Environmentally Sustainable Paratransit

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Abstract: Paratransit in the Philippines is the backbone of its public transport. Public transport of this type reaches as high as 70% in the national market and within this sector, the Jeepney is predominant. However, due to outdated technology, this paratransit significantly contributes to GHG-emissions. In Europe, paratransit is hardly known. However, it had recently emerged as a supplementary form of traditional public transport and is more identified as Demand Responsive Transport (DRT). Given the significance of paratransit in the Philippines and in Europe, today's environmental requirement challenges the current policies and requires for the advancement of technological solutions towards sustainability in the transport sector. The paper investigates different kinds of policies, measurements and best practice cases found in Europe and the Philippines that stress the future developments in the paratransit sector. Moreover, this paper shows how each area could learn from the other's advantages in order to advance sustainable paratransit.

Keywords: Paratransit, Sustainability, Demand Responsive Transport, Alternative Fuels, E-mobility, Ecodriving

1 INTRODUCTION

Evidence of climate change and its corresponding impact on humanity consequently show a need for action towards environmentally friendly policies and sustainable society. Particularly, in the transport sector of both developed and developing countries.

Already, environmental issues in the transport sector have become a major issue. In developed countries, road transport accounts for about 80% of the total transport demand, which in turn corresponds to more than 20% of the total CO_2 emissions (Abuzo and Muromachi, 2014). Transportation rapidly contributes to the rising sources of GHG emissions (Schipper *et al.* 2001) as well as 20% to 30% of all greenhouse gases (Ramos, 2014). Moreover, its share of non-methane hydrocarbons nitrogen oxides exceeds 50% in developing countries (Graza and Ishida, 2001).

Alongside this concern are the issues behind sustainable public transportation systems. Public transport has been a primary mode of motorized trips in urban areas of developing countries (Darido 2003). Urban areas such as those in the Philippines is faced with deteriorating air quality coupled with transportation issues (i.e. lack of public transport, deteriorating vehicle engines, inefficient driving behavior, etc.). There are also issues related to the decline of paratransit utilization (Kawaguchi *et al.*, 2013); due to safety issues and limited level of

service (i.e. inhumane working conditions, congestion in inner city streets, and intense market competition). Whereas, the public transport in Europe is faced with serious problems in providing appropriate services in rural areas (Cervero, 2001, Velaga *et al.*, 2012) and the provision of transport for the elderlies and persons with disability.

The study of Graza (2001) had established a list of technical solutions for Jeepneys based on a survey conducted among Jeepney operators in Metro Manila, shortly after the Clean Air Act (CAA) became effective. The result revealed that alternative fuels ranks first, followed by exhaust-gas cleaners, testing devices, testing centers, and finally modified engine parts. In addition the study established that there is a need for laws, policies and government support. Furthermore, the study of Chiu (2008) criticized that there is a lack of articulated and thought through development strategies concerning the Jeepney sector. In order to move towards alternative fuels and E-mobility in the Jeepney sector Nacino (2014) points out that a concerted effort from various sectors, including power generation and distribution, is needed in order to ensure the mainstream use of electric Jeepneys.

Cervero (2001) suggested paratransit as a supplementary mode of Western public transport and that the need for healthy competition, relaxed regulation, reduced market distortions, and promotion, serves as essential elements towards successful paratransit transfer and adaptation in Western World. Constructive aspects of paratransit are organizational capacity, the ability to make self-financing business and the ability to identify and respond to user needs. Finn (2012) suggested the transfer of paratransit-experience from developing countries to combat the lack of effective transport modes in Europe for responsive, pervasive and frequent transport. The study of Halden (2006) that reviewed the developments of Scottish DRT-systems analysis indicated that DRT already plays an important and growing role in the spectrum of transport provision, with potential for further growth. Even if there is still a heavy reliance on public funding. Cervero (2001) indicated that Manila is a good example in terms of investigating paratransit, more precisely Jeepneys.

Considering the transportation environmental issues and sustainability issues of public transportation, particularly on paratransit in the Philippines and in Europe, there is a need to review on the current situation, practices, programs, and policies on paratransit. This study will focus on analyzing paratransit in the Philippines and in Europe. While policies, data and experiences collected and collated from countries such as Southern Africa, Tanzania, and the United States were considered in this review. However, measurements, results, conclusions and recommendations will only cover Philippines and Europe.

1.1 Background of Paratransit

Paratransit and Demand Responsive Transport. Paratransit serve a as public transport a non-traditional public transport that fills the gaps in formal transit provision (World Bank, 2002). Interpretations for the term Paratransit vary tremendously, including anything from a two passenger Rickshaw to so-called minibuses that actually carry up to forty or fifty passengers. Vuchic (2007) define paratransit as “For-Hire Urban Passenger Transport”, more precisely as transportation service provided by an operator and available to all parties who meet the conditions of a contract for carriage (i.e. pay prescribed fares) but which is adjustable in various degrees to the individual user’s needs. Paratransit includes taxi, dial-a-ride as well as jitney. These systems have no fixed routes or schedules and are therefore considered as Demand Responsive Transport (DRT) systems (Connected Cities, 2006). These

vehicles are often old, having been retired from other countries or other domestic uses, so that the capital investment necessary to enter the business may be small. Some of these vehicles, such as the motorized rickshaws of East and South Asia and the Jeepneys of Manila, are very specialized, but in many cases they are simply adaptations for passenger carriage of whatever vehicle is inexpensively available (World Bank, 2002).

