State of the Art of Paratransit Literatures in Asian Developing Countries

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Abstract: Paratransit systems cause traffic and environmental issues but they also serve as a personalized and flexible public transport mode in response to passenger demand, especially in Asian developing countries. Given the lack of an adequate mass transit system, the paratransit service is indispensable, while a harmonized public transport system has also recently attracted considerable interest. This paper reviews the paratransit literature and summarizes the existing fields of studies, establishes a common terminology for paratransit services, provides a more comprehensive classification scheme for the paratransit system, and discusses potential issues in relation to its sustainability. In the existing literature, we identify four key factors necessary to sustain the paratransit system such as improvements in the quality of service, integration with mass transit systems, promotion of electric paratransit modes, and government support. This information provides insights into strategic planning for increased harmonization of public transport systems in Asian developing countries.

Keywords: Asian developing country, LAMAT, Sustainability, Paratransit, Public transport

1. INTRODUCTION

Paratransit is an indispensable mode of public transport in Asian developing countries, where mass transit systems are inadequate. It provides personalized and flexible transport services, filling service gaps between private transport modes and mass transit systems (Roos and Alschuler, 1975). It assists socioeconomic activity through its availability and by providing employment opportunities for poor or low-skilled workers (Cervero and Golub, 2007). Moreover, it requires little policy intervention and no public investment or subsidies (Joewono and Kubota, 2007c). Paratransit modes include angkot and Bajaj in Indonesia, jeepneys and tricycles in the Philippines, motodops and remorks in Cambodia, sidecars in Myanmar, and tempos in Nepal.

On one hand, paratransit appears to offer numerous benefits. On the other hand, it has been seen as the root cause of traffic and environmental issues. As a result of a lack of control and regulation by the government, paratransit services operate freely in general traffic, letting passengers on and off anywhere along the service routes. These activities have resulted in traffic chaos, and sometimes lead to traffic accidents (Cervero, 2000). In addition, paratransit vehicles are often in poorly maintained condition (e.g., non-standardized vehicles and design), which in turn contributes to substantial levels of air and noise pollution. To some extent, paratransit is considered to be an unreliable transport service characterized by minimal comfort, inhumane working conditions, and a criminal-style structure (Joewono and Kubota, 2007b). Consequently, questions have been raised as to whether paratransit services should be
eliminated from the public transport system or whether they should be promoted along with better service performance and less negative impacts (Loo, 2007; Tangphaisankun et al., 2009b; Fujiwara and Zhang, 2013, p. 140).

As a result of the slow progress of economic development, most Asian developing countries have limited budgets to provide citizens with more reliable, environmentally friendly, and efficient urban transportation systems like mass rapid transit (MRT), light rail transit (LRT), or bus rapid transit (BRT). The majority of people in these countries, especially the poor, cannot afford private transport, and hence rely predominantly on paratransit services for transport. Therefore, paratransit remains indispensable in the urban mobility context. A number of studies have investigated various aspects of the paratransit system, including physical and operational characteristics, costs and benefits, and sustainability (e.g., Shimazaki and Rahman, 1995; Regidor et al., 2009; Tarigan et al., 2010). Several aspects of both the demand and the supply sides have been analyzed to determine the sustainability of the paratransit system. Studies on the demand side have mainly involved user perceptions such as user satisfaction, perceived service quality, and behavioral intentions (e.g., Joewono and Kubota, 2007a; Sumaedi et al., 2012). Studies on the supply side have focused on the drivers’ quality of life and job performance, and government regulation (e.g., Diaz and Cal, 2005; Weningtyas et al., 2013; Li et al., 2014). Although researchers have been able to come up with some policy implications through various case studies (e.g., Fujiwara and Zhang, 2013, Chapter 6), a review of existing studies on the paratransit sector can provide vital information for researchers and the relevant authorities regarding the future of public transport systems in Asian developing countries.

This study provides a detailed review of the literature on paratransit systems in Asian developing countries with the following four objectives: 1) summarizing the existing fields of paratransit studies, 2) proposing a new terminology for paratransit, particularly in Asia, 3) establishing a more comprehensive classification system for paratransit, and 4) identifying the key factors influencing the sustainability of the paratransit system. Although several previous studies have provided an overview of the paratransit sector (e.g., Roos and Alschuler, 1975; Cervero, 2000; Lave and Mathias, 2000), none have conducted a detailed review of the sector, particularly in Asian developing countries. In addition, the concept of paratransit is rather different between developed and developing countries (Shimazaki and Rahman, 1996). Subsequently, several definitions of the term “paratransit” have been used in the developing world. Therefore, the second objective of this paper is to provide a common terminology and definition that is suitable for Asian developing countries. Because most paratransit vehicles are indigenously manufactured to fit the market needs, they take various forms and are ill-equipped and non-standardized. As a result, the vehicles are traditionally classified by their power source (non-motorized or motorized), number of wheels, vehicle type, seat capacity, etc. This classification system can be useful for the government in terms of public transport regulations and standard classifications of transport modes. The classification system proposed herein is another possible contribution of this paper. A review of the paratransit market size in each city and discussion on which paratransit system is most suitable for each city are beyond the scope of this paper.

The rest of this paper is organized as follows. Section 