ADB

# Air and Noise Pollution Reduction from Tricycles

## A Strategic Plan for Quezon City and Puerto Princesa City, Philippines

Asian Development Bank

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Quezon City and Puerto Princesa City,
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ADB analysis of technical and social aspects of the environmental issues of tricycles, a popular mode of transportation in the Philippines
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4. Philippines.

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# ABBREVIATIONS

| | | |
|---|---|---|
| ADB | – | Asian Development Bank |
| AQMS | – | Air Quality Management Section |
| AUV | – | Asian utility vehicle |
| BIMP-EAGA | – | Brunei-Darussalam, Indonesia, Malaysia and the Philippines-East Asian Growth Area |
| CAA | – | Clean Air Act |
| CBD | – | central business district |
| CENRO | – | City Environment and Natural Resources Office |
| CKD | – | complete knocked-down |
| CLUP | – | Comprehensive Land Use Plan |
| CO | – | carbon monoxide |
| CPDO | – | City Planning Development Office |
| C-3 | – | Circumferential Road No. 3 |
| C-4 | – | Circumferential Road No. 4 |
| C-5 | – | Circumferential Road No. 5 |
| C-6 | – | Circumferential Road No. 6 |
| DENR | – | Department of Environment and Natural Resources |
| DOTC | – | Department of Transportation and Communication |
| DTI | – | Department of Trade and Industry |
| DOST | – | Department of Science and Technology |
| DOLE | – | Department of Labor and Employment |
| ECE | – | Economic Commission for Europe |
| EDSA | – | Epifanio De Los Santos Avenue |
| FTODA | – | Federation of Tricycle Operators' and Drivers' Associations |
| HC | – | hydrocarbon |
| HOV | – | high-occupancy vehicle |
| LGU | – | local government unit |
| LOS | – | level of service |
| LRT | – | Light Rail Transit |
| LTFRB | – | Land Transportation Franchising and Regulatory Board |
| LTO | – | Land Transportation Office |
| MDPPA | – | Motorcycle Development Program Participants Association |
| MMDA | – | Metro Manila Development Authority |
| MRT | – | Metro Rail Transit |
| MMUTIS | – | Metro Manila Urban Transportation Integration Study |
| NLEX | – | North Luzon Expressway |
| NMT | – | nonmotorized transport |
| $NO_X$ | – | nitrogen oxide |
| $NO_2$ | – | nitrogen dioxide |

| | | |
|---|---|---|
| NSCB | – | National Statistical Coordination Board |
| $O_3$ | – | ozone |
| PCIERD | – | Philippine Council for Industry and Energy Research Development |
| PETC | – | Private Emission Testing Center |
| PM | – | particulate matter |
| PPC | – | Puerto Princesa City |
| PPNR | – | Puerto Princesa North Road |
| PPSR | – | Puerto Princesa South Road |
| RMC | – | route-measured capacity |
| SP | – | Sangguniang Panglungsod |
| SUV | – | sports utility vehicle |
| TEC | – | Traffic Engineering Center |
| TESDA | – | Technical Education and Skills Development Authority |
| TFB | – | Tricycle Franchising Board |
| TODA | – | Tricycle Operators and Drivers Association |
| TRU | – | Tricycle Regulatory Unit |
| TSP | – | total suspended particulates |
| TVRP | – | tricycle volume reduction program |
| UP-NCTS | – | University of the Philippines-National Center for Transportation Studies |
| VOC | – | volatile organic compounds |
| VPD | – | vehicles per day |
| WB | – | World Bank |
| WHO | – | World Health Organization |

## WEIGHTS AND MEASURES

| | | |
|---|---|---|
| Cc | – | cubic centimeter |
| Db | – | decibel |
| Mm | – | millimeter |
| Ml | – | milliliter |
| $PM_{10}$ | – | particulate matter with diameter of less than 10 microns |
| Ppb | – | parts per billion |
| Ppm | – | parts per million |
| Rpm | – | revolution per minute |

## CURRENCY EQUIVALENTS

(as of December 2004)

Currency Unit – Philippine peso (P)

P1 – $0.0178

$1 – P56.04

## NOTES

In this report, "$" refers to US dollars.

# PREFACE

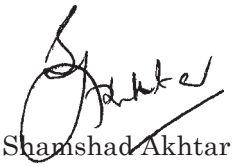
Vehicular emission is among the major concerns of air pollution in the Asia-Pacific region, as it threatens both people's health and their daily activities. According to the World Health Organization (WHO), 12 of the 15 cities with the highest levels of particulate matters, and 6 of the 15 cities with the highest levels of sulfur dioxide are located in Asia. While it is seemingly common in the light of rapid urbanization, vehicular emissions are predominantly severe in the Philippines where one third of vehicular population is composed of two- and three-wheeled (tricycles) vehicles. These two- and three-wheeled vehicles are major contributors to air emissions as they usually are equipped with old model engines and are poorly maintained.

While policy makers can deal with some aspects of tricycle pollution by setting technical standards and imposing tricycle operational practices, it is important to understand the unique social, economic and technical environment in which the tricycles operate to ensure the sustainability of any tricycle management strategies.

Asian Development Bank (ADB) supported this study through a technical assistance on Promoting Cleaner Production for the Philippines. The study also supplemented the Metro Manila Air Quality Improvement Sector Development Program (MMAQISDP), in order to cover every aspect of urban air quality management. The study looked into the issues of and introduced cleaner technology to the often-ignored tricycle industry and transport ecology in two local government units (LGUs), i.e., Quezon City in Metro Manila and Puerto Princesa in Palawan. Owing to the support granted by the Department of Science and Technology (DOST), the executing agency, and the two LGUs, the implementing agencies, we now have a better understanding of the tricycle subsector issues from a holistic view of political, economic, social and technological aspects.

Despite the health and environmental hazards that tricycles bring, the study found that the two cities continue to experience increase in tricycle population due to: (i) high unemployment and absence of alternative livelihood; (ii) limited road network; and (iii) increase in commuting population. The first two are especially true for Puerto Princesa. The study also discovered that a majority (70%) of the drivers earned a daily net income of P100-P150 ($1.80-$2.70). This leaves the tricycle drivers little interest to maintain their vehicles to reduce air or noise emissions. Therefore, while the tricycle subsector is counted as a major contributor to pollution, its vulnerability to haphazard solutions should be noted and prudent considerations should be observed.

Given the insights and valuable information on the tricycle subsector gathered during the study and the commitment of DOST and Puerto Princesa City government, ADB is able to further finance pilot testing of the recommended strategies in Puerto Princesa City through the Poverty and Environment Fund. The pilot test was commenced in September 2005 and will help tricycle owners and operators solve the environmental problems caused by tricycle operation without jeopardizing their livelihood. This is a good example of ADB working together with an LGU to look after the environment and poverty issues. We expect to see more replication of the approach in other LGUs in the Philippines.



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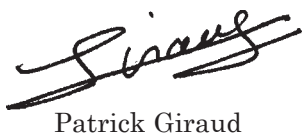
Southeast Asia Department



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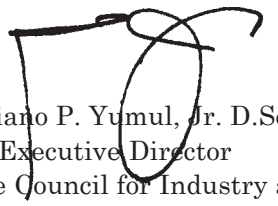
# FOREWORD

This report provides valuable information on the various options and strategies for the reduction of air and noise pollution from tricycles in Quezon City and Puerto Princesa City. This is a jumpstart in our initiatives to clean the air by providing a sound basis for implementing technical and policy strategies to effectively address the issues facing the tricycle subsector.

The tricycle industry grew rapidly over the last 14 years despite the absence of formal policies from the Government. The demand for this mode of transportation will continue to grow with the increase in tricycle-riding population. As such, the tricycles' effects on the environment are threatening and the noise level is beyond the maximum standard. These have provided the context for the Asian Development Bank-initiated study under the Cleaner Production Program, which the Philippine Council for Industry and Energy Research and Development (PCIERD) fully supported.

We would like to underscore the importance of the Local Government Units' support through the passage of local ordinances that would regulate the tricycle subsector in terms of the acceptable and locally-applicable strategies stated herein. We all have taken the most important step in solving this environmental problem. We have identified where the problem is and what causes it, and came up with a strategic plan of action that hopefully will lead us to a safe and sound environment.



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The Study Team wishes to thank the assistance extended by the central and local governments in the Philippines. Secretary Estrella Alabastro of the Department of Science and Technology (DOST) and Graciano P. Yumul, Jr., executive director of the Philippine Council for Industry and Energy Research and Development, provided full support and valuable comments to the study throughout the implementation period. The Departments of Environment and Natural Resources, Energy, and Transportation and Communication also supported the study through stakeholder consultations and participation in workshops.

The preparation of this report was impossible without the support of Mayor Edward Hagedorn of Puerto Princesa City and Mayor Feliciano Belmonte, Jr. of Quezon City. The Study Team also received significant assistance and suggestions from Jovenee Sagun, Angel Padon and the staff of Puerto Princesa City Planning and Development Office, Traffic Management Bureau and City Environment and Natural Resources Office, as well as Marge Toledo of Quezon City Tricycle Regulatory Unit. The Tricycle Operators' and Drivers' Associations of Quezon City and Puerto Princesa City and their members contributed their time and ideas, which enabled a large amount of work on consultation, survey, interview, and data analysis to be completed in a timely manner and rendered a better understanding of the social, economic, and environmental aspects of the three-wheeler (tricycle) subsector in the two cities.

# EXECUTIVE SUMMARY

About 34% of total vehicular population in the Philippines is made up of two- and three-wheelers, which is a popular transport tool for both urban and rural areas. Quezon City, a suburb in the capital of Metro Manila, for instance, registers the highest population of tricycles in the country with 20,316 units. These tricycles are major causes of air and noise pollution, traffic congestion and accidents. In Puerto Princesa City, capital of the province of Palawan, the 2,824 tricycle units plying along the city proper account for about 153 million tons of carbon dioxide emissions. The tricycle subsector is also responsible for noise pollution, with levels measured at 83-97 decibel (dB). The population and speed capacity of tricycles are also causing traffic congestion, especially in the central business district (CBD). The instability and sight obstruction caused by the sidecar also make tricycles more accident prone compared to four-wheeled vehicles. Such risk is further aggravated by the drivers' recklessness.

Despite all the negative impacts of tricycles, they remain a major transport tool to the residents in the local government units (LGUs), especially among students and employees, due to their (i) high accessibility; (ii) availability; (iii) affordability; (iv) comfort, and (v) convenience. Tricycle driving is also the most preferred alternative livelihood among the unemployed as it does not require a huge amount of capital nor an extensive mental skill.

A number of programs aimed at reducing pollution from tricycles have been initiated in the past but most of them failed. This is because of relatively low and ineffective coordination of efforts among concerned stakeholders that boils down to the absence of proper planning on the part of lead agencies. On top of that, reliable baseline data and impact assessments to back-up the programs' effectiveness are absent; thus, their implementation often lead to debates, as they are perceived as threats to the drivers' livelihood.

Quezon City and Puerto Princesa City were selected as study cities due to their different degree of urbanization while sharing the same environmental issues caused by the tricycles. The study tried to identify if the strategies of solving the environmental impacts of the tricycle subsector would be different for various types of cities.

In order to understand the social profile of the tricycle subsector in the two cities, the Study Team conducted questionnaire surveys and consultation workshops through a participatory approach that involved city government officials, tricycle operators and drivers' associations of the two cities, respectively. Roadside noise and emissions of tricycles were also measured on selected road sections in the two cities. The findings are discussed in Chapters II, III and IV, respectively.

A set of strategies for reducing the noise and air pollution of tricycles is proposed for the two cities as the study did not find significant differences of the subsector profile in each city. These strategies include (i) LGU-led maintenance program, (ii) mandatory orientation on traffic management, (iii) tricycle volume reduction program, and (iv) restriction on new/renewal tricycle franchise application. However, the detailed approaches to the implementation of some strategies are different for the two cities due to the unique social and economic status in each city. The details of the strategy and implementation approaches are discussed in Chapter V.

# I. INTRODUCTION

Vehicles are one of the dominant sources of urban pollution in the developing world that threatens both people's health and economic activity. While this is common to growing urban areas throughout the world, it is particularly severe in Asia where majority of vehicles are two- and three-wheelers made up of less efficient and poorly-maintained engines. In the Philippines, for example, motorcycles[1] and tricycles[2] comprise 34% of vehicle population. Because they are less expensive than other vehicles, they play an important role in the country's transport market. They are very visible in most cities of the country providing an alternative mode of transport for short distances.

About 94% of these motorcycles and tricycles have 2-stroke engines[3] emitting fine-particulate matter, which pose a danger to public health. Epidemiological studies revealed that fine particles have serious health effects including premature mortality and such nonfatal effects as respiratory symptoms, exacerbation of asthma, and changes in lung function.[4] Two-stroke engines typically have a lower fuel efficiency compared with 4-stroke engines, with as much as 15-40% of the fuel-air mixture escaping from the engine through the exhaust port.[5] As such, the incompletely-burned gasoline and lubricant are emitted as small oil droplets, which in turn increase visible smoke and particulate emissions.

Moreover, vehicle age, poor maintenance, lubricant misuse, and fuel adulteration exacerbate emissions. Most of the tricycles in the country are aging and poorly maintained. Because tricycles are used commercially, their operation is often extended beyond their useful life in order to maximize income while their maintenance is often postponed due to the opportunity costs associated with this. The problem of maintenance is particularly severe when drivers lease their tricycles, because neither the driver nor the owner feels solely responsible for the mechanical condition of the vehicle.

Most drivers also use excessive quantities of lubricant either because of their lack of knowledge on the correct lubricant-gasoline ratio, or their perception that adding extra lubricant increases fuel economy and provides greater protection against piston seizure.

Many tricycles do not use the quality of lubricant recommended by vehicle manufacturers for economic reasons. Instead they apply untreated used oil sold in bulk at some gasoline stations, which is equivalent to only P10.00 or $0.18 per liter. Recycled (treated) engine oil, however, costs around P50.00 or $0.90 per liter while specially formulated virgin 2T oil costs around P90.00 ($1.64) per liter. The use of untreated used oil leads to greater deposit build-up in the tricycle engine and higher emissions.

Adulteration of gasoline with kerosene also increases emissions. Higher boiling point

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[1] Motorcycles are two-wheeler vehicles like mopeds, scooters, etc., like those used for personal transportation.

[2] Tricycles are three-wheelers or motorcycles with sidecars that could carry between 3 to 10 passengers.

[3] University of the Philippines-National Center for Transportation Studies (UP-NCTS). 2003. *Standards Development for Local Motorcycle/Tricycle Sector: 4th Quarter Progress Report.* Quezon City: UP Diliman.

[4] Kojima, M. *et al.* 2000. *Improving Urban Air Quality in South Asia by Reducing Emissions from Two-Stroke Engine Vehicles.* World Bank.

[5] Ibid.

of kerosene makes it more difficult to burn compared with gasoline and thus, resulting in deposits build-up in the engine and more unburned hydrocarbons are emitted in the exhaust gas. Such adulteration practice can be attributed to the huge gap between the prices of these fuel types.

Due to the social and technical complexity behind the subsector, it has been difficult for both central and local governments to develop appropriate strategies to overcome the environmental issues related to it. For instance, the emission standard of hydrocarbon (HC) for motorcycles and tricycles set for urban centers is 7,800 ppm, which is an extremely low standard. The standard is not difficult to be complied with by tricycles while it compromises the public's health and environmental standards. According to the Department of Environment and Natural Resources' (DENR) schedule, the standard will be reviewed and revised, if necessary, in 2006.

## A. Past and Present Initiatives in the Tricycle Subsector

A number of programs have been initiated by different sectors in the country to improve the environmental performance of the tricycle subsector ranging from engine modifications, fuel and additive quality improvement, proper vehicle use and maintenance promotion to traffic management enhancement. However, most of them failed, thus the problem of air and noise pollution from tricycles prevail.

The failures experienced in past initiatives show that there is relatively low and ineffective coordination of efforts among concerned stakeholders. It boils down to the absence of proper planning on the part of lead agencies and therefore, to the lack of integration of efforts that often results in neglect, overlapping and duplication of activities. On top of that, there is also weak monitoring and assessment of the program's effectiveness, leaving all the lessons behind.

Reliable baseline data to back-up tricycle pollution reduction programs are also absent. In fact, even the official data on tricycle registration at the municipality or provincial level is not readily available because of complex institutional arrangements on tricycle franchising and registration. Thus, the fragmented, ad hoc and short-term solutions of dealing with the problems associated with the subsector often lead to debates, as they are perceived as threats to the drivers' livelihood.

## B. The Technical Assistance

In 2004, ADB sponsored a special study under a technical assistance[6] to assist the local governments of Quezon City and Puerto Princesa to develop effective air emission reduction strategies for the tricycle subsector. Specifically, it assisted the local governments in identifying the: (1) factors affecting the supply of and demand for tricycles; (2) potential environmental and health damages from tricycles; (3) current practices and future scenarios in tricycle operations; and (4) advantages and disadvantages of possible pollution-reduction strategies in the subsector. The study results led to the selection and development of a city-wide strategic plan for each of the two local governments to address tricycle pollution. This publication documents the results of the special study.

[6] ADB. 2002. *Technical Assistance for Promotion of Cleaner Production in the Philippines.* Manila.

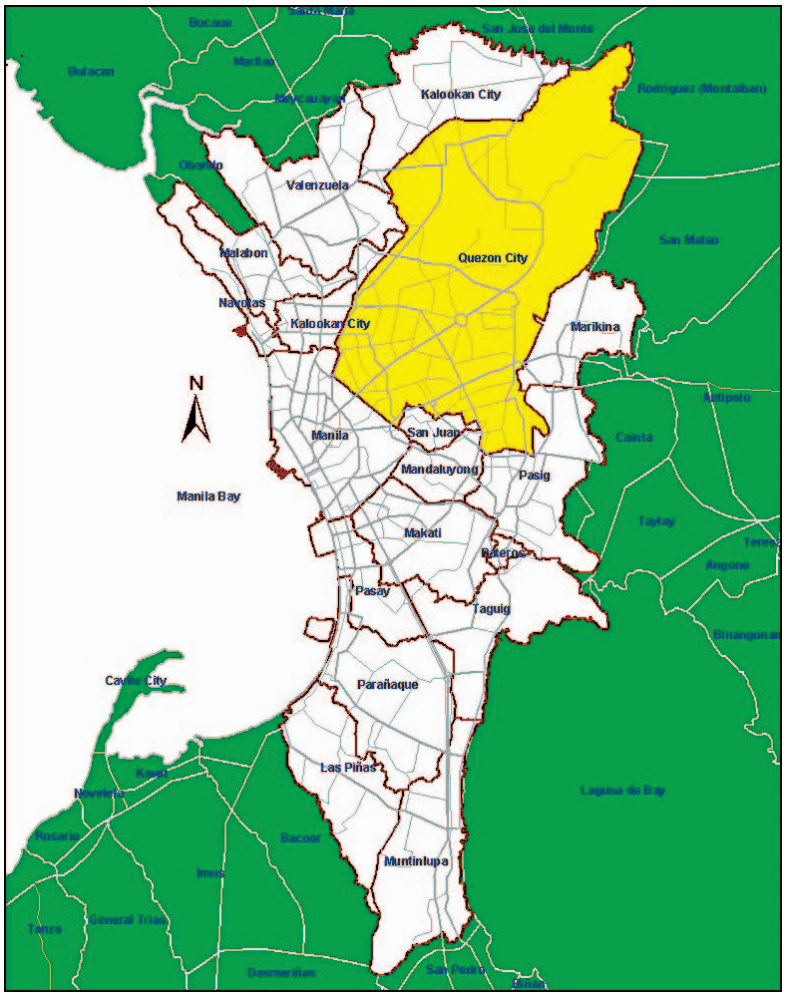
# II. QUEZON CITY AND ITS TRICYCLE SUBSECTOR

## A. General Description

Quezon City is situated on the northeast portion of Metro Manila. It is bounded on the north by Caloocan City and San Jose del Monte, on the south by Pasig City, Mandaluyong City and San Juan, on the west by the City of Manila, Caloocan City, Valenzuela City, and on the east by Rodriguez, San Mateo and Marikina City. With an area of 16,113 hectares, it is the largest among the 12 cities and 5 municipalities in the region and is almost one fourth the size of Metro Manila (Figure 1). Of the total land area, 56% is residential, 2% commercial, 6% industrial, 5% institutional, 1% military, 1% parks and recreational sites, 12 open lands, 1% waterways and 16% reservoir.

From its creation in 1939, Quezon City has always been predominantly residential. Its area doubled to 15,359 hectares when it was declared the Philippine capital in 1948 through Republic Act (RA) 333, while the new areas included were Novaliches, Tandang Sora and Payatas[7]. Later, the Lagro area was added to the City. And to this date, it has become the border of the City in the northern part adjacent to Bulacan.

**Figure 1: Map of Metro Manila**




Source: MMUTIS, 1999.

[7] Proposed Amended Comprehensive Land Use Plan of Quezon City, 2004.

The City's population is relatively dispersed but unevenly distributed in its four districts. District II has the largest population while District III has the least. Even with a decrease of 3% during the period 1970-1995, the population of Quezon City still registers a higher rate of growth than that of the National Capital Region (NCR) and the country. The trend is an indication that nearby developed areas like those of Caloocan, Valenzuela, San Jose del Monte (Bulacan), Montalban (Rizal), and San Mateo (Rizal) have attracted migrants who otherwise could have opted to reside in Quezon City.

The population in the northern part of the City signifies a substantial increase due to the development of residential areas. Corollary to this, establishments providing ancillary services like markets, churches, schools and hospitals emerged. With this condition, the City became a favorite destination for migrants from different parts of the country, primarily the north, due to accessibility. Some have migrated due to economic difficulty or insurgency in the nearby provinces. As a result, squatters have proliferated in vacant government lands within the City.

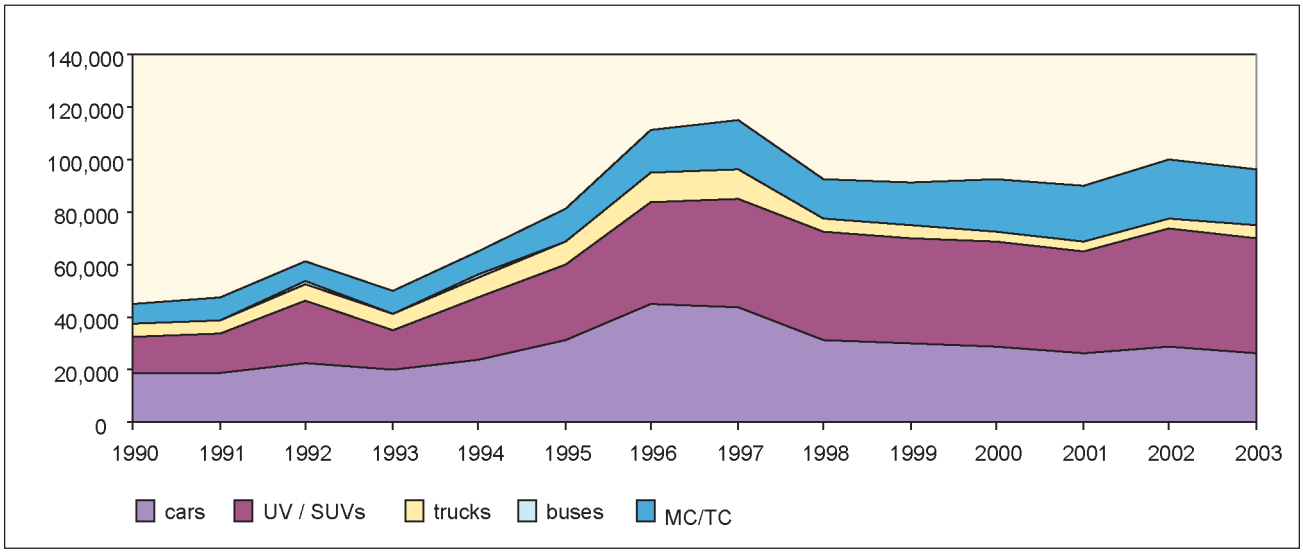
## B. Profile of the Tricycle Subsector

Quezon City has almost 2,000 kilometers of roads, as of 1999. Based on the data from Land Transportation Office (LTO), total vehicle registration exhibited a 114% increase from the 1990 to 2003 levels (Figure 2). Motorcycle and tricycle registration generated a 212% increase for the same period and is considered the third major contributor, next to cars and utility vehicles, for the significant increase in vehicular population in the area.

In the study conducted in April 2004, half (50%) of the tricycle samples in the City are aged more than 5 years, of which about 18% are more than 10 years of age. Some tricycles (5%) are still in operation for over 20 years. The prolonged operation of these tricycles results in over-lubrication of the engine, with a lubricant-to-fuel ratio[8] averaging to as high as 1:6 (that is, 200-300 ml for every 5 liters of gasoline). To make the matter worse, most of the tricycle units are poorly maintained. Because tricycles are used commercially, their

[8] Most motorcycle manufacturers prescribe a lubricant-to-fuel ratio of 1:40—that is, 100 ml of lubricant to 4 liters of gasoline.

**Figure 2: Motor Vehicle Registration, Quezon City 1990-2003**




Source: LTO, 2004.

operation is often extended beyond their useful life in order to maximize income while their maintenance is often postponed due to the opportunity costs associated with this. The problem of maintenance is particularly severe when drivers lease their tricycles, which is 45% of the surveyed population, because neither the driver nor the owner feels solely responsible for the mechanical condition of the vehicle. As such, tricycle drivers and operators indicated that tricycle parts such as carburetor, air filter, and exhaust system are cleaned up every 6 months, 1-2 months, and 4 months respectively.

Population is the primary reason why there is a demand for tricycles. Sudden increase in volume of the commuting public, due to increased economic activities in the area as well as in-migration, created a market. The City's mode of transport is purely land-based. Vehicles for public use include jeepneys, buses, trains, mini-buses and tricycles. Jeepneys and buses dominate the primary roads of Quezon City, which according to the Metro Manila Traffic Engineering Center (TEC), comprise 17% and 3% respectively of the total traffic volume. Private vehicles, specifically cars, comprise 23% of the recorded volume, while trucks for commercial and industrial transport contribute 3% of the total traffic. Tricycles, on the other hand, ply within the inner areas and communities. Based on the 2004 data from the Tricycle Regulation Unit (TRU), a total of 20,316 tricycles are registered in Quezon City grouped into 147 Tricycle Operators' and Drivers' Associations[9] (TODAs) that serve specific routes or areas.

As to passenger volume vis-à-vis the transport mode, the count made by Department of Transportation and Communication (DOTC) in selected main routes shows that 69% of the total number of passengers is using public utility vehicles (excluding tricycles) as against only 20% of volume in private vehicles. Of the 69% public commuters, 57% takes jeepneys and 38% takes buses or mini-buses, while 5% takes taxi. It should be noted, however, that the absence of tricycle commuter data does not exclude tricycles from the transport sector. Most of the time, tricycles provide supplementary services by transporting the commuting public from tertiary roads to the primary roads, and vice-versa, where four-wheeled vehicles operate. The high visibility of tricycles along the tertiary roads adjacent to the primary roads yields a captured market for contracted services (special trips) among them.

Competition between tricycles and four-wheeled vehicles is very minimal due to territorial control. Within the tertiary roads, however, tricycles of the same TODA tend to compete due to constant increase in the number of members. There are also some service areas that are being shared by different TODAs, thus making competition interassociation as well.

