Abstract: This paper examines the role of indigenous transport as a potential component of the transport system in the drive towards climate change adaptation, to complement mitigation, especially in developing countries in Asia. The rampant presence of indigenous transport in Asian city streets, either formally or informally, reflects the demand for the mode as well as its important role in the overall transport system. It becomes imperative to understand their role, function and the use of indigenous transport modes within the whole transport network, specifically in the public transport realm, to be able to draw an overall portrait of the potential of indigenous modes to supplement, complement or compete within the transport system. At the same time, the paper hopes to contribute policy-relevant insights to better understand the role of indigenous transport in climate change adaptation.

Key Words: Indigenous transport, non-motorised transport, paratransit, sustainable, climate change adaptation, Asian developing city

1.0 INTRODUCTION

1.1 Role of Indigenous modes in a developing city context
Road network in developing cities carry various modes, both private and public. The latter is not only limited to buses but include a whole spectrum of alternative modes ranging from paratransits, two and three-wheelers, motorcycles, rickshaws, jeeps, among others. These modes developed based on local needs and context, thus, considered as indigenous transport modes. They offer low cost on-demand transport, provide essential job opportunities particularly to the poor, supplement the transport system in areas with a pronounced lack of access, and are well-suited for short trips along narrow urban roads. On the other hand, their presence are also considered as contributory factor to traffic congestion and the cause of accidents, and creates imbalance in public transport provision as they typically ply during peak period competing with formal modes. Benefits and disbenefits of these modes are still not clearly understood which leads to ungrounded public policies and inaccurate strategies.

Current literature has referred to these modes as “informal” because of its being small-scale,
unregistered and not mainstreamed. However, they still undertake some market production and serve as alternatives to unemployment (Domingo, 2004). To a certain extent, they are considered as “illegal” because of the lack of the required licensing, the illicit quality of their operation and due to inadequate regulatory framework. Cervero and Golub (2007) reiterate that the issue of informality goes on because those who have the power to change regulations do not use these modes, thus, do not have an experiential understanding of the critical importance of indigenous transport modes toward the people being served.

These modes, more often than not, have a negative connotation attached to them as public transport modes in developing countries are assumed to be chaotic and unsafe. This paper, however, argues that such transport modes have developed to suit a specific purpose or group, originated and has adapted to its local context and setting, and serves a distinct and essential role to supplement the existing transport system. These attributes reflect the indigenous character of these modes.

1.2 A move towards a more climate-adapted Asia
Climate change is one of the greatest challenges of our time. It threatens the livelihood and well-being of the global populace especially the poorest and the most vulnerable. Developing countries are more susceptible to the impacts of climate change such as changing weather conditions, higher rainfall and rising temperatures as compared to their developed counterparts. Because of the lack of adaptive capacity, not only do these cities fail to efficiently respond to disasters but also tend to be reactive in its policy framework and regulatory mechanism. The lack of capacity to adapt also threatens the very existence of archipelagic and small island countries in Asia-Pacific.

Earlier studies on climate change have focused mainly on mitigation measures. However, evidence shows that mitigation alone is not enough to address the impacts of climate change. Thus, the need for adaptation measures has become an important agenda alongside mitigation. Time is of the essence because the longer we wait, the more the impact of climate change worsens and the associated cost increases. In this context, planning becomes a major player in increasing the adaptive capacities of cities to make them more resilient in the long run.

1.3 Climate Change Adaptation and Indigenous Transport
Indigenous knowledge is defined as knowledge or information developed through years of experience which is present within a specific group or culture, often passed from one generation to the next (Mukhopadhyay, 2009). Various literatures especially in the environmental management area have extensively discussed the value of indigenous knowledge as a means of informing climate change adaptation. For example, traditional weather forecasting assists a community to improve disaster prevention, preparedness, response and mitigation (Mukhopadhyay, 2009). The transport sector offers a huge opportunity to contribute to climate change adaptation but until the present, there has been limited focus on indigenous transport knowledge as a potential strategy in climate change adaptation. For example, promoting the use of rickshaw, a non-motorised indigenous transport alternative, contributes to lesser greenhouse gas emissions per passenger kilometer as compared to using motorised vehicles (e.g. car). The rickshaw is the only mode which facilitates movement of both people and goods during times of disaster such as the flooding in Dhaka. Three-wheelers in Bogota (Colombia) serve as feeder mode to the Transmilenio bus rapid transit (BRT) encouraging public transport. The term indigenous is defined as that which is ‘originating in and characteristic of a particular region or country’ (Butler, 2009) while in reference to
transport, indigenous transport modes pertain to modes developed by locals, based on local conditions and cultures (Hossain and Susilo, 2011).

This therefore justifies the need to better understand indigenous transport within a given locality, acknowledge their presence and recognize the relevance of these modes to the overall context with the end goal of establishing effective strategies towards climate change adaptation.

