gender and (c) average family income per month **using t-Test and Anova**. This is done in order to articulate the determinants of the variances. Also, specific trends may be established and can be related to the respondent's characteristics. All these are important in the process of rationalization and forecasting.

5.5 Presentation and Analysis of Results

The questionnaire retrieval level is relatively low, and must definitely be improved in a subsequent study. There are five-hundred and sixty-five respondents. Two-hundred and thirty-eight are drivers and operators of jeepneys and tricycles; one-hundred and fifty-four are professionals; and one-hundred and seventy-three are students.

The mean and standard deviation of the ratings (extent of need) for the support components are calculated as surveyed from the total respondents. The results are presented in Table 1.

Respondents place high premium on (a) clear policies emanating from the national governance and harmonized at the towns/cities; (b) laws, rules and regulations pertaining to the maintenance of good air quality; and (c) information dissemination specially through

education and training. Moreover, respondents favor the collection of fines and the implementation of penalties for violations.

There are observable variations in the ratings of the respondents for the support components. It is important to articulate the cause(s) of such variations. For this purpose, the relationships between the personal circumstances of the respondents such as access to information, average monthly income of the family and gender, and the perceived need for each support component are examined.

Table 1. Calculated Mean and Standard Deviation of the Ratings by All Respondents.

COMPONENTS	MEAN	STD. DEV.
PART II		
1. Policies on Air Quality		
a. National	3.77	0.55
b. Provincial	3.08	1.01
c. Town/City	3.57	0.69
d. Organization	3.17	1.00
2. Laws on Air Quality (National)	3.74	0.59
3. Resolutions on Air Quality (Town/City)	3.52	0.67
4. Rules and Regulations on Air Quality (Organization)	3.48	0.79
5. Standards for Engine Exhaust	3.52	0.78
6. Organizational Structure for the Management of Air Quality	3.33	0.78
7. Lead Agency for the Implementation of the Clean Air Law	3.54	0.78
8. Process		
a. Control	3.62	0.63
b. Monitoring	3.60	0.67
c. Coordination	3.64	0.63
9. Support Technologies		
a. Alternative Fuel	3.43	0.88
b. Exhaust-Gas Cleaner	3.43	0.80
c. Testing Device	3.30	0.86
d. Testing Center	3.32	0.81
e. Modified Engine Part	3.15	0.87
f. Alternative Engine	3.05	1.04
g. Alternative Propulsion System	2.99	1.06
10.Incentives for Compliance		
a. Loan Package	2.99	1.07
b. Tax Exemption	2.89	1.20
c. Tax Credits	2.82	1.16
11.Fines for Non-Compliance to the Law	3.42	0.88
12.Penalties for Non-Compliance to the Law	3.49	0.86
13.Information Dissemination		
a. National	3.72	0.56
b. Regional	3.50	0.66
c. Municipal	3.52	0.67
d. Multimedia	3.49	0.78
e. Print	3.36	0.86
f. Broadcast (Radio and Television)	3.64	0.67
g. Education	3.67	0.62
h. Training	3.57	0.78

The correlation analysis shows significant relationship between the respondent's access to information and technology, and the extent of need for the following components: (a) resolutions on air quality at the town/cities, (b) standards for engine exhaust, (c) organizational structure for the management of air quality, (d) lead agency in the

implementation of Clean Air Act, (e) monitoring and control processes, (f) support technologies (except alternative engine), (g) incentives for compliance to the law, (h) fines and penalties for non-compliance to the law, and (i) information dissemination strategies (except training). In most cases the professionals indicate the highest need for the said components.

The results of the t-test show that gender is significantly related to the extent of need for the following components: (a) laws and resolutions on air quality, (b) standards for engine exhaust, (c) organizational structure for the management of air quality, (d) lead agency in the implementation of Clean Air Act, (e) processes for monitoring and control, (f) testing center, and (g) information dissemination through education, multimedia and print. In all cases, the women register higher need for such components.

The correlation analysis also shows that the need for (a) the standards for engine exhaust, (b) alternative fuel, and (c) information dissemination in multimedia and print varies significantly with the average family income per month. Respondents with the monthly income of P25,001 and more have higher need for the particular components.

The mean and standard deviation of ratings confirmed the earlier assumption that the infrastructure components included in the survey questionnaire are needed for compliance to a established set of air quality standards. There are, however, those that are rated much needed. When both time and resources are limited in providing a support structure, as in the case of the Philippines, the much needed components are deemed basic hence given the priority consideration.