The tricycle passenger survey conducted in April 2004 shows that majority (88%) belong to the productive age group of 16-45 years bracket primarily students and employees. About 84% of the surveyed population claimed to be regular commuters, of which 34% are regular tricycle passengers taking at least two rides on a daily basis. Reasons cited for tricycle preference are (i) high accessibility; (ii) availability; (iii) affordability; (iv) safety relative to four-wheeled vehicles, and (v) convenience.

Since four-wheeled vehicles can only be accessed at the primary roads, commuters residing away from these roads highly depend on tricycle services to avoid walking some distance. Tricycles provide the convenience of traveling irrespective of distance or destination. Also, with tricycles, the commuter's waiting and traveling costs are minimized since it takes only 3-4 passengers per unit, of which some commuters are willing to offset the cost in order to get special services.

[9] TODAs are cooperatives duly registered at the Securities and Exchange Commission (SEC) with tricycle operators and drivers with the same routes as members. Each TODA is governed by a set of officers, who then compose the TODA federation (TODA Fed) that represents the entire subsector in the city.

The commuters' perspective on the issue of tricycle service affordability is relative, depending on the routes. The minimum tricycle fare is P4 per passenger and gradually increases based on distance or zone. While some say that the fare is reasonable, others believe that tricycle drivers take advantage of the distance and the absence of alternative transport. And since the commuters have no other options, they simply accept the fare imposed by the tricycle drivers.

Similarly, the survey on tricycle drivers revealed that 55% of the total respondents finished high school while 11% finished college, and are therefore eligible to be employed in other fields of labor. This signifies the lack of employment opportunities in the area which compels them to be underemployed as tricycle drivers. Moreover, considering that tricycle driving does not require a huge amount of capital nor an extensive mental skill, a number of people are lured to venture in this business.

About 79% of the driver-respondents signified that they solely depend on tricycles for livelihood as it provides instant cash. However, majority admitted that such income is often insufficient to sustain their personal and family needs on a daily basis. A tricycle driver typically earns between P200-P300 daily but usually spends P100 for boundary,[10] P90 for fuel and P20 for lubricant, leaving a net income of less than P100. Moreover, with an average household size of 4-5 members among driver-respondents, the daily income barely meets their food and nutritional requirements. Other basic needs such as clothing, education, and medicine are often neglected.

City-wide inspection was also conducted to identify the sources of fuel and lubricant for the tricycles. It was observed that despite the proximity of gasoline stations in the area, most tricycle drivers buy from informal vendors called *takal*.[11] This is because income (and thus, purchase of fuel) can only be realized once a trip is made. The drivers are also not comfortable lining up at a gasoline station to buy a liter or two of gasoline.

## C. Quezon City Road Network

The City is traversed by several major metropolitan thoroughfares, namely C-3 (Araneta Avenue), C-4 Epifanio Delos Santos Avenue (EDSA), C-5 (Katipunan-Luzon-Republic Avenue), R-6 (Aurora Blvd.), R-7 (Quezon Avenue-Commonwealth Avenue) and R-8 (Bonifacio Avenue-Quirino Highway) linking the City to the rest of Metro Manila. These thoroughfares are supplemented by main and secondary intracity roads for area-wide mobility. Numerous tertiary roads, on the other hand, provide access to minor communities and individual properties.

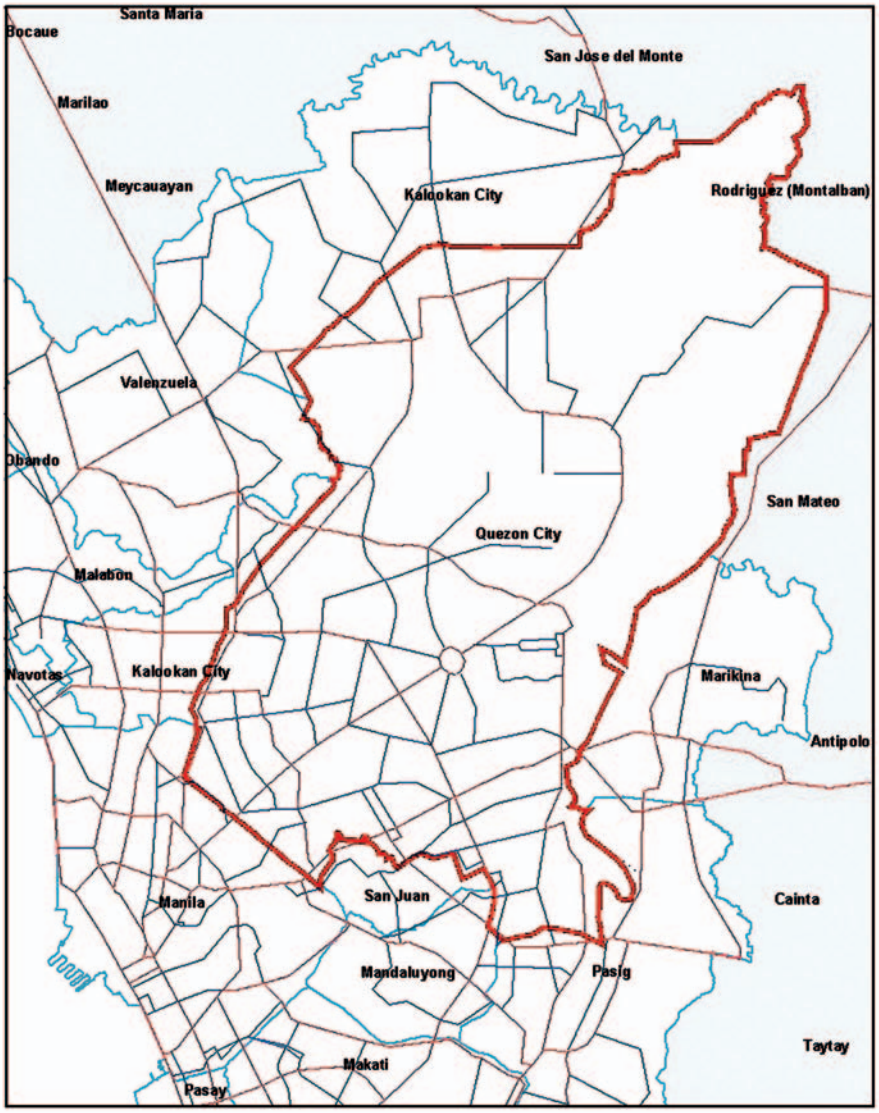
There are plans to further expand the road network in Quezon City. Future improvements along EDSA include the construction of West / North Avenue Interchange and Roosevelt Avenue Interchange. Circumferential Road-5 (C-5), however, serves as an alternative to EDSA via Katipunan, Luzon and Republic Avenues and will further be stretched towards North Luzon Expressway (NLEX).

The City's vast road network linking it to almost every part of Metro Manila has attracted the majority of the working class in the region to reside in the area. As such, subdivision developments started to mushroom, which further expanded the local road network inwardly from the existing main thoroughfares. Road capacities were similarly improved and other major road segments were constructed that significantly enhanced the City's road network. Highlighted in Figure 3 are primary and secondary roads, in which majority of the developments are clustered.

[10] Boundary is a type of rent that the tricycle driver pays on a daily basis to the operator or owner for the use of a tricycle unit.

[11] *Takal* is an informal gasoline station that sells fuel and lubricants in repacked smaller quantities (usually, a liter of gasoline per bottle and 300 ml per bottle of lubricant).

**Figure 3: Primary (red) and Secondary (blue) Roads in Quezon City**




Source: MMUTIS, 1999.

Tertiary roads (not visible), however, are collector roads that link up the bulk of the residential areas to the main arteries.

However, there are some areas that were left underdeveloped. Even with the proliferation of small transport modes, their fixed narrow roads constrained them from achieving their urbanization potential. Properties remained undervalued and became targets of real estate developers, as well as industries.

Accessibility is relatively good in the southern districts (indicated by broken lines) while the northern part, including Novaliches, is still considered deficient in terms of accessibility due to the very limited capacity of Quirino Highway (concrete but with 4 lanes) and Gen. Luis Avenue (concrete but with only 2 lanes). The absence of convenient alternate access in the area also makes it prone to heavy traffic congestion.

Moreover, the Payatas area is generally of poor accessibility in terms of road size and usage. Litex Road, which is the only existing primary road in the area, is a mere 2-lane, 2-way road with half of its length in poor condition. Other roads within the area are private subdivision roads for exclusive use, and thus of limited application as secondary access routes.

Other areas experiencing difficulty of access are the Tandang Sora district, Baesa and San Bartolome-Sauyo. Characterized by small villages with uncoordinated road layouts and narrow interneighborhood collector roads, circulation is very much obstructed. Urban growth is constrained by the pending development of new primary roads traversing and integrating the northern half of the City to its neighboring localities, while the much-needed expansion of existing roads in these areas seems impossible. The comparative increases of road kilometerage in the City are shown in Table 1.

Urbanization sprawled rapidly, outpacing the government resources to formally establish a well-defined master plan. The constructions of tertiary roads represent the City's efforts to catch up with the growth of population and proliferation of fixed structures in the districts. An increase in the

**Table 1: Periodic Total Road Kilometerage**

| Road Category | 1972 | 1985 | 1995 | 1999 |
|---|---|---|---|---|
| Primary | 129.42 | 137.63 | 141.21 | 146.52 |
| Secondary | 182.77 | 275.85 | 283.75 | 284.76 |
| Tertiary | 754.18 | 1,039.18 | 1,128.43 | 1,330.81 |
| Others | 95.63 | 125.41 | 125.14 | |
| **Total** | **1,162.00** | **1,578.07** | **1,678.53** | **1,762.89** |

Source: Quezon City CLUP, 2004.

transportation requirement, due to increased economic activities and housing constructions, was felt and triggered an immediate need for mobility. The nature of these tertiary roads therefore attracted some residents to venture into small-scale transport modes such as tricycles.

## D. Prospects in the Quezon City Tricycle Subsector

Understanding the dynamic nature of society, technology, and economy that influence the formation of scenarios will assist the local government unit of Quezon City in addressing and coping with possible conflicts in the future. Describing and analyzing the situation will illuminate the key pressures and will provide a clear picture of probable changes that are needed.

As such, political, economic, social and technological (PEST) analysis is conducted to determine the factors that are most likely to affect the future demand for and supply of, tricycle services. This will allow a greater understanding of the situations that could lead to the adoption of an informed and more prudent decision.

### Political Factors

**1. Implementation of Tricycle Regulations.**

About 27 ordinances have been adopted by the City government to regulate tricycle activities in the area, which include among others, the following:

*(i) Quezon City Tricycle Ordinance of 1992 (SP-15, S-1992).* This ordinance institutionalizes the tricycle sector, which identifies the City office in which the tricycle subsector is regulated, specifying the procedures for franchise applications, and setting the franchise application fees.

*(ii) Instituting the Tricycle Zones/Routes in Quezon City and Designating their Numbering Scheme and Fixing the Route-Measured Capacity (SP-387, S-1996).* This ordinance sets the allowable number of tricycles units that could operate under a certain TODA. Should an increase in the number of units is deemed necessary, as agreed within the association and discussed with the *Barangay* (Village) Captain, a resolution is filed by a City Councilor before the Tricycle Regulatory Board (TRU) requesting for such an increase in route-measured capacity (RMC).

However, this ordinance is violated most of the time as some tricycle drivers operate even without a franchise and are therefore inconsistent with the RMC. This illegal operation, called *colorum*, is often difficult to monitor because some routes are shared by several TODAs. Some TODAs, especially those in a confined route, are vigilant enough to monitor and prevent this unfair competition along the affected routes. Others, on the other hand, have no control over them and merely ignore the issue. What the TODA usually does is to "formalize" its operations by requiring drivers to be members of the association. As such, the tricycle data in TRU and in the TODAs usually do not tally at all.

(iii) *Requiring Noise Pollution Testing and Muffler Installation or Silencer (SP-1227, S-2003).* Recognizing the adverse effect of tricycle noise on humans, the City adopted this ordinance in 2003. As a result, most of the tricycles have installed silencers. In a tricycle driver survey conducted by ADB, 83% of the driver-respondents signified installation of silencers in their tricycle units.

(iv) *Authorizing the Use of Designated City Streets and Properties as Tricycle Terminals and Requiring the Imposition of Terminal Fees on All Tricycle Units Franchised in Quezon City (SP-177, S-1994).* As some tricycles are catering to the collector roads toward the primary roads, the City government allowed the use of city streets as TODA terminals with a corresponding parking fee. This, however, results to the crowding of major intersections and becomes more problematic over the years as volume of vehicles in the City increased.

(v) *Setting a Uniform Structural Design and Engine Displacement for all Tricycle Units Operating in Quezon City (SP-538, S-1997).* Under Section 3 (1), the ordinance classifies a tricycle as "a motor vehicle composed of a motorcycle with not more than two (2) cylinders of five hundred cubic centimeters (500cc) engine capacity filled with a single-wheel side car designed to accommodate three (3) passengers only including the driver." The ordinance also provides that "three-wheeled motorized vehicle of integrated body/chassis configuration shall be allowed provided that the specified limitation on engine capacity is observed and that the passenger capacity does not exceed five (5) including the driver." In many areas, however, there is a weak enforcement of this regulation due to the lack of manpower resources and capabilities on the part of the TRU. As such, tricycles accommodating about 6-10 persons are visible in certain parts of the City.

**2. Tricycle Franchises and Operations.**

The route-measured capacity (RMC) should be determined by the TRU, given a specific formula, for a particular tricycle route. Note, however, that such RMC can be changed, when the TODA deems it necessary. Once the TODA sees that additional tricycle units are needed to adequately serve the commuters in the respective areas, a petition is made before the District Councilor who, then prepares a resolution before the *Sangguniang Panglungsod* (Board of Councilors). Hearings on such resolution are deliberated upon at the TRU and Tricycle Franchising Board (TFB) levels. Once approved, the TODA submits the detailed information on the tricycle units and names of the drivers who will be awarded with additional franchises.

Over the years, the City remains flexible on tricycle franchise issuance and it is far from imposing a cap or limit on them. Reasons vary from political to economics, but the fact that there is no specific ordinance imposing a franchise cap serves as an encouragement for others to venture into tricycle services.

**3. Formation of TODAs.**

Road network development was realized in the 1980s, while additional roads that were not initially included in the road network plans were built in the 1990s. Since public transports have to secure route registration from the Land Transportation Franchising and Regulatory Board (LTFRB) before operating within specific routes, the construction of new routes paved the way for additional routes among them as well. Take the case of roads like C-3, Mindanao Avenue and C-5, for instance. At the onset, only private vehicles were passing through these roads since they were not in the route descriptions among buses and jeepneys. Eventually, the preferences of public commuters somehow pushed the public transports to amend their routes by including these areas.

A similar case is observed among the tricycles. The construction of new tertiary roads, especially along residential area developments, attracts tricycle drivers and operators to serve the affected areas informally, that is, no formal route has been secured from the TRU. Commuters then become acquainted with the presence of tricycles and start to patronize them as well. This all the more attracts additional drivers and operators to the business. As the number grows, the drivers and operators start forming an association and seek to "formalize" their operations by petitioning to TRU the need for a TODA and tricycle franchises. With a formalized operation via TODA, the number of tricycle drivers and operators continue to grow.

## Economic Factors

### 1. Economic Condition of the City.

There is a great disparity on the income distribution among households in Quezon City. Families belonging to the upper-income level with an average monthly income of P123,585 ($2,210) make up only 17% of the City's population. Middle- and lower-income levels are averaged at P28,357 ($507) and P7,180 ($128) per month, respectively. Fixed-income earners comprise 64% of the City's population while 16% is engaged in entrepreneurial activities.[12]

The ADB tricycle driver survey shows that 86% of the driver-respondents belong to the productive age of 18-50. As previously discussed, majority of them are eligible for other forms of employment. In fact, some of the drivers are also engaged every now and then as mechanics, carpenters, electricians, and computer technicians but tricycle driving remains to be their primary livelihood. Considering that the City's unemployment rate is at 15%, it can be hypothesized that it is common among the male population to resort to tricycle operations as a means of immediate occupation. Therefore, tricycle transport service is expected to increase in the absence of employment opportunities in the City.

### 2. Motorcycle Availability and Financing Scheme.

The motorcycle industry is currently becoming more competitive with the entry of new players due to trade liberalization. Majority of the motorcycle production, with engines lower than 500cc, is basically assembly. Complete-knocked-down (CKD) motorcycle parts are imported from the mother company, usually Japan, and then assembled locally. Manufacturing plants in the country are subsidiary or subcontracted firms. The locally-produced parts comprise about 50% to 60%, as required by the Department of Trade and Industry (DTI).

New players are also gaining a portion of the market[13] due to comparatively lower prices. A Japanese 4-stroke model normally costs around P69,000 ($1,235) to P75,000 ($1,342) on cash basis depending on the model grade. For installment schemes, an initial down payment is usually about P12,000 ($215) with a monthly payment of P4,000 ($72) for three years. A Chinese model of the same type and grade would cost about P50,000 ($895) or less on cash basis. Initial installment packages vary from P2,900 ($52) to P6,500 ($116) depending on the brand.

In general, the Chinese models are cheaper by about 40%. The problem with the new players is the lack of after-sales support like spare parts availability, which makes repairs and maintenance difficult. However, in due time all brands of motorcycles are expected to reach saturation point, in which the new players eventually will catch up on quality, price and market share.

The influx of scooters also has paved the way to more business opportunities in the sector. This is because scooters eliminated the pedal controls and integrated it all in the front

[12] Quezon City CLUP, 2004.

[13] Market share of new players is still undetermined since most are engaged in trading.

console instrumentation, making them easier to drive regardless of age and gender. Most scooters are imported and are made of 4-stroke engines, which are relatively more efficient.

Reduced prices and availability of motorcycles have been great factors for the proliferation of tricycles, as the associated financing and operating expenses are made affordable even to lower-income groups. Tricycle operation can also provide instant income, which is essential to drivers to survive on a daily basis.

### 3. Parts Producers, Vendors and Service Providers.

Automotive-parts makers and/or vendors supply two markets: (i) the original equipment manufacturer (OEM) or assembler; and (ii) the after-sales or spare-parts producers. The OEM market is quite stable as it depends on the orders made. The after-sales, on the other hand, is unstable as demand builds up only when there is a need for repairs and replacements, thus availability of parts is not consistent. Tricycle-service providers, on the other hand, are composed of spare-parts vendors, service centers, repair shops, freelance mechanics, machinists, welding shops, foundries, metal/ironworks shops, accessories suppliers, car washers, etc. They exist because most of the tricycle units in the area have been operating for more than 5 years, requiring engine as well as sidecar rehabilitation and modifications.

## Social Factors

### 1. Population Growth.

The population in Quezon City is expected to increase at a rate of 3.6% per year. From the estimated population of 2.73 million in 2004, it is expected to reach 3.38 million by year 2010 (Table 2). In addition, there are also by-passers along Quezon City but who actually live in the nearby areas of Bagong Silang (Caloocan), San Jose del Monte, Sapang Palay (Bulacan), San Mateo (Marikina), and Valenzuela (Bulacan). Aside from that, there are residents from other areas who commute to Quezon City as most of government offices are in the area.

In a survey conducted by the ADB Study Team, about 59% of the respondents belongs to the productive age of 21-40 and 30% is aged below 20, which is assumed to be majority students. This indicates that students and employable populations are highly dependent on tricycles. With a projected increase in the City's population, demand for mobility, which includes tricycle demand among others, is expected to increase subsequently.

**Table 2: Projected Quezon City Population, 1995–2010**

| Year | Population ('000) @ Growth rate of 3.60% |
|---|---|
| 1995 | 1.989 |
| 1996 | 2.061 |
| 1997 | 2.135 |
| 1998 | 2.212 |
| 1999 | 2.292 |
| 2001 | 2.460 |
| 2002 | 2.548 |
| 2003 | 2.640 |
| 2004 | 2.735 |
| 2005 | 2.834 |
| 2006 | 2.936 |
| 2007 | 3.042 |
| 2008 | 3.151 |
| 2009 | 3.265 |
| 2010 | 3.382 |

Source: Quezon City CLUP, 2004.

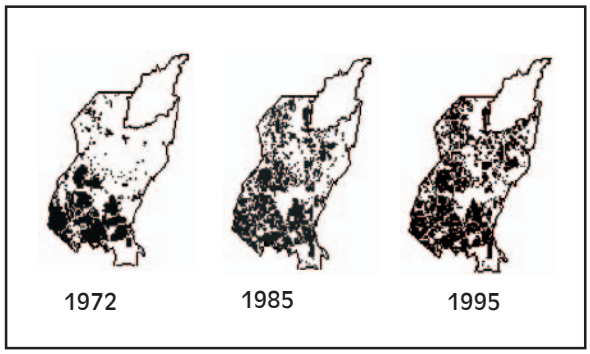
### 2. Development of Residential Areas.

It can be said that the City's problem on transport, particularly on public three-wheelers, can be traced way back even before the Second World War. When Manila, being the center of development then, became congested, the Government identified Quezon City to be a host for most of its offices and universities. A master plan was made that entailed large-scale construction and development for housing and institutions including the University of the Philippines

(1908) that occupy a large tract of land. From its creation in 1939, Quezon City's character has always been predominantly residential. Its area doubled when it was declared the Philippine capital in 1948 and its coverage was expanded as new areas were added.

Moreover, the sudden influx of migrants in certain areas has also created a scarcity of transportation especially when transport infrastructures or facilities are limited and in which access is typically via 2-lane, 2-way unpaved roads. Therefore, majority of the areas where tricycles proliferate are those with unplanned growth and population influx (Figure 4).

**Figure 4: Growth of Residential Areas**




Source: QC CLUP, 2004

The last three decades became even more challenging for the city planners when the development of residential and housing subdivisions boomed northward while commercial establishments, led by the shopping malls, started to mushroom in many areas across the metropolis. Tricycles emerged as the only viable means of transport in these areas due to the following conditions, making the public commuters heavily dependent on the subsector:

- Short trips do not require high-occupancy vehicles (HOV);
- The road size and width of most residential roads are ideal for tricycles unlike other public vehicles like jeepneys, taxicabs or AUVs (Asian utility vehicles);
- Jeepneys, the closest competitor of tricycles, are compelled to have the seats totally filled up before leaving the terminal to meet the daily profit. Tricycles can be hired (special trip) at a low price with very short waiting time; and
- Tricycles are very flexible means of transport since there are only few regulations and policies covering their operations.

Moreover, majority of the roads in the 'tricycle territories' are still two-way streets and no other alternative transport can replace the three-wheelers, in terms of size. Enough demand has accumulated over the years justifying their existence, while the public got acquainted with them as the standard people carrier among major modes of travel.

### 3. Commuters' Preferences.

Especially for residential areas located along tertiary roads, people recognize that only tricycles will be able to cater to these areas on 24-hours-7-days-a week situations. Therefore, they take whatever fee which the tricycle drivers and operators might impose on the corresponding distance of their trips made.

## Technological Factors

### 1. Sidecar Manufacturing.

The tricycle sidecar industry can be considered as an informal sector due to its unique set up. A typical assembly plant is basically a small welding shop not different from vulcanizing and vehicle repair stalls along secondary roads. The local fabrication of sidecars can be considered a 'backyard industry.' At present, there is no official record as to how many manufacturers are there in the City. Shops vary in appearance that ranges from garage to junk shops. The Study Team's visits to most manufacturers reveal that sidecar fabricators are primarily

welding shops that have a wide variety of services.

Tricycles have never been a subject of roadworthiness evaluation or assessment by the concerned agencies, nor have standards been set for sidecars. Technically, the sidecar is not passenger-friendly due to instability. Majority of the units observed are under appropriate specifications, which are undersized for a common Filipino passenger, inconvenient on rainy/sunny days, and uncomfortable in terms of ride.

Over the years, sidecar designs even became smaller and less safe due to material minimization in construction. Most designs are not ergonomic as they are either too low or too narrow, especially when 3 to 4 people are accommodated. A prototype is shown in Figure 5.

**Figure 5: Typical Quezon City Tricycle**


Source: Photo courtesy of NCTS, 2003.

A tricycle sidecar does not cost very much depending on the location. In Quezon City, a basic design could cost around P8,000 ($145) while custom-made ones could cost about P10,000 ($180) each.

A study conducted by the Department of Science and Technology—Philippine Council for Industry and Energy Research and Development (DOST-PCIERD) in 2004 shows that the level of quality and workmanship of the product are not uniform across the country and thus, no design can be adopted for national application. In Quezon City alone, no two sidecars are identical in terms of overall dimensions, refinement of details and clearances, as well as in comfort and ride. The differences are due to: (i) manufacturing process (since it is manually done, there is ample room for human error); (ii) tools used in fabrication (mostly improvised); (iii) workplace condition (often not comfortable and safe); (iv) market acceptability (which accepts whatever is available); and (v) absence of standard (no mandatory requirements for design and specifications).

As the tricycle industry is becoming more attractive due to the availability of affordable motorcycle units, sidecar manufacturing is growing continually alongside. Moreover, the flexibility of the metal-fabrication support industry to sustain its operation even in the absence of demand for sidecars attracts more small-scale investors to this business.

**2. Mass Transport and Road Network Developments.**

While the City has mass transport projects in the pipeline, the locations of these are mainly along the primary roads. Residential areas are usually located distance away from these primary roads and therefore, there will still be need to transport the commuters via collector roads resulting to a consistent demand for tricycles.

The City government is also planning to expand its road network in which widening of Payatas, Novaliches and Litex roads are considered. If these projects will push through, there is a potential for other modes of transport like jeepneys or multicabs to be introduced in the near future.

About 18 interneighborhood roads, on the other hand, are scheduled under the Comprehensive Land Use Plan (CLUP). These roads are intended to connect private subdivisions to provide alternate roads due to congestions along tertiary roads. If no safety measures will be implemented, the demand for tricycles will soon be realized in these areas as it has been in the past.

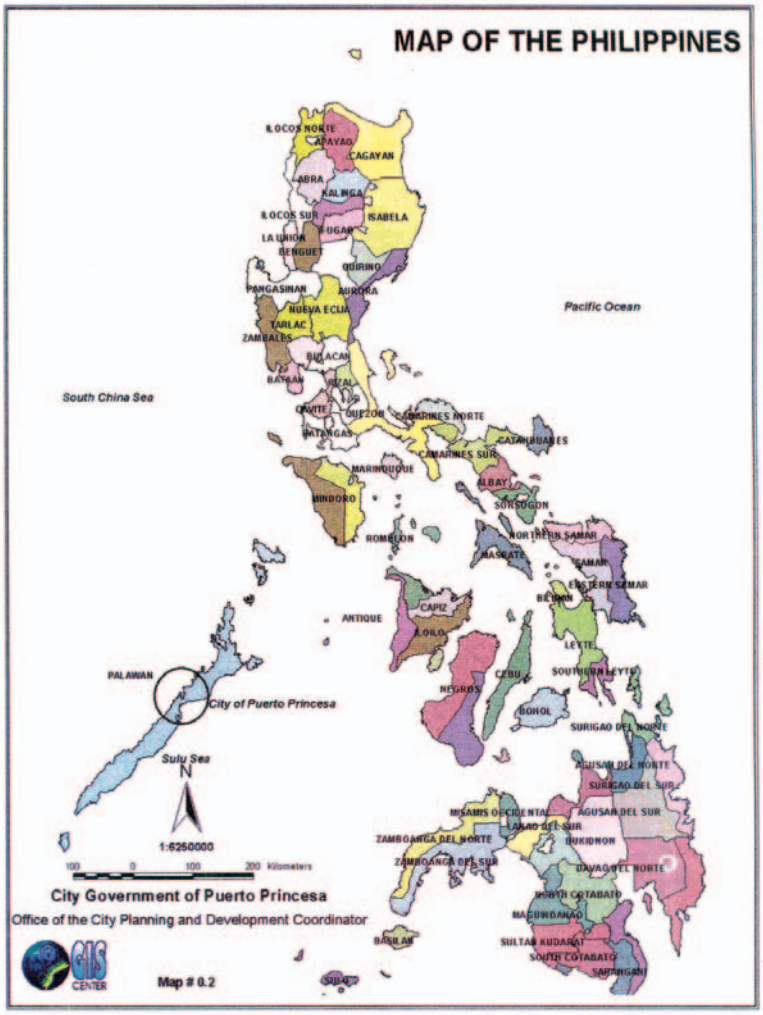
# III. PUERTO PRINCESA CITY AND ITS TRICYCLE SUBSECTOR

## A. General Description

Puerto Princesa sprawls across 253,982 hectares of land making it the country's largest city. Located 306 nautical miles southwest of Manila, it stretches 106 kilometers long with its narrowest breadth in Bahile where only 8.5 kilometers of land separate the east and the west coasts (Figure 6). It has 66 *barangays* (villages), 35 of which are urban and 31 are rural settlements.