1.4 Objective and Significance of the study

There had been limited studies focusing on indigenous transport much less on its possibility of increasing the adaptive capacity of cities, especially developing cities, towards achieving climate change adaptation. Thus, this study aims to fill this gap. The objectives of this paper are:

1.4.1 Better understand the role, function and use of indigenous modes within the whole transport network, specifically in the public transport realm, to be able to draw an overall portrait the potential of indigenous modes to supplement, complement or compete within the transport system;

1.4.2 Contribute policy-relevant insights to better understand the role of indigenous transport in climate change adaptation; and

1.4.3 Provide an introductory perspective which will feed into a larger scale study on indigenous transport as a strategy towards climate change adaptation.

The study is significant as it contributes to cultural-awareness, sensitive planning and mainstreaming of local knowledge into the transport planning process. A better understanding of indigenous knowledge encourages a broader respect for local powers and cultural diversity as well as leads to a more sustainability-oriented mobility culture.

1.5 Methodology

The paper is purely descriptive in nature drawing its analysis based on secondary data and survey literature to better understand indigenous transport and its role in the overall context of the city under study. As this paper is still in its early stages, this serves as a preparatory work on the assessment of the current condition and situation of indigenous transport in the selected case cities. It is expected that this will serve as a preparatory piece leading to a larger scale field survey expected to commence in the near future. One limitation of the study is compiling reliable information on indigenous transport as most are studied or researched in the context of being informal and oftentimes illegal.

The succeeding sections cover the background on the case cities, the types of indigenous transport modes and their corresponding attributes, usage pattern and user characteristics, and indigenous transport contribution to climate change adaptation. The paper collects information from various sources and uses this to the extent of information that can be possibly gathered from the sparse secondary literature dealing with indigenous transport and climate change adaptation.

1.6 The case cities

The case study areas are as follows: Dhaka (Bangladesh), Delhi (India), Bandung (Indonesia) and Davao (Philippines). The decision to consider the four cities as case cities for this paper is due to its scale and size, availability of resources and the extent of use of indigenous transport modes. Dhaka and Delhi are considered to be two of the largest megacities in South Asia while
Bandung and Davao are emerging metropolitan centres in Southeast Asia. Experiences in the former could provide potential lessons learned to the latter.

The city of Dhaka, the capital of Bangladesh, is currently one of the tenth largest mega-city around the globe. It has an estimated population of 12 million (Economicexpert.com, 2009). With the highest growth rate, it is expected to be the second largest city of the world with a population of 22.8 million by 2015. Delhi, or the National Capital Territory of Delhi (NCT), is the largest metropolitan by size and second largest by population in India. It is the eighth largest worldwide with an estimated population of 12.25 persons within the territory and 22.2 residents in the National Capital Region urban area. Bandung, the West Java capital, is the third largest city in Indonesia with a 2007 population of 7.4 million people. Developed during the Dutch colonial period to serve as an alternative capital to Jakarta, it typifies a fast developing Indonesian city which demonstrates strong colonial roots. It is home to three of the finest higher educational institutions in the country, attracting a large student populace. Its well-known factory outlets serve as intercity weekend shopping attractors contributing to its thriving commerce and tourism industry. Davao city is considered as Mindanao’s capital, the southernmost region of the Philippines. Census estimates for 2007 sets its population to be 1.4 Million. These cities are common due to the presence and rampant use of indigenous modes of transport.

Impacts of climate change are affecting these cities primarily through flood drainage problems and heat stress. As an example, in Dhaka, glacier melting and snow in the Himalaya as well as the increasing rainfall led to more frequent annual flooding. The city has experienced major floods since 1950s up to the present due to overflowing of surrounding rivers. The recent floods (e.g. 1988, 1998 and 2004) floods were the most damaging (Rabbani and Alam, 2007). Also, being urban centres, these cities typically have higher temperature than their surrounding areas, thus are more prone to heat island problems. This is further compounded by emissions from vehicles, the increasing use of airconditioning and other industrial activities. These factors contribute to heat generation and will likely increase in the future.

2.0 FINDINGS

A number of factors can be attributed to the presence of indigenous transport such as user demand, population movement, new technology, material availability, diversity of trip patterns, transformation of the physical environment, changing operating environment or social context, and even shifting regulatory frameworks. To be able to identify the potential role of indigenous transport in climate change adaptation, it is important to better understand the overall context on which the mode exists and operates. This includes, but not limited to, the planning context, policy climate, the users and its functions, the operating environment, the physical and social environment, among others.

2.1 Types of indigenous modes

This section discusses the different indigenous modes that are used at present.

2.1.1 Minibus or microbus

Paratransits are public transport modes which include public utility jeepneys (PUJ), Asian utility vehicles (AUV), and tricycles (Cervero, 2000) providing urban transport services which can be classified as in between private passenger and conventional public transport in terms of
cost and quality service (Rimmer, 1986). It can carry 10-25 passengers (Cervero and Golub, 2007). Although considered as part of the informal sector of the economy (Leinbach, 1989), it provides better physical access to destinations (e.g. employment, education and health services) especially for the poor.