Paratransit in the Philippines: The Jeepney. Doroy *et al*. (2005) indicated that partransit in the Philippines include: tricycle (three-wheeled motorcycles), multicab (Asian utility public transport), Jeepney, and minibus. Chiu (2008) classified Jeepney according to its passenger capacity and ceiling distance between multicab and minibuses. Jeepneys evolved from World War II vintage jeeps that local residents adopted to serve as a type of minibus. Normally, the seats of the passengers are a lengthwise arrangement of two opposing benches from the front to the rear end of the vehicle. The center aisle between benches serves as access area for boarding and alighting of passengers. The usual passenger capacity of a regular size Jeepney carry about 14 to 18 passengers in the interior, excluding the seating (i.e. two more) on the driver's bench; however, according to the Department of Transport and Communication (1997) the loading capacity of some Jeepney could reach up to thirty two (32) passengers. The Jeepney in Manila as a paratransit have a share of 45% of trips in the city (Gwilliam, 20012) that reaches 60% of motorized transport for poverty groups (Kato 2010).

Paratransit in Europe: Dolmus and DRT. Cervero (2001) indicated that paratransit in Europe is different from those in the Philippines. The paratransit in Europe acts as an additional service than a primary one. Nevertheless, different kinds of paratransit are getting more and more important in Europe, which can be clustered to three main groups or types. One is the Jeepney-like Dolmus in Istanbul known since the 1930, others are emerging demand responsive transports acting as feeder lines or operating as service transport in populated areas. Some paratransit are dedicated to certain target groups such as students, the physically challenged and the older. Connected Cities (2006), describe paratransit as “those public or private entities that provide transportation services with a fleet of buses of small capacity”. This definition points out that in the European context, only buses fit into this category, excluding taxis and Rickshaws. Hennig (2011) considers the Turkish Dolmus as an informal service that functions as a collective taxi with fixed routes but stops wherever needed. The rickshaws are usually cheaper than taxis however the vehicle will only get mobile or start the trip if all the passenger seats were filled. On the other side there is a relatively new trend of Demand Responsive Transports implemented in several municipalities across Europe. Mageean *et al.* (2003) describe these as a service vehicle that provides “transport on demand” from passengers using fleets of vehicles scheduled to pick up and drop off people in accordance with their needs. DRT is an intermediate form of transport, somewhere between bus and taxi which covers a wide range of transport services; ranging from less formal community transport to an area-wide service networks.”

Paratransit in North America: Vehicle Pooling and DRT. Paratransit according to the National Transport Resource Center (NTRC) of the United States is similar to the paratransit in Europe, especially those which are found in Great Britain. It underlines the flexibility of paratransit in terms of routes and vehicles (bus services, shared-ride taxis, carpooling and vanpooling, jitney services and etc.) but emphasizes that the term “most often refers to wheelchair-accessible, demand-response van service.” While Dial-A-Ride or DRT is also known in suburbs, paratransit primarily supplies disabled people with a DRT on more or less

flexible routes or schedules.

Paratransit in Africa: The Daladala. Schalekamp *et al*. (2009) define paratransit in Africa as entrepreneurial services delivering highly demand-responsive, affordable transport in settings not conducive to scheduled or "formal" public transport operations. Paratransit such as the Daladala operate on fixed routes at central locations which allow loading and unloading of goods and passengers. Therefore, the Daladala serves as transport for feeder lines.

1.2 Current Situation

Comparing paratransit in Asia, Africa, Europe and America shows different kind of services with similar vehicles or schemes. Table 1 lists typical features of Jeepneys, Daladala, Dolmus, DRT, and the US ADA-Paratransit. Common characteristics are passenger capacities around twenty (20) passengers, route lengths up to 30km or 40km, the absence of fixed schedules, and the offering of demand responsive services. Contradictory routes vary from fixed to variable, fares range from fixed to distance based. Entrances are in the back or sideways, are sometimes low floor or even equipped with a wheel chair lift.

Table 1. Comparison of paratransit in the Philippines, Turkey and Austria

	Philippines ***Jeepneys***	**Tansania** ***Daladala***	**Turkey** ***Dolmus***	**America** ***US-ADA***	**EU/AUT** ***e.g. Gmoabus***
Loading Capacities	12–32 passengers	17-40 passengers	8 passengers	4-10 passengers	Ca. 20 passengers
Body Make	Jitney type/AUV	various	Otokar etc.	various	VW-minibuses etc.
Routes	Fixed route (regular, limited-stop or express) or variable routes within a specified area as authorized	Fixed route, variable stops	Fixed route, variable stops	From fixed route to door to door service	Demand responsive – door to door service; within a specified area (municipality)
Schedule	Flexible schedule	Flexible schedule	Flexible schedule. It is partly conn. to interval/connection	Flexible schedule	Flexible schedule. Partly conn. to interval/connect.
Entry	Backside	sideways	sideways	Sideways wheelchair lift	Sideways low-floor-entry
Fare	Based on distance or zonal as authorized	Fixed rate, "coined" term: Dollar-reference fare	Based on distance, in cash. as authorized	Fixed rate for any connection	Fixed rate (1€) for any connection
Operation area	Urban as well as provincial areas	Urban and provincial areas	Urban and provincial areas	Urban and rural areas	Suburbs, spare populated areas