Settlements are highly dispersed. Concentration exists mainly in the peninsula on the east coast where the city proper and the urban growth point area lies relatively close to each other. The rural barangays are scattered over the length of the City's coastline, separated by underdeveloped tracts of land. There are five barangays on the west coast, which are blocked off by rugged mountains and thick forest. Three of these barangays so far have been reached by the road network of the City and are

**Figure 6: Location of Puerto Princesa City**




Source: MMUTIS, 1999.

already accessible during the dry season. However, the two other barangays remain to be connected to the City's road network.[14]

In terms of population, Puerto Princesa City registered a total population of 129,577 in 1995. It increased by two-and-a-half times (250%) over a 25-year period. This enormous increase may be traced to the rapid growth experienced between 1970 and 1980, when the city's population was escalating at the rate of almost 5.0% per annum. However, the rate started to perk up during the first half of the decade (1990-1995), registering an average of 6.6% annual growth (Table 3). Assuming the persistence of the current rate of growth, the 1998 mid-year population of the city stands at 155,234.[15]

**Table 3: Historical Population Growth, Puerto Princesa City, 1995**

| Year | Population | % Increase or (Decrease) | % Average Growth Rate |
|---|---|---|---|
| 1903 | 1,208 | | |
| 1918 | 6,427 | 432 | 11.14 |
| 1939 | 10,887 | 69 | 2.54 |
| 1948 | 15,177 | 39 | 3.47 |
| 1960 | 23,125 | 52 | 3.69 |
| 1970 | 37,774 | 63 | 4.92 |
| 1975 | 45,709 | 21 | 4.87 |
| 1980 | 60,234 | 32 | 5.67 |
| 1990 | 92,147 | 53 | 4.34 |
| 1995 | 129,577 | 41 | 6.59 |

Source: City Planning and Development Office (CPDO), Puerto Princesa City.

The household size, conversely, was on a declining trend. From 6 members in 1970, the size shrunk to an average of 5 in 1995.

As of 1995, the City's population was predominantly urban. Its major concentration was the urban areas, which accounted for about 72.98% of the total population. The barangays of the urban area and surroundings encountered a yearly growth rate of 7.50% while the rural barangays had an average yearly growth rate of 4.50%.[16]

The economy of the City of Puerto Princesa is still basically dependent on agriculture, where farming provides livelihood to 8,932 households representing about 30% of the City's total population. Fishing, on the other hand, supplies about 60% of the marine requirements in Metro Manila.

The City of Puerto Princesa is also noted as a tourist destination. Being known as the "last frontier" of the Philippines, the City is endowed with vast natural resources and unique ecosystems. It rapidly became a vital tourist destination after the St. Paul Subterranean River National Park was handed over by the Department of Environment and Natural Resources (DENR) to the City government.

From 1995 to 2000, the growth rate of tourist arrivals in the City averaged at 22% every year. Although it declined in 1998 by 10%, the tourism industry remains stable. With the inflow of tourists in the City, many residents have invested in tourism-related establishments and services. These establishments, however, are mainly concentrated in the City proper.

## B. Profile of the Tricycle Subsector

The population increase in Puerto Princesa city led to an increasing demand for mobility during the past years. Table 4 shows the number of registered vehicles in Palawan from the period 1990-2003. During the periods 1992-1994 and 1996-1997, the demand for mobility significantly increased by 16% and 30% respectively. The downward trend in the said registration, however, can be noted in year 2003, of which reduction in the number of registered motorcycles and tricycles is observed. Except for year 2003, the volume of tricycle increased exponentially over the said

[14] Comprehensive Land Use Plan, 2001-2010, City of Puerto Princesa, 2000.

[15] City Planning and Development Office (CPDO). *Puerto Princesa City Socioeconomic Profile Report, 2003.*

[16] City Planning and Development Office (CPDO), *Puerto Princesa City Socioeconomic Profile Report,* 2003.

**Table 4: Palawan Vehicle Registration by Type of Vehicle, 1990–2003**

| Year | Cars | Utility Vehicles | Trucks | Buses | Motorcycle/ Tricycles | Total | % Increase |
|---|---|---|---|---|---|---|---|
| 1990 | 108 | 1,227 | 349 | 41 | 4,062 | 5,787 | |
| 1991 | 120 | 1,417 | 353 | 54 | 4,063 | 6,007 | 3.80 |
| 1992 | 140 | 1,669 | 419 | 50 | 5,199 | 7,477 | 24.47 |
| 1993 | 163 | 1,928 | 667 | 57 | 5,877 | 8,692 | 16.25 |
| 1994 | 199 | 2,125 | 508 | 67 | 7,536 | 10,435 | 20.05 |
| 1995 | 187 | 2,106 | 671 | 141 | 8,324 | 11,429 | 9.53 |
| 1996 | 258 | 2,806 | 633 | 138 | 11,103 | 14,938 | 30.70 |
| 1997 | 378 | 3,192 | 702 | 156 | 13,774 | 18,202 | 21.85 |
| 1998 | 461 | 3,277 | 782 | 142 | 14,079 | 18,741 | 2.96 |
| 1999 | 548 | 3,921 | 820 | 136 | 14,537 | 19,962 | 6.52 |
| 2000 | 596 | 4,344 | 900 | 144 | 16,092 | 22,076 | 10.59 |
| 2001 | 603 | 4,604 | 1,034 | 146 | 16,449 | 22,836 | 3.44 |
| 2002 | 566 | 4,784 | 980 | 156 | 17,138 | 23,624 | 3.45 |
| 2003 | 535 | 4,805 | 982 | 124 | 14,742 | 21,188 | (10.31) |

Source: Land Transportation Office (LTO).

period (Figure 7). It is estimated that about 70% of the registered tricycles in Palawan are in Puerto Princesa City.[17]

Public transportation within the City proper is via motorized tricycles and jeepneys. About 2,824 tricycles serve commuters within the *poblacion* (commercial center) and adjacent barangays while about 230 passenger jeepneys (multicabs) ply on their assigned routes between the City proper and adjoining barangays and municipalities.[18]

The study conducted a survey in Puerto Princesa City in April 2004, which established the high dependence of population on tricycles as a means of public transportation. About 58% of the total respondents are regular tricycle commuters, taking at least two rides daily. Among nonregular commuters, 25% of the respondents signify that they take at least 5 rides on a weekly basis. Among the reasons cited for tricycle dependence are (i) high accessibility; (ii) availability; (iii) affordability, and (iv) convenience.

About 81% of the respondents belong to the productive age group between 11-40 years old, implying that students and employees constitute the majority of the commuting public in the City. Usual destinations are residence, work, school, church, market or malls, and parks.

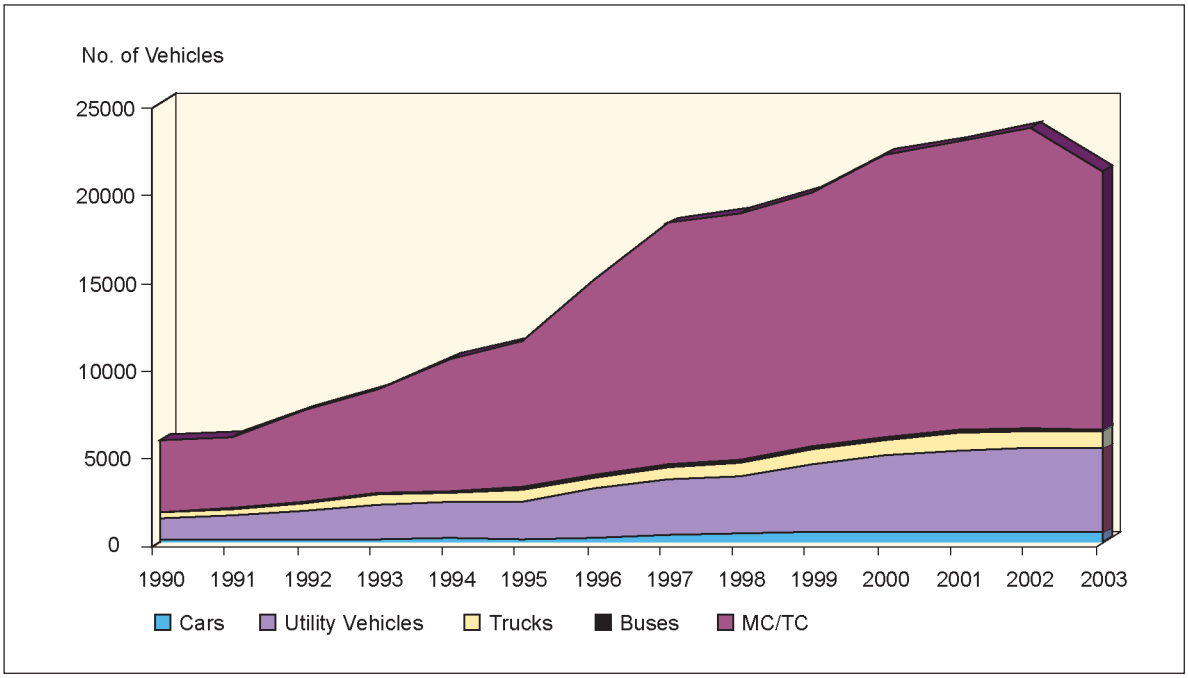
Moreover, tourists prefer taking the tricycle in going around the City because of the convenience and comfort it gives. For transporting passengers and cargoes to distant destinations, jeepneys and buses provide the required services.

The closest substitute to a tricycle is a multicab. However, the latter takes a particular route, in which the commuter is prompted to walk some distance or transfer to another multicab with another route. The tricycle, on the other hand, provides the convenience of traveling regardless of required distance or destination. Furthermore, with a tricycle, the commuter's waiting and traveling costs are minimized as it accommodates only 3-4 passengers per unit compared with a multicab with 14 passengers. Some areas in the City are also not served by multicab, especially those that are classified as residential areas. That is why the tricycle is more visible and thus, readily available for the commuters.

The commuters' perspective on the issue of tricycle service affordability is relative. While the minimum tricycle fares is P6 per passenger, which is 10% higher than the

[17] City Planning Development Office (CPDO), Puerto Princesa City.
[18] Strategic Environmental Plan for Puerto Princesa, 2003.

**Figure 7: Palawan Vehicle Registration by Type of Vehicle, 1990–2003**




Source: Land Transportation Office (LTO).

multicab's fare, most of the commuters feel that the said tricycle fare is still modest compared with the convenience they get out of it.

With respect to tricycle drivers and operators, the survey revealed that about 53% of the driver respondents are high school graduates and are therefore eligible to be employed in other fields of labor. About 88% of the driver respondents signified that they solely depend on tricycles for livelihood as it provides readily available income, of which 74% operate 11-15 hours per day. However, majority admitted that such income is often insufficient to sustain their personal and family needs on a daily basis. A tricycle driver typically earns between P200-P300 daily but usually spends P100 for boundary, P120 for fuel and P30 for lubricant, leaving a net income of around P100-P150.

In terms of vehicular age, the survey results show that about 60% of tricycle population in the city age more than 5 years, of which about 40% are more than 10 years of age. The prolonged operation of these tricycles result to over-lubrication of the engine, with a lubricant-to-fuel ratio averaging to as high as 1:15. Most of the tricycle units are also poorly maintained, with 75% drivers indicating that they clean the carburetor every 3 months at the minimum, 70% clean air filter every 3 months and beyond, and 72% clean the exhaust manifold at least every 5 months.

Compared to Quezon City, tricycle operations in Puerto Princesa City are compounded by the loading capacity and road condition. Tricycle tires (inner and outer parts) in the latter are replaced or even recapped after only 4 months compared to the former, which has an average duration of 6 months. In the case of tricycles in Puerto Princesa City, the cargo at the rear end and the extra load at the front shelf transmit significant pressure on the tires. Since the road is relatively of poor quality regardless of its paved condition, the tires absorb the shocks thus they get damaged easily.

City-wide inspection was also conducted to identify the sources of fuel for the tricycles. There are only three gasoline stations in the

area, which are all located in the city proper. The limited number of vehicles, as well as their dispersed operations, serves as a disincentive to gasoline station operators to branch out in other areas. As such, most of the fuel and lubricant are sourced from the informal stores, which sell in smaller quantity (*takal*). The tricycle drivers prefer to buy from these stores since their income could only be realized once a trip is made.

## C. Puerto Princesa City Road Network

At present, the total road network in the city is 531.5 kilometers, of which 155.9 km is categorized as national road and 375.6 km as city roads. With a total land area of 253,983 hectares, the average road density of the city is 0.21 km per square kilometer. The national standard is 1.0 km per square kilometer.

Of the total city roads, 309 km (82%) are gravel, 39 km (10%) are concrete, 16 km (4%) are asphalt, and 12 km (4%) are earth roads. Within the city proper, secondary national roads are concrete. Outside the *poblacion*, primary national roads of Puerto Princesa South Road, (PPSR) and Salvacion-Bahile Road are asphalt, while the Puerto Princesa North Road (PPNR) is concrete.

PPNR and PPSR are the two major highways that converge in Puerto Princesa City thus they link the entire province. The PPNR connects the city to the northern towns of Roxas, San Vicente, Taytay, Dumaran and El Nido while the PPSR links the city to the southern towns of Aborlan, Narra, Quezon, Rizal, Espanola, Brooke's Point and Bataraza. The PPNR leads to more tourist destinations in the province such as the famous Underground River, Coco-Loco Island Resort, Club Noah, and Miniloc, among others.

The City government's decongestion program calls for the establishment of a new urban subcenter in Barangay San Jose (approximately 4 km away from the old market). Major activities include the construction of new roads to provide smooth access to and around the area. The existing access road (1.08 km x 12.0 m) connects the north and the south national highways while the peripheral road (0.76 km x 10.0 m) is still to be constructed and paved. With this, it is also targeted to complete concreting and widening of south and northbound national arterial roads in the nearest possible time.

Access roads to seaport, airport and farm-to-market roads are being targeted for improvement, widening and rehabilitation until end-2005. Since there is a plan to upgrade and expand the city's seaport, existing access roads will be widened. To support the expansion of the airport, however, alternate roads to the terminal will also be provided. Existing farm-to-market roads with a total of about 142 km, on the other hand, will also be supplemented and improved in the next 5 to 10 years. The City Agriculturist Office proposes to have about 337 km farm-to-market roads opened up within the 10-year period.

The City government gives priority as well to the tourist access roads especially those leading to Honda Bay and Underground River.

With all these innovations and improvements of roads, the implementation of a mixed road use for motorized transport (especially for mass transport) and nonmotorized transport (NMT) like the addition of bike lanes is also a part of the plan to enhance traffic flow.

## D. Prospects in the Tricycle Subsector

Understanding the dynamic nature of society, technology and economy that influence the formation of scenarios will assist the City government of Puerto Princesa in addressing and coping with possible conflicts in the future. Describing and analyzing the situation will illuminate the key pressures and will provide a clear picture of possible changes to occur.

In analyzing the most likely scenario in the tricycle subsector, a political, economic, social and technological (PEST) analysis is conducted to determine the factors that are most likely to affect the future demand for and supply of tricycle services. This will allow a greater understanding of the situations that could lead to the adoption of an informed and more prudent decision.

## Political Factor

### 1. Setting Environmental Goals.

The two-fold aim of becoming one of the best tourist destinations and being the cleanest and greenest city in the country gives high priority in boosting economic activities that focus on the operation of sites and areas developed for eco-tourism, scientific, educational and specialized convention groups, as well as on the provision of services and support of activities that are related to these. As for the transport sector, the City government is also aiming to reduce the number of tricycles to 3,000 units through the adoption of a mass-transport system with lesser carbon emission.

## Economic Factors

### 1. Developing Urban Centers and Corridors.

The development of urban centers and corridors are expected to trigger economic activities that would increase employment opportunities and income within the affected areas within the following years. As income increases, it is also expected that demand for mobility will also increase. At present, however, only a few multicabs are irregularly passing through these target areas despite the road's capacity to accommodate bigger vehicles. Moreover, some houses within these barangays are so remote that only tricycles are willing to serve. The bad road condition further aggravates the nonavailability of other modes of land transportation aside from tricycles. Should there be no new investments for road rehabilitation and construction, it is therefore expected that households and businesses will continue to be dependent on the tricycles.

### 2. Growing Tourism Industry.

The City of Puerto Princesa is a popular tourism destination as it is endowed with natural beauty and rich biodiversity. The peace and order situation, both due to effective police and civil vigilance, makes it even more attractive for local and foreign tourists alike.

With its 22% average growth per year, additional investments for tourism development and tourism-related services are expected. At present, there are about 71 establishments and 806 employees directly connected to the tourism industry.[19] Moreover, the active participation of the City in Brunei-Darusalam, Indonesia, Malaysia and the Philippines-East Asian Growth Area (BIMP-EAGA) initiative may continue to broaden its tourism economy. The ADB-funded intermodal transport development initiatives will further make Puerto Princesa City accessible for tourists. The City government is targeting to host about 200,000 foreign and local visitors annually from 2005 onwards.

Since tricycles are highly accessible and provide round-the-clock services irrespective of destinations, they are more tourist-friendly. Getting around the City and its nearby barangays would be difficult for tourists due to nonfamiliarity with the area itself and with multicab or bus routes. Tricycle fares are also much cheaper compared to other vehicles for hire.

### 3. Making Tricycle a Tourism Icon.

The tricycles of Puerto Princesa City vary widely from most of the tricycles here in the Philippines. Like the *tuk-tuks* of Thailand, they are an added attraction to the City's already booming tourism industry and are already an easily identified icon among

[19] Comprehensive Land Use Plan for Puerto Princesa, 2001-2010. City of Puerto Princesa, 2000.

tourists. Should the City government decide to keep the current design in promoting its tourism industry, sidecar and tricycle specifications are therefore expected to remain the same for at least 10 years.

**4. Enhancing Agricultural Production.**

The City government aims to further promote agricultural industry in the area, as it captures 60% of the market for marine products in Metro Manila. Initiatives like provision for affordable fishing boats and support for post-harvest activities have already been extended by the government especially to fishing villages; this will further increase the supply of marine products from these areas. Considering that these villages are presently catered by tricycles in transporting their marine harvests from the wharf to the public market and to other customers within the City, it is uncertain if multicabs will be allowed to serve these areas in the near future. Therefore, demand for tricycle services is expected to increase.

**5. Increasing Unemployment Rate.**

Socioeconomic data[20] for Puerto Princesa City indicates that in 1997, the percentages of employed and self-employed (which include tricycle operators and drivers) are almost of equal values (23.6% and 23.9%, respectively). Unemployed but employable population, however, accounts for 14%. The data also shows that of those in gainful activities, only 27% are in the highly-skilled occupation (that is, government employees, private employees, teachers, traders/ businessmen).

In the survey of April 2004, around 10% of the tricycle drivers have finished elementary and 53% have finished high school studies. About 75% of these sample drivers belong to the productive age of 25-50 years. Although some of the driver respondents have other jobs as mechanics, carpenters, electricians, and computer technicians, tricycle driving remains their main source of income. This indicates that the lack of employment opportunities for these drivers induced them to resort to tricycle driving.

## Social Factor

**1. Increasing Population.**

Demand for transportation is directly proportional to population growth—as population increases, the demand for mobility also increases. And in the case of Puerto Princesa City, where tricycles dominate the roads, it is expected that as population growth exhibits an upward trend, the demand for tricycle services increase similarly. The population survey conducted by the National Statistical Coordination Board (NSCB) in 1995 indicated that the age groups of 0-14 and 15-64 comprise 40% and 58% of the total population, respectively. This implies that the productive age group will continue to compose the majority of the commuting population.

In terms of location, the urban barangays near the City proper are expected to experience an annual population growth rate of 7.5%. Residential developments are also expected to encourage in-migration and thus, intensify population growth in the City proper.

The day population of the City increases by an average of 20,000 people coming from the different parts of the hinterlands including by-passers.[21] Being the center of government, education, health and trade in the province, Puerto Princesa City attracts a number of transients to the City increasing thereby the demand for transportation, especially for tricycles.

[20] Population Distribution by Gainful and Nongainful Occupation, data from the City Planning and Development Office.

[21] Puerto Princesa City Traffic Study, 1994.

## Technological Factors

### 1. Urban Road Network.

Inadequate infrastructure is one of the major problems faced by the City. The urban road network can hardly accommodate the present traffic volume, as busy streets (within the central business district or CBD) are narrow and some are poorly paved. Existing terminals, parking areas and drainage facilities are inadequate and substandard. Widening of streets surrounding the old market seems no longer feasible.[22]

Considering the anticipated population growth rate of 6.6% per annum, traffic volume is expected to increase. It should be noted, however, that the streets within the CBD, are narrow making it difficult for bigger vehicles (like, multicabs) to traverse along these areas; hence, there is a bias for the motorcycles and tricycles. And with technological constraints for road expansion and construction in some of its streets, the City is expected to be highly dependent on tricycles as a mode of public transportation.

### 2. Motorcycle Availability and Financing Scheme.

The motorcycle industry is becoming more competitive now with the entry of new players due to trade liberalization. Majority of the production of motorcycles with engines lower than 500cc[23] is basically assembly. Complete-knocked-down (CKD) motorcycle parts are usually imported from Japan, and then assembled locally. Manufacturing plants in the country are either extension plants of the mother firm or authorized local franchisees carrying the same products but not necessarily the name of the mother firm. The locally-produced parts constitute about 50% to 60% since this is a requirement set by the Department of Trade and Industry (DTI).

New players are also gaining a portion of the market especially with their lower prices. A Japanese 4-stroke model normally cost around P70,000 ($1,285) to P75,000 ($1,375) on cash basis depending on the model grade. For installment schemes, initial down payment is usually about P12,000 ($220) with a monthly payment of P4,000 ($74) for three years. A Chinese model of the same type and grade would cost about P50,000 ($920) or less for cash buyers. Initial installment packages vary from P2,900 ($53) to P6,500 ($120) depending on the brand and market share.

In general, the Chinese models are cheaper by about 40%. The problem with the new players is the lack of after-sales support like spare parts availability. However, in due time all brands of motorcycles are expected to reach a saturation point, in which the new players eventually will catch up on quality, price and market share.

The low prices and the availability of motorcycles have been great factors for the surge of the tricycle subsector. As a result financing and operating tricycles have become relatively inexpensive. Thus, compared to other businesses it yields lower risk on investment due to the minimal capital required and quick revenue generated.

The influx of scooters also paved the way to more business opportunities in the sector. This is because scooters eliminated the pedal controls and integrated it all in the front console instrumentation, making it easier to drive regardless of age and gender. One of the benefits from scooters is that most of the importation is 4-stroke, thus, they are more energy efficient. Another benefit is that many parts are in complete-knocked-down (CKD) assembly kits, which encourages drivers to assemble their own unit in any fashion. This also opens new doors to local technicians to do the same practice with the motorcycles.

### 3. Sidecar Manufacturing.

Like in Quezon City, tricycles have never been a subject of roadworthiness evaluation or

[22] Comprehensive Land Use Plan for Puerto Princesa City, 2001-2010. City of Puerto Princesa, 2000.

[23] Cubic centimeters (cc) denote the size of internal combustion engines in automobiles and motorcycles.

assessment by the concerned agencies, nor standards have been set for sidecars. Sidecars in Puerto Princesa City are relatively unstable as they are designed to carry more people than the capacity of the engine. Most tricycles carry people inside the cab or behind the driver.

Sidecar assembly can be done practically anywhere, as this is considered a backyard industry. Designs are not regulated while dimensions do not have specific standards. Sidecars are designed to be ergonomically detrimental, as they are too narrow and becomes crowded when another person is accommodated in front. Shown in Figure 8 are typical designs of sidecars in Puerto Princesa City.

**Figure 8:**
**Typical Tricycle Sidecar, Puerto Princesa City**

# IV. ISSUES RELATED TO TRICYCLES

The previous section discussed the factors that could contribute to the further increase of tricycle demand and supply in Quezon City and Puerto Princesa City. It is, however, equally important to understand the issues associated with the subsector in order to come up with an unbiased and prudent policies in this regard.

## A. Ambient Air Pollution

Motorcycle and tricycle emissions threaten the city's air quality. The incomplete combustion, caused by poor maintenance and abusive use (i.e., overloading) of vehicle, produces various air pollutants. As previously discussed most tricycles have been in operation for over 5 years. The performance of the motorcycles is not only aggravated by its old age but also by the infrequent maintenance and repairs done by the drivers and operators.

The following discussions provide information on the air pollutants typically emitted by motorcycles and tricycles. Different studies are cited to determine the environmental and health damages caused by a particular pollutant based on the period of exposure and the concentration of such pollutant. The population at risk is also identified.

### Particulate Matter

Almost all vehicular particulate emissions are extremely damaging to public health. Concentrations of total suspended particles (TSP) and particulate matters with aerodynamic diameter of less than 10 ($PM_{10}$) and 2.5 microns ($PM_{2.5}$) remain in suspension in the air for hours or days and can travel significant distances from the source. These particles enter the respiratory tract, reaching deep into the lungs. $PM_{10}$ includes all particles likely to pass through the nose and mouth while $PM_{2.5}$ includes those that are able to reach deeper parts of the respiratory tract especially the alveolar regions of the lung.[24]

Low fuel quality, inefficient combustion processes, and poor vehicle and equipment maintenance in tricycles all contribute to particulate emissions at ground level that can easily enter the human respiratory system. Some of the smallest particles called respirable particulates (particulate matters equal or less than 10 microns) lodge in the lung capillaries and alveoli and can cause the following effects:[25]

- Slowing down the exchange of oxygen and carbon dioxide in the blood, causing shortness of breath; and

[24] Kojima, M. *et al.* 2000. *Improving Air Quality in South Asia by Reducing Emissions from Two-Stroke Engine Vehicles.* World Bank.

[25] Available: http://www.dnr.state.wi.us/org/aw/air/

- Straining the heart, because it must work harder to compensate for oxygen loss.

Those with a known history of asthma or chronic lung disease are especially sensitive to these effects. The elderly or those with preexisting heart conditions may also have severe reactions, since the resulting lack of oxygen may strain the heart. The adverse health effects from particulate matter exposure are often not immediately noticed. Particulates can accumulate in the lungs after repeated, long-term exposure causing respiratory distress and other health problems.

Some particles themselves may be poisonous if inhaled or absorbed, and can damage remote organs like the kidneys or liver. Swallowed mucous laden with poisonous particulate matter may also damage the gastrointestinal system. Irritating odors are also associated with particulates. Examples of sources are gasoline and diesel-engine exhausts, among others.