In consideration of the extent of need (much needed) expressed within a narrow range of variance (less than one), twenty-six (26) factors in the questionnaire are selected as components of the basic support infrastructure for the successful compliance of jeepneys and tricycles to the air quality standards. The components are highlighted in Table 1. The technology solutions are, however, still specified in terms of the applications.

6. SURVEY OF TECHNOLOGY SOLUTIONS

It is important that the infrastructure support includes specific technologies vital to compliance. There are already a wide range of products and processes available in the world that can prove adequate for the requirements of jeepneys and tricycles. It is only a matter of identifying which are more suitable to the local conditions and urgently needed during the initial implementation of the Clean Air Act.

Results from the need analysis identify the general technology requirements in terms of the various applications. In addition, the respondents in the survey are given the opportunity to provide feedback on factors related to successful technology adoption.

The information thus gathered are used to develop an instrument that shall identify the solutions critical to the initial compliance of jeepneys and tricycles to the air quality standards.

6.1 Basis of the Evaluation Instrument

FACTORS IN TECHNOLOGY ADOPTION.

There are certain technical, economic and social factors that determine the choice of technology. Careful consideration of the factors become all the more important if the enabling resources for procurement are limited. In order to insure sustainability the technology choices must be suitable to the needs and capacity of the users.

The technical factors are: **technical impact; level of technology; suitability to local conditions; local access to the technology; provision for regular maintenance; availability of parts, and environmental impact.** The economic factors are: **cost; availability of local capital; rate of return on investment; and competition with local products.** The social factors are: **societal need for the technology; possible loss of employment; movement of labor; and compatibility with local values and practices.** These factors determine relative access to technology, acceptability, efficiency and effectiveness of utilization, and sustainability of application.

PARAMETERS IN THE SELECTION OF TECHNOLOGY SOLUTIONS

Twenty-one (21) parameters for technology selection are included in the questionnaire for the evaluation of the respondents. The mean and standard deviation of the ratings for each item are calculated. The results are shown in Table 2.

Table 2. Calculated Mean and Standard Deviation of the Ratings by All Respondents.

COMPONENTS	MEAN	STD. DEV.
PART III		
1. Source of Technology		
a. Philippines	3.68	0.63
b. Asia	3.36	0.76
c. Other Parts of the World	3.17	0.98
2. Cost		
a. Less than P5000	3.27	1.04
b. P5,000-P10,000	2.67	1.06
c. More than P10,000	2.50	1.29
3. Sale Center		
a. Town/City	3.58	0.75
b. Provincial	3.24	0.91
c. National	3.52	0.74
d. International	3.13	1.13
4. Repair Center		
a. Town/City	3.64	0.68
b. Provincial	3.28	0.89
c. National	3.53	0.71
d. International	3.07	1.19
5. Part Center		
a. Town/City	3.59	0.74
b. Provincial	3.27	0.86
c. National	3.49	0.76
d. International	3.06	1.13
6. Economic Life		
a. Less than 2 years	2.57	1.29
b. 2-7 years	2.98	1.01
c. More than 7 years	3.47	0.87

There is a close agreement among the respondents regarding the parameters in technology selection. The mean ratings serve as guides in assigning the credit points to the technology

characteristics in the evaluation instrument. This is in turn used to identify the technology solutions that are needed during the initial implementation of the air quality standards in the Philippines.

6.2 The Evaluation Instrument

The instrument that was developed for the purpose of the study is called the **Technology Information and Evaluation Sheet**. It scrutinizes twenty-three (23) criteria items. Each item in the evaluation instrument is assigned credit points based mostly on the result of the need analysis.

The instrument is divided into four sections. Section IA is exclusively applied to fuels and includes the critical material characteristics; Section IB is applied to units and whole systems, and includes the critical technology characteristics; Section II is applied to all technology solutions that are under scrutiny and has the technology adoption and support criteria; and Section III includes the economic and social criteria..

The instrument is validated by soliciting the professional endorsement of the specialists/experts who evaluate for their agency/organization the technologies that are under consideration in this study. Also, the information and evaluation sheet is used to assess a set of technology solutions of known order of utility that comes from a standard-setting body.

6.3 The Priority Technology Areas

The following applications are considered priorities because they were rated much needed (mean between 3 and 4) with satisfactorily small variance (less than 1) by the respondents of the survey that was conducted.