The first public transportation in Bandung came around 1930’s. Up to today, this paratransit is well known as angkot, an abbreviation of angkutan kota (city transport). They are small, mostly 12-seat, minibuses owned by individuals and rented to drivers on a daily basis. However, they are also considered as contributor to traffic congestion as they tend to stop-and-go everywhere to pick and drop the passengers. The Philippine jeepney was originally conversions of the US-manufactured “Jeep”; they have gradually become bigger over the years, with longer wheelbase chassis assembled locally (Iles, 2005).

2.1.2 Three-wheelers-motorised

Hybrid three-wheeled motor-taxis such as Indonesia’s bajajs provide similar services to a car while larger three-wheeled bemos and toyokos can accommodate eight to ten passengers (Cervero and Golub, 2007) on longitudinal bench seats with an open rear for entry and exit. Some types (e.g. bemo) are operated on a fixed route basis. Iles (2005) describe these vehicles as offering low standard of comfort, slow, noisy and often can cause severe pollution as passengers (and drivers) are continuously being exposed to excessive exhaust emissions. However, these vehicles are now being powered by cleaner technologies. Although these vehicles are capable of speeds up to 40 kilometres per hour (kph), the typical average operating speeds are of the order of 8 to 10 kph.

Bemo, a three-wheeled motorized vehicle, was produced by Japanese automotive producer Daihatsu. It is considered a very practical and capable vehicle because of its capability of reaching narrow streets and can drive much faster than the pedicab. This type of transport mode has been introduced in Jakarta, Indonesia in 1962 but was being replaced by 4-wheel vehicles after a decade as this had limited carrying capacity.

2.1.3 Three-wheelers-Non-motorised

Non-motorised three-wheelers such as the cycle-rickshaws in Dhaka have one front wheel and two rear wheels and capable of carrying two passengers in addition to the driver, or freight loads of up to 250 kg without a passenger (Replogle, 1992). Configuration typically varies from country to country and even city to city but pedicabs (bicycle with a side cab) also known as becaks often serve short distance trips and serve as feeder modes to other formal modes. They tend to travel along flat and smooth surfaces but can access relatively narrow roads which could not be accessed by other types of modes. It can travel up to 10 kph but average operating speed is around 5kph (Iles, 2005).

The word ‘rickshaw’ comes from the Japanese ‘jin-riki-sha’, which means literally ‘man-powered vehicle’ (Gallagher, 1992). The name was originally given to the hand-pulled rickshaws which thronged Asian cities in the 1920’s and 1930’s, but now applies to cycle-rickshaws. It has been adapted and suited to local context in various Asian cities. The emergence of pedicabs in Bandung (Indonesia), called becak, is not clearly known. Pedicab is a three wheeled transportation mode that is commonly found in parts of Asia. The capacity of a pedicab is two passengers and one driver. It is an environment-friendly mode of transportation as it does not cause air or noise pollution. It also serves as a tourist attraction for foreign tourists (Katam and Abadi, 2008). The end of the nineteenth century saw the popularity of the
rickshaw in Indochina, Malaya and Burma. It reached Kolkata and Dhaka in the 1930s. Industrial progress replaced hand-driven rickshaws to cycle rickshaws. It was in the 1940s that cycle-rickshaw was entered Delhi (Rajendra and Lokayan, 2006).

2.1.4 Two-wheelers-Motorised
Motorcycle taxis such as the habal-habal in Davao or ojeks in Bandung are increasingly becoming common forms of individual public transport particularly in Southeast Asia. Capital and operating costs are relatively low and sometimes personal motorcycles are being used on a part-time basis to supplement income from other employment (Iles, 2005). Regulatory framework are not in place for this mode, thus, operate illegally or informally. It offers slightly longer trip distances and can navigate one to two passengers along dirt roads or narrow residential streets in compact settlements such as kampungs.

2.1.5 Two-wheelers-Non-motorised
In Asia, bicycle ownership is pegged at 400 million with bicycle ownership rate in China estimated at one bicycle per household. In India, there are roughly 25 times as many bicycles as motor vehicles (Replogle, 1992).

2.1.6 Animal-powered
Horse-drawn carriages are used for individual public transport but are less common as compared to other types of indigenous modes. These modes are typically utilized in rural areas where traffic is relatively light with adequate road capacity (Iles, 2005). Bandung’s oldest transport mode is a pedati or sado which is basically a litter carried by buffaloes, cows, horses or men. This carried both passenger and goods. This was then followed by a wooden-wheeled cart sometime with an attached roof for shade. They were rampant in the early 1900s but by the middle of the 20th century, these carts were rarely found in Bandung. A more luxurious type was the ‘impala udin’ which was utilized by the aristocrats. These carriages have seized their functions at present but are used more often for recreational purposes and as tourist attractions (Katam and Abadi, 2008).

2.1.7 Rickshaw vans
Use of rickshaws in Bangladesh is not limited to moving people but also goods as illustrated by the bicycle van which is designed in such a way that it can carry goods at the back of the rickshaw. Rickshaw vans can carry goods to and from markets as well as raw materials and products from small-scale industry. The abundance of rickshaw vans in Bangladesh towns shows the economic importance of this mode to local economies.