In addition, particulate matter can: (i) corrode metals and masonry; (ii) soil structures and motor vehicles (cleaning of which, e.g., window washing, sand blasting, and repainting, could costs millions of dollars annually); (iii) dust the leaf surfaces of crops, trees and shrubs, which may injure or inhibit the growth of these valuable plants, and (iv) impair visibility and reduce solar radiation (very small particles remain suspended in the air for long periods of time, and also effectively scatter light. The haze caused by these particles can affect crop productivity by reducing solar radiation, as well as adversely affect property values, aesthetics in urban, countryside and wilderness areas, transportation safety; and potentially the weather.

Isolating the effects of different types of particulate matter is difficult because other pollutants, as well as other factors in the environment like changes in temperature or epidemics or infections also affect health. But a series of extensive studies, has tied changes in particulate concentrations to changes in a wide range of health indicators including deaths, changes in lung function, emergency room visits, exacerbation of asthma, hospital admissions, respiratory symptoms, and time off from school or work.[26]

## Carbon Monoxide

Carbon Monoxide (CO) is a colorless, odorless, and tasteless gas. It is emitted when there is incomplete combustion. High levels are possible near large parking lots, traffic jams, or crowded streets, where a large number of slow-moving vehicles accumulate. It may temporarily accumulate at harmful levels, especially during cold weather when fuel combustion reaches a peak and carbon monoxide is chemically most stable because of low temperature.

Based on a study made in Wisconsin, carbon monoxide enters the blood stream by combining with hemoglobin, the substance that carries oxygen to the cells. The pollutant adversely impacts health in many ways such as:[27]

- It weakens the heart contractions, lowering the volume of blood distributed to various parts of the body;
- It causes people to feel tired and drowsy from short-term exposure to concentrations greater than 30 parts per million (ppm);
- It causes shortness of breath and chest pain in people with heart disease at exposures as low as 10 ppm; and
- It induces irritability, headaches, rapid breathing, blurred vision, lack of coordination, nausea, dizziness,

[26] Holgate, S. *et al.* 1999. *Air Pollution and Health.* London: Academic Press.
[27] Available at: http://www.dnr.state.wi.us/org/aw/air/

confusion and impaired judgment in healthy people at levels greater than 35 ppm.

Even three or four hours after exposure, half the excess carbon monoxide may remain in the blood stream. The study also revealed that people especially susceptible to CO include:

- Children (and the human fetus);
- The elderly;
- Those with respiratory or heart illnesses;
- Those with anemia;
- Those exposed for long periods of time, especially traffic officers; and
- Cigarette smokers. Smoking while driving in heavy traffic may result in increased exposure from cigarette smoke and engine exhaust. Tests of automobile drivers show exposure to high levels of carbon monoxide can impair a driver's judgment and ability to respond rapidly in traffic. It can also impair vision and produce headaches.

On-the-spot emission tests to a number of tricycles in Quezon City and Puerto Princesa City were conducted in April 2004 and the results are shown in Tables 5 and 6. It is interesting to note that the CO concentrations, for both idle and higher speed (2,000 rpm), of 4-stroke engines have higher values on the average compared with those of 2-stroke engines. Technically, 4-stroke emits lower CO compared to 2-stroke. In this case, however, for a 4-stroke to have high CO emission, drivers probably made inappropriate modifications during repair or maintenance.

The tests also show that CO concentration, regardless of the type of tricycle engines, is higher at higher speed. This indicates that acceleration, both gradual and abrupt, produces more CO pollutants. Nevertheless, it is interesting to note that all the tricycles tested passed the 4% standard set by the Clean Air Act.

**Table 5: Comparison of CO Concentrations in Tricycles, Quezon City, April 2004**

| Type of Engine | Condition | CO, % |
|---|---|---|
| 2-stroke | Idle | 1.97 |
| | 2,000 rpm | 2.24 |
| 4-stroke | Idle | 2.19 |
| | 2,000 rpm | 2.87 |

**Table 6: Comparison of CO Concentrations in Tricycles, Puerto Princesa City, April 2004**

| Type of Engine | Condition | CO, % |
|---|---|---|
| 2-stroke | Idle | 1.77 |
| | 2,000 rpm | 2.08 |
| 4-stroke | Idle | 2.32 |
| | 2,000 rpm | 2.81 |

## Oxides of Nitrogen

Nitrogen oxides ($NO_x$) are formed during combustion as nitrogen in the air reacts with oxygen at high temperature and under certain other conditions. Nitric Oxide (NO) and nitrogen dioxide ($NO_2$) are the two most important. Certain members of this group of pollutants, especially $NO_2$, are known to be highly toxic to various humans and animals. The Wisconsin study reveals that high levels may be fatal, while lower levels affect the delicate structure of lung tissue. In experimental animals this leads to a lung disease that resembles emphysema in humans. As with ozone, long-term exposure to nitrogen oxides makes animals more susceptible to respiratory infections. Nitrogen dioxide exposure lowers the resistance of animals to such diseases as pneumonia and influenza. Humans exposed to high concentrations suffer lung irritation and potentially lung damage. Increased respiratory disease has been associated with lower level exposures.[28]

[28] Available at: http://www.dnr.state.wi.us/org/aw/air/

The human health effects of exposure to nitrogen oxides, such as nitrogen dioxide ($NO_2$), are similar to those of ozone. These effects may include:

- Short-term exposure at concentrations greater than 3 parts per million (ppm) can measurably decrease lung function;
- Concentrations less than 3 ppm can irritate lungs;
- Concentrations as low as 0.1ppm cause lung irritation and measurable decreases in lung function in asthmatics; and
- Long-term lower level exposures can destroy lung tissue, leading to emphysema.

Children may also be especially sensitive to the effects of nitrogen oxides.

Oxides of nitrogen also can: (i) seriously injure vegetation at certain concentrations with effects ranging from bleaching or killing plant tissue, causing leaves to fall, and reducing growth rate; (ii) deteriorate fabrics and fade dyes; (iii) corrode metals (due to nitrate salts formed from nitrogen oxides); and (iv) reduce visibility.

Oxides of nitrogen ($NO_x$), in the presence of sunlight, can also react with hydrocarbons, forming photochemical oxidants (see discussions on ozone). Also, $NO_x$ is a precursor to acidic precipitation, which may affect both terrestrial and aquatic ecosystems.

## Ozone

Ozone ($O_3$) is a colorless gas and forms as a secondary pollutant—i.e., it is not directly emitted but is produced by a reaction involving other substances in the air. Hydrocarbons (volatile organic compounds or VOCs) and nitrogen oxides ($NO_x$), the ozone *precursors*, chemically react in sunlight to form ozone.

According to the Wisconsin study, ozone is a highly reactive gas that affects the respiratory system by severely irritating the mucous membranes of the nose and the throat. Since 90% of the ozone breathed into the lungs is never exhaled, ozone molecules react with sensitive lung tissue to cause several health consequences. Ozone's effects are more severe in individuals with preexisting respiratory disease. The length and frequency of exposure, as well as the concentration, are significant factors in determining the many effects, which may include the following:[29]

- Increased susceptibility to respiratory infection;
- Impaired lung function and reduced ability to perform physical exercise. Recent studies suggest that healthy exercising individuals exposed to 120 parts per billion (ppb) of ozone for an hour experience significant shortness of breath. Similar decreases are also seen upon a 6-hour exposure to 80 ppb;
- Severe lung swelling and death, due to short-term exposures greater than 300 ppb;
- Increased hospital admissions and emergency room visits for respiratory diseases, which may be associated with exposures to one-hour ozone concentrations greater than 120 ppb; and
- Longer-term exposures to moderate levels of ozone present the possibility of irreversible changes in the lungs, which could lead to premature aging of the lungs and/or chronic respiratory illnesses.

Activity levels (e.g., moderate-heavy exercise) and environmental stress (e.g., humidity and high temperatures) also affect susceptibility. Other factors include:

[29] Available at: http://www.dnr.state.wi.us/org/aw/air/

(i) individual sensitivity; (ii) age (children and young adults appear to be more sensitive than older adults); (iii) smoking status (smokers appear to be less sensitive than nonsmokers); (iv) chronic obstructive pulmonary disease or asthma, which may increase susceptibility to ozone-induced decreases in lung function (decreases in lung function are greater in asthmatics concurrently exposed to ozone and pollen than for either pollutant alone); and (v) possibly additive or synergistic effects when ozone combines with sulfur dioxide, nitrogen oxide, carbon monoxide, sulfuric acid, or other particulate aerosols.

Other at-risk groups include adults who are active outdoors (e.g., outdoor workers), and individuals with preexisting respiratory disease such as asthma and chronic obstructive lung disease.

US researchers announced in February 2002 the first evidence suggesting that ground-level ozone is a "causative factor" in development of childhood asthma. Previously scientists suspected it might aggravate asthma cases. To find out whether ozone pollution, also known as smog, can actually cause asthma, researchers followed children in different age groups living in different cities for up to five years. In high-ozone cities, children who played the most outdoor sports were 3 to 4 times more likely to develop asthma than children who played no sports. Meanwhile, in low-ozone cities, children who played outdoor sports were no more likely to develop asthma than sedentary children, which suggests that the ozone pollution, rather than participation in sports, causes higher asthma rates.[30]

The emission tests conducted in April 2004 indicate that the average HC emission of tricycles both in Quezon City and Puerto Princesa City is below the Clean Air Act standard of 7,800 ppm (Tables 7 and 8). Note, however, that 4-stroke engines are emitting substantially low level of the said pollutant, both in idle and higher speed conditions.

[30] Available at: http://www.ems.org/air_pollution/air_pollution.html

**Table 7: Comparison of HC Concentrations in Tricycles, Quezon City, April 2004**

| Type of Engine | Condition | HC, ppm |
|---|---|---|
| 2-stroke | Idle | 4,316.94 |
| | 2,000 rpm | 4,576.35 |
| 4-stroke | Idle | 1,145.82 |
| | 2,000 rpm | 862.52 |

**Table 8: Comparison of HC Concentrations in Tricycles, Puerto Princesa City, April 2004**

| Type of Engine | Condition | HC, ppm |
|---|---|---|
| 2-stroke | Idle | 6,606.20 |
| | 2,000 rpm | 5,341.00 |
| 4-stroke | Idle | 689.67 |
| | 2,000 rpm | 386.04 |

## B. Noise Pollution

### Tailpipe Noise Level Measurement

The impact of traffic noise from tricycles on the community depends on various factors such as road location and design, land use planning measures, building design, vehicle condition and driver behavior. The World Health Organization (WHO) suggests that noise can affect human health and well-being in a number of ways, including annoyance reaction, sleep disturbance, interference with communication, performance effects, effects on social behavior and hearing loss. Noise can cause annoyance and frustration as a result of interference, interruption and distraction.

Research into the effects of noise on human health indicates a variety of health effects. People experiencing high noise levels differ from those with less noise exposure in terms of: increased number of headaches, greater susceptibility to minor accidents, increased reliance on sedatives and sleeping pills, and increased mental hospital admission rates. Exposure to noise is also associated with a range of possible physical effects including: colds, which is the second most frequent ailment of tricycle drivers according to the

survey; changes in blood pressure; other cardiovascular changes; increased doctor/ hospital visits; problems with the digestive system and general fatigue. Further, there is fairly consistent evidence that prolonged exposure to noise levels at or above 80 decibels (dB) can cause deafness. The amount of deafness depends upon the degree of exposure.[31]

Based on the tailpipe noise level measurement of April 2004, all tricycles tested under running condition are way above the maximum permissible environment noise level for motorcycles of 77 dB set under ECE Regulation 41. Tricycles with 2-stroke engines produce noise levels ranging between 83-87 dB and 90-97 dB (Figures 9 and 10), while that of 4-stroke ranges between 78-86 dB and 82-91 dB (Figures 11 and 12) in Quezon City and Puerto Princesa City, respectively. In terms of engine age, tricycles aging beyond 15 years contribute most to noise pollution.

It is important to note that while the reading of the noise level exceeds the standard, 83% of driver respondents in Quezon City and 79% in Puerto Princesa City signified

**Figure 9: Noise Level of 2-Stroke Engines vs. Motorcycle Age, Quezon City, April 2004**

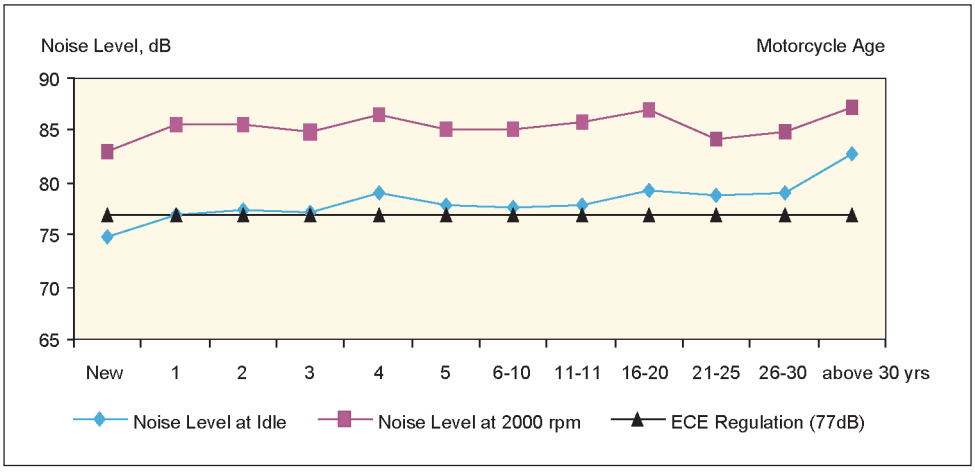
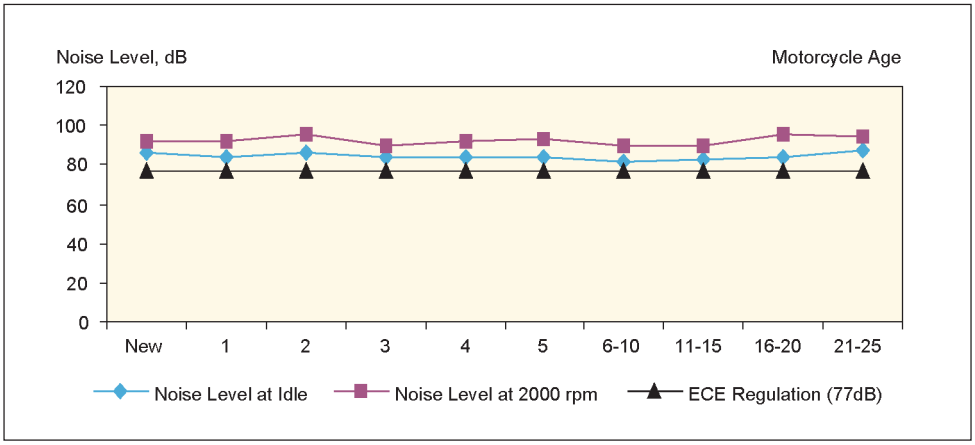



**Figure 10: Noise Level of 2-Stroke Tricycle Engines vs. Motorcycle Age, Puerto Princesa City, April 2004**




[31] http://www.epa.nsw.gov.au/soe/97/ch1/ch1.htm.Job%201996

**Figure 11: Noise Level of 4-Stroke Engines vs. Motorcycle Age, Quezon City, April 2004**

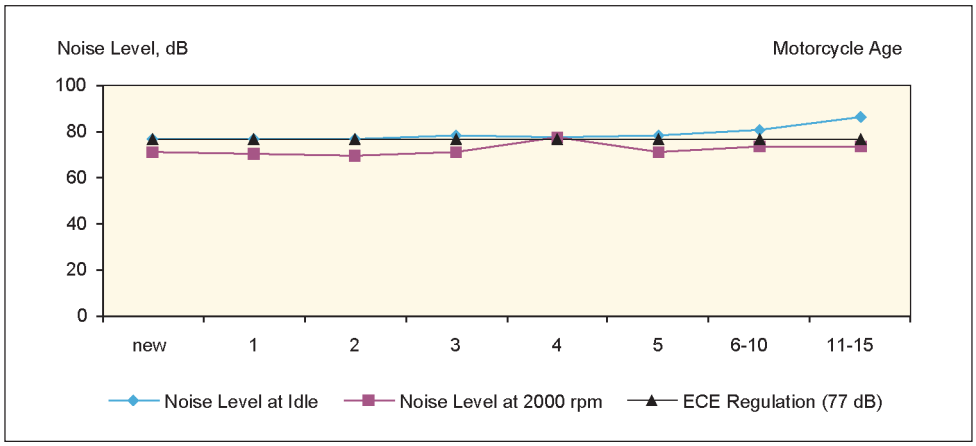
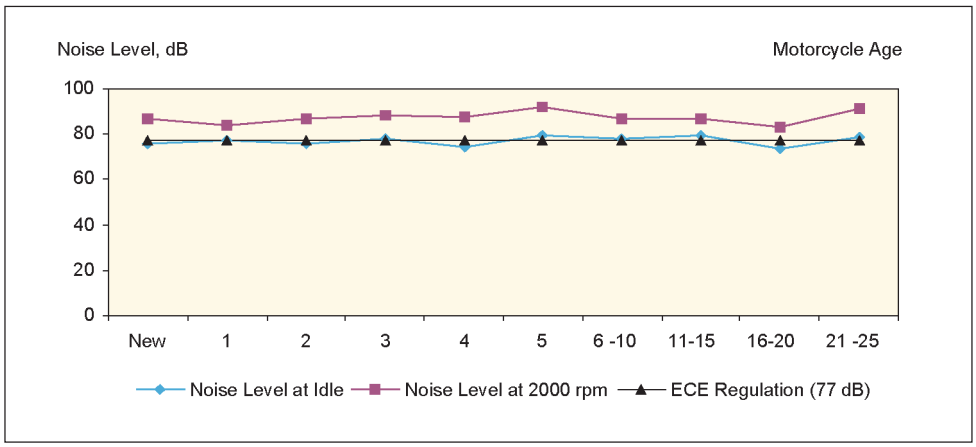



**Figure 12: Noise Level of 4-Stroke Engines vs. Motorcycle Age, Puerto Princesa City, April 2004**




that they have functional silencers. It is conclusive therefore that even though the silencers are attached in their motorcycles, they are not functional.

## Ambient Noise Level Sampling

For roadside conditions, noise levels are measured in areas where majority of transportation is tricycle. In Quezon City, the average noise level is registered at 88 dB while in Puerto Princesa City, it is at 74 dB. The measured levels in both cities are above the local permissible standard of 70 dB (for commercial area[32]).

In Quezon City, District II has the most number of areas registering substantially high noise levels of more than 110 dB due to its gradient terrain. The district also has the most number of tricycles operating in the City. Observations were also made in a residential area (Novaliches) of the said district served by

[32] In general, the *poblacion* is a commercial district. The highest noise limit except light industrial area (75 dB) and heavy industrial area (80 dB) based on standards set by the National Pollution Control Commission (PD 1152 Sect. 5).

more than 5 TODAs and adjacent to several factories, schools, religious establishments and to the central business district. About 70% of the vehicles in the area are tricycles serving students, factory and office workers, of which operation is at peak between 5 PM to 8 PM. It has been measured that noise levels averaged at 80 dB in the morning until early evening (6 AM to 7 PM) and 65 dB in the late evening until dawn (10 PM to 4 AM). Note, however, that the figures are way above the national standards for residential area of 60 dB during daytime and 50 dB during nighttime. It has also been observed that during late evenings, tricycles have tendencies to speed up thus creating loud irritating noise. As for the rest of the City, high noise levels are also observed along commercial areas, factories and schools where there is significant demand for tricycle services.

In Puerto Princesa City, the area with the highest noise level in the city is the Malvar-National Highway Junction (82 dB) wherein 45% of the vehicles are tricycles. Other areas with significant noise levels were along the Rizal Avenue between Malvar and Valencia streets and at Valencia-Rizal Avenue intersection registering 78 dB. The rest of the City is naturally quiet that even local noise level standards of 60 dB can be attained. These places are Manalo-Fernandez intersection (63 dB) and along Abueg Street near the radio station DZRH (60 dB). The lowest noise level in the City is measured at daytime along Abueg Road with 42 dB.[33] The other areas measured were between 77 dB to 67 dB, these areas have corresponding prominence of tricycles as public transportation.

The noise level sampling and measurement results obtained from the two cities are detailed in Appendix 1.

## C. Traffic Congestion

Tricycles are the major contributors to traffic congestion. The frequency of tricycles plying the major streets is obviously higher than that of passenger jeeps/ buses and private vehicles combined. Because of their numbers and constraint in speed, they contribute most to road congestion.

In Quezon City, it has been noted that many secondary and tertiary roads leading to residential areas across the city experience traffic congestion during 6:30 AM to 9:00 AM. A slight build-up reoccurs by 11:00 AM lasting until 12:30 PM and then again by 4:30 PM until 8:00 PM. The road condition is not really the problem but the volume of the vehicles, which far exceeds the carrying capacity of the road.

In Puerto Princesa City, daily traffic congestions occur between 7:30 AM to 8:30 AM and 10:00 AM to 12:00 noon. Heavy traffic occurs in four major roads namely: Rizal Avenue (Roxas Street-Junction 1); Malvar Street (Public Market-Caltex Station); Manalo Street (Fernando-Roxas Streets); and National Highway (Junction I-Junction II). Similarly, traffic congestions are experienced in four minor streets of Lancao, H. Mendoza, E. Valencia and Burgos. Note that a significant number of tricycles is operating in these areas than the rest of the City.

## D. Accidents

Tricycles are perceived to be more accident prone than four-wheeled vehicles. Among the reasons for this are the instability of the sidecar attached to the motorcycles, which serves as passengers' seat, and the obstruction it brings as its height usually exceeds the driver's line of sight.

The ADB tricycle passenger survey in April 2004 shows that in Quezon City, about 37% of the respondents claim that tricycles are not safe, in which 11% had accidents with a tricycle while in Puerto Princesa City, the

[33] 40 dB is equivalent to bedroom noise without any noise from radio or television.

figures are at 25% and 14%, respectively. Among the types of accidents encountered are colliding either with a fixed structure (wall), a person or another vehicle; tipping over on a ground or drainage; and flat tires. Those who suffered from accidents needed medical attentions with effects ranging from bruises, back pains and broken bones. Some, however, admitted that the accidents were traumatic for them.

Among the major causes of tricycle accidents are: (i) drivers' attitude, (ii) sidecar fabrication, and (iii) tricycle stability. Majority of the respondents said that tricycle drivers are often reckless and negligent of traffic rules, as they are in the habit of competing against each other in transporting as many passengers as possible. Also, the relatively small size of the tricycle, compared with other public transport, makes it easier for the driver to take turns anywhere, where miscalculations result in collisions.

Sidecar fabrication is another concern. The height, length (legroom) and width of the tricycle's body seem insufficient for an average tricycle passenger. Any abrupt movements in the tricycle caused either by the driver's recklessness or potholes along the road could cause physical pains to the passenger. Appendix 2 details the physical specifications of the sidecars in Quezon City and Puerto Princesa City.

Tricycle sidecars in Quezon City are small for the average Filipino as illustrated in Figure 13. The basic dimensions are 1.3 meters in height, 1.0 meter in width and almost 1.6 meters in length. The most distinctive features of the tricycles are:

- Low-rise overall seating;
- Ornamented in and out including a pajero-type[34] bumper;
- Inadequate room for two adult Filipinos;
- Suspension system—bumpy since coil springs are made of scraps or, sometimes no suspension at all; and
- Body number and sidecar body color—to identify service area TODA membership.

Sidecar fabrication in Quezon City is flexible, in which reconfiguration of the total outlook of the tricycles disregards the fact that motorcycles are intended for single riders. Most tricycles carry two passengers inside the cab and another at the seat behind the driver. The designs in Quezon City are beyond ordinary by making the tricycle a sporty transport or a heavy workhorse with such a small engine that is not even close to 500cc.

Shown in Figures 14, 15 and 16 are units with engines not greater than 125cc but are used for public transportation. Designs of tricycles vary due to material (and thus, cost) minimization (Figure 7), capacity optimization (Figure 8), and image or style (Figure 9).[35] Except for the 11-seater tricycle configuration, all other design formats almost have the same suspension system that is basically a scrapped-coil spring welded to a 1-inch reinforcement bar. In the interviews conducted among tricycle drivers, about 40% do not even install used-coil spring to cushion the ride. The bumps therefore are absorbed by the tires and

**Figure 13: Proportion of a Filipino to a Quezon City Tricycle**

[34] Pajero is a type of 4-wheeler sport utility vehicle (SUV) with customized protruding bumper.

[35] Photos courtesy of UP-NCTS Tricycle Study Team, 2003.

**Figure 14**
Lean materials—lowered body, cheaper fabrication, gaining popularity.

**Figure 15**
Heavy tricycle workhorse: 11-seater, modified rear-wheel configuration.

**Figure 16**
Extreme and sporty—lowered, leathered, folded, stainless and galvanized.

improvised contraption of reinforcement bar. As a result, this gives an unpleasant ride to passengers that could further cause injuries.

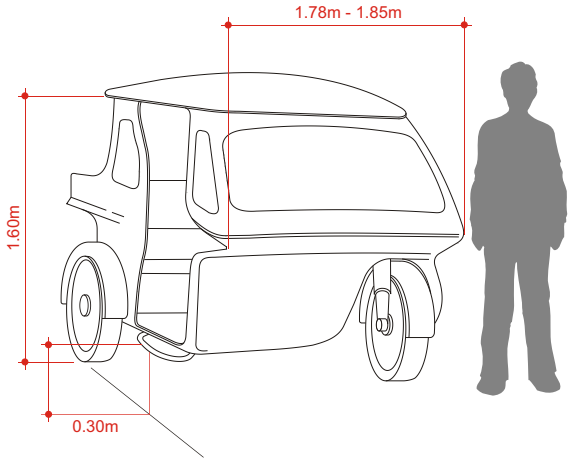
Recognizing the accidents caused by tricycle sidecars, the UP-NCTS conducted a study on the recommended design, height, width and capacity of a sidecar. The study recommends that the sidecar should be based on cost, safety and comfort, aesthetics, durability and environment-friendly. The said study, however, recognizes that resistance in tricycle sidecar modifications can be anticipated because the tricycle users are so accustomed with the present appearance.[36] As shown in Appendix 2, the basic specifications of a tricycle sidecar in Quezon City are compared to the ideal model.

Puerto Princesa City, on the other hand, is basically an agricultural and tourism area, which explains the emphasis of design incorporating the rear cargo compartment. Profile of the design is still reminiscent of the 1950s vintage cars with long trunks. This trunk-like design however, has no purpose but mere ornament. Tricycle sidecars are generally larger than the Metro Manila model. Shown in Figure 17 is an illustration of the proportion of an average Filipino beside a unit. The basic dimensions are 1.6 meters in height, 1.8 meters in width and almost 2 meters in length. The most distinctive features of the tricycles are:

- Windshield—wide and integrated with the driver;
- Integrated roof—resulting in a simpler structure;
- Roomy sidecar—the absence of a dividing panel between the driver and passenger provides sufficient space for passengers;
- Suspension system—parallel link with active moving parts but appears to be scrap material yet functional; and
- No color code—body panels are not colored to denote the line or route or to indicate their membership.

The fabrication of sidecars of the tricycles in Puerto Princesa City is designed to carry more people than the capacity of the engine.