Alternative Fuels: Includes new gasoline and diesel formulations, the alcohols, natural gas, and other "cleaner" fuels.
Exhaust-gas Cleaner: Devices that are fitted in the exhaust system of the engine to remove most of the air pollutants from the products of combustion prior to their exit to the ambient air.
Testing Device: A system that can be on-board the vehicle or not, and can indicate the levels of emissions for the appropriate action of the driver.
Testing Center: A facility that can be conveniently accessed by the drivers for purposes of testing their engines for the actual levels of emissions and appropriate certification of the results.
Modified Engine Part: Any part of the engine that is changed (custom-made or mass produced) to accommodate a switch in fuel, a change in operating condition, etc. in order to maintain a better quality exhaust gas.

Specific technologies that are commercially available for each priority application are searched and examined. Technologies that are already available in the Philippines are most preferred. When none is available in the country, the Asian market is searched.

Data pertinent to the technical, economic and social implications of the technology are gathered through a survey of existing documents and records, and through direct query.

6.4 Prioritization of Technology Solutions

The documented technology characteristics/properties were rated using the Technology Information and Evaluation Sheet. The total credit points (in a 100-point scale) have the corresponding adjectival rating of need or acquisition priority. 1-20 is not needed; 21-40 is slightly needed; 41-60 is needed; 61-80 is much needed; and 81-100 is very much needed.

All technology solutions that are rated 61 and more (much needed and very much needed) are then prioritized.

6.5 Presentation and Analysis of Results

Pertinent technology solutions that are available in the Philippines and in neighboring countries are evaluated and prioritized for use in the initial implementation of the Clean Air Act in the light public transport sector of the Philippines. The results of the use of the Technology Information and Evaluation Sheet are shown in Table 3.

Table 3. Technology Solutions Arranged in the Order of Priority.

FUELS, UNITS AND SYSTEMS	RATINGS USING THE TECHNOLOGY INFORMATION AND EVALUATION SHEET	
	Numerical	Adjectival
Fuels		
Gasoline, best quality		
Petron XCS Plus with Valvemaster	90	Very much needed
Shell Velocity	81	Very much needed
Caltex Vortex	79	Much needed
Diesel		
Petron	92	Very much needed
Caltex	88	Very much needed
Natural Gas (as diesel extender)	86	Very much needed
Ethanol (as gasoline extender)	84	Very much needed
Exhaust-gas Cleaner		
Catalytic Converter		
Philcat	78	Much needed
Silentor NoTox	74	Much needed
Exhaust Control Industry (ECI)	72	Much needed
Testing Device		
On-Board Diagnostic II System (OBD II Sys)	76	Much needed
Minivol Portable Sample	66	Much needed
OPSIS Multi-gas, Multi-path, CEM Monitoring System	66	Much needed
Testing Center		
Emission Testing Services, Inc. (ETS)	76	Much needed
Clean Air Engineering, Inc. (CAE)	76	Much needed
Modified Engine Part		
ECO Fuel System	66	Much needed
Sparrow IM	66	Much needed

The three big fuel companies, Caltex, Petron and Shell, are ready to provide fuels that satisfy the standards set by the Clean Air Act of the Philippines. In addition, technologies for the use of clean alternative fuels such as ethanol and natural gas are already commercially matured. Standards for engine modifications that allow optimum performance of retrofits on cleane

fuels can be made available.

Ethanol, either in pure form or in a mixture with gasoline, has been used commercially in spark-ignition engines in the Philippines. The use of anhydrous alcohol in internal combustion engines is an established technology, and the utilization of "wet" ethanol in a blend with gasoline is feasible after appropriate engine modifications. Incidentally, large quantities of ethanol for energy applications can be produced in the country from both sugar cane and cassava. (Graza, N. C. 1995)

Recently a major natural gas find off the coast of Palawan has been commercialized. The use of compressed natural gas in vehicle engines in the adjacent regions is presently an attractive technology solution to air pollution by mobile sources. The necessary engine modifications may be provided by the EPA accredited companies like ECO Fuel Systems Incorporated and Alternative Fuel Systems Incorporated, both of Canada, through local partner companies.

There are companies that sell exhaust gas cleaners which are either made in the Philippines (ex. Philcat) or made by foreign manufacturers like Silentor NoTox of Denmark and Exhaust Control Industry of Australia. The units are declared compatible with engines that are currently used in the Philippines.