Operating Conditions	a) Allowed to carry passenger and freight for provincial operations b) Urban routes 15 km; inter-urban/provincial routes 30 km	a) Only passenger operations b) Inter urban about 30 km	a) Only passenger operations b) Inter urban routes 40 kms	a) Only passenger operations b) Inter urban 30 km	a) Only passenger operations b) Inter urban 30 km
Source	DOTC 1997	Schalekamp *et al.*, 2009	Hennig 2011	Cervero 2001	Bmvit 2009

As Table 2 shows paratransit services can be grouped according to traffic share, function and served area. While Jeepney, DalaDala, and Dolmus share almost the same features, DRT in Europe have different attributes as well as paratransit in the United States, which is clearly devoted to a special target group.

These approaches show similarities as well as differences among different types of paratransit all over the world. However, this review will further focus on Jeepney-like minibuses without fixed schedules but with a passenger capacity about 20 passengers. Modes with fixed routes should be included as well as those that includes either dial-a-ride or hired type services.

Table 2. Function, traffic and domain of paratransit in different parts of the world

	Philippines *Jeepneys*	Tansania *DalaDala*	Turkey *Dolmus*	America *US-ADA*	Europe *e.g. GmoaBus*
Traffic share [modal split]	Remarkable share of public transport [up to 50+ %]			Minimal	Low [5-10%]
Function	Backbone, Feeder lines, Rural areas			Special target group	Basic supply, Supplementary
Area	Urban, provincial areas				Predominantly suburbs, province, and sparely populated
Source	DOTC 1997	Schalekamp *et al.*, 2009	Hennig 2011	Cervero 2001	Bmvit 2009

Advantages of paratransit. According to Schalekamp *et al.* (2009) paratransit is an integral part of transport systems in developing world cities, providing demand-responsive, intensely competitive but self regulating, transport services. Mobility is provided to people who are excluded from appropriate, affordable or any transport at all demonstrating social aspects of paratransit.

Gwilliam (2002) indicated that paratransit are generally used on non-trunk routes, feeder services and narrow streets and in developing countries is used as a transport service outside the conventional public transport regulatory system. It is often classified as a transportation mode in between the private motorized mode and conventional public transportation; usually a share-ride mode (Goodwill and Carapella, 2008). Kawaguchi *et al.*, (2013) indicated further that in small and medium sized cities of developing countries, paratransit plays a dominant role in providing affordable public transport for lower income groups and residents in lower density urban areas due to its flexibility and low initial investment. This can be a main mode of motorized transport.

Fare levels are equivalent to public utility buses which provides generally lower service level (JICA, 1995) and complement but also compete with conventional services (Cervero,

2000). In East and South Asia, and to some extent in Latin America, paratransit complements the formal sector, providing differentiated services in identified market niches (World Bank, 2002). These systems provide. Even the informal Jeepney industry is often described as a low productivity backwater “sponge” absorbing those who cannot find productive employment in formal urban activities but in reality it generates more jobs and income per vehicle (Chiu, 2008).

Depending on the respective mode, paratransit application in Europe for the poor, elderly, and remote situated people can be offered as flexible transportation, moreover it can be made accessible for the working class even during night time (Cervero, 2001). This is especially viable for local distribution in inaccessible areas that are not served, or are underserved, by conventional public transport (World Bank, 2002). Moreover Cervero (2001) stresses that fifty-passenger-buses serving every 30 minutes are not acceptable anymore in many circumstances as mobility needs to become increasingly diverse.

Disadvantages of Paratransit. In Metro Manila alone, studies on air quality revealed that the major source of pollution come from motor vehicles and Jeepneys (Pokharel *et al.*, 2013). As mentioned above, vehicles operating as paratransit in developing countries generally tend to be cheap, motorized with old engines of poor quality, consequently heavily emitting GHG, having low fuel efficiency (Nacino, 2014), causing noise pollution traffic accidents and traffic congestion (Cervero and Galub, 2007).

Even though paratransit is more effective in terms of traffic flow, they still do not reach capacities of regular bus or train systems. Missing regular stops, frequent interruptions of traffic flow but also repeated fuel-intensive acceleration and deceleration phases are the consequence. Furthermore Schalekamp *et al.* (2009) blames paratransit business for ruinous and violent competition between operators for higher volume routes, ‘cream skimming’, and aggressive driver behavior. In Europe DRT-Systems intensely rely on public funding, especially in the start-up phase (advertisement, vehicle investments, etc.). Additionally operating costs are usually not fully covered by the quite low-levelled fares (Bmvit, 2009).