**Figure 17: Proportion of Passenger to Tricycle**

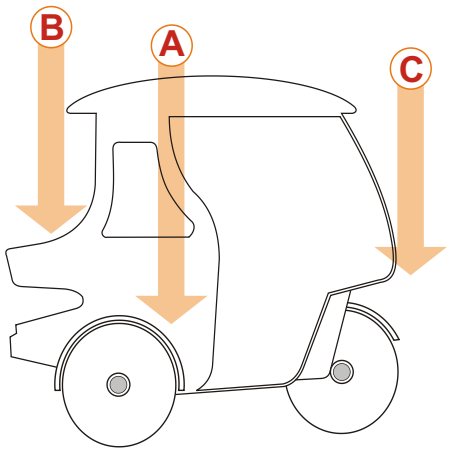



[36] University of the Philippines National Center for Transportation Studies Foundation, Inc. (UPNCTSFI). 2004. *Standards Development for Local Motorcycle/Tricycle Sector: Final Report.* Quezon City.

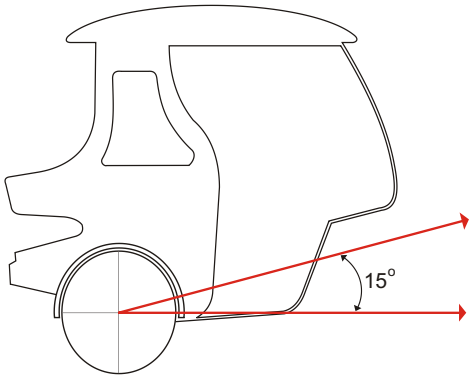
Most tricycles carry people inside the cab or behind the driver. The design in Palawan considered loading even at the front making it flexible for cargo or passenger (Figure 18).

The suspension is working fairly but loading at the front causes tilting, applying pressure and reducing the speed. In order to counter this, the inventor or pioneer mounted the sidecar on an angle to give a rear tilt. This would mean that if a load is applied at the front, the sidecar runs on a flat angle and balance is achieved. However, in the long run the tilt will affect the total ride and comfort while a sudden jerk at high speed may result in overturning.

**Figure 18: Loading Design for Sidecars of Tricycles in Puerto Princesa City**




Pressure points for the Puerto Princesa tricycle design format




Required angle to provide comfort tilt for passengers should be approx. 15°

# V. CONCLUSIONS AND RECOMMENDATIONS

The previous sections discussed the observable and potential driving forces that could stimulate demand and supply for tricycles in each city, and identified the issues related to the respective tricycle subsector. It is therefore imperative for the local governments of both Quezon City and Puerto Princesa to review and assess their existing capabilities in order to come up with prudent decisions in responding effectively on possible scenarios in the future of the subsector. To assist the city governments in developing its strategic plan for tricycle pollution reduction, a number of possible options are presented in a matrix (Appendix 3) providing a concise description of each strategy and the extent of its impacts. These strategies are classified into different approaches and specific to the manner of intervention—those directly targeted at the tricycle units (engines, fuels and lubricants) and those external but could affect the operations of the tricycles (traffic and transport management). The possible implications of each option were evaluated to provide greater understanding of the issue at hand and assist the stakeholders, especially the local government, in the selection of the most appropriate strategy and policy option to take.

After the evaluation of currently available resources and consultation with various stakeholders, and considering the institutional, technical, cultural, social and economic aspects in the two cities, the following strategies are recommended: (a) LGU-led maintenance program; (b) mandatory orientation of tricycle drivers; (c) tricycle volume reduction program; (d) restriction on new and renewal tricycle franchise application with engines more than 15 years; and (e) promotion of alternative transportation. A set of activities that the two LGUs need to implement to supplement the strategies are also recommended (Table 9). The strategies are further classified into short term (those that can be implemented within a year), medium term (those that can be implemented between 2 to 3 years), and long term (those that can be implemented between 4-5 years).

While the strategies are recommended for the two LGUs, the actual implementation of some of the strategies could be different due to the different social and economic status in the two LGUs. These differences are discussed under each respective strategy.

## A. LGU-led Maintenance Program (Short Term)

One of the most effective abatement measures in air pollution is adequate vehicle maintenance. This scheme can be made in partnership with the local government unit and the motorcycle manufacturers in which the task is to teach the TODA on preventive and periodic maintenance. Preventive maintenance is regular cleaning of the engine and other related parts affecting performance. It can be performed by the driver weekly or

**Table 9: Strategies and Supplementary Activities for Reducing Tricycle Pollution**

| Strategy | Supplementary Activities | Features |
|---|---|---|
| A. LGU-led Maintenance Program (Short Term) | 1. Enhance Implementation of City Ordinance on the Use of Silencers in Tricycles (Short Term)<br>2. Require Frequent Emission Testing (Medium Term)<br>3. Periodic Roadside Monitoring (Medium Term) | • Preventive maintenance could reduce air and noise pollution by at least 20%<br>• Adequate training could translate to a savings of at least P500 for a complete maintenance<br>• Capacity building among tricycle drivers could provide alternative livelihood |
| B. Mandatory Orientation of Tricycle Drivers (Short Term) | 1. Ban on Street Parking (Short Term)<br>2. Enhancement of Tricycle Database (Short Term)<br>3. Regulation of Tricycle Load (Short to Medium Term)<br>4. Road Assessment and Isolation/ Rerouting of Tricycles (Short to Medium Term) | • Leveling of traffic understanding could ease traffic situations<br>• Adequate knowledge of traffic signs and rules could ensure public safety<br>• Orientation could double-check the validity of drivers' licenses and facilitate consensus among traffic enforcers and drivers |
| C. Tricycle Volume Reduction Program (Short Term) | 1. Elimination of Illegal / *Colorum* Tricycle Units (Short Term)<br>2. Adoption of Tricycle Body Colors and Numbers for Identification (Short Term) | • Reduction in tricycle volume could ease traffic by as much as 14% in QC and 20% in PPC<br>• Reduction in the number of tricycle operating in the cities per day could reduce air and noise pollution by at least 20%<br>• Reduction in volume could also reduce competition, thus could increase drivers' income by as much as 50%[37] |
| D. Restriction on New and Renewal of Tricycle Franchise Application with Engines Beyond 15 years of Age (Short Term) | 1. Phase-in of More Efficient Engines (Short to Medium Term)<br>2. Strict Monitoring of Lube Quality (Short Term) | • Engines beyond 15 years in operation contribute mainly to noise and HC emission<br>• Franchise restriction could encourage tricycle drivers to venture on alternative livelihood |
| E. Promotion of Alternative Transportation (Medium to Long Term) | 1. Market Study to Determine:<br>• Competition between different transport modes<br>• Applicability in certain areas<br>• Availability of infrastructure and support services<br>• Passenger demand and willingness to pay | • Alternative transport encourages the shift to less pollutive transport modes<br>• Bigger (and therefore, more efficient) vehicles could yield higher income due to higher occupancy |

[37] An experiment was conducted in Puerto Princesa City in April 2004, where the number of tricycles operating in the city was reduced by 20% per day. The drivers reported increase in their income levels of between 30-50%, depending on their areas of operation.

monthly. Estimated maintenance cost for important parts are about P500, and may take 1 day (or 9 hours).

Periodic maintenance, on the other hand, is cleaning and replacing parts that have been exhausted of their effective service life. Cost will depend on the parts to be replaced. For both Quezon City and Puerto Princesa City, the unanimous replacement period among drivers for most parts is semiannually.

Tapping the local government as the lead in maintenance program can be effective means to abate emissions. Technical and administrative capability can be sourced through partnerships with private institutions like Motorcycle Development Program Participants Association (MDPPA). The main role of the LGUs is to assure that all tricycles plying the area are regularly maintained. The TODAs and LGUs can work hand-in-hand to enhance enforcement, in which the former is encouraged to self-monitor its members. Proof of training participation can be done via certification (sticker type), which will then serve as a control mechanism.

A customized vehicle will be required so that the maintenance program will be done mobile. This will enable the maintenance team to reach out to TODAs and tricycles serving remote areas. If an existing vehicle is available at the LGUs, customizing a vehicle may cost P100,000 ($1,800) inclusive of tools, consumables and vehicle improvement. The amount could be partially raised with TODA contributions, considering that there are about 147 TODAs in Quezon City and 20 TODAs in Puerto Princesa City that will benefit from the program. Also, the contribution will steer up a sense of ownership and will increase the level of participation among them.

Maintenance training could be free except for parts that will be replaced. This could be an attraction for the TODAs since the trainers will come from the manufacturers. They will also be assured of good practices plus the training, which will enable the TODAs to maintain their own vehicles and save P500 per complete clean-up.

To sustain the program, the City governments could assist the TODAs in setting up their own mobile maintenance unit, which at most will require a motorcycle. Certificate of accreditation should be provide by the LGUs and MDPPA to ensure the quality of the trained personnel in handling such program at the TODA level.

Vocational education on automechanics or any related courses (like, engine repair and maintenance) can also be initiated by the City government, in cooperation with the Department of Labor and Employment—Technical Education and Skills Development Authority (DOLE-TESDA). According to TESDA, it would only take 15 full days to complete a vocational course composed of 30% theory and 70% actual or hands-on application. And since a continuous course could significantly affect the participating driver's daily income, it is suggested that different schemes be explored and agreed upon by the City government, Federation of Tricycle Operators and Drivers Association (FTODA) and TESDA.

It should be noted, however, that the program in itself will not achieve its optimal effect and therefore, the following activities are suggested as supplements:

**1. Enhance Implementation of City Ordinance on the Use of Silencers in Tricycles (Short Term)**

As previously discussed, it is deduced that most of the tricycle silencers, although installed, are no longer functioning as the noise level measured at the tailpipe shows that almost all of the tricycles surveyed exceeded the standard set under European Commission for Europe (ECE) 41. Chances are the silencers are not properly installed due to the limited knowledge of the drivers. This usually happens during engine cleanup, wherein the silencer is detached in order to remove the carbon deposits in the unit. With the appropriate preventive maintenance training to be initiated by the LGUs,

dislocation and/or modifications of motorcycle silencers could be prohibited. This will then ensure that the silencers attached to the motorcycles are indeed functional.

Similarly, the LGUs should institutionalize the use of silencers among the drivers. Although the drivers signified in the survey that they use silencers, spot inspections conducted during the study proved otherwise.

In Quezon City, for instance, City Ordinance No. SP-1227 series of 2003, requires the silencer installation in all tricycles and thus, 83% of the driver-respondents indicated that they use silencers. However, given the average noise level measured in the area (78-85 dB) under running conditions, it is suspected that silencers may be malfunctioning. Moreover, it is recommended that the Ordinance be revisited and appropriate corrective actions be done. Flaws on this ordinance were identified, which include among others: (i) the law does not impose penalty, (ii) it mandates noise pollution emission testing but not as a requisite for registration, (iii) its enforcement is weak as the implementing unit (TRU) lacks the equipment to measure tricycle noise levels, (iv) it requires a noise standard of 90 dB for tricycles in residential areas, which is not even acceptable for heavy industrial areas which is only 80 dB, and (v) there is a need for the TRU and even for the LGU to strengthen capacities in order to ensure effective enforcement of this ordinance.

In Puerto Princesa City, there is an existing City Ordinance that mandates the use of silencer and violation from such will result in a penalty of P50. Tricycle drivers, however, admitted that they would rather pay the nominal penalty than the expensive repair. It is therefore suggested that the said Ordinance be updated for a more effective implementation.

**2. Require Frequent Emission Testing (Medium Term)**

The current emission-test requirement is not sufficient to resolve air pollution from mobile sources. In reality, it is just procedural on the part of the tricycle drivers because one-day compliance in a year does not guarantee compliance for the remaining 364 days. Arranged and nonappearance emission tests and vehicle registration is also rampant in the subsector for just a few extra charges. For the tricycle driver, this becomes more practical than going through all the procedures. This scenario makes the whole emission test requirement useless.

It is therefore recommended that at least semiannual emission tests be required among tricycles and motorcycles. In order to do this without creating a market for private emission testing centers (PETC) or passing additional cost burden to the drivers, it is recommended that the City government explore possible arrangements with PETCs initially. One alternative is to arrange for a reduced fee (say, P70 per test, in which semiannual tests will be more or less the same with the existing emission fee). This could be done through a memorandum of agreement (MOA) between the PETC and FTODA, attested by the LGUs.

**3. Periodic Roadside Monitoring (Medium Term)**

Annual emission tests do not solve the problem on vehicular emissions because it is only a day of inspection. A periodic emissions monitoring program may offer better results. Roadside monitoring needs to be done at random in order to determine the actual emissions from tricycles.

For Quezon City, since the local government is burdened with acquiring its own gas analyzer, it is suggested that the Air Quality Monitoring Section of DENR be tapped for periodic roadside monitoring under a collaborative effort.

In the case of Puerto Princesa City, the government has its own gas analyzer, which could be used for periodic roadside monitoring. There is a need, however, to enhance the technical capacities of the LGU, specifically the City Environment and Natural Resources

Office (CENRO) in conducting the tricycle tailpipe emission monitoring. It is therefore suggested that coordination with the Department of Science and Technology (DOST) should be forged for capacity building for the authorized personnel in the LGU.

## B. Mandatory Orientation of Tricycle Drivers (Short Term)

Educating the target sector is one way of solving an issue. Mandatory orientation is leveling of expectations between the traffic enforcers and tricycle drivers by clarifying the City's traffic ordinances and policies, as well as admonishing roadworthiness among the drivers.

The Tricycle Regulatory Unit (TRU) may pass an ordinance requiring all tricycle drivers to undergo the orientation. Traffic enforcers should be tapped while experts can also be sourced from other firms or institutions. It is expected to achieve high level of service (LOS) on the road when the users are educated. It could even reduce accidents and risk.

After 100% orientation, a pilot run must be made to assess the traffic situation. Once implemented, there must be associated penalties on the violations. New applicants will be required to undergo the same process; this way double checking of driver's license can also be addressed.

Orientation alone may not resolve the traffic congestion problems. As such, the following activities are also proposed to supplement the program:

### 1. Ban on Street Parking (Short Term)

Tricycles tend to park or make long stops along their route, which are the tertiary and secondary roads (in some areas). This behavior causes delays and at times accidents due to limited road space. Prohibiting the tricycle from this action will help alleviate the traffic flows where traffic delays can be lessened. Available tricycles parked on the street may be convenient for some passengers but the risk associated with this is also a major concern. This can be lessened if there will be no obstruction along the roads.

For this purpose, it is suggested that on-street parking be banned through a city ordinance. The LGUs should provide enforcers who can rove around their areas of jurisdiction while a corresponding terminal must be made available for the tricycles.

As a complementary solution, a transportation hub can be established whenever possible. A transportation hub is basically a convergence terminal of the available modes of public transportation where transferability is made easy since commuters will not roam around the CBD in order to get a ride. Some transport hubs are poorly planned that they create more problems to the environment. The local authorities should carefully assess the available land resources in their area near the CBD. The ideal hub must have a good circulation system, shaded walkways, ample space for vehicle parking, free from street vendors and, lastly, with high-ceiling structure and enough ventilation.

### 2. Enhancement of Tricycle Database (Short Term)

There is a great need to improve the tricycle data at the city government level. The registration data from the Land Transportation Office (LTO) for motorcycle and tricycle is in a single account and for the entire provinces of Metro Manila and Palawan. Similarly, the registration data are misleading because tricycles cannot be isolated. Monitoring of tricycles can also be erroneous because the motorcycles can be easily detached while the sidecar has no registration plate in most areas.

In the case of Quezon City, what has been done so far by TRU is to mandate the provision of a body number and the name of service area on the sidecar's front and rear body.

Other data that requires improvement are actual population, actual services areas, route specifications, registration validity of tricycles units especially in Quezon City where some tricycles are also serving the adjacent cities of Marikina and Caloocan, plans and programs for the sector, completeness of ordinances, review of pending resolutions and evaluation of TODAs. The LGUs should form a Study Team or tap specialized institutions to assess the data gaps at TRU's end (or its equivalent agency) and formulate a strategy to address other requirements. The LGUs should also set aside a budget to finance the data collection and maintenance.

### 3. Regulation of Tricycle Load (Short to Medium Term)

Load regulation strategy is a control mechanism to limit the pressure on an engine originally designed for two people. Present tricycle market has no restrictions on load. In Quezon City for instance, notice that an ordinance in this connection has been passed (No.SP-358,S-94) 10 years ago but most of the drivers confirmed that they load as much as 5 to 10 passengers in a tricycle. It is therefore recommended that review and effective implementation of such ordinance be done.

In Puerto Princesa City, on the other hand, the agricultural and tourism activities in the area should be considered in determining the appropriate load in order to match the passengers' transport needs. Another factor is the road condition, in which most of the tertiary roads in the City are deteriorated. The combined effect of the load and road condition yields stress on the engine and tricycle parts. As such, it is suggested that the maximum tolerable number of load should be 2 passengers, or 1 passenger and a luggage that weighs almost equal to 1 average person (that is, 75 kg).

With tricycle load being regulated, it is expected that the service life of the chain and sprocket will be extended from 6 months to 8 months. The total reduction of load is around 54.5 kg. There is an expected P114 ($2) savings on maintenance plus a lesser risk of exposure to danger and better stability due to lesser load.

Penalty can be imposed to put pressure on the drivers to comply. It should be emphasized that overloading poses great risk both to the passengers and road users. Considering that the demand for tricycle services is inelastic, it is possible for the TODAs to impose higher fares to compensate the cost of reducing load.

### 4. Road Assessment and Isolation/ Rerouting of Tricycles (Short to Medium Term)

Isolating and /or rerouting the tricycles from the other modes can be a promising traffic reduction program. High level of service (LOS) will be experienced on both main road and new route. It will also minimize the risk between the tricycles and the bigger modes.

Isolating and/or rerouting strategy is to separate small three-wheelers from bigger transport modes. Mixing both modes add more friction to the traffic. The idea is similar to the expressways where a service road is provided for slower vehicles with shorter travel while vehicles on the expressway move with high speed. In some areas where there is inadequate land resource, the immediate alternative will be traffic rerouting for the tricycles (short-term plan). The LGUs should pursue the rerouting as the initial step in improving traffic and road safety. This strategy will be more beneficial if complemented with a plan that will identify and acquire a road right-of-way (RROW) to cater to the residential environment, in which budget for acquisition will be required. This should be coordinated with the DPWH for proper execution.

For Puerto Princesa City, three TODAs plying along Rizal Avenue and around the poblacion will be affected with the rerouting scheme. About 11 TODAs taking the Malvar-National Highway route will also be affected. In general, all tricycles plying the Rizal Avenue may be diverted to the adjacent streets

without passing the main road. Although operation in the said avenue will be prohibited, tricycles may be allowed to pass through as they are redirected to their newly designated routes. It has been observed that Malvar Street absorbs 55% of the tricycle routes and most of these routes are directed outside the poblacion. Also, the long-haul trips to Sabang and El Nido also traverse this route, most of which are over-sized jeepneys and medium-sized buses with terminals located near the west end of Malvar St. On top of that, the temporary wet market and other major establishments are situated along this road. Although Malvar Street is a 4-lane, 2-way road that should be enough to accommodate the current travel demand, the absence of shoulder recess for boarding and alighting, coupled with a mix mode of small- to medium-sized public transport, makes the road chronically congested. Even with the relocation of the public market, it is expected that the congestion in this street will prevail due to the volume of vehicular flows.

Therefore, a daily inventory of the congested areas along Malvar Street should be made to pinpoint the major contributors. Also, an on-site route-specific study should be made to carefully pilot and gauge the total impact in redirecting tricycle routes away from this street. The LGU can also complement the rerouting scheme with terminal relocation, transfer of establishments, no-parking road policy, new by-pass roads, or one-way street conversion. Also, pedestrian controls like fenced sidewalks and designated pedestrian lanes are necessary since there are no specific crosswalks for the people; allowing them to cross the street anywhere causes slower vehicular traffic.

## C. Tricycle Volume Reduction Program (Short Term)

The tricycle volume reduction program (TVRP) must be used as an independent measure to reduce traffic as well as emission levels. This entails a one-day off among tricycle drivers within the same TODA. Localizing this program at the barangay level will provide for more effective implementation since the TODA members themselves will monitor and apprehend any illegal tricycle operations.

With an estimated 14% reduction in traffic volume in Quezon City, there will be corresponding 17 additional trips for the drivers, translating to an increase in their income. Estimated reduction on HC will be 123,435,000 ppm per week and 2% CO reduction per unit. Given the proper arrangement with the TODAs and traffic management groups, a one-year window is enough to start its implementation.

In Puerto Princesa City, however, a 20% reduction in traffic volume is estimated. This could translate to 17 additional trips for the drivers, reduction on HC of about 123,435,000 ppm per week, reduction on CO of about 2% per unit.

This can be easily implemented in a year's time given the proper arrangement with the TODAs and traffic management groups. TVRP should not be mixed with future traffic reduction programs for bigger modes. It should be applied independently since tricycles operate differently. This strategy could be applied to all areas within the city regardless of urbanization level.

This could also be made mandatory through a city-wide ordinance from the LGUs and should cover even the outskirts of the city bordering the neighboring areas. There must also be enhancement of local capacities in undertaking monitoring and apprehension at the barangay level. Similarly, traffic enforcers at the barangay level should be intensified in this connection.

To ensure the success of the program, it is suggested that the following supplementary activities be conducted as well:

### 1. Elimination of Illegal / *Colorum* Tricycle Units (Short Term)

During the site inspections conducted by ADB, it has been observed that a number of tricycles are operating illegally. Most of the TODA representatives and barangay captains expressed serious concerns on tricycles that are operating illegally in various routes and utilizing public roads as terminals. The implementation of TVRP in the absence of control mechanisms on these illegal tricycles will defeat the traffic-reduction purpose and put the franchised tricycle drivers in a disadvantaged position.

However, illegal operators signified their interests in applying for franchise as they usually end up paying bribes to traffic personnel. Considering the volume of franchise applicants and the tedious process of applications due to the limited number allowed to operate in a particular route, there is very low probability for a new tricycle operator to get a franchise in a year or two. Total franchise application fee does not exceed P5,000 per unit. But the current system creates a market among tricycle drivers to trade the franchise among themselves for as much as P25,000. It is therefore suggested that TVRP be complemented with process simplification and policy modifications in tricycle franchise applications.

Similarly, the absence of identification codes encourages the proliferation of illegal units. In Quezon City, body color is used to identify the TODA as well as facilitate identification of illegal units. In Puerto Princesa City however, there is no existing ordinance on body color for the tricycle. The current system of using a sticker in the front end of the sidecar as identification is not as effective as body color since the former requires tedious vehicle inspection. The danger of implementing a TVRP without using body color is the possible operation of affected tricycles in other routes, thus causing further traffic congestion. The body color can be used to identify specific routes where tricycles should operate, and be subjected to their route's TVRP scheme.

To supplement the body color scheme, a body number and TODA name painted on the front and rear end would be practical to adopt. The two control mechanisms can help address the problem on illegal units. The current situation has loose control measures due to the absence of these. A body number can avoid sidecar switching and therefore, minimize illegal operations.

The body color used in Quezon City is placed on the front panel where it can be visible to the public. The number is six inches high; above it is the TODA name and underneath is the name of the city. A body number also provides additional control in case body colors are duplicated in another TODA. Body numbers could significantly contribute to the implementation of TVRP by providing highly visible identifications that could easily determine if such tricycle unit is allowed to operate on a particular day of the week, in such particular route.

## D. Restriction on New and Renewal Tricycle Franchise Application with Engines more than 15 Years (Short Term)

Important consideration should be made in discouraging the use of engines that have been operational for a long time. Technically, tricycle performance is reduced as it ages and therefore, the use of old units should be prohibited.

Previous discussions show that tricycles beyond 15 years in operations are major sources of air and noise pollution. Therefore, initial target could be set at tricycles with age above 15 years. In doing so, it is recommended that any application, either new or renewal, for tricycle units with motorcycle engines beyond 15 years old be disallowed. Over time, the target prohibition should be gradually reduced to tricycles with age more than 10 years. This will encourage the use of new and therefore more efficient tricycle fleet in the cities while promoting more efficient transport modes at the same time.

To prevent resistance or public dispute from the affected tricycle drivers, it is recommended that this strategy be accompanied with a trade-in option or financial assistance for those who would like to buy new motorcycle units. Such arrangement can be explored with motorcycle manufacturers to determine whether this option is acceptable to them.

Buy-back, on the other hand, may not be advisable considering the procurement and disposal issues involved. First, an LGU buying old and inefficient vehicles (which can be classified as waste) may be questioned considering the current government procurement practices. Second, if such units will be bought and relocated in other areas, the problem of air and noise pollution is not reduced but shifted to another location. Third, considering that there is very short serviceable life remaining for such vehicles, LGUs will soon face disposal problems. Fourth, the purchase of these old and inefficient vehicles could drain the LGU's financial resources. A motorcycle unit of 15 years and above is estimated to cost about P10,000 ($185) the most. Given 1,305 affected units in Quezon City and 256 units in Puerto Princesa City, the buy-back option could cost the LGUs about P13.05 million ($233,450) and P2.56 million ($45,800) respectively for the first year alone. Considering that there are vehicles that will be reaching the cut-off age in the succeeding years, it could result to a tremendous financial burden on the part of the LGUs.

Similarly, the following activities are suggested to supplement the program:

**1. Phase-in of More Efficient Engines (Short Term to Medium Term)**

As the franchise restriction program allows the entry of new vehicles, it is suggested that the use of more efficient engines and cleaner technologies be encouraged as well in the short to medium term. Emission tests conducted shows that 4-strokes have lower hydrocarbon emissions compared to 2-stroke engines at idle and running conditions. Technically, it also has very low CO emission if maintained properly.

A 4-stroke motorcycle engine, however, is expected to cost an additional upfront cost of P1,000 ($18) to P5,000 ($92) upon procurement compared to a 2-stroke engine. Additional maintenance and labor cost amounting to P2,200 ($40) is also expected per year since more parts have to be maintained upon conversion to a tricycle. However, since 4-stroke is fuel-efficient compared with 2-stroke, it is expected to reduce fuel consumption by 10-20% or an equivalence of P4,700 ($86) per year. Lubricant consumption will also be eliminated, translating to lube savings of P5,400 ($99) per year. Therefore, the additional maintenance and labor cost will be offset while the additional upfront cost for procurement is expected to recover within 6 months of operations.

On the other hand, extra precaution should be exercised as 4-strokes are known sources of nitrogen oxides. A number of tests are currently being conducted in other countries that include the application of catalytic converters in order to address these problems. However, in the absence of appropriate tests for Philippine application, it is recommended that adequate maintenance be encouraged among tricycle drivers. As such, this could also be tied up with the strategy initially proposed on preventive maintenance. Also, the use of 4-stroke engines should not be used as an exemption from the coverage of standards set under the Clean Air Act (CAA), as well as from periodic roadside monitoring program proposed previously.

**2. Strict Monitoring of Lube Quality (Short Term)**

During site inspections conducted by ADB, it was observed that informal gasoline and lubricant store or *takal* (repacked in small amounts) are rampant in several areas in both cities. The case is much severe in Puerto Princesa City where there are only three gasoline stations, which are all located in the CBD. Tricycles operating in distant areas have

no choice but to resort to takals. The drivers' mode of operation also makes takals attractive given that their income is realized in small amounts and only when services are rendered. In that way, they do not have to line up at a gasoline station to buy a liter of two of gasoline every now and then. However, since gasoline and lubes are repacked, the tricycle drivers may not be aware of the source from which they were acquired, as well as on possible adulteration or contamination of qualities.

In general, all lubricants look the same, regardless of brand and source. Therefore, it is difficult for a tricycle driver to determine if the lube being sold is refined, treated (used oil but undergo treatment) or untreated (used oil that undergo simple sedimentation process) once poured into smaller containers. Sometimes, the driver themselves pay little attention on the type of oil as they are more concerned about the cost. Refined lube usually costs P90 ($1.65) per liter while treated lube costs around P65 ($1.20) per liter. Used and untreated lube, commonly sourced from used transformer oils, costs only P20 ($0.37) per liter. If the driver intends to minimize his operational costs, he would be tempted to buy the cheapest which is the used and untreated oil. Considering that in a 2-stroke, the fuel and oil are mixed in the combustion chamber. Thus, lower lube grade has lower combustion efficiency that results to higher CO and HC emissions.