Table 1. TYPE/CLASS OF INDIGENOUS MODES

<table>
<thead>
<tr>
<th>CLASS</th>
<th>CLASS</th>
<th>BANDUNG</th>
<th>DAVAO</th>
<th>DELHI</th>
<th>DHAKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini-bus</td>
<td></td>
<td>Mikrolet</td>
<td>jeepney</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitney</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro-bus</td>
<td></td>
<td>angkutan kota (angkot)</td>
<td>multicab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pickup</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-wheelers/motorised</td>
<td>bemo (larger) baju (1-3pax)</td>
<td>Tricycle</td>
<td>auto-rickshaw bajaj</td>
<td>tempo auto-rickshaw</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-wheelers/NMT</td>
<td>Becak</td>
<td>pedicab/padyak</td>
<td>cycle-rickshaw</td>
<td>cycle-rickshaw</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-wheelers/motorcycle taxis</td>
<td>Ojek</td>
<td>habal-habal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horse-carts</td>
<td></td>
<td>Pedati/sado</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2 Attributes/Characteristics of indigenous modes

2.2.1 Service characteristics
Indigenous modes offer flexibility of travel ranging from a personalized transport system that can provide door-to-door service such as that provided by a becak to a fixed route system such as that provided by a bemo. The decision to utilize a specific mode is dependent on the passenger’s trip purpose, need, time, route, among others. For example, rickshaws can provide ease of travel for smaller groups, typically two to four individuals. It also has zero waiting time because of their availability all over the place. Both driver and passengers do not need to wait for a long time for people to ride it. Rickshaws are cheaper as compared to its alternatives (e.g. auto rickshaws or taxicabs). Compared to a single bus or tempo, rickshaws can operate more economically and efficiently (Gallagher, 1992).

2.2.2 Mode characteristics
Indigenous transport modes are typically smaller in size and are designed as low-occupancy vehicle. Such a modal configuration allows for ease of movement along generally congested roads as well as has the potential to provide ‘door to door’ services (Guillen and Ishida, 2004). In narrow roads in Dhaka, where it is hardly impossible for one car to access, two rickshaws can operate from opposite directions quite efficiently (Habib, 2002).

2.2.3 Vernacular and indigenous quality
Indigenous modes evolve to suit a specific local context such as a distinct geographic feature, climate, or air quality. As an example, the airy design of Philippine jeepneys allows cross-ventilation of the interiors, thus, well-adopted to counter the tropical climate of the country. Also, it is developed based on local conditions and cultures, basically homegrown and has unique designs identifying its country of origin (Guillen and Ishida, 2004). Dhaka’s rickshaws are among the most artistic and distinct as these are dressed up making them not only functional modes but also artistic creations. The distinct Bangladeshi cycle-rickshaw art depicts geometric motifs, imagery of the physical environment and even popular actors, historical artefacts and structures, among others. Rickshaw art in Bangladesh dates back to the middle of the twentieth century (MCC, 2008). Rickshaws although present in different Asian cities, its physical form differs and is highly a product of its citizens and of time. These further provide evidence of the important role played by these modes.

2.2.4 Equity
Indigenous modes are low-cost vehicles utilized for commuting passengers. Thus, it provides better access to the majority of the populace typically those belonging to the low and middle income group (see Kalthier, 2002) for more discussion regarding urban transport and poverty in developing countries. Demand for motorcycle taxis in rural area results from the lack of other alternatives to provide the required movement to move passengers and goods. Also, because of the perceived security issues, the female population utilizes the rickshaw for commuting and social trips. It also allows higher mobility for the elderly population when they conduct social and shopping trips.

2.3 Users and Uses

2.3.1 Usage pattern
The versatility of indigenous transport is captured by its flexibility to cater to different types of
trip purposes. In the study of Hossain and Susilo (2011), it was determined that the trip purpose of individuals who used rickshaws were work trips, social trips and shopping trips while the rest were students accessing colleges and universities and other purposes. Indigenous transport modes also cater for local, intra-city trips as well as longer trips. It can also provide flexible route service as well as fixed route trips. *Bemos* offer fixed transport routes while *ojeks* are more flexible and can be utilized to provide door-to-door service. Rickshaws in Dhaka provide trip movement for trip length less than 3.8km (STP, 2005). In the case of Bandung’s *pedati*, although not commonly used for day-to-day trip purposes, people use *pedati* to carry goods or things to be sold such as woods or bamboo around the villages. In small cities or villages, it can be found that people use *delman* as transportation to reach certain places (Andriana, 2002).

An information regarding the characteristics of indigenous transport in five Javanese cities in 1987 (Bandung, Solo, Magelang, Salatiga, and Banjarnegara) can be gathered from Dimitriou (1995) (see Table 2). Table 3 explains the comparison of the operational characteristics of *becak* between 1981 and 2004. More information about the characteristics of paratransit and non-motorized mode in Bandung can be found in Joewono and Kubota (2005).