1.3 Policies

Due to climate change several policies adopt guidelines and measurements and towards more sustainable transport which of course also effects the paratransit sector. For developing countries, with much more rapid growth in vehicle stocks and utilization, the real policy challenge is to reform transportation policies and customs now while systems are still only beginning to grow and customs to eliminate obvious and hidden subsidies and make users pay full social costs yet boost overall social welfare (Schipper *et al.*2001).

International – World Bank. Schipper *et al.* (2001) developed a policy framework consisting of five fundamental strategies to reduce GHG emissions from the transport sector. These are the (1) increase of vehicle efficiency; (2) switch to less greenhouse gas intensive fuels; (3) switch to less greenhouse gas intensive transport modes; (4) decrease travel distance; (5) increase occupancy of vehicles. Especially number 1 and 2 are relevant for the paratransit discussion, while 5 may apply to Western paratransit as well as cases in developing countries.

Philippines. In the Philippines policies affecting the Jeepney-industry are the Clean Air Act from 1999 that regulates the systematic elimination of existing pollution-promotion

technologies (processes and products) and the prevention of the emergence of other sources of pollution that can adversely affect the quality of the air (Graza and Ishida, 2001). The Natural Gas-Vehicle Program for Public Transport (NGVPPT) is an initiative of the Filippino government to promote the utilization of compressed natural gas (CNG) for the transport sector in order to raise fuel supply diversification and sustainability, using indigenous natural gas sources from the Malampaya gas field, offshore in northwest Palawan (Nacino, 2014). In 2006 the Biofuels Act furthermore underlined the need for protecting the environment by mandating the use of biofuels. It responds to the need to explore cleaner and alternative fuels. In addition, it is continually looking for ways to upgrade fuel quality to approximate international standards (Vergel, 2014). Subsequently the Renewable Energy Act 2008 (DOTS 2009) and the formulation of a National Environmentally sustainable Transport Strategy for the Philippines were issued.

Europe. In Europe relevant policies are found on supranational, national and communal level. On the supranational level projects like SAMPO, SAMPLUS and INVETE aim to develop telematics-based technologies that support flexible and demand responsive transport. The potential of DRT has been further endorsed by the European Conference of Ministers of Transport (Grosso, 2002). Furthermore FLIPPER (Flexible Transport Services and ICT platform) is supporting Eco-Mobility in urban and rural European areas (Klementschitz, and Wurtz, 2010). Grosso (2002) shows that on a national level the “Ten Year Plan” in Great Britain encourages municipalities to introduce sustainable DRT-systems and in Austria “Klima Mobil” fosters the development of E-buses for the use in DRT-systems in sparsely populated areas (Bmvit, 2009).

United States of America. The goal of the paratransit program is to ensure that all Americans have access to transit to meet basic mobility needs. The passage of the Americans with Disabilities Act (ADA) in 1990 recognized that people with disabilities have the same rights as other citizens to access services and facilities that are available to the public, including transportation. The U.S. Department of Transportation (DOT) is responsible for the enforcement of ADA's transportation requirements.

1.4 Issues - Transportation in Urban areas

The rising number of cars especially in developing countries creates different problems like traffic congestion due to a limited road capacity. This problem, include: use of small and often inexpensive old vehicles, excess in supply, and congestion. Excess in supply means more vehicles are in service than are necessary to provide uncrowded service at high frequency lead to even more congestions. Paratransit such as 50-seaters-buses can carry far more passenger in a much higher efficiency than rickshaws. This also is true for paratransit like minibuses and Jeepneys (World Bank, 2002). There is a need to advance the vehicle technology and performance of the Jeepney for it to remain as a primary mode of transport. Policies should also protect paratransit position in the market otherwise it is questionable if the governments should ban these paratransit from city centers or main traffic arteries and switch to a formal kind of transports such as standard buses, BRT or train-based services.

Environmental issues increase the demand for a cleaner and healthier environment; therefore raise the need to address air pollution caused by emissions from the transport sector and calls for the need to conduct studies on the various options that can contribute in mitigating these emissions (Pokharel *et al*., 2013). As paratransit tend to be of older fabricate,

being very inefficient in terms of fuel use, measurements are needed for reduction of emission, fuel consumption or replacing traditional engines by E-mobility or others.

Beside technological innovations and improvements, lax enforcement and weak regulation are the biggest challenges in the paratransit sector in developing countries (Cervero and Galub, 2007). This is needed to prevent open conflict of unlicensed operator when looking for customers, causing congestion of streets, intimidating law abiding motorists, and all-too-often causing accidents. Social benefits of supplemental free market services often exceed social costs; however in others they clearly do not. Therefore local authorities need to take a firm position on informal transport, choosing among the policy options in between the extremes of acceptance and outright prohibition (Cervero and Galub, 2007).

Transport policies put pressure on governments to improve the modal shift towards a higher share of public transport. While this cannot only be done by improving and extending classic modes of public transport, paratransit can fill the gap of inefficient providing services in suburban areas, for disabled people and during nighttime (Brake *et al.*, 2004). Therefore cities should strive to mobilize the potential of the informal sector. Informally supplied small vehicle paratransit is often dominant in providing for dispersed trip patterns and in flexibly addressing the demands of poor people, particularly in low income countries, but it is typically viewed as part of the problem of public transport and not part of the solution (World Bank, 2002). Summing up paratransit should be improved to its best in fields were it is really needed.