To address this issue, it is recommended that the City government coordinate with the Department of Energy (DOE) in monitoring the quality of lubricants sold in the retail stores. Random testing can be done by DOE, since they have the personnel and equipment, but the local government should assist in identifying the locations of these stores as well as ensure the safety of the DOE personnel. Similarly, the local government should assist the DOE in promoting its proper disposal campaign of used oil at the gasoline stations, considering that used oil is classified as a hazardous waste under Republic Act 6969. It could also be beneficial to accredit or partner with some vendors to sell fuel and lubricant in the remote areas after formal arrangements from the gas stations.

In Puerto Princesa City, the limited operations of gasoline stations due to market disincentives should be considered in making fuel and lube available in distant areas. One possibility is to establish a cooperative in each TODA, which will then administer the retail selling of fuel and lube among its member-drivers and operators. The cooperative can enter into partnership with oil companies or gasoline stations to guarantee product quality and promote environmental and health safety in product handling, storage, and waste disposal. The gas refilling stations to be managed by the cooperative can be housed in the tricycle terminals and repair service stations as suggested previously.

## E. Promotion of Alternative Transportation (Medium to Long Term)

There is a need for a low-emission transport mode to replace the tricycle. Alternative transport, in any sense, is a mode that can both be practical and environment-friendly. There is no competition with tricycle in terms of practicality especially in areas where tricycles are the main mode of transport in collector roads. But medium-sized vehicles like multicabs can be an option. The multicab is a 4-stroke transport mode with higher occupancy and capacity that emits lesser pollutants. Fares can be made competitive due to higher occupancy. Tricycles generally charge higher fare across the metropolis, e.g., P6-P10 per person. There is potential fuel savings compared to tricycles, and is expected to yield higher income.

Prior to its implementation, a market study is needed to determine (i) the extent of possible competition with other modes, (ii) the appropriate area especially those with no tricycles yet, (iii) availability of support services like gas stations, repair shops, parts supply, and (iii) passenger demand.

For Quezon City, it would be best that the next pipelined urban and/or housing development project will mandate the prohibition of tricycles and pilot test the area without any intervention of three-wheelers in order to see the full potential of the program. Also, since LGU has access to the suppliers of multicabs, as they are being used as transport service of city government officials and offices, it may be possible to arrange procurement with flexible terms for small investors. At any rate the City government must coordinate directly with the manufacturers in order to significantly reduce the price and make it more commercially competitive. This program should not be limited to multicabs since there are other potential alternatives but only lacks marketing. In essence the criteria for an ideal alternative transport mode is (a) less pollutant or even zero-emission, (b) viable for feeder roads, (c) ample and accessible support services, (d) price competitive, and (e) sustainable.

For Puerto Princesa City, however, it is very crucial to identify areas of development and set a standard for transport modes other than tricycles. Such transport mode should take into consideration the nature and potentials of particular areas in which they will be applied. Examples of such areas are the proposed urban corridors of San Manuel, Sta. Monica, San Jose and San Pedro. Note that these areas are mostly fishing villages and support services needed are mainly for transporting marine products. Thus, the load requirement and hauling conditions should also be met. Furthermore, since multicabs are already in place in Puerto Princesa City but usually cater to longer routes, it is advisable to identify areas, especially in remote communities and fishing villages, in which they can be utilized given fixed trip intervals. This will reduce dependence on tricycles and thus minimize pollution.

Promotion of HOVs is only one way to make the strategy effective, and complementary program should be aimed at the target market. Many policies become effective because the receiving ends are well informed. In this case, there should be a public information campaign on the benefits of high-occupancy vehicles especially if the local residents themselves will be directly affected. It is generally accepted that pollution-free environment is a major consideration for communities as well as land and housing development. The elimination of a heavier polluting transport mode can therefore be translated into better living environments and improved living standards. Note however, that the corresponding program for the promotion (and supply) of clean alternative transport is demand-driven. Thus, educating the passengers to utilize cleaner technologies is an effective means of promoting this strategy.

Appendix 1

# Ambient and Roadside Noise Measurements in Quezon City and Puerto Princesa City

**Table A1.1: Quezon City 16-Point City-Wide Ambient Noise Measurement Results, April 2004**
(in dB)

| | AREA | | NUMBER OF TRIALS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | AVE. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | QUIRINO HIWAY— NOVALICHES TOWN PROPER | | 75.6 | 93.5 | 65.3 | 95.7 | 87.0 | 85.0 | 79.0 | 78.5 | 80.1 | 98.2 | 83.8 |
| | | 66% | flat terrain: 68 vpm at average speed of 30-40 kph | | | | | | | | | | |
| 2 | QUIRINO HIWAY— JORDAN PLAINS | | 70.2 | 88.3 | 83.5 | 78.9 | 70.6 | 70.4 | 77.7 | 69.9 | 80.1 | 70.1 | 76.0 |
| | | 28% | flat terrain: 35 vpm at average speed of 50-65 kph | | | | | | | | | | |
| 3 | SUSANO ROAD | | 78.5 | 80.7 | 69.8 | 70.2 | 74.3 | 76.4 | 78.4 | 89.9 | 72.7 | 77.8 | 76.9 |
| | | 12% | flat terrain: 54 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 4 | QUIRINO HIWAY— SAN BARTOLOME | | 68.7 | 83.4 | 77.5 | 75.8 | 76.9 | 79.2 | 80.0 | 77.8 | 79.2 | 79.1 | 69.8 |
| | | 56% | flat terrain: 43 vpm at average speed of 40-55 kph | | | | | | | | | | |
| 5 | QUIRINO HIWAY— DELREY VILLAGE (TALIPAPA) | | 69.4 | 59.2 | 73.2 | 78.5 | 55.3 | 70.8 | 74.7 | 65.9 | 69.2 | 76.4 | 69.3 |
| | | 32% | hilly: 23 vpm at average speed of 50-60 kph | | | | | | | | | | |
| 6 | PROJECT 8 EXTENSION | | 54.2 | 67.4 | 78.9 | 69.9 | 77.3 | 58.3 | 71.2 | 73.2 | 63.5 | 66.9 | 68.1 |
| | | 10% | flat terrain:17 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 7 | PARKWAY—FRISCO | | 60.7 | 74.2 | 72.8 | 75.9 | 81.5 | 63.7 | 70.5 | 73.3 | 79.7 | 76.9 | 72.9 |
| | | 13% | flat terrain: 30 vpm at average speed of 30-40 kph | | | | | | | | | | |
| 8 | MAYON ROAD—FRISCO | | 78.0 | 80.4 | 84.3 | 82.0 | 77.4 | 79.1 | 91.0 | 75.8 | 80.3 | 79.4 | 80.8 |
| | | 22% | hilly: 45 vpm at average speed of 35-50 kph | | | | | | | | | | |
| 9 | UP TV—PHILCOA | | 89.3 | 93.1 | 112.0 | 80.0 | 76.8 | 90.4 | 97.1 | 89.3 | 88.4 | 84.8 | 90.1 |
| | | 79% | flat terrain: 78 vpm at average speed of 45-60 kph | | | | | | | | | | |
| 10 | ANONAS—SIKATUNA VILL. | | 79.0 | 85.3 | 88.4 | 86.7 | 79.7 | 82.3 | 81.9 | 90.2 | 83.8 | 81.1 | 83.8 |
| | | 60% | flat terrain: 80 vpm at average speed of 25-40 kph | | | | | | | | | | |
| 11 | BAGUMBAYAN—C5 ROAD | | 69.3 | 70.4 | 77.2 | 80.5 | 73.6 | 87.8 | 89.3 | 79.1 | 79.0 | 89.3 | 79.6 |
| | | 33% | flat terrain: 30 vpm at average speed of 30-40 kph | | | | | | | | | | |
| 12 | CENTRAL AVENUE— COMMONWEALTH AVE | | 78.4 | 65.3 | 80.3 | 78.4 | 80.4 | 67.5 | 75.6 | 73.5 | 79.8 | 76.0 | 75.5 |
| | | 56% | flat terrain: 28 vpm at average speed of 40-50 kph | | | | | | | | | | |
| 13 | DON ANTONIO— COMMONWEALTH AVE | | 89.9 | 78.3 | 78.0 | 79.5 | 92.0 | 74.0 | 87.0 | 78.9 | 80.6 | 90.4 | 82.9 |
| | | 55% | sloping terrain: 57 vpm at average speed of 40-55 kph | | | | | | | | | | |
| 14 | BATASAN HILLS | | 70.5 | 88.3 | 87.4 | 79.9 | 83.9 | 84.1 | 80.9 | 83.4 | 69.8 | 90.4 | 81.9 |
| | | 68% | partly hilly: 79 vpm at average speed of 40-50 kph | | | | | | | | | | |
| 15 | DAHLIA AVE FAIRVIEW | | 80.8 | 93.9 | 101.0 | 84.1 | 89.5 | 78.9 | 77.3 | 88.4 | 79.1 | 86.4 | 85.9 |
| | | 69% | flat terrain: 79 vpm at average speed of 45-55 kph | | | | | | | | | | |
| 16 | MALIGAYA PARK— ROBINSON / SM | | 90.2 | 89.8 | 88.3 | 102.0 | 119.0 | 94.0 | 92.0 | 86.8 | 89.0 | 99.0 | 95.0 |
| | | 80% | sloping terrain: 72 vpm at average speed of 45-55 kph | | | | | | | | | | |

vpm = vehicles per minute, kph = kilometers per hour.
Legend: % Percentage of tricycles in total vehicular count in the selected area
1-10 Denote the corresponding sampling results in a 10-minute interval
Areas where low noise levels are registered
Areas where high noise levels are registered

**Figure A1.1: Vehicle Volume Count for 24-Hour Ambient Noise Measurement, Novaliches, Quezon City**

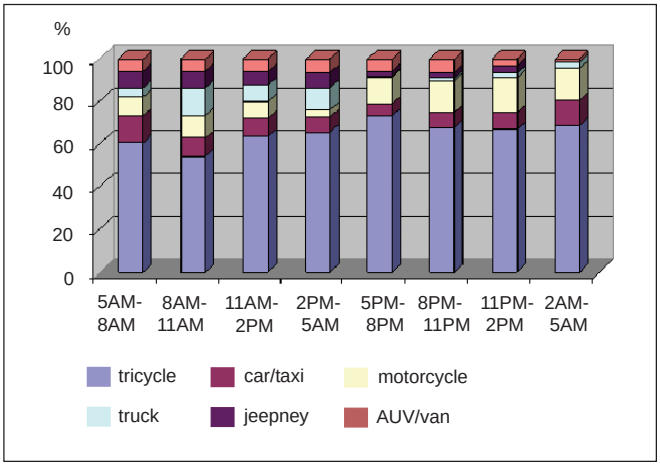
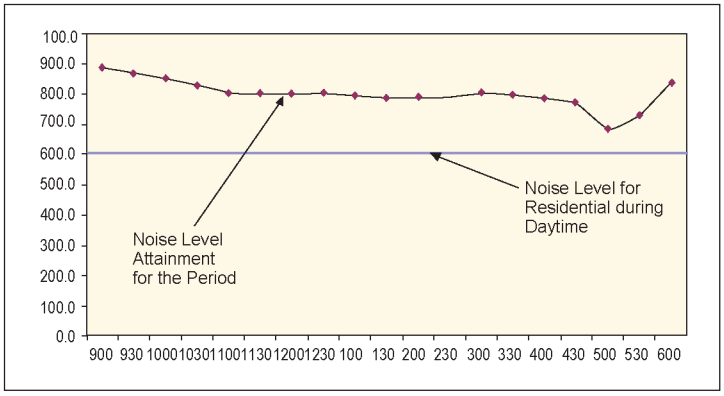
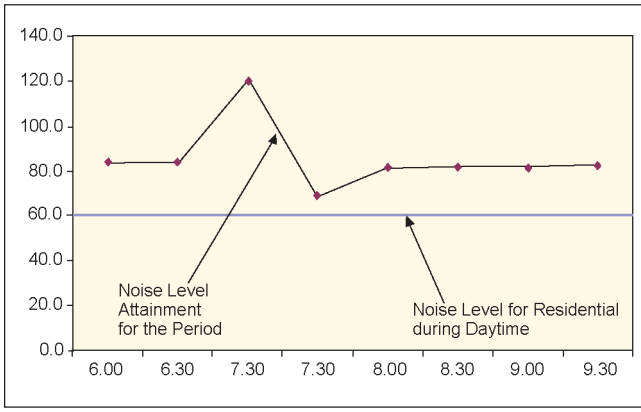



**Figure A1.2: Results of Ambient Noise Measurement, Novaliches, Quezon City**

**Daytime, 9 AM to 6 PM**




**Evening, 6 PM to 10 PM**




**Nighttime, 10 PM to 5 AM**

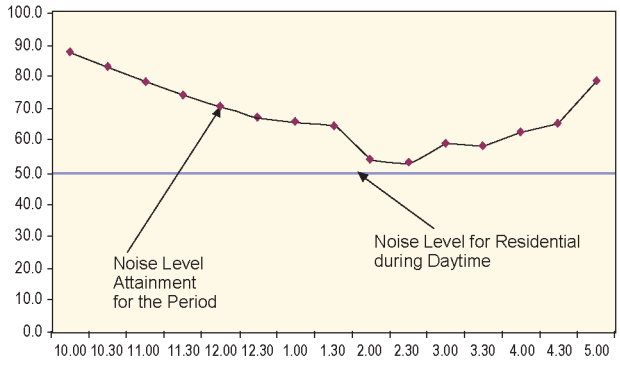


**Figure A1.3: 16-Point Noise Sampling Sites in Puerto Princesa City, April 2004**

**Table A1.2: Puerto Princesa City 16-Point Noise Measurement Results, April 2004**
(in dB)

| | AREA | | NUMBER OF TRIALS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | AVE. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LACAO—RIZAL AVE | | 78.0 | 75.4 | 76.5 | 78.6 | 76.9 | 74.5 | 76.3 | 76.4 | 78.2 | 74.8 | 76.56 |
| | | 55% | flat terrain: 50 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 2 | H. MENDOZA—RIZAL | | 77.2 | 77.9 | 73.3 | 78.4 | 73.1 | 85.6 | 74.7 | 77.1 | 80.9 | 78.5 | 77.67 |
| | | 30% | flat terrain: 25 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 3 | MANALO—FERNANDEZ | | 78.3 | 73.1 | 72.8 | 72.7 | 69.3 | 70.1 | 69.2 | 70.4 | 64.8 | 69.8 | 71.05 |
| | | 22% | flat terrain: 14 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 4 | NCCC PARKING | | 79.5 | 73.8 | 73.9 | 77 | 76.6 | 70.1 | 72.7 | 75.8 | 78.4 | 76.5 | 75.43 |
| | | 70% | flat terrain: 45 vpm at average speed of 0-15 kph | | | | | | | | | | |
| 5 | RIZAL AVE—NATL HIGHWAY | | 77.0 | 75.0 | 78.9 | 77.2 | 79.6 | 79.2 | 79.6 | 79.9 | 79.9 | 79.2 | 78.55 |
| | | 40% | flat terrain: 30 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 6 | RUNWAY—NATL HIGHWAY | | 76.5 | 77.3 | 75.1 | 78.6 | 79.6 | 74.3 | 75.7 | 76.0 | 76.0 | 79.2 | 76.83 |
| | | 20% | flat terrain: 32 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 7 | MALVAR—NATL HIGHWAY JUNC. | | 83.8 | 83.8 | 81.9 | 84.5 | 82.1 | 83.8 | 80.7 | 81.1 | 81.1 | 81.0 | 82.38 |
| | | 45% | flat terrain: 65 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 8 | COLISEUM—NATL HIGHWAY | | 75.3 | 75.8 | 74.4 | 80.9 | 77.0 | 77.2 | 77.6 | 76.5 | 80.5 | 75.9 | 77.11 |
| | | 25% | flat terrain: 35 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 9 | FRONT AIRPORT | | 74.3 | 75.0 | 73.8 | 75.6 | 76.5 | 73.8 | 74.7 | 74.5 | 74.6 | 73.9 | 74.67 |
| | | 15% | flat terrain: 30 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 10 | ABREA—JACANA | | 67.3 | 73.7 | 68.8 | 63.8 | 59.7 | 62.4 | 68.8 | 69.5 | 71.3 | 65.7 | 67.10 |
| | | 10% | flat terrain: 9 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 11 | JACANA—ABUEG (DZRH) | | 63.6 | 48.4 | 47.0 | 53.6 | 64.0 | 63.9 | 60.6 | 63.0 | 70.8 | 67.5 | 60.24 |
| | | 33% | flat terrain: 3 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 12 | TEMPO WET MARKET | | 78.9 | 77.0 | 78.1 | 76.7 | 77.9 | 76.4 | 78.7 | 77.3 | 76.3 | 76.4 | 77.37 |
| | | 55% | flat terrain: 30 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 13 | RIZAL AVE—VALENCIA—MALVAR | | 77.7 | 75.0 | 77.4 | 76.3 | 76.2 | 77.5 | 74.5 | 84.0 | 79.7 | 77.7 | 77.60 |
| | | 68% | flat terrain: 35 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 14 | RIZAL AVE—VALENCIA | | 77.8 | 78.2 | 75.5 | 77.8 | 76.7 | 75.7 | 76.2 | 75.1 | 78.1 | 73.6 | 76.47 |
| | | 45% | flat terrain: 36 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 15 | RIZAL AVE.—BURGOS | | 76.5 | 77.3 | 75.5 | 76.6 | 77.3 | 75.0 | 75.7 | 77.4 | 76.5 | 79.2 | 76.70 |
| | | 20% | flat terrain: 20 vpm at average speed of 20-30 kph | | | | | | | | | | |
| 16 | NATL HIGHWAY—JUNCTION | | 75.1 | 76.9 | 76.3 | 74.7 | 79.4 | 75.4 | 77.1 | 79.3 | 77.1 | 76.2 | 76.75 |
| | | 40% | flat terrain: 20 vpm at average speed of 20-30 kph | | | | | | | | | | |

vpm = vehicles per minute, kph = kilometers per hour.
Legend: % Percentage of tricycles in total vehicular count on a particular area
1-10 Denote the corresponding sampling results in a 10-minute interval
Areas where low noise levels are registered
Areas where high noise levels are registered

Appendix 2

# Tricycle Sidecar Specifications, Quezon City and Puerto Princesa City

**Table A2.1: Basic Specifications of Tricycle Sidecar, Quezon City**

| **SIDECAR** | | |
|---|---|---|
| **General Specifications** | **Current (typical)** | **Prototype** |
| Total width / (plus motorcycle) | 1,040 mm / 1,630 mm | 1,130 mm / 1,790 mm |
| Total length | 1,625 mm | 1,450 mm |
| Total height / (with driver roof) | 1,300 mm / 1,610 mm | 1,600 mm / 1,750 mm |
| Total weight | 126 kg | 120 kg |
| Seat width | 700-760 mm | 820 mm |
| Number of passengers (sidecar) | 3 ++ | 2 |
| Seat length | 300-350 mm | 400 mm |
| Seat backrest height | 400-500 mm | 630 mm |
| Seat height (from floor) | 260 mm | 360 mm |
| Seat inclination | (Undetermined) | 15 degrees |
| Legroom (seat to front panel) | 400-520 mm | 600 mm |
| Ceiling height (from floor) | 880-970 mm | 1,200 mm |
| Ceiling height (from seat) | 650-800 mm | 890 mm |
| Entry width clearance | 535-580 mm | 620 mm (average) |
| Floor height (from ground) | 330 mm | 410 mm |
| Wheelbase (depends on motorcycle) | 1,245 mm | 1,245 mmKawasaki HDIII |
| Tread | 1,190 mm | 1,300 mm |
| Wheel Formation | Three-point, right angle | Same |
| Turning radius (3rd wheel basis) | Variable, dependent on maker, average 2,000 mm | 2,428 mm |
| **Component Features** | | |
| Front bumper | Steel frame & G.I. sheet with steel tubes normally same with 4x4 pick-ups | Steel frame with G.I. sheet, small ornamental type |
| Rear bumper | Metal & thick tube (typical) | None |
| Suspension system | Cross-bar type, spring-assisted | Improved cross-bar, coil spring and telescopic shock absorber |
| Coil spring | Scrap from surplus or junk shop, half-length | 1995 Toyota Corolla, front helical coil, squared 4.5 coils, 15 mm diameter |
| Shock absorber | Optional | Heavy duty, hydraulic damper assembly |
| Suspension cross members | Corrugated bars, 40 mm & 20 mm | Corrugated bars, 40 mm & 20 mm |
| Space for baggage (top) | Optional | None |
| Space for baggage (rear) | Standard in some areas | None |
| Money box | Optional, detachable | Provided |
| Sidecar entry handles | Not standard | Left and right |
| Interior cushion (ceiling) | Not standard | Standard |

continued on next page

**Table A2.1: Basic Specifications of Tricycle Sidecar, Quezon City** (continued)

| **SIDECAR** | | |
|---|---|---|
| **Component Features** | **Current (typical)** | **Prototype** |
| Interior cushion (side walls) | Not standard | Standard |
| Seat pan cushion | Cushion not standard | Standard |
| Seat back cushion | Cushion not standard | Standard |
| Seatbelts | None | None |
| Signal lights front & back | Optional | Standard |
| Front reflector | Optional | Optional |
| Back reflector | Optional | Optional |
| Side reflector | Optional | Standard |
| Front panel shape | Too many variety | Geometric, pointed |
| Rain protectors | Not standard, scrap from packaging materials | Standard, tailored |
| Splash pads | Optional | Standard |
| **DRIVER SIDE** | | |
| **General Specifications** | | |
| Driver roof height (from seat) | 800-850 mm | 950 mm |
| Roof | Frame & cloth | Frame & cloth |
| Roof material | Canvass/vinyl | Canvass/vinyl |
| Roof support | 2-points | All around, 20 mm diameter tube |
| Rain protectors | From scrap | Standard, tailored |
| Wind deflector | None | Clear plastic |
| **SIDE CAR** | | |
| **Material Specifications** | | |
| Frame body | | Reinforcing bar |
| Body panels | | G.I. sheet, gauge 22 |
| Floor panel | | G.I. sheet, gauge 18 |
| Handle bars | | G.I. tube, |
| Seat frame / windshield frame | | Angle bar, 2.5 mm |
| Connector rods (to motorcycle) | | G.I. tube |
| Suspension cross-members | | Reinforcing steel bars<br>No. 14-43 mm diameter<br>No. 11-35 mm diameter<br>No. 10-32 mm diameter |
| Rain protector | | Clear plastic & leatherette lining |
| Frame roof | | G.I. sheet, gauge 22 |
| Frame support | | G.I. tube |
| Roof materials | | Leatherette, plastic |
| Rain protector | | Clear plastic & leatherette lining |

G.I. = galvanized iron.
[a] Typical specifications have a wide variety as tricycles in the City often differ from each other.
Source: Derived from PCIERD-UPNCTS Tricycle Study, 2004.

**Table A2.2: Basic Specifications of Tricycle Sidecar in Puerto Princesa City**

| General Specifications | Specifications | Component Features | Specifications |
|---|---|---|---|
| Total width / (based on windshield) | 1.78-1.85 m | Front bumper | Nonexistent |
| Total length | 1.80-2.20 m | Rear bumper | Trunk-like construction |
| Total height / (with driver roof) | 1.60-1.78 m | Suspension system | Scrap parallel links |
| Total weight | - | Coil spring | None |
| Seat width | 0.76-0.85 m | Shock absorber | None |
| Number of passengers (sidecar) | 3 -5 pax | Suspension cross members | Corrugated bars, 40 mm & 20 mm |
| Seat length | 0.40 m | Space for baggage (top) | None |
| Seat backrest height | 0.3-0.45 m | Space for baggage (rear) | Compartment behind |
| Seat height (from floor) | 0.26 m | Money box | None |
| Seat inclination | (Undetermined) | Sidecar entry handles | Not standard |
| Legroom (seat to front panel) | 0.50-0.70 m | Interior cushion (ceiling) | Not standard |
| Ceiling height (from floor) | 0.80-1.20 m | Interior cushion (side walls) | Not standard |
| Ceiling height (from seat) | 0.70-0.90 m | Seat pan cushion | Cushion not standard |
| Entry width clearance | 0.75 m | Seat back cushion | Cushion not standard |
| Floor height (from ground) | 0.30 m | Seatbelts | None |
| Wheelbase (depends on motorcycle brand) | 1.25 m | Signal lights front & back | Optional |
| Tread | 1,190 mm | Front reflector | Optional |
| Wheel formation | Three-point, right angle | Back reflector | Optional |
| Turning radius (3rd wheel basis) | (Undetermined) | Side reflector | Optional |
| | | Front panel shape | Too many varieties |
| | | Rain protectors | Not standard, scrap from packaging materials |
| | | Splash pads | Optional |

**DRIVER SIDE**

| General Specifications | Current (typical) |
|---|---|
| Driver roof height (from seat) | 0.80-1.10 m |
| Roof | Frame & vinyl cloth |
| Roof material | Canvass/vinyl |
| Roof support | Integrated with windshield |
| Rain protectors | From scrap |
| Wind deflector | None |

**SIDE CAR**

| | |
|---|---|
| Item | Prototype |
| Frame body | Reinforcing bar |
| Body panels | G.I. sheet, gauge 22 |
| Floor panel | G.I. sheet, gauge 18 |
| Handle bars | G.I. tube, |
| Seat frame / windshield frame | Angle bar, 2.50 mm |
| Connector rods (to motorcycle) | G.I. tube |
| Suspension cross-members | Reinforcing steel bars |
| | No. 14—43 mm diameter |
| | No. 11—35 mm diameter |
| | No. 10—32 mm diameter |
| Rain protector | Clear plastic & leatherette lining |
| Windshield integrated with driver | Metal sheet & clear acrylic |
| Frame roof | G.I. sheet, gauge 22 |
| Frame support | G.I. tube |
| Roof materials | Leatherette, plastic |
| Rain protector | Clear plastic & leatherette lining |

G.I. = galvanized iron.

Appendix 3

# Potential Strategies for the Tricycle Subsector

## A. Engine, Fuel and Lubes

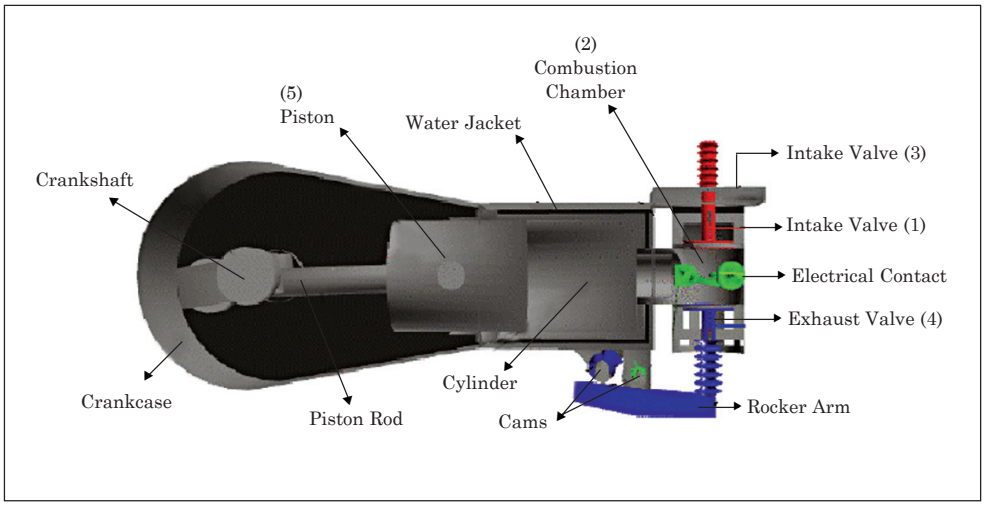
### 1. Engine Design

#### a. Phase-in of 4-Stroke Engine

This is replacing the 2-stroke with the 4-stroke engines in the tricycles. Four-stroke engines (Figure A3.1) have no scavenging process compared with the 2-stroke making it fuel-efficient and have significantly low hydrocarbon emission. Scavenging is the process of forcing the product of combustion from the previous cycle out of the cylinder by new air-fuel charge; at this point, exhaust port is also open allowing 35-70% of the fuel to be lost directly to the exhaust line/stream.