### Table 2 Characteristics of Mode of Transport in Five Javanese Cities (1987)(Dimitriou, 1995)

<table>
<thead>
<tr>
<th>Mode of Transport</th>
<th>Cruising speed (speed limit) (kph)</th>
<th>Average speed (kph)</th>
<th>Ideal trip length (m)</th>
<th>Average trip length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>5</td>
<td>3.5</td>
<td>400</td>
<td>1.1</td>
</tr>
<tr>
<td>Pushcharts*</td>
<td>5</td>
<td>n.a.</td>
<td>400</td>
<td>n.a.</td>
</tr>
<tr>
<td>Bicycles</td>
<td>15</td>
<td>6</td>
<td>3.3</td>
<td>2.8</td>
</tr>
<tr>
<td><em>Becaks</em> (pedicab)</td>
<td>10</td>
<td>5.3</td>
<td>1.5</td>
<td>2.3</td>
</tr>
<tr>
<td><em>Andongs</em> (horse drawn carriages)</td>
<td>10</td>
<td>n.a.</td>
<td>1.6</td>
<td>n.a.</td>
</tr>
<tr>
<td>Motorcycles and motorcycle taxis (<em>ojeks</em>)</td>
<td>80</td>
<td>9</td>
<td>43</td>
<td>3.9</td>
</tr>
<tr>
<td><em>Bemos</em> and <em>bajajs</em></td>
<td>40</td>
<td>8</td>
<td>20</td>
<td>4.5</td>
</tr>
<tr>
<td>Mikrolets, Minibuses, and City buses</td>
<td>60</td>
<td>8</td>
<td>43</td>
<td>4.5</td>
</tr>
<tr>
<td>Motorcars</td>
<td>100</td>
<td>8</td>
<td>110</td>
<td>4.7</td>
</tr>
</tbody>
</table>

*There are two kinds of pushcharts, i.e. the *gerobak* (a pushchart for carrying freight and merchandise of all kinds, including solid waste) and the *kakilima* (which mostly serves as a mobile food vending facility often left stationary on the road-sides). They usually run on bicycle wheels and come in various widths, but the majority is designed to access the narrowest footpaths.

n.a. = not available

### Table 3 The Cycle Rickshaw (Becak) Operational Characteristics in Bandung (Prianto, 2004)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean of Distance (km)</th>
<th>Longest Distance (km)</th>
<th>Travel Speed (kph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>1.5</td>
<td>2.3</td>
<td>5.53</td>
</tr>
<tr>
<td>2004</td>
<td>1.13</td>
<td>2.46</td>
<td>9.93</td>
</tr>
</tbody>
</table>

2.3.2 Market identification

Indigenous transport modes provide equitable access to destinations for different individuals that belong to different income levels. For example, in Dhaka, low to middle class use
rickshaws because of the affordability issue of using other modes such as auto-rickshaws. The study by Hossain and Susilo (2011) identified that the ones who are likely to be mostly affected in a rickshaw-free scenario is the low and middle income groups in terms of making commuting trips.

2.3.3 Drivers and operators

Public transport driving, especially for indigenous and informal modes, is a difficult occupation as drivers are typically on the road for more than 12 hours a day with buses and PUJs serving long-distance trips and tricycles and MC taxis complementing and servicing short-distance trips. Compared with the drivers of formal modes, those of the indigenous and informal modes lack the necessary social protection benefits. Informal modes are usually driven by its owner and if not, usually employ 1-2 drivers. Strict implementation of labor code policies is not enforced since most often, drivers are also the owners, or if not, verbal arrangements exist (Guillen, 2008). In a survey on rickshaw drivers in Dhaka City, the average age was 40 years. Drivers have been driving for 16 years. Most drivers estimated their daily travel to be about 100 kilometers (km), ranging from around 70 over 150 km. Their average monthly income was less than Rs. 4300 ($100) from a pool of between 20 and 80 customers. Their typical work hours extend to 14 hours from 8am to 10pm. Drivers approximated that on a yearly basis their rickshaw was only out of service for about two weeks total. Some issues associated with indigenous drivers and operators are as follows: license restriction create a lucrative black market in duplicate or falsified licenses making cycle-rickshaw drivers and owners vulnerable to extortion and abuse from local police and even loss of livelihood (Replogle, 1992); minimal check is being executed on the behavior of its drivers for their indiscipline, violations, disobedience to traffic rules and regulations (Luthra, 2006) and driver exposure to exhaust on a daily basis results in higher health risks.

2.4 Policy context

2.4.1 Philippines

Philippine national-level figure on informal sector is pegged at 10.5 million wherein 10% is attributed to informal sector operators in transport, storage and communications. Guillen (2008) mentions of the increasing role transport plays in growth and development especially in developing cities. However, data employment on specific informal sectors is still vague. Informal sector in the Philippines include street hawkers, market vendors, pedicab or bicycles with side-cab and tricycle drivers, small construction workers and home-based industries and services (DOLE, 2001).