1.5 Role of Paratransit

There is a need to investigate the role of paratransit; this includes their importance and future potential as a mode of transport. The share of paratransit within the public transport sector reaches from some 5% of DRT in rural areas in Austria (Bmvit 2009) up to an official modal share of two thirds in South Africa (Schalekamp *et al.* 2009). In the metropolitan area of Manila Jeepneys carry around 40% of the traffic (Cervero, 2001 indicated 35% while the World Bank, 2002 indicated 45%). In 1990 62% of all motorized passenger kilometers in Manila took place in mass transportation vehicles, forming the third highest level in Asia behind Honk Kong and Tokyo (Cervero, 2000). This shows that even shares of paratransit vary distinctively from city to countryside and that between different countries the share is still considerably high in many parts of the world.

However, public transport in general and paratransit in developing countries are on decline due to rapid motorization. In Istanbul the share of Dolmus is declining from 10.2% in 1987 to only 4.8% in 2006 (Hennig 2011). Even though there is a positive loyalty towards paratransit within in the society (Joewono and Kubota, 2007) expect a growing competition of future public transport due to motorization and underline the need for improvements in the paratransit sector not only in terms of technological solutions but in the field of comfort, service, supporting infrastructure, accessibility and price of public transport. A decline of the share in the transport market is expected (Kawaguchi *et al.*, 2013) if paratransit will not adopt to become more customer friendly.

1.6 Need for Action and future Potential

As shown above paratransit is an important mode of public transport that has potential in the Western World, as a flexible alternative to conventional public transport. Existing paratransit as well as future ones need to tackle the challenge for sustainability to remain a significant transport mode. Environmental protection and air pollution remediation ask for reduction of pollution but also of increasing transport efficiency as well as traffic safety, meaning that paratransit have to reduce emissions, use modern efficient engines or switch to alternative fuels. This could also create financial potential through fuel savings, reduction of fuel and vehicle maintenance costs. Finally, making paratransit more sustainable shows a company's social responsibility and a measure to use for green marketing.

Demand Responsive Transport is an evolving phenomenon in Europe. Representing a most needed supplement to existing public transport. In Asia, paratransit has a significant market share but still has to meet the challenges of addressing emission reduction and sustainability. As the paratransit sector needs improvements but also represents an enormous potential for public transport measurements, solutions and best practice case need to be investigated with the necessity of stakeholders improving future paratransit service.

2 PROBLEM STATEMENT

Fabian and Gota (2009) concluded that "addressing emissions from Jeepneys is tantamount to reducing the over-all contribution of the transport sector to CO2 and PM emissions." Policies driven by the climate change discussion affect paratransit in several issues. The need for sustainability requires alternative fuels, E-mobility, introduction of new technologies, implementing of new transport modes, etc. Therefore it is crucial for the further development of paratransit in Asia as well as in Europe to know which technologies are available, what are their disadvantages and advantages, are there side-effects as well as risks in introducing those measurements? Moreover experience with the acceptance of operators, drivers, and customers could be helpful for initiating new methods as well as know-how for introduction, processing, and supervision. Last but not least stakeholders are interested if the move to sustainability is affordable, if new synergy effects could be matched and if there is a possibility to get funding.

3 OBJECTIVES

The main objective of the study is to compare environmentally sustainable paratransit application in the Philippines and in Europe. More specifically:

- to investigate the current practice, policies, and issues of paratransit
- to present the different measures that could advance sustainable paratransit
- to present the different best practices and challenges in advancing sustainable paratransit

4 METHODOLOGY

The first part of this paper deals with journals and reviews on paratransit, public transport, and sustainability were investigated. The focus was set for literatures related to current status, policies, issues and the role of paratransit in an Asian or European context. To cover the Asian

perspective, journals and paper of proceedings related to Asian context and the Philippines were reviewed. Whereas, for the European context, reports of the European Union were especially helpful. In addition definitions, trends and experiences collected and collated from other areas or countries such as Southern Africa, Tanzania, and the United States were considered.

In the second part of the paper, technical measurements towards environmental sustainability were discussed and afterwards supplemented with best practice cases and challenges that have to be faced. This was done separately for the Philippines and the European Union and afterwards differences in implementation processes and how both areas could learn of each other were discussed. Questions of economic and social sustainability were not further covered as the circumstances in both areas vary distinctively.

Research in the Asian context was concentrated on the Philippines specific paratransit called Jeepney as it is a traditional and established kind of paratransit but hast to face several challenges. In the European context the focus was laid on newly established paratransit like shared taxis or hired taxis using innovative technologies. Analysis included application of specific and innovative or unique measurements and the driving force behind recently implemented projects. Special attention was paid to underlying policies, implementation and results as well as challenges and side effects. Finally measurements and best practice cases were filtered and chosen for detailed discussion.

The study focused on the Philippines for developing country paratransit application and Europe for developed country paratransit application. The review of related literatures on paratransit were focused on the measures, best practices, and challenges that were deemed necessary to advance sustainability in the transport sector and paratransit systems in both Europe and Asia.