In the 4-stroke engine, air-fuel mixtures from the carburetor through the intake valve (1) enters the combustion chamber (2) through the inlet manifold (3) and release its product of combustion in the exhaust valve (4). The intake valve of the 4-stroke engine opens up during intake stroke, fresh air-fuel mixture is sucked by the piston (5) to the combustion chamber on its downward movement During the combustion process or burning of fuel in the cylinder, intake and exhaust valves are closed. After combustion, exhaust valve opens up to exhaust the burned fuel out of the cylinder in preparation for the next cycle.

**Figure A3.1: Parts of a 4-stroke Gasoline Engine[1]**




Source: Glen Research Center.

[1] Available at: http://www.grc.nasa.gov/WWW/K-12/airplane/engopt.html

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• 4-stroke engines readily available<br>• Parts available in the market | • 35% fuel savings, no scavenging process compared with the 2-stroke engine<br>• Lube savings of 200-300 ml/day, based on the survey result[a] | • Lower HC emission by 74% compared with the 2-stroke based on the survey<br>• Lower PM emission, since it does not require 2T oil[b] | • Partial implementation is possible within a year·<br>Can easily be enforced via registration but should be subject to emission standard |
| **Negative Impacts**<br>• In general, 4-stroke motorcycle needs modification of sprocket and chain to be used for tricycle purposes<br>• 4-stroke engine design is relatively complicated than 2-stroke, thus more parts to maintain<br>• Less engine power (torque) compared to 2-stroke considering same engine size or piston displacement | • 4-stroke motorcycle is P1,000-P5,000 more expensive than the 2-stroke per unit depending upon the down payment and dealers' offer<br>• Additional cost for the modification of sprocket and chain<br>• More parts and expensive to maintain than 2-stroke<br>Valve seat – P250<br>Valve seal – P200<br>• Valve clearance adjustment every 6 months, labor – P100[c] | • Higher NOx emission by 2% than 2-stroke·<br>Higher CO emission by 10% than 2-stroke based on survey result<br>• Higher engine operating temperature than 2-stroke could cause health damage to muscle and lower legs of tricycle driver | • Could cause public dispute and resistance, if no support mechanism is in place |

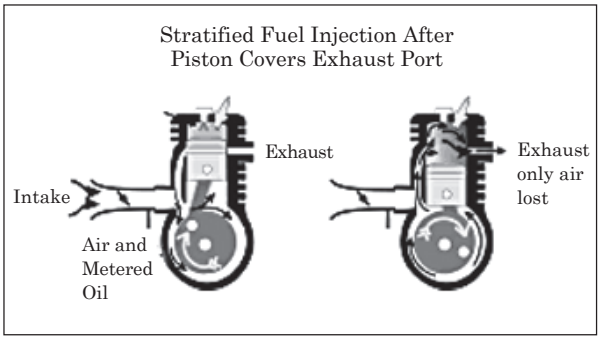
[a] ADB TA 3921- PHI: *Tricycle Emission Survey*, April 2004, Puerto Princesa City.
[b] Kojima, M. *et al.* 2000. *Improving Urban Air Quality in South Asia by Reducing Emissions from Two-Stroke Engine Vehicles.* World Bank.
[c] Kawasaki Authorized Mechanic, registry # L136.

### b. Conversion of 2-Stroke to Direct-injection-fuel System

This is retrofitting the 2-stroke carbureted petrol engine with direct-injection-fuel system. This technology is capable of reducing significantly the gas emissions from 2-stroke engines by allowing exhaust products to be scavenged from the cylinder using air alone.

Fuel is introduced in the cylinder by an injector mounted at the top of the cylinder head (Figure A3.2) when the piston closes the exhaust port; this method greatly reduces the amount of unburned fuel that escapes during scavenging.

**Figure A3.2: Direct-injection-fuel System**




Source: Bryan Wilson, Colorado State University, 2002.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• This technology can make use or retrofit the existing 2-stroke units<br>• Retrofitting kit available upon request from manufacturer | • 35% reduction in fuel consumption compared to standard 2-stroke carbureted-fuel system<br>• 50% reduction in 2T oil consumption | • 70-90% reduction in HC under controlled condition<br>• 50-70% reduction in CO under controlled condition<br>• 80% reduction in PM expected[a] | • Retrofit is possible within a year<br>• Local implementation can be done under City ordinance |
| **Negative Impacts**<br>• Technology is relatively new, therefore no skilled technician and parts available at this stage<br>• Compatibility of injector with the local fuel quality has to be tested<br>• Durability of the electronic control system has to be tested under Philippine condition and application | • Cost of retrofitting is estimated ₱200-₱250 | • Heat emitted by the engine and exhaust pipe could cause damage to muscle and lower legs of the tricycle driver | • Potential resistance due to unfamiliarity with the technology, especially if it remains to be tested |

[a] Wilson, Bryan. 2002. *Development of a Direct Injection Retrofit Kit for Reducing Emissions from 2-Stroke Cycle Engines in Asia.* Colorado State University.
[c] Kawasaki Authorized Mechanic, registry # L136.

### c. Conversion of 2-Stroke Petrol-fed-engine to LPG

Liquefied petroleum gas (LPG) is a mixture of light hydrocarbons mainly propane and butane. It is a much cleaner fuel than gasoline due to its high combustibility. In LPG-fed vehicle, fuel is stored in a pressurized tank at a low-to-moderate pressure depending upon the ambient temperature. The fuel is conveyed from the tank to a vaporizer/pressure regulator (also called a converter) where it is transformed into vapor. The vapor flows to an air-fuel mixing device that feeds the engine. In the exhaust system, an oxygen sensor sends signal to the electronic control system for automatic adjustment of air-fuel ratio.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• LPG has superior antiknock characteristics compared to gasoline, it has antiknock[a] index of 104<br>• The practice of over lubrication will be eliminated since 2T oil cannot be mixed manually with LPG | • 2T oil cannot be mixed with LPG, over-lubrication is eliminated; substantial savings in 2T oil can be achieved<br>• Low maintenance[b] on fuel system and engine parts | • 76% reduction in CO emission<br>• No $SO_x$ emission<br>• Negligible $NO_x$<br>• HC emission negligible | • This can be easily monitored and validated during annual registration<br>• Periodic monitoring can be done with the help of TODAs |
| **Negative Impacts**<br>• The use of LPG for three-wheeled vehicles was popularized in Thailand, but no initiative has been under taken in the Philippines<br>• Technology is relatively complicated compared to traditional 2- and 4-stroke fuel system<br>• Lubrication method have to be changed, 2T oil will have to be sprayed directly to the bore (internal spray system)<br>• More parts will be added in the conversion, like pressurized fuel tank, vaporizer, fuel mixer and computerized fuel control system<br>• Reduced power by as much as 7-10%<br>• Lack of infrastructures for the distribution of LPG for vehicle application<br>• Needs to be tested for Philippine application<br>• Lack of market support<br>• 2-stroke problem on scavenging still remains | • Given the same volume of fuel, less distance is traveled compared with gasoline due to 7-10% power reduction[c]<br>• Cost of maintenance still not available<br>• Average cost is between ₱130-₱250 (Alternative Fuel Technologies, Inc.) | • If not properly handled, poses risk from potential leakage | • Public acceptance of the technology |

[a] Antiknock—various compounds (tetraethyl lead) that are added to gasoline to reduce engine knocking.
[b] Automative Research Association of India (ARAI), available: http://www.araiindia.com/; and Shakti Gas Limited of India.
[c] National Renewable Energy Laboratory (NREL), US Dept of Energy.

## 2. Fuel and Lubes

### a. Use of Premix

The level of hydrocarbon and particulate emission of 2-stroke engines are dependent on the quality and quantity of 2T oil used in the engine. Motorcycle manufacturers recommend a fuel-oil ratio of 20:1. But misuse of 2T oil still persists due to lack of knowledge and wrong perception that by using more lubricant will provide greater engine protection against wear and tear. A solution to this practice is by premixing the fuel and 2T oil at a prescribed ratio in the pump station, this would greatly help reduce if not eliminate over-lubrication of 2-stroke engines.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• High-grade 2T oil with low fuel-to-oil ratio available in the market | • Reducing pollution while saving money[a]<br>• Reduced frequency of maintenance due to less deposit on engine components and exhaust system | • Reduction of visible smoke by as much as 42%[b]<br>• Reduction in PM by as much as 20% | • Local implementation can be done under City ordinance to address the issue of HC and white smoke emission |
| **Negative Impacts**<br>• Premix technology for 2T oil-gasoline available in other countries, none from the petroleum industry invested in selling premix<br>• No infrastructu re for premix dispenser at the pump station as of this moment<br>• Requires special type of fuel tank with agitator pump to prevent separation of fuel and oil<br>• Existing auto-lube pump has to be removed, since 2T oil is already mixed with the fuel<br>• Lubrication rate is fixed both at idle and higher engine speed, requires a high grade 2T oil to protect the engine especially at full load and higher engine speed (severe engine operation) against engine wear | | | • Motorcycle manufacturers may not buy the idea of premixing 2T oil and gasoline because of fix lubrication rate both at idle and at higher engine speed, may cause premature engine breakdown if inferior 2T oil is used |

[a] Informal World Bank Survey, 1999, quoted in Kojima, M. *et al.,* 2000.
[b] Role of Fuels and Lubricants for Emission Control in 2-Stroke Engines, ADB Workshop, Hanoi, Viet Nam, 6 September, 2001

### b. Use of High Quality 2T Oil (JASO FC[2])

The quality of 2T oil used affects the level of hydrocarbon and particulate emissions from 2-stroke engines. Motorcycle manufacturers recommended a 20:1 ratio of gasoline to 2T oil but practice of many drivers is to add considerably more lubricant than it requires due to perception that greater quantity of lubricant will increase fuel economy and will provide greater protection against engine wear. By making JASO FC (low-smoke lubricants) as the minimum requirement for 2-stroke tricycle engine lubricant and the correct concentration of 2T oil to use, the problem on HC and PM emission will be addressed.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• JASO FC specification for 2-stroke engine lubrication has long been established and highly accepted by motorcycle manufacturers<br>• High-grade 2T oil minimizes combustion chamber deposits and spark plug misfire | • JASO FC grade 2T oil has a low oil-to-fuel ratio that will represent cost savings to the tricycle driver | • Can reduce PM by as much as 79%[a]<br>• Can reduce HC emission by 33% | |
| **Negative Impacts**<br>• No JASO FC certified 2T oil available in the local market<br>• JASO FC 2T oil ratio of gasoline-to-oil is 100:1 designed for single rider use only<br>• A thorough study has to be made on the proportion of fuel-to-oil for tricycle application | • Cost of oil is high | | |

[a] Kojima, M. *et al.,* 2000.

[2] The benchmark standards in the area of lubricants for the motorcycles are the Japanese Automotive Standards Organization (JASO) standards. There are different types of JASO standards. For 2-stroke, the highest level is JASO FC. JASO grants the label after analysis of the oil. To differentiate engine oils, JASO uses FA, FB and FC codes wherein FC denotes the one with the highest grade.

### c. Use of Plant-Based 2T Oil (Bio-2T)

Environment friendly 2-stroke lubrication oil derived from plants can easily biodegrade. These are oxygenated lubricant that enhances burning of fuel. It is an oil that burns and lubricates the engine at the same time. With the use of the plant-based oil, sulfur and aromatics are eliminated, and carbon dioxide emission is reduced. Some life-cycle studies point to the reduction of 3.2 tons of carbon dioxide for every ton of vegetable oil-based product burned in lieu of petroleum-based product.

### d. Use of Bio-fuels

Bio-fuel for petrol engine are blends of gasoline and ethanol (i.e., E10 is 90% petrol and 10% ethanol or E85). Ethanol is a renewable fuel, it comes from corn, sugar or wheat, high on oxygen content that facilitates combustion that reduces CO and HC emission. It is a safe replacement for toxic octane enhancers in gasoline such as benzene and methyl tertiary butyl ether (MTBE).[3]

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Plant-based and environment-friendly (sometimes called synthetic oil) 2-stroke engine lubricant available in the international and local market<br>• High lubricity property, proven to reduce coefficient of dry metal to metal friction by 85.7%[a]<br>• 99.5% biodegradable<br>• 6-8% increase in horsepower and torque | • 35% gain in fuel economy<br>• Longer engine life due to high lubricity property<br>• Low engine maintenance compared to petroleum-based 2T oil because no carbon deposit on cylinders or on the piston | • 85% improvement in HC and CO emission for older engines<br>• 25% improvement HC and CO emission in newer clean burning engines | • LGUs can encourage the use of plant-based and environment friendly 2T oil through information and education campaign |
| **Negative Impacts**<br>• Needs to be tested for Philippine setting | • Price is twice the rate of petroleum-based 2T oil, but can be offset to the 35% fuel economy, lesser down-time period for maintenance and longer engine life | | |

[a] www.bluemarblecanada.com/?section=articles

[3] Methyl tertiary butyl ether (MTBE) is gasoline additive to enhance engine performance, improve combustion and reduce emissions of air pollutants but pollutes ground water.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Ethanol production is a mature technology and can come from sugar<br>• Ethanol-gasoline blends have optimum effect on older engines running rich (low air-to-fuel ratio) | • Bio-industry will be developed if implemented | • 25-30% decrease in CO emission<br>• 10% decrease in $CO_2$ emission at low blend (E10) blend and up to 20% decrease at 85% at high blend (E85) blend<br>• 5% decrease to 5% increase at low blend (E10) and up to 20% decrease at high blend (E85)<br>• 7% decrease in VOC at E10 and 30% decrease at E85 blend | • LGUs can encourage the use of bio-fuel through information and education campaign (IEC) |
| **Negative Impacts**<br>• Catalytic converter is necessary if ethanol-gasoline blends are used due to increase in aldehydes<br>• Needs to be tested in Philippine application and condition | • More expensive to produce than gasoline[a] | • All oxygenates emit higher level of aldehydes than non-oxygenated gasoline, 30-50% increase in aldehydes[b] | • Expect resistance if implemented due to cost |

[a] US Department of Energy, EERE Information Center.
[b] Canadian Renewable Fuels Association—Emission Impacts of Ethanol. Available at: www.greenfuels.org/emissionimpact.html

### e. Use of Compressed Natural Gas (CNG)

If CNG vehicles are based on a 2-stroke engine design, 2T oil will still need to be metered and injected directly into the combustion chamber eliminating the possibility of over lubrication. CNG reduces significantly particulate matter and hydrocarbon emissions compared to gasoline emissions. The product of combustion in using CNG also yields no volatile organic compounds or sulfur oxide emissions. Natural gas is lighter than air, thus in cases of escape or leaks it will not lie on the ground.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• CNG has a superior antiknock index of more than 120<br>• Less vibration and quiet engine operation<br>• Adequate supply of CNG | | • Very low PM emission<br>• Very low emission of airborne toxins[a]<br>• Negligible sulfur-containing emission | • LGUs can encourage the use of CNG as a clean alternative fuel than gasoline |
| **Negative Impacts**<br>• CNG contain less energy per unit volume than gasoline<br>• Thick and heavy fuel tank to withstand 3,000 psi pressure<br>• Power loss of 10-15%, primarily related to the displacement of intake air by the fuel vapor | • Shorter driving range due to less energy content of CNG compared to gasoline<br>• Heavy fuel tanks reduce fuel efficiency and leads to greater braking distance<br>• Expensive fuel distribution and storage<br>• Price of CNG is higher that gasoline | | • Government has to subsidize program due to high cost of CNG and its operation[b] |

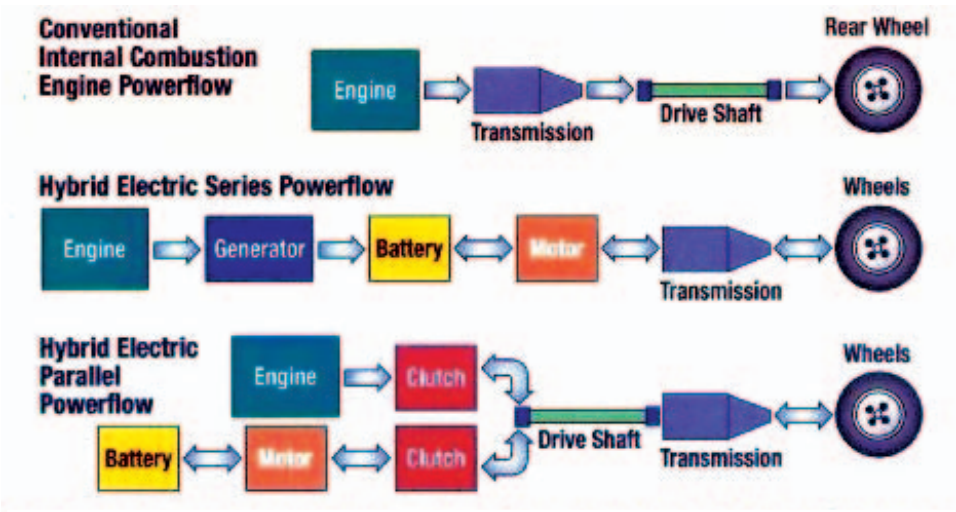
[a] World Bank. 2004. *Urban Air Quality Pollution: Policy Framework for Mobile Sources.* March.
[b] MTA New York City Transit Department of Buses, 2000.

### f. Use of Hybrid Electric Vehicles (HEV)

Hybrid Electric Vehicles (HEVs) are most appropriate in traffic where there is a lot of stop-start driving situations because of the characteristics of hybrid drives. This consists of an internal combustion engine as an onboard generating plant that can be designed to run on gasoline, diesel or alternative fuels. A generator is needed to turn the energy developed by the engine into electricity and an electric motor to propel the vehicle. Hybrids also include a small battery pack to store energy recovered through regenerative braking and to provide extra power beyond what the generator can produce on its own when the vehicle must accelerate quickly. HEVs produce very low emissions because of the electric powertrains and their highly efficient internal combustion engines (Figure A3.3). The engines in conventional vehicles are relatively inefficient under average driving conditions because they are designed for peak demand situations, which occur when a vehicle is accelerating or driving uphill. In HEVs, the fuel-burning engines that run generators are tailored to efficiency in meeting the average power requirement of the vehicles, since onboard batteries handle surge power requirements[4] (Figure A3.3).

[4] US Department of Energy, Office of Energy Efficiency and Renewable Energy, August 2003. *Just the Basics: Electric Vehicles.* Available:http://www.eere.energy.gov/vehiclesandfuels/pdfs/basics/jtb_electric_vehicle

**Figure A3.3: Powertrain of a Hybrid Electric Vehicle**




*The two most common types of hybrid vehicle (series and parallel) powertrains compared to the conventional gasoline engine powertrain.*

Source: US Department of Energy.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Produce very low emissions because of highly efficient internal combustion engine<br>• Eventual transition to an emission-free and petroleum-free vehicle technology | • Less dependence on fossil fuel | • Electric vehicles turn out to be more than 90% cleaner that the cleanest conventional gasoline-powered when the electricity running them comes from clean energy sources like CNG, LPG, or renewable fuels | • Government to introduce the use of vehicles that are fuel-efficient and vehicles that produce very low emission through massive IEC<br>• Government to encourage the use of HEVs by giving incentives to the users, i.e., lesser tax, lower registration cost, priority in parking |
| **Negative Impacts**<br>• HEVs technology has not yet been introduced to the Philippines<br>• Long-term maintenance characteristics of commercially available HEVs have not yet been established, since vehicles only recently reached the market<br>• Very limited service technicians available, since it is still a new technology<br>• Performance and durability still have to be tested for the Philippine setting | • Significantly more expensive than conventional vehicles | • Disposal of used onboard batteries | • A new technology just introduced in the market, government to conduct IEC for public awareness and acceptance of the technology. |

### g. Use of Battery-operated Electric Vehicle

Electric vehicles are the least polluting mode of transportation available today, it is sometimes referred to as "zero-emission vehicles" because they do not directly pollute through tailpipe emissions, fuel evaporation, fuel refining or fuel transport to service stations. A certain amount of pollution is associated with the use of these vehicles; this comes from power plant emission that produces electricity, used to recharge the batteries of this vehicle, light homes and run industries. This vehicle consists of a battery that runs the electric motor that propels the vehicle.

## B. Transport and Traffic Management

### 1. Tricycle Volume Reduction Program for Tricycles (Short Term)

Tricycle Volume Reduction Program (TVRP) was patterned after the current number coding scheme that started in the mid 1990s to reduce the vehicular flow in the main arteries of Metro Manila when the volume of the vehicles exceeded the carrying capacity of the main roads. This strategy is proposed to be a stand-alone traffic and pollution measure, and intended for tricycles only.

This strategy is rarely considered for the tricycle sector since they only ply the tertiary and secondary roads. But in Puerto Princesa, tricycles are now also occupying the main roads, and even the national highways. Past experiences in Metro Manila show that 25-30% daily reduction of vehicles along the thoroughfares was enjoyed when full implementation was made of a similar scheme for four-wheeled vehicles in the 1990s. With TVRP therefore, reduction in the volume of tricycles during particular days of the week is also expected to translate to a 16% reduction in HC and CO emissions.

This scheme can be made mandatory through a city-wide ordinance from TRU and must be applied to all areas. Traffic congestion may not be as severe in provinces but this is

### Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Zero emission | • Attractive only in countries with abundant sources of low-cost electricity | • Considered the least polluting mode of transportation available today<br>• Pollution can easily be controlled in power-generating plants | • Government to encourage the use of zero-emission mode of transportation |
| **Negative Impacts**<br>• Driving range is short<br>• Long charging time of battery, approximately 4-14 hours depending upon the battery type and materials used[a]<br>• Battery life is limited to a number recharges | • Too costly compared to conventional vehicles | • Indoor recharging facilities must be well-ventilated for lead-acid batteries, emits hydrogen during charging<br>• Disposal of battery | |

[a] World Bank. 2004. *Urban Air Pollution: Policy Framework for Mobile Sources.* March.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Weekly rest for the vehicle for at least 12 hours daily or 624 hours yearly<br>• Maintenance schedule may be done on this day | • More economical for motorists to resort to public transportation<br><br><u>Quezon City</u><br>• 14% reduction in traffic (2,844 daily trips or 17,065 weekly total)[a]<br>• Additional no. of trips daily is 17(P272) | • Weekly emission reduction is estimated to be 123,435,500 ppm[c]<br>• Weekly reduction of CO estimated to be 2.24% per unit (22,400 ppm)[d] | • Other parts of Quezon City have already adopted |
| | <u>Puerto Princesa City</u><br>• 20% reduction in traffic (560 daily trips or 3,360 weekly total)[b]<br>• Additional number of trips to be made daily is 17, resulting to additional income of P272 | • Weekly emission reduction is estimated to be 184,968,000 ppm[e]<br><br>• Weekly reduction of CO estimated to be 2.08% per unit (20,800 ppm)[f] | • Experimental scheme was conducted in mid-2004 so drivers are already familiar with the concept |
| **Negative Impacts** | • 1 day foregone income (P15,600 annually)[g] | • Unaccustomed motorists may worry over their safety when taking public transport | • Resistance in areas not implemented<br>• Corresponding assurance of safety for commuters must be made |

[a] Tricycles are 46% of total public transport (MMUTIS, 1999), Unified Vehicle Reduction Program 20% reduction in traffic, 20,316 tricycles in Quezon City.
[b] 20% times the number of units registered.
[c] At average 4,375 ppm times the TRU declared population of tricycles of 20,316.
[d] At 1% is equal to 10,000 ppm.
[e] At average 6,606 times the declared population of tricycles of 2,800.
[f] At 1% is equivalent to 10,000 ppm.
[g] At P300 daily income over 52 weeks.

more of an emission-reduction measure than a traffic reduction. The required coding day is only one each week, operators may choose to have more than required.

The scheme should be accompanied by the issuance of body color and body number for the tricycles for identification of routes and covered units, respectively. These are necessary conditions for the TVRP's effective implementation.

### 2. Isolating / Rerouting Tricycle Route from Other Modes (Short Term)

Isolating and/or a rerouting strategy is to separate small three-wheelers from bigger transport modes. Mixing both modes add more friction to the traffic. The idea is similar to the expressways where a service road is provided for slower vehicles with shorter travel while vehicles on the expressway move with high speed. In some areas where there is

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | • Smoother traffic for the general public due to elimination of congestion caused by tricycles<br>• Shorter travel time because of high level-of-service (LOS)[a] | • Minimize risk with bigger modes | • Lesser problem for enforcers<br>• Could be a collaboration with other agencies |
| **Negative Impacts** | | | • Nonapplicability in some areas with inadequate land resource<br>• Additional enforcers required to ensure public safety and order |

[a] In transportation terminology, LOS is a measure of smoother or faster flow of vehicles, pedestrians or even goods passing at a certain point on the road or any transport corridor, e.g., the Skyway has a high LOS but the queue along the Shaw Blvd. underpass at 7:30 AM experiences low LOS.

inadequate land resource, the immediate alternative will be traffic rerouting for the tricycles (short-term plan). This, however, should be complemented with a medium- to long-term plan that will identify and acquire a road-right-of-way (RROW) to cater to the residential environment, in which budget for acquisition will be required. This should be coordinated with the Department of Public Works and Highways for proper execution.

### 3. Load Regulation (Short Term)

Load regulation strategy is a control mechanism to limit the pressure on an engine originally designed for 2 people. Puerto Princesa City does not have regulations on load. This should be addressed properly since there is a tendency to overload a tricycle in Palawan as agriculture and marine commerce prevails in the city. In Quezon City, for instance, QCTRU Ordinance No.SP-538, S-97 requires only 3 passengers including driver for tricycles with engine lower than 500cc and not more than 2 cylinders. This law, however, has not been implemented since the ordinance was issued in 1997. To enforce it, a penalty might be needed to put pressure on the drivers. Traffic enforcers could be tapped to implement the regulation.

For Puerto Princesa City, the reasonable load is equivalent to 3 persons—compose of a driver and 2 passengers, or an estimate of 646 kg[5] total weight load. In case a passenger is also transporting goods, it is advisable that the total load be composed of only one passenger and a weight allocation of 75 kg for the baggage.

Supporting research on load against emissions and instability of the tricycle is available. Expected benefit from load reduction includes longer serviceable life for the tricycle.

[5] Estimated load: Palawan sidecar 200 kg. All other weight data is same with Quezon City.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Technical study available to support the law | • Prolonged chain and sprocket life from 6 to 8 months due to reduced loading[a]<br>• Maintenance savings of P114<br>• Reduced engine load of 82 kg per trip | • Reduced emission[b]<br>• Lesser accident risk | • For QC, less legal effort since Ordinance No. SP-358,S-94 I is in place |
| **Negative Impacts** | • Foregone income of P1,728 annually due to reduced load from 4 to 2 passengers | | • For PPC, ordinance is required<br>• Possibility that enforcers may be bribed |

[a] Comparison between 3 passengers and 5 passengers, from DOST-UPNCTS tricycle study.
[b] Based on DOST-UPNCTS study, emission is reduced at half load but will also depend on the speed and 2T oil and fuel mix. Half load, as defined in the study means three (3) average passengers weighing 60 kilograms. Sidecar is estimated to be 130 kilograms.