Indigenous transport in the Philippines are typically road-based considering the archipelagic nature of the country, water-based transport are present but use and operation to transport passenger is quite limited. Road-based indigenous transport modes include: public utility jeepneys (PUJs), tricycles (motorcycle with a side cab), habal-habal or motorcycle taxis and/or non-motorized ones like the pedicab and calesas (or house-drawn vehicle). Guillen (2008) mentions that non-motorised vehicles are often excluded from national statistical counting. This contributes further to their “informality.”

Before the enactment of the Local Government Code of 1991, the tricycles were also covered by the LTFRB. However, unlike the other motor vehicles used for public transport where operations are usually inter-city or inter-municipality, the tricycles have been limited to certain
areas. Compared with PUJs or other high occupancy vehicle (HOV), tricycles operate on short-distance travel. When the devolution took place in 1992, only the regulation of tricycle operations was transferred to the local government units (LGU). On the other hand, the Office of Transportation Cooperatives (OTC) promotes the formation of cooperatives among transport providers.

2.4.2 Dhaka, Bangladesh
In April 1987, the government of Dhaka announced plans to completely ban pedicabs from the city on safety grounds, although at the time, they employed more than 100,000 people (Replogle, 1992). Later this did not materialize due to political reasons and public movement. This has been followed by restricted registration as well as licensing for NMPT in 1989 and high taxation on spare parts. The former is still in practice. Replogle (1992) emphasized the NMV unfriendly situation stating that stiff protectionist policies aimed at aiding domestic NMV producers impose a high cost on cyclists and cycle-rickshaw users while often failing to create viable industries. When combined with low taxes on motor vehicle imports, such policies foster economically inefficient choices.

In the Second Five Year Development Plan (1980-1985), not one transport project in three hundred projects was connected with rickshaws. In the Third Five Year Plan, rickshaws were dismissed in a single sentence: “Slow-moving vehicles such as pedal-rickshaws, push and pull carts, etc. should be gradually eliminated through development of automotive vehicles and training of existing operators for such vehicles” (Government of Bangladesh, 1985).

In line with such policies, in 2002 Dhaka City Corporation banned rickshaws from eight major roads. Their aim was to improve traffic flow by making more space for motorized transport since rickshaw are considered to be slow moving vehicle that occupy much road space and create congestion (Bari and Efroymson, 2005). Hossain and Susilo (2011) however discussed the counterproductive results of such a policy in terms of increased travel time and cost on the users as well as increased level of air pollution. This has been attributed to the lack of study on a better understanding of rickshaw as a mode, usage pattern and the importance of rickshaw to the different segments of society as well as the lack of understanding of people’s basic travel needs, behaviours and adaptation.

2.4.3 Bandung, Indonesia
Similar to Indian and Bangladesh cities, restrictions by a 10% reduction on the number of becak registration was implemented from the middle of the 1990s. Becaks were also not allowed in central areas as marked by prohibition signs. However, during the financial crisis, these prohibitions were weakly enforced due to the increase in unemployment. The monetary crisis emphasized the role of becaks as a means of livelihood. Conflicts between the authorities and becak operators in Jakarta have demonstrated that strong measures to implement the reduction policy are not politically feasible.

Mayoral decree limits the number of licenses to 5,436 but about 4,695 angkots actually operate. The angkot network comprises only 38 routes. The largest route (No.1) has 427 angkots permitted, of which 325 are in operation. Every owner of an angkot vehicle operating in kota Bandung must be a member of one of the three cooperatives, and each co-operative maintains an effective monopoly on access to the routes it controls. No vehicle may operate on route unless the vehicle owner or driver is a member and has paid membership fees.
**Ojeks** are motorcycle taxis which originally served hilly and remote areas is now providing feeder services between kampongs as well as serve as a ‘taxi’ service on congested traffic condition. There is no enforcement on ojeks although it appears to be regulated as many stands have shelters, and riders don on distinctive helmets. Ojeks are being unofficially ‘registered’ by the local Police Sector Offices and the local security office instead of vesting this on the transport regulatory authority, DISHUB (n.d.).

### 2.4.4 Delhi, India

New Delhi followed during the early 1980’s and also put restriction on the number of cycle-rickshaw registrations as well as licensing (Rahman et al., 2009). The practice in Delhi is to issue a number of licenses each year to rickshaw drivers. The number is much lower than the actual number of drivers. Thus, one out of five (5) individuals who works as rickshaw pullers are not registered, thus, informal. However, his situation has been ongoing. Typically, indigenous modes are considered as informal sector and have not been incorporated into the present policy framework.

### 3.0 INDIGENOUS TRANSPORT CONTRIBUTION TO CLIMATE CHANGE ADAPTATION

This section illustrates preparatory work that would feed into strategies and policies on the potential contribution of indigenous transport towards climate change adaptation.