A diagnostic system either on board the vehicle or portable is necessary in providing information that can be a basis for action on the part of the transport owner and the authorities charged with the implementation of the provisions of the law. There are sophisticated systems that monitor emission levels as well as control engine variables in order to insure best engine performance and compliance to environmental requirements. Such units are expensive and cannot be considered practical solutions for jeepneys and tricycles. A simple diagnostic system that gives the appropriate indication when emission limits are surpassed may be affordable in the case of the jeepney. A diagnostic center equipped with portable unit(s) is the logical alternative for the tricycles.

Initially, modification of the fuel system is anticipated if a clean substitute/extender is utilized in place of the conventional fuel. Also, crankcase ventilation system and evaporative emission control system may have to be installed as many jeepney and tricycle engines do not have such provisions.

7. DETERMINATION OF THE RELATIVE ADEQUACY OF CURRENT SUPPORT INFRASTRUCTURE

The state of the infrastructure that can support an immediate implementation of the Clean Air Act in the light public transport sector is reviewed in the light of the basic requirements that have been established. Table 4 shows the results.

Table 4. State of Basic Support Infrastructure for the Compliance of Jeepneys and Tricycles to the Air Quality Standards in the Philippines.

STATUS / COMPONENTS OF BASIC INFRASTRUCTURE SUPPORT	OPERATIONAL/ COMMERCIAL	OTHERS
1. Policies on Air Quality		
a. National	X	
b. Town/City		Not all towns and cities have established clear policies

Table 4. State of Basic Support Infrastructure for the Compliance of Jeepneys and Tricycles to the Air Quality Standards in the Philippines. (Continued)

STATUS / COMPONENTS OF BASIC INFRASTRUCTURE SUPPORT	OPERATIONAL/ COMMERCIAL	OTHERS
2. Laws on Air Quality (National)		Partly operational
3. Resolutions on Air Quality (Town/City)		Not all towns and cities have related resolutions
4. Rules and Regulations on Air Quality (Organization)		Implementing rules and regulations (IRR) for the Philippine Clean Air Act have just been approved; later, they are being adopted by the concerned organizations/agencies
5. Standards for Engine Exhaust		Included in the provisions of the Clean Air Act; being implemented to a limited extent
6. Organizational Structure for the Management of Air Quality		Included in the provisions of the Clean Air Act; partially operational
7. Lead Agency for the Implementation of the Clean Air Law	X	
8. Process		
a. Control		Partially operational through the implementation of related laws
b. Monitoring		Included in the provisions of the Clean Air Act; partially operational
c. Coordination		Included in the provisions of the Clean Air Act; partially operational
9. Support Technologies		
a. Alternative Fuel		
Gasoline, best quality		
Petron XCS Plus with Valvemaster	X	
Shell Velocity	X	
Caltex Premium Unleaded	X	
Diesel		
Petron	X	
Caltex	X	
Ethanol	X	Not sold as ICE fuel
Natural gas	X	Not sold as ICE fuel
b. Exhaust-Gas Cleaner		
Catalytic Converter		Available in limited number
Philcat		
Silentor Notox		
Exhaust Control Industry (ECI)		
c. Testing Device		
On-board		Not used in jeepneys and tricycles
On-Board Diagnostic II System (OBD II Sys)		
Portable		Acquired by specific order
Minivol Portable Sample		
OPSIS Multi-gas, Multi-path, CEM Monitoring System		
d. Testing Center		Not all rural and urban centers have one
e. Modified Engine Part		Custom-built for specific engine by medium-scale independent fabricator; quality is difficult to standardize
10.Fines for Non-Compliance to the Law		Partly implemented through related laws; included in the provisions of the Clean Air Act
11.Penalties for Non-Compliance to the Law		Partly implemented through related laws; included in the provisions of the Clean Air Act
12.Information Dissemination		
a. National	X	
b. Regional	X	The extent and effectiveness varies
c. Municipal	X	The extent and effectiveness varies
d. Multimedia	X	
e. Print	X	
f. Broadcast (Radio and Television)	X	
g. Education	X	Advocacy is still limited
h. Training	X	Advocacy is still limited

The Clean Air Act and the other related laws are already in place. The implementing rules and regulations have just been approved. There is, however, still need for resolutions in every town or city to lend support to the implementation of the rules and regulations. The organization charged with the management of programs and other concerns has just started to function and the standards provided by the law are yet to be imposed in their entirety. The necessary facilities, resources and processes for control, monitoring and coordination are just being established slowly due to the absence of a specific source of funds.