5 RESULTS AND DISCUSSION

5.1 Measurements in the Philippines

Alternative fuels. Based on the Biofuel Act of 2006 the Department of Energy (DOE) forged a Memorandum of Understanding with several Public Utility Jeepney (PUJ) transport groups on the “Adopt an Eco-Jeepney Program” in 2011. Consequently on-road performance tests of Auto-LPG fueled Jeepneys were conducted to develop drive cycles. Findings were compared with a similar done by Thaweesak (2009) analyzing the effect of coco-methyl ester (CME) on the performance and idle opacity of PUJs (Pokharel *et al*., 2013). Other studies regarding the use of Auto-LPG for Jeepneys cover carbon footprint (Ramos, 2014) and performance of Auto-LPG fuelled Jeepneys on long runs in rural areas (Vergel, 2014).

E-Vehicles. The introduction of E-mobility in the Philippines is fostered by the Renewable Energy Act 2008 (DOTS, 2009). As other vehicle categories the development does not follow any standard specifications (Nacino, 2014). E-mobility offers quieter engine, lesser moving parts, cheaper operating costs, and has no tailpipe emissions. While DOTS (2009) states the conversion to Auto-LPG already is a comparable expensive measurement, conversion to E-Jeepneys, regarding electricity production via Natural Gas, is even nine times

more expensive.

Hybrid Vehicles. Introduction of pure electric and hybrid electric vehicles poses a number of issues. Hybrids could combine advantages of both kinds of motor types. Limitations affected by sharp transients of the lead-acid battery based electric vehicles may be overcome with the introduction of super capacitors, but for the reason of their relative low cost lead-acid batteries are still used for most e-vehicles. Infante, et al. (2012) proves with simulations that peak fuel consumption is lessened to 31.3% in series hybrid electric vehicles when lead-acid batteries are coupled with super capacitors. Compared to a system solely using lead-acid batteries; hybrids makes e-vehicles more affordable.

Standardization of Jeepney components. The sustainable Transport Strategy for the Philippines also asks for Standardization of Jeepney components. Bacero and Vergel (2012) proves that the majority of the passengers are not willing to pay for the adoption of clean technology yet they wish to improve and standardize the Jeepney vehicle. Otherwise drivers support standardization and Bacero and Vergel (2012) lists recommended dimensions suggests further studies to overcome lacking of safety standards and high level of emission of average Jeepneys. Not solely dedicated to paratransit but effective in terms of efficiency and financial feasibility are other measures like vehicle restrictions, pricing mechanism, parking and bus lanes (DOTS, 2009).

5.2 Best practice cases in the Philippines

E-mobility. E-Jeepney and COMET represent projects in Metro Manila which are applying E-mobility in the paratransit sector. COMET (City Optimized Managed Electric Transport) is a fully electric-powered shuttle that uses state-of-the-art lithium ion batteries, promising great lifespan and durability. This 21-seater vehicle can travel 80 to 100 kilometers after full charge and can travel up to 60 kilometers/hour (Ranada, 2014). Pasang Masda, a Philippine Jeepney association, plans to purchase 10,000 units in tranches of 3 years. Contradictory to conventional paratransit it doesn`t stop wherever it is called but in terminal stations. Emitting zero emission, fuel costs are about half of a conventional Jeepney, while fares purchased via a cashless payment scheme, are just the same as for traditional Jeepneys (Ranada, 2014). On the other hand the E-Jeepney by Philippine Electric utility Vehicle (PHUV), a Filipino firm engaged in the manufacturing of electric vehicles, was able to secure an incentive package from the government (Desiderio, 2013). The E-Jeepney features a maximum range of 55 kilometers on a single full charge, with a top speed of 35 kilometers per hour it is a so-called low-speed vehicle (Vergel, 2014).

Auto-LPG. The NGVPPT aims to promote the use of natural gas as a clean alternative for transport systems, such as buses, Jeepneys, taxis and other public utility vehicles. Among the various modes of transport that caught using Auto-LPG, taxis took advantage of the program the most. As of 2011, about 19,052 taxis were successfully converted to run on Auto-LPG (DOE, 2012). On-road performance tests of Auto-LPG fueled Jeepneys were conducted to develop drive cycles. Results illustrated that the cost is slightly higher (about 14% higher than the diesel and 9% higher than the biodiesel), as the price for Auto-LPG is increasing by 1.7% instead of 3.2% (diesel), in the future, the cost for Auto-LPG operation is expected to be lower than the diesel (Vergel, 2014).

The Challenges Jalotjot (2012) concluded that electric vehicles such as plug-in hybrid

and battery electric vehicles are more expensive to operate by 47% and 79%, respectively, as against to conventional vehicle. Moreover, the 40% fuel savings are inadequate to make up for its expensive Price tag, being almost twice the amount of the latter. On the other hand, it is a fact that the mass adoption of these vehicles could initiate a decrease of prices as vehicle construction will drop due to economies of scale. Moreover, firms such as GET, provide financing schemes which help Jeepney owners during the transition phase (Ranada, 2013). Scoping the situation that E-mobility has not prevailed yet in Metro Manila. Regarding alternative fuels like Auto-LPG Pokharel *et al.* (2013) indicated that in 2013 costs for LPG was slightly higher than for diesel or biofuel. Ramos 2014 reveals that the LPG Jeepney Conversion will lead to higher CO_2 emissions due to lower fuel. Generally many measurements or mitigations are limited to research projects or pilot studies and predominantly can be found in Metro Manila.