#### 3.1 Increasing the adaptive capacity of cities

Cities in developing countries are much more vulnerable to changes in climate as they are not well-equipped and lack the adaptive capacity to respond to the impacts of climate change. Developing more compact settlements is one anticipatory strategy that aims to increase the adaptive capacity of communities (Sperling and Szekely, 2005). Compact urban structures typically characterize Asian settlements. Such urban forms are being encouraged because the capacity to physically expand outwards entails high social, environmental and economic costs (Burchell et al, 2002). As cities are becoming more compact in form, trips tend to be shorter and different activities can be accessed within a few minutes. This is reminiscent of Clarence Perry’s neighborhood concept which may serve as a viable model towards the development of compact settlements as it encourages a mix in land uses that can be accessed within a five-minute radius. Active transport such as walking and cycling and public transport become viable options to provide the necessary mobility for individuals for short as well as long intra-city trips, respectively. Jakarta (Indonesia) is served by a wide range of vehicles, from human-powered *pedicabs* to minibuses which offer regular passenger services. For example, *pedicabs* called *becaks* serve short distance trips, *ojeks* or motorcycle taxis serve slightly longer distances. *Bajajs* or three-wheeled motor taxis provide similar services to a taxi while *bemos* and *toyokos* carry as many as eight passengers (Cervero, 2000). Moreover, Asian historic districts and settlements have narrow roads because they were initially developed for walking. Buses because of their larger configuration tend to be not-suited into the urban form and pattern of Asian historic settlements. In this case, indigenous transport such as paratransits because of their compact and smaller configuration allows ease of maneuverability within urban centres. At the same time, cycle rickshaws and auto-rickshaws easily provide two passengers the required mobility and door-to-door service without the need for longer waiting time.

#### 3.2 Shifts towards cleaner transport technology
Transport is considered as one of the highest contributor to greenhouse gas emissions and at the same time has provided the least progress in cost-effective GHG reduction (Hook, 2007). With increasing urbanization, it is expected that automotive related pollution will increase exposure of 300-400 million city dwellers in developing countries if effective control measures are not put in place (Faiz and Aloisi De Larderel, 1993). A gasoline taxi car emits 293 grams/vehicle-km of CO₂ while a diesel articulated bus emits 1,000 grams/vehicle-km (Sperling and Salon, 2002). As a response, multinational organisations have encouraged the use of cleaner fuels and the conversion of fuel cell or battery operated two-or three-wheeled vehicles designed to carry more than one person, for public transport and goods delivery (Hook, 2007).

Shifts toward cleaner transport technology can be seen in various Asian developing cities such as the pilot electric jeepsneys in the Philippines being implemented in Makati City and Puerto Princesa, Philippines, retrofitting motorcycles to direct injection which aims to reduce emissions from two-stroke tricycles and the use of electric tricycles in Bicol City and Puerto Princesa, Philippines (Ibay and Bathan, 2008). Highly polluting auto-rickshaws in India have left its drivers with increased respiratory morbidity due to their direct exposure to automotive exhaust and air pollution. The design and development of the next generation electric auto-rickshaws is considered as a potential improvement as well as the development of solar-powered battery recharging stations at the city outskirts (Lukic, 2007). Electric scooters or e-scooters which is a two-wheeled motorized vehicle operated solely on battery power is being encouraged by the Asian Development Bank as an alternative to its gasoline-powered counterpart as they have zero local tailpipe emissions, virtually silent and contribute to air and noise pollution reductions (ADB, 2009). However, with new technology, it also becomes imperative to ensure a community’s physical and social readiness to adapt and use the new technology especially in addressing technical and mechanical problems.

3.3 Promoting non-motorised transport (NMTs)

Promoting non-motorised transport is a strategy to increase adaptive capacities of cities especially in the developing world. Replogle (1992) cites a number of reasons why NMTs such as bicycles, pedicabs, cycle-rickshaws and carts contribute to a better urban fabric and residents. NMTs offer low cost private transport, emit no pollution are therefore environment-friendly alternative, use pedal power, thus, utilize renewable energy, emphasize labor rather than capital for mobility and are well-suited for short trips in most cities regardless of income (Replogle, 1992). It also provides health benefits to its drivers. The use of smaller vehicles along specific public transport routes provides ease of maneuverability especially in narrow roads of older districts of the city. Roads within old districts of Asian cities have restrictive road widths because they have been developed centuries ago, and were designed to carry either pedestrian movement or animal-drawn carts. NMTs such as cycle-rickshaws have small size and narrow body which allows ease of navigation. Moreover, a number of Asian cities have experienced unprecedented rains resulting in the worst flooding and landslides in the last 100 years. During the seasonal floods that accompany the monsoon, rickshaws play a vital role as it is the only mode capable of operating in the flooded streets of Dhaka City. This illustrates the resilience of this indigenous transport. In the study of Hossain and Susilo (2011), 74% of the sample surveyed in Dhaka was dependent on rickshaw during heavy rains or flood.