### 4. Banning of On-street Parking (Short Term)

Tricycles tend to park or make long stops along their routes, which include major roads and national highways. This behavior causes delays and at times accidents due to limited road space. Prohibiting the tricycle from this action will help alleviate the traffic flow. This can be mandated through an ordinance from the TRU or the local authority and traffic enforcers can be tapped to apprehend violators.

For Quezon City, ordinances allowing tricycles to use some portions of the road as terminals should also be reviewed because it has been abused in some parts of the city. It should be made clear that the designated streets for terminals will not get in conflict with this strategy.

For Puerto Princesa City, as most of the TODAs have no terminals, it is also suggested that a rapid road audit be conducted to identify inner roads which could be used as terminals for these TODAs.

### 5. Mandatory Orientation for Tricycle Drivers and Operators (Short Term)

Educating the target sector is one way of solving an issue. Mandatory orientation is informing the tricycle drivers and operators how they should behave on the road. The LGU must be able to control the tricycle operation within their jurisdiction since transportation is a vital factor to human activity. A survey showed only 95% have professional driver's license. Under the law, the 5% is not allowed to drive public transportation but are doing so. Actual observation shows that many drivers violate road rules and possess different mindset on overall traffic. It would be advisable to develop a common understanding on traffic and transport in the community. The TRU may pass an ordinance requiring all TODAs to undergo the orientation. The traffic enforcers may be tapped as the implementing agency but experts may be sourced from other firms or institutions. The target audience should be drivers, operators and traffic enforcers. An option is to invite the public as participants.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | • Reduced traffic congestion is expected<br>• Travel delays can be avoided | • Lesser accident risk | |
| **Negative Impacts** | | | • Ordinance is required<br>• Unfavorable to passengers as it might cause inconvenience due to walking<br>• For QC, review of existing ordinance on designated portions of road as terminals is required<br>• For PPC, unfavorable to TODAs without terminals |

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | • High level of service | • Program may help reduce accidents and health risks as well as traffic congestion | • More transparency on traffic rules |
| **Negative Impacts** | | | • Require specialized LGU personnel<br>• Potential bribery during apprehension |

After a thorough orientation, a pilot run must be made to assess the traffic situation. During full implementation, penalties must be imposed on violators. New applicants will be required to undergo the same process which serves as a double check on the drivers' licenses.

### 6. Alternative Transport for Future Site Developments (Medium to Long Term)

There is a need for a low-emission transport mode to replace the tricycles. Alternative transport, in any sense, is a mode that can both be practical and environment-friendly. There is no competition with tricycles

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | | | |
| • Will induce the market for multicabs | • Fuel savings[a]<br>• Expected to yield higher driver income | • Lower emissions due to applicable standard | |
| **Negative Impacts** | | | |
| • Could encourage proliferation of second-hand refurbished units | • Unattractive to small investors since cost is approximately 150% higher[b] | | • Require technical knowledge to identify possible areas |

[a] Compared to tricycle with a maximum load of 5 passengers, in terms of volume of transported load.
[b] ARAI, 1998.

in terms of practicality especially in areas where tricycles are the main mode of transport in collector roads; but in areas where there is still no established transport yet, it would be wise to establish an alternative transport that is bigger than the tricycle but smaller than the jeepney, like the multicab. The multicab is a 4-stroke transport mode with higher occupancy and capacity that emits lesser pollutants. It could also charge a relatively lower fare due to higher occupancy. Tricycles generally charge higher fares across the metropolis, e.g., P6-P10 per person.

However, there are requisites prior to its implementation of this mode, such as a market study to determine (i) the extent of possible competition with other modes, (ii) the appropriate area especially those with no tricycles yet, (iii) availability of support services like gas stations, repair shops, parts supply, and (iv) passenger demand. Since tricycles always rise to the occasions for transport demand, it is very crucial to identify areas of development and set a standard for transport mode exempting tricycles. In Puerto Princesa City, the multicab is already in place but usually services a longer route. It is therefore advisable to identify areas, especially in remote communities and fishing villages, in which multicabs can be utilized given fixed trip intervals.

### 7. Buy Out Old Units (Medium to Long Term)

The buy-out scheme in this study refers to the purchase of 2-stroke motorcycles used for tricycles. However, only the 15-years and older engines will be given priority. The age of vehicle coupled by poor maintenance aggravate vehicular emissions. A study in the US showed that the 20% poorly maintained vehicles accounted for 80% of the vehicular pollution.[6] Most drivers would like to buy a new unit in order to have better operating conditions and lower maintenance cost but are often confronted by the issue of disposal and financing. Buy-out scheme for old pollutant 2-stroke (even 4-stroke) motorcycles may offer favorable solutions. The scheme must incorporate financing plan that may be assisted by the City or external financial institutions. Payment schemes should be made affordable and flexible, with due consideration on the economic status of the driver.

From the point of view of the LGU, buy-back may not be advisable considering the procurement and disposal issues involved. First, an LGU buying old and inefficient vehicles (which can be classified as waste) may be questioned considering the current government procurement practices. Second, if

[6] ARAI, 1998.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Could induce a "disposable type of motorcycle" good enough for 10 or more years | • Economic gain from the sale of units<br>• More liquid assets, more options for business | • Reduce HC 6,000 ppm<br>• Reduce CO 3%<br>• Reduce NOx 38 ppm | • More favorable political situation |
| **Negative Impacts** | • Could encourage proliferation of second-hand refurbished units and spare parts | • Problem on disposal of old motorcycle units | • Financial stress on the LGU<br>• Commission on Audit does not allow purchase of second-hand units |

such units will be bought and relocated in other areas, the problem of air and noise pollution is not reduced but shifted to another location. Third, considering that there is a very short serviceable life remaining for such vehicles, LGUs will soon face disposal problems. Fourth, the purchase of these old and inefficient vehicles could drain the LGU's financial resources. During the first year, substantial amount would already be required. A motorcycle unit of 15 years and above is estimated to cost about P10,000 ($185) the most. Given 1,305 affected units in Quezon City and 256 units in Puerto Princesa City, the buy-back option could cost the LGUs about P13.05 million ($233,450) and P2.56 million ($45,800) respectively for the first year alone. Considering that there are vehicles that will be reaching the cut-off age in the succeeding years, it could result to a tremendous financial burden on the part of the LGUs.

### 8. More Frequent Emission Tests (Short Term)

The current emission test requirement is not sufficient to resolve air pollution from mobile sources. In essence, it is merely procedural because one-day compliance in a year does not guarantee compliance for the remaining 364 days.

More frequent emission testing is closer to the objective of abating air pollution. In order to be accepted, the cost should be lowered. A new strategy on pricing should be made to make this policy viable and acceptable, while logistics should also be considered. Frequency may be semiannual, quarterly, bimonthly, or monthly. This will depend on the consensus once it is brought up in a dialogue with the stakeholders. The LGU may act as a counter-check partner since TODA and LGU are more closely tied up than the city government.

On the other hand, extra precautions should be imposed with respect to the engagement of private emission test centers (PETC) as they are sometimes associated with corruption. Arranged and nonappearance emission tests and vehicle registration are possible with extra payments by the driver. For the driver, this becomes more practical than going through all the procedures. This scenario makes the whole emission test requirement useless.

### 9. Periodic Roadside Emissions-monitoring Program (Short Term)

Roadside emissions monitoring is random checking of tricycles to determine their actual emissions. This is more reflective of the

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Many authorized and accredited PETCs are already in place | | • Reduced emissions | |
| **Negative Impacts**<br>• Unsynchronized and uncalibrated will yield different results | • Annual cost of emission test will be greater than P150 depending on the frequency | | • Resistance from drivers and operators due to cost of testing |

normal operating conditions of the vehicles because annual scheduled tests can be eluded by a simple tune-up and engine maintenance.

Annual emission tests do not solve the problem of vehicular emissions because it is only a single day of inspection, while there are 364 more days for the vehicle to be pollutant. For Quezon City, since the local government is burdened with acquiring its own gas analyzer, it is suggested that the Air Quality Monitoring Section of Department of Environment and Natural Resources (DENR) be tapped for periodic roadside monitoring under a collaborative effort.

For Puerto Princesa City, the availability of a gas analyzer in City Environment and Natural Resources Office (CENRO) can make implementation possible through CENRO and the Traffic Management Bureau. The results of such actual emission tests can then be considered in the renewal application of operating permits of tricycles. In cases where the tricycles pass the random check, no fees will be charged (and therefore, a savings on the required emission test) but those who fail should be penalized.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | | • Could reduce emission | |
| **Negative Impacts** | • Could cause travel delays<br>• Estimated operational cost for roadside emissions monitoring is approx. P3,000[a] daily | | • Requires investments<br>• Needs additional manpower<br>• Could result to bribery during apprehension<br>• Needs technical knowledge to undertake |

[a] At P5 million equipment, 3 persons at P300 daily, fuel at P300 daily, emission cost of P1,600 at P100 / vehicle at cost (based on PETC rate of P150/vehicle).

**10. LGU-led Maintenance Program (Short Term)**

One of the most effective abatement measures in air pollution is vehicle maintenance. This scheme is a partnership of the local government unit and the motorcycle manufacturers in which the task is to teach the TODA on maintenance. Preventive maintenance is regular cleaning of the engine and other related parts affecting performance. It runs a shorter period (e.g. weekly, monthly) and can be performed by the driver. Estimated maintenance cost for important parts are about P500, and may take 1 day (or 9 hours).

Periodic maintenance is cleaning and replacing parts that have been exhausted of their effective service life. Cost will depend on the parts to be replaced. Tapping the LGU as lead in maintenance program can be effective means to abate emissions. Technical and administrative capability should be provided if necessary. The main role of LGU is to assure that all tricycles plying their area are regularly maintained. TODA and LGU can work hand in hand. Certification (sticker type) will be required as control measure.

**11. Improvement of Motorcycle / Tricycle Data System (Short Term)**

One of the development challenges in government is the availability of significant data. In the tricycle sector, substantial and accurate data are also important in order to come up with prudent plans and decisions.

Document review shows that the Land Transportation Office registration data for motorcycles and tricycles is in a single account. This is misleading because data for tricycles cannot be isolated. Monitoring of tricycles, similarly, can also be erroneous because the motorcycles can be easily detached and interchanged with other sidecars. Other data that are lacking are the correct population of tricycles in a particular area (or route-measured capacity) and service areas.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Technology transfer can be possible to augment knowledge at the LGU<br>• MDPPA can be tapped for support | • Savings of P500 due to personal maintenance | • Assurance of maintained engine | • Opportunity for LGU & TODA to build partnership |
| **Negative Impacts**<br>• Could result to engine and parts alteration due to driver's curiosity | • 1 day forgone income on the training (P300-P350) | | • Financial stress on LGU—estimated cost shop building and equipment is P100,000<br>• Requires specialized LGU personnel |

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Could lead to the development of appropriate technology | | • Better understanding of environmental conditions | • Could improve guidance on prudent decisions |
| **Negative Impacts** | • City-wide research cost is approx. P1.5 million for QC and P600,000 for PPC | | • Requires funding |

### 12. Terminal Relocation (Short Term)

Relocating tricycle terminals means moving them away from the core or the concentration of economic activities. Trading area and public transport terminals are almost always tied up in the same area. This is relative in many urban / urbanizing centers due to short-range foresight. This condition creates traffic congestion and concentration of emission in the area. Moving the terminal away from the core will relieve the congestion and create more breathing space for everyone.

### 13. Maintain Good Quality of Roads (Short to Medium Term)

Well-paved roads result to faster travel and lesser damage on the vehicles. However, the quality of smaller roads is not well maintained in general due to limited budget allocation. In addition, many civil / road works in the city were observed to have been poorly done, wherein some portions were never restored to their original paved condition. This results to rough roads that stop traffic and expose the riding public to potential accidents.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | | • Could reduce congestion, in effect reduce the emission | |
| **Negative Impacts** | • Required space may entail cost (rental cost in Metro Manila is about P30,000 up) | | • Availability of space in other areas<br>• Resistance of tricycle users |

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | • Eliminate possible delays in traffic | • Eliminate potential accidents<br>• Could reduce traffic congestion by elimination of obstructions, in effect reduce emissions | |
| **Negative Impacts** | | | • Arrangements with subcontractors are difficult[a] |

[a] Road repairs administered at the local government levels have been observed to have relaxed terms and conditions resulting in road construction of low quality.

The LGU has authority over the public facilities within its jurisdiction but not the allocation of infrastructure budget. Thus the best alternative is to minimize the damage inflicted on the roads.

There are a number of ways to do this:

(i) Mitigation of road and civil works;

(ii) Road rehabilitation;

(iii) Zoning ordinance; and

(iv) Transportation plan / Traffic management plan.

What is do-able and practical to the LGU based on the above alternatives is the mitigation of road and civil works because it entails minimal expenses. A resolution or an ordinance from the city or municipal government should be adopted in order to ensure that construction companies comply with the allowed completion time and road restoration conditions.

### 14. Carpooling / Vanpooling (Short Term)

Carpooling is simply sharing the ride with other people through coordination in which the cost of travel is also shared. If well executed,

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts** | • Minimized cost of travel<br>• Lesser vehicles to compete with road space (when fully implemented) | • Reduced emissions compared to individual motoring | • Can be promoted by city government (for QC, through MMDA and supported by the LGU) |
| **Negative Impacts** | | | • Only promotion is possible, cannot be enforced |

dependency on tricycles especially during rush hours can be minimized. Target groups are the frequent trip makers.

Limitation of this strategy, however, includes accessibility, privacy and security issues. The best that can be done is for a number of motorists who are taking the same route on a regular basis to group together and form a carpool. Promotion and advocacy are the most practical means to inform the motorists and the commuters.

### 15. Walking (Short to Medium Term)

Walking is the basic and natural form of transport. Although this is relatively very easy, it will entail a considerable amount to build support infrastructures in order to attract people to walk. Support infrastructures include promenades, plazas, walkways (covered or open), sidewalks rehabilitation, underground crosswalks and elevated footbridges.

Implementation will be easier when these facilities are in place. As walking may not be imposed, it can however be encouraged once the facilities are there. Funding may be the biggest problem in establishing the required infrastructures. Additional funding can be sourced out from the private sector or donor agencies.

### 16. Pedestrianization (Short Term)

Although this is still under the category of walking, a separate discussion is made to emphasize its unique impact. This is a measure to increase human mobility by closing a certain road segment used by vehicles for exclusive pedestrian use. This is most applicable in old towns with high saturation of people, transportation and commerce in which the tendency is to become 'stagnant'. By declaring a short segment of the road free from vehicular traffic, the circulation is renewed and improved. Vehicles are rerouted to the nearest possible streets.

An assessment of the area is needed and careful traffic study is required. Once implemented, enforcers will be required to regulate the activities and maintain good circulation. Compared to other support infrastructures, pedestrianization is relatively cheaper.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Adequate studies to support the scheme | • Savings on fare for short distance travel | | • Promotion can be made not mandated |
| **Negative Impacts**<br>• Technology requirement will be on the support infrastructures *(discussed in the proceeding options)* | • Budget for support infrastructure will be required<br>• May require comfortable footwear on regular period | • May not be ideal in places with high emission levels<br>• Safety may be a drawback especially during the night | • Corresponding infrastructures are needed in order to encourage the public |

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Ample research is available locally as well as experts | • Increased commercial activity in declared area | • Safer for pedestrians<br>• No friction with vehicles | • Satisfactorily tested in some areas |
| **Negative Impacts** | • Over-commercialized areas become very congested, the outer perimeters are affected including traffic flow<br>• Typical cost approx. P300,000-P500,000 including study | • Unmanaged areas become blighted, leading to urban decay. | • Enforcers are required to maintain orderliness<br>• Requires regular clean-up due to vendors |

### 17. Promote Bicycling as Private Alternative Transport (Short Term)

Bicycling, in general, fills the gap between short-distance trip (walking) and long-distance trip (motorized transport). Being nonmotorized, bicycles have gained popularity because it is a clean and sustainable technology. Despite the absence of proper infrastructure support, biking has been practiced by a few in many urban centers. However, since there is an issue of safety and security, there is a need to set up support facilities such as bikeways, rest areas/ shelter, parking facilities and signage system.

In the last five years there have been individuals and groups which promote biking as the main everyday transport, where corresponding programs have been publicly

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Efficient bicycle design and supply are already in place | • Savings in fare<br>• Shorter travel time for congested areas[a]<br>• Profit for the bicycle industry<br>• Reduction in traffic congestion if motorist will shift to bicycles | • Zero emission<br>• Good for the health | • Support organizations are already in place |
| **Negative Impacts** | • Initial investment as low as P1,500 for the bicycle | • Safety for the biker<br>• Security for the bicycles | • Formal support infrastructure is still unavailable |

[a] Bicycles can flexibly move and course through traffic flows especially in a bumper-to-bumper situation.

endorsed by nongovernment organizations. Despite these developments, huge funding still is needed to support this transport alternative and though this is most ideal in congested areas, it is also viable for developing urban centers to counter pollutant-transport services.

**18. Construction of Bikeways (Medium to Long Term)**

This is a major support infrastructure for bicycling. The Marikina bikeways built a few years ago provided many benefits to the residents including workers who shifted from being commuters to bikers. The bikeways have two options, fully concreted bike and jogging lanes or concreted bike lanes with earthen jogging lanes. The total stretch of the bikeways is 50 km, and cost between P53 million to P89 million, depending on the options.

**19. Establishment of GIS[44]-based and Its[45] Traffic Monitoring and Broadcasting (Short to Medium Term)**

This is usually done by the government or contracted firm to monitor the traffic situation and broadcast the findings in order to guide the motorists to avoid congested traffic corridors. For Quezon City, this should be coordinated with the Metro Manila Development Authority (MMDA) while for Puerto Princesa City, this could be coordinated with the Mayor's Office since a GIS-mapping system is already in place. This may require further discussions although some radio stations have traffic news on selected time slots. A local radio station, DZRH is located nearby along Abueg Street.

## Potential Impacts

| Technological | Economics | Health and Environment | Administrative and Enforcement |
|---|---|---|---|
| **Positive Impacts**<br>• Model city as reference for study is available<br>• Experts on bikeways are locally available | • Reduction in traffic congestion<br>• Shorter travel time<br>• Revitalize the bicycle market including related industries | • Better accessibility for the people·<br>Safer for pedestrians<br>• Jogging lanes and parks can be built within the plan | • Advocacy groups may be tapped for assistance |
| **Negative Impacts** | • Huge investment will be needed. For PPC about P100 million | | • Bikeways area identification<br>• An administering body will be needed for enforcement and maintenance of bike lanes |

[7] Geographic Information System is a mapping tool that performs many different tasks and incorporates information in the data.
[8] Intelligent Transport System is a general term for a single or complex combination of equipment programmed to monitor, evaluate, analyze, broadcast, store, process and etc., transport-related data.

**20. Review and Audit PETC (Medium Term)**

The private emission testing centers have been riddled with controversies when the Clean Air Act (CAA) mandated annual emission test for all motorized vehicles. Securing a certificate of conformity is possible without even the vehicle. This makes the whole procedure ineffective.

Review and audit of PETC data could reveal potential information on how to resolve the air pollution problem. The average attainment compared to the standards can be a good basis to review and upgrade the existing standards. Further, if the goal is solving air pollution from mobile sources, there is a need to have more stringent measures and frequent emission tests to be complemented by tamper-proof auditing equipments. As budget is scarce especially in the present situation, this proposal will have to wait since it will also require more discussions with the Department of Transportation and Communication (DOTC) and DENR.

**21. Traffic Management Plan (Medium Term)**

Traffic Management Plan (TMP) is a comprehensive study on the transportation system and traffic situation, after which, possible solutions are identified. TMP can be worked out within the Comprehensive Land Use Plan (CLUP) of the city / municipality or can be made separately. Usual budget ranges from P2 million to P5 million.

**22. Traffic Impact Assessment (Medium Term)**

Traffic Impact Assessment (TIA) is forecasting the future growth of transport demand versus the actual land use of an area, or even a city. TIA is often not practiced since only very few LGUs are able to administer. Business districts are now experiencing traffic congestion and unprecedented changes, which should have been addressed very early in the planning stage if TIA was made. Usual budget for this task ranges from P1.5 million to P4.0 million.

**23. Land Use and Zoning Measures (Medium to Long Term)**

This is normally the output of CLUP and can be made by the city planning office. It has been observed in the past that many of the LGU personnel need formal education on planning. LGUs are now catching up on this aspect as many officers are sent to planning schools to learn the proper practice.

The big problem in most developing areas is that settlements and built-up areas are rapidly spreading. The inadequacy of constant updating of the CLUP, coupled by the changing priorities and discontinuity of plans due to changes in administrations, result to uncontrolled urban mix of different zones. Therefore, traffic congestion, urban decay, informal settlements, uncontrolled population growth, air and water pollution normally follow.

**24. Urban Renewal, Urban Design, Maintenance, Urban Density, Garden City Concept (Medium to Long Term)**

As a response to urban decay, urban renewal promotes replanning, eradication of urban blight, restoring order, realignment of land boundaries, etc. Urban design promotes good traffic circulation while retaining the basic aesthetics of a town, municipality or city. A Garden City promotes the interaction of environment and urbanization. Cities are built with integrated garden-like design to preserve the natural environment.

**25. Traffic Management Association (Medium to Long Term)**

Traffic Management Association (TMA) is a public-private partnership that focuses on the transportation and traffic situation. Private sectors are actually associations from

different industries which are competitive enough to run the transport sector, while government sets the rules and regulations in which they should operate. The model was initiated in California and was successful since its implementation in the mid-1990s. TMA acts as a central body for all traffic and transport coordination and events management.

This can be worked out through partnership under minimal investment, just enough to sustain enforcers and traffic planners, as well as provide uniforms, gadgets and inexpensive transports. About P1 million will be enough to jumpstart the whole operation but sustainability should be maintained.

**26. Special Research for Puerto Princesa City Urban Transport Integration Study (Long Term)**

A transportation integration study should be done to further establish the present scenario and project the future conditions. Rapid urbanization and population growth normally bring increased traffic congestion, pollution, garbage and informal settlers. In order to properly address these problems, there is a need to establish a database on the current conditions. Multiple benefits can be derived from the output of this research, just like the Metro Manila Urban Transportation Integration Study (MMUTIS), 1999. The budget required may be around P10 million to P12 million.

**27. Transport and Environment Course for City Personnel (Short Term)**

Information and education campaign (IEC) for LGU is one step further to improving the performance at the local level with respect to understanding transport and its effects on the environment. The agency to carry out directives is the LGU with assistance from the national / regional agencies. It is estimated that a two-week course is sufficient and could cost around P300,000.

**28. Establishment of an Action Center (Short to Medium Term)**

Many issues are related to the tricycles primarily on areas of air pollution, noise, and accidents. However, most LGUs have no specific unit to monitor and address these concerns. It is therefore wise to set up a temporary Action Center to handle all these until the city government is ready to absorb all the responsibilities. Since there is no budget for projects such as this, private initiatives can be tapped and citizen participation / volunteers can be utilized.

# REFERENCES


Asian Development Bank. 2001. Role of Fuels and Lubricants for Emission Control in Two- Stroke Engines. ADB Workshop, Hanoi, 6 September.

_____. 2002. *Report and Recommendation of the President to the Board of Directors on a Proposed Technical Assistance to the Philippines for the Promotion of a Cleaner Production*. Manila.

_____. 2003. *Policy Guidelines in Reducing Vehicle Emissions in Asia: Cleaner Two and Three Wheelers*. Manila.

_____. 2003. *Policy Guidelines in Reducing Vehicle Emissions in Asia: Cleaner Fuels*. Manila.

Benson. Tom. 2004. *4-Stroke Internal Combustion Engine*. Glen Research Center. Available: http://www.grc.nasa.gov/WWW/K-12/airplane/engopt.html

Camagay, Manuel Jose D. 2004. Development of Policy Instruments for Emission Standards Compliance of Tricycles. Master's Thesis, School for Urban and Regional Planning. Quezon City: University of the Philippines.

Canadian Renewable Fuels Association. 2005. *Ethanol*. Available: http://www.greenfuels.org/ethanol/index.htm

City Development Council and Office of the City Planning and Development Coordinator. 2000. Comprehensive Land Use Plan, 2001-2010: City of Puerto Princesa. Puerto Princesa City.

City Planning and Development Office. 2004. *Proposed Amended Comprehensive Land Use Plan of Quezon City*. Quezon City.

City Planning and Development Office. 2003a. *Puerto Princesa City Socioeconomic Profile Report*. Puerto Princesa City.

_____. 2003b. *Strategic Environmental Plan for Puerto Princesa*. Puerto Princesa City.

Garcia, Daisy 2000. Assessment of Cleaner Production Opportunities in Municipal Management: The Case of Marikina City, Philippines. Master's Thesis, Lund University. Lund: International Institute for Industrial Environment Economics.

Garcia, Daisy. 2003. Cleaner Production in City Management as a Strategy for Poverty Reduction. Paper presented at the 4th Asia-Pacific Roundtable for Cleaner Production. Chiang Mai. 21 January.

Holgate, S.T., J.M. Samet, H.S. Koren, and R.L. Maynard. 1999. *Air Pollution and Health*. London: Academic Press.

Job, R. 1996. *The Influence of Subjective Reactions to Noise on Health Effects of the Noise*. Quoted in Department of Environment and Conservation (NSW), *State of the Environment*. Available: http://www.epa.nsw.gov.au/soe/97/ch1/15_3.htm

Kojima, Masami, Carter Brandon, and Jitendra Shah. 2000. *Improving Urban Air Quality in South Asia by Reducing Emissions from Two-Stroke Engine Vehicles*. Washington, DC: World Bank.

Transportas. 2001. *Transport and Traffic Management Studies for Puerto Princesa City: Final Report.* Quezon City: Transportas.

United States Environmental Protection Agency. 2002. *Ozone.* Available: http://www.epa.gov/ epahome/ozone.htm

United States Department of Energy, Office of Energy Efficiency and Renewable Energy. 2003. *Just the Basics: Electric Vehicles.* Available:Http://www.eere/energy/gov/vehiclesandfuels/pdfs/basics/jtb_electric_vehicle

_____. 2004. *Hydrogen Topics.* Available: http://www.eere.energy.gov/RE/hydrogen.html

University of the Philippines–National Center for Transportation Studies Foundation Inc. (UPNCTSFI). 2004. *Standards Development for Local Motorcycle/ Tricycle Sector: Final Report.* Quezon City: University of the Philippines.

Wilson, Bryan. 2002. *Development of a Direct Injection Retrofit Kit for Reducing Emissions from 2-Stroke Cycle Engines in Asia.* Colorado State University.

Wisconsin Department of Natural Resources. 2004a. *Total Suspended Particulates.* Available: http://www.dnr.state.wi.us/org/aw/air/health/tspart.htm

_____. 2004b. *Carbon Monoxide.* Available: http://www.dnr.state.wi.us/org/aw/air/health/carbon.htm

_____. 2004c. *Nitrogen Oxides.* Available: http://www.dnr.state.wi.us/org/aw/air/health/oxides.htm

_____. 2004d. *Ozone Basics.* Available: http://www.dnr.state.wi.us/org/aw/air/ozone/

World Bank. 2004. *Urban Air Quality Pollution: Policy Framework for Mobile Sources*. Washington, DC.