Clean fuels, conventional as well as alternative, are available. The technology for utilization can easily be adopted and supported locally. Important modifications can be done in accordance with available and tested procedures. On board emission monitoring is currently non-existent in jeepneys and tricycles. Testing centers for similar purpose are limited in number and located only in progressive towns and cities. The number of experts, specialists and technicians who can render satisfactory technical support is still relatively inadequate.

Information dissemination programs are underway nation-wide. The extent and effectiveness, however, vary from town to town, from city to city. There are formal higher education programs and courses as well as training courses directly in support of the nation's bid for clean air. Also, relevant research and development activities are continuing, in the process generating valuable information and much needed technology solutions. The number of implementing institutions and groups is still in the minority though.

It is apparent that an immediate implementation of the provisions of the law to the jeepney tricycle sector can pose difficulties that can lead to serious problems on the part of the drivers, operators and the implementers at the local government level. The result shall with certainty adversely affect the riding public.

The full implementation of the law must be synchronized with the establishment of a full complement of support infrastructure otherwise such implementation foments discontent, demoralization and mistrust in the concerned sector.

8. CONCLUSIONS AND RECOMMENDATIONS

- The survey among the drivers and operators of jeepneys and tricycles, concerned professionals, and students was successfully conducted in Metro Manila where the situation of air pollution is serious, and where large densities of jeepneys and tricycles can be found. In spite of the variances caused by the variation in access to information and technology, income and gender, the results clearly as well as satisfactorily indicated the consensus on the facilities that are much needed, therefore, must be provided for the successful compliance to the air quality standards.

- A viability analysis of the available technology solutions to high level of emissions in jeepney and tricycle engines was undertaken with the use of an evaluation instrument that incorporates parameters such as the critical technology characteristics, technology adoption and support criteria, and economic and social criteria. A list of technology solutions composed of alternative fuels, exhaust gas cleaners, testing devices, testing centers, and modified engine parts have been arranged in the order of priority.

- A basic package of support for the compliance of jeepneys and tricycles to the Clean Air Act was developed. The package is composed of (a) clear policies emanating from the

national governance and harmonized at the towns/cities; (b) adequate laws pertaining to the maintenance of good air quality that are translated into implementable rules and regulations at the level of the local governments and the various concerned organizations/agencies; (c) a functional organizational structure that is ably led by (d) an agency that is successfully overseeing the necessary (e) processes of controlling, monitoring and coordinating activities and information for the promotion of clean air. Also included in the package are the specific (f) fines and penalties that can be imposed in cases of proven violations of the law; (g) various information dissemination strategies (utilizing all available mediums) that are consistently and effectively carried out nation-wide up to the level of the town or city; and (h) the various technology solutions. The technology solutions include alternative fuels, exhaust gas cleaner, testing devices, testing centers, and modified engine parts.

- A careful assessment of the available policies, guidelines and other infrastructure in the Philippines in terms of their adequacy to support the compliance of jeepneys and tricycles to the Clean Air Act was undertaken. A difficult compliance to an immediate implementation of the Act is indicated by the disparity between the basic infrastructure support package that emerged and the support components already operational/existing in the country. Success may be achieved in the medium-term and through the concerted efforts of the government and the non-government sectors.

The following recommendations are therefore being made:

- The Department of Local Government (DILG) under a comprehensive plan should start empowering the local government (from passing appropriate resolutions to establishing adequate testing and monitoring facilities) for its role in the management of activities and projects related to the implementation of the Clean Air Act.
- The Department of Environment and Natural Resources, together with the Department of Trade and Industry should hold as many meetings as needed with the private investors, both local and foreign, in order to promote the availability of vital technology solutions under the influence of natural market forces.
- Education and research in support of the successful compliance by various concerned sectors to the air quality standards in the Philippines must be encouraged and promoted.
- The government should demonstrate its leadership in the implementation of the law by providing experts and trained personnel as well as facilities and other resources that would insure successful and continuous compliance to the law.
- A national inspection and certification system must be implemented as an integral part of the requisite to vehicle registration.
- The full implementation of the law in the jeepney and tricycle sector should be started when the support infrastructure is in place and operational. Henceforth, the application of the law must be consistent and fair.
- A study must be conducted in order to determine the viability of the continued operation of jeepneys and tricycles.
- The Philippines must implement a national transport plan that provides for urgent technical and social requirements, and specifies clear domains of the different transport modes.

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