Promoting non-motorized transport can be done by improving the technology. Using technology that helped improve the Indian rickshaw, Indonesian drivers can look forward to a becak that is much easier to use. It is hoped that the strain on them will be reduced by 40%, which means the drivers will be able to earn more money – as much as 20-50% more (Utz and
There is the potential of electric bike to be implemented in developing countries to adopt the seemingly positive progress in China (Cherry and Cervero, 2007, Cherry et al., 2009, Weinert et al., 2008).

3.4 Reduced vulnerability of the urban poor to climate change impacts
Existing regulatory frameworks within Asian cities more often than not increase poor people’s vulnerability to hazards and climate impacts rather than minimize them. Special attention is necessary in identifying the potential role and the rights of indigenous transport sector users, drivers and operators. Job employment from indigenous transport such as rickshaw pulling reduce vulnerability of the urban poor to climate change impacts by ensuring that they can maintain an income to meet their basic needs. Rickshaw pulling is a relatively easy livelihood for those lacking specific skills and is considered a way out of poverty (Begum and Sen, 2004). It also supports and promotes resilience and to build people’s capabilities so to avoid economic disadvantage in people.

Rickshaw pulling can also be a seasonal work option combining this with agriculture or other jobs which can only be done at particular time of the year. It can also be done in shifts wherein two rickshaw pullers share time within the day. Ali and Islam (2005) estimate that about 2.5 million people or 20% of the total population in Dhaka city relies on rickshaw directly or indirectly. Aside from pulling, various industry provide support as repairers, makers, owners, shop keepers who sell cycle parts, even tea stalls whose main customers are rickshaw pullers (Wipperman and Lee, 2007). In Dhaka, rickshaw operation contributes highly to the social and economic activities of almost 5 million people. As a whole, bicycles, rickshaws, bullock carts and country boats account for about 75% of the value added, 80% of the employment, and about 40% of vehicle assets employed in the transport sector. On secondary roads, non-motorized transport vehicles make up about 85% of traffic (Replogle, 1992). Gallagher’s study (1992) suggests rickshaws contribute to 34% of the total value-added by the transport sector in Bangladesh which is twice more than the contribution of all motorized road transport, 12 times the contribution of Bangladesh Railways, and 12.5 times the contribution of Bangladesh Biman (Airways) (Hossain and Susilo, 2011).

3.5 Increasing awareness on indigenous transport system
Some strategies which aim to mitigate environmental impacts are adopted from our Western counterpart. But these solutions sometimes fail to address problems that are experienced within the Asian developing city context. Traditional knowledge refers to systems that were already in place in the past and are presently being reconsidered as potential solutions to current problems. Thus, the identification of local knowledge especially in the transport system and the need to mainstream indigenous knowledge seem a plausible approach to counter climate change impacts as well as alleviate transport disadvantage in developing cities. This mainstreaming may be in the form of identifying and sharing of information, advocacy and lobbying with the aim of incorporating into existing legislation, training and traineeships, development of best practice principles which may be adopted within the local context.

3.6 Community-based approach to increasing adaptive capacity
Climate change also brings about challenges that do not only affect the natural but also our
built environment. Adapting as a collective rather than as individual becomes a more strategic approach in increasing the adaptive capacity of settlements. It then becomes imperative to form social networks. By doing so, communities work together more effectively, interact and develop collaborations, both at the local and international levels, with other organizations more easily. Indigenous transport modes often create operators’ and drivers’ association which provides a more organized process of operation. It also facilitates better information dissemination and knowledge transfer, effective management of information, enhance the decision-making process and, in the long run, respond to climate change challenge in a more effective manner. However, a group’s ability to adapt is limited by monetary resources, lack of access to technical skill-set, among others.

4.0 CONCLUSION

To acknowledge the presence of and consider the potential of incorporating indigenous transport mode into the overall transport system become important steps toward ensuring a broader respect for local powers and cultural diversity. The paper was able to reflect on the multitude of insights provided by the presence and use of indigenous transport modes within the various case cities. It also provided some possibility of increasing the adaptive capacities of developing cities by the consideration of local knowledge towards achieving climate change adaptation. At present, governments especially within developing cities have not clearly articulated in their national level plans climate change perspectives nor has there been a comprehensive approach towards integrating strategies in various sectors (e.g. in transport, urban development and the like) towards mitigating or adapting to climate change. This paper becomes the first step to provide implications of indigenous transport as a potential approach to climate change adaptation. This will serve as a background study towards gathering the evidence base that may pave way towards increasing the adaptive capacities of cities and making them more resilient in the long run. Furthermore, it will help local authorities towards supporting policy-relevant insights to better understand the role of indigenous transport in climate change adaptation at the local level. Through the previous discussions, there was better articulation on the role, function and use of indigenous modes within the whole transport network. Although this paper provides only provides an introductory perspective that would later on feed into a larger scale study, as a way forward, further studies are deemed necessary to develop indigenous transport strategy towards adapting to climate change. There is a need of further support regarding capacity building, specified tools, and technical expertise, so that they can develop adaptation actions and strategies for reducing the severity of many of the impacts of climate change.

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