5.3 Measurements in Europe

Ecodriving. Ecodriving can be achieved through several methods such as the addition of advanced vehicle technology (e.g. controlling or limiting of acceleration) and/or the energy efficient choice of route (Eco-routing) or transport mode (e.g. less vehicle idling, less time in traffic congestion, or lower emissions intensity) especially suited for application in buses or paratransit. Alam and McNabola (2012) conducted a critical examination (among bus drivers) that was carried out on Ecodriving methods and concluded that Eco-Routing has much potential over other methods. Best results were achieved by using eco-routing tools such as prediction and real time estimation.

Intelligent Vehicle Technologies – IVT. Telematics like the intelligent in-vehicle terminal (IVT) offer liable methods for reducing fuel consumption. The IVT can be used for different transport services (regular and flexible collective transport) operating in different environments (GSM, private radio network). The IVT makes it possible to develop telematics services, which increase the quality and the reliability of collective transport, and which give a better service to the citizens. The provision of better quality and more reliable services will make collective transport more attractive and cause a modal shift to collective transport, and will also result in an increasing mobility and energy efficiency (Scholliers, 2002).

Intelligent Transportation System (ITS). Intelligent Transportation System like coordinated traffic signal timing and adaptive control, active traffic management (e.g., lane and speed control) and Managed lanes (HOV, HOT) would improve safety on the roads and leading to maximizing economic opportunities by increasing throughput. Further benefits are reducing environmental impacts through the reduction of vehicle energy consumption and vehicle emissions (Boriboonsomsin, 2011).

E-mobility. The Flexible Transport Services and Information and Communication Technology (ICT) platform for Eco-Mobility in urban and rural European areas which are financed by the European Union`s Regional Development Fund helps Region of Europe to work and share experiences as well as good practice in the area of innovation, the knowledge economy, the environment, and risk prevention. The overall objective being the transfer of experience, knowledge, and good practices (i.e. establishing e-vehicles in the flexible transport or Demand Responsive Transport sector). Aims are reducing energy consumption and environmental impacts thus encouraging sustainable social and economic growth (Wright and Masson, 2011).

Demand Responsive Transport and* Flexible Transport Services *in Rural Areas. There is clearly a need to provide good quality transport services that are responsive to people's real needs, flexible, well-marketed, well-integrated, and provide stable and reliable transport services for socially-disadvantaged groups that are not able to access conventional public transport and personal cars. Velaga *et al.* (2012) could identify that Flexible Transport Services (FTS) can be a promising solution for developing transport solutions, particularly in rural and remote areas where public transport is not active. Communicating with passengers in real-time is a major issue; communication is done by telephone and is rarely through the Internet. A more sophisticated passenger information "ecosystem" enabling all users to share information that could enhance the benefits of integrated flexible transport services (Velaga *et al.*, 2012).

DRT – Telematics Solutions. DRT systems need to tackle logistical challenges to combine booking and routing while managing available vehicles efficiently. As the staffing of a call center or booking office may be the most costly investment for a DRT-system appropriate solutions are needed. Those could be GSM-systems, outsourcing of dispatching or a Provincial Dispatch Center (Brake *et al*., 2006). Major investments in technological solution are only profitable if high patronage is predicted (Grosso *et al*., 2002). Dispatch Centers (TDC) consist of dispatcher, booking, scheduling, dispatching, and payment functions. Onboard equipment compromises of mobile phones, on-board units or smart card readers. Using ITSO (Integrated Transport Smartcard Organization) compliant equipment will enable greater interoperability between transport and non-transport-service (Brake *et al*., 2006). The Automated Vehicle Location (AVL) provides real time information on the status and the location of the fleet feeding route optimizing software (Wright and Masson, 2011). Different research projects focusing on telematics solutions for DRT like SAMPO (Travel Dispatch Centers), SAMPLUS, SIPTS and INVETE are presented by Ambrosino *et al*. (2003).

Additional Measurements. Hennig (2011) indicated that metropolitan areas like Istanbul need divided busways wherever free bus circulation is not possible, privileged dispatching at toll stations and signal periodization should be given to public transport in general.

5.4 Best practices in Europe

Ecodriving. While ECOWILL (2011) reports Ecodriving potential is about 5% in fuel reduction on the long term, during an Ecodriving training session of bus drivers in Athens an estimation of 10.2% in fuel saving was achieved, valuable for about €6,630,000 per annum (Alam and McNabola, 2012).

E-mobility. The recently introduced Flexibus in Almada (Portugal) is using electric mini-buses due to their size which is ideal in the old town where streets are narrow, in addition they do not emit pollutants locally and are quiet compared to conventional diesel vehicles (Wright and Masson, 2011). The Solarbus initiative is part of the implementation plan for E-mobility in Austria and developed mini-buses serving as DRT vehicles with a range of 180km/day, performing extremely well in several rural areas in Austria (Austrian Energy Agency, 2012).

DRT dispatching systems. While GmoaBus in Austria, having 21, 000 passengers a year and being said a model case, is ordered through pre-booking a ride by directly calling the

driver. The highly successfully Personal bus in Florence is based on GSM-technology, allowing steadily contact between driver and the TDC, having no in-vehicle devices. Ring a Link in Kilkenny, Ireland, is using a fully automated I-Pilot scheduling software sending routing and passenger details (Wright and Masson, 2011).

Intelligent Transportation System (ITS) - Congestion Management. Boriboonsomsin (2011) showed that in addition to congestion management strategies, speed management and traffic flow smoothing strategies should also be considered. Potential savings from Traffic Flow Smoothing eliminating congestion would reduce energy and emissions by 7%, the elimination of speeding would reduce energy and emissions by 8%. Real-world experiment on SR-91 in Southern California shows fuel savings of 13% for the eco-driving vehicle. Congestion management can be implemented relatively quickly (within a few years) while their potential energy and emission benefits in near term are significant and immediate (Boriboonsomsin, 2011).

The Challenges. The transition towards extension of DRT in Europe needs further promotion and government initiatives. Currently, the DRT systems rely heavily on public funding (as they hardly pay for themselves) apart from investment costs (Halden, 2006). Thus, there's that challenge to overcome public prejudice, low awareness, and low motivation. This is similar to the Ecodriving promotion in Europe which had proven its potential for saving fuel and yet companies are not in support to pay for Ecodriving courses of its drivers (ECOWILL, 2011).

Table 3. Overview of best practice cases in the EU and the Philippines

Objectives	**E-mobility**	**Auto-LPG**	**Ecodriving**	**DRT dispatching systems**	**Intelligent Transportation System (ITS**
What are concrete measures to reach environmental sustainability in the paratransit sector?	Using vehicles powered by electric engines	Convert motors of conventional Jeepneys from diesel to Auto-LPG	Teaching drivers of buses how to drive forward-looking and efficient	Trips coordinated by demand, mini buses instead 50-seaters-buses often run by E-vehicles	Congestion management strategies, Speed management, Traffic Flow Smoothing
Where can we find best practice cases?	E-Jeepney (PH) COMET (PH) GmoaBus (AUT) Flexibus (PT)	Pilot studies in Manila (PH)	Training Sessions in Athens (GR)	GmoaBus (AUT) Personalbus (IT)	Real-world experiment in California (USA)
What are the challenges?	Relatively high investment and operation costs	Higher amount of Auto-LPG is needed the positive effect is reduced	Positive effect often decreases a certain time after training	High costs, especially in beginning phase	Extensive implementation measurements

6 CONCLUSIONS

Due to high market shares but poor engine efficiency and quality, paratransit in developing countries create significantly amounts of the overall GHG-emissions. Polices like the Clean Air Act, the Biofuel Act or the National Environmentally Sustainable Transport Strategy for

the Philippines clearly state the necessity for modernization of vehicles, improvement of combustion engines and more sustainability.

Measurements in the Philippines cover E-vehicles, alternative fuels, hybrid vehicles and standardization of components. In Europe “soft measures” like Ecodriving, Intelligent Vehicle Technologies, Intelligent Transportation systems or Demand Responsive systems in rural areas are discussed.

In the Philippines best practice cases are found in the sector of E-mobility and alternative fuels. While pilot studies are on the way and Auto-LPG use is widespread among taxis, the potential in the Jeepney-sector is still considerable. Studies show that newly introduced fuels like Auto-LPG emits more GHG than conventional Jeepneys demonstrating the risk of negative side effects of new technologies. Electrically operated Jeepneys are available but financial feasibility on a large scale is still uncertain. Additional challenges in the move towards environmentally sustainable paratransits are higher investment and operation costs of vehicles with alternative fuels or electric power units. However, mass adoption of these vehicles will probably lead to a decrease in costs in the near future as well as financing schemes support operators in implementing alternative technologies.

In Europe best practice cases can be found in the field of Ecodriving, E-mobility, Congestion Management or DRT dispatching systems. DRT supplements conventional public transport, filling market gaps and serves people with special transport needs. Environmental aspects play a minor role as alternative technologies are quite common in the paratransit anyway. There is further potential to replace private cars or inefficient conventional transport but the transition towards extension of DRT needs further promotion and governmental initiatives to overcome public prejudice, low awareness and low motivation. In addition DRT systems still rely heavily on public funding.

7 RECOMMENDATIONS

Aside from introducing alternative fuels, E-mobility or lighter building materials, attention should be likewise given to “soft measures” such as Ecodriving or Eco-Routing programs. This requests support from education or research, experts and trained personnel.

Traffic light prioritization, Intelligent Transportation Systems or bus lanes are additional measures. Finally there is still need for research in fields of vital technology solutions, from DRT-management to light and efficient batteries for E-mobility.

Europe needs to widen up its public transport sector and adopt suitable polices, promote paratransit amongst sceptic customers and provide appropriate funding for start-ups and experience from developing countries should be transferred.

On the one hand, Europe could learn from the experiences in the field of paratransit in the Philippines to enhance its public transport market. Otherwise, stakeholders in the Philippines could profit of technological solutions or Ecodriving know-how from Europe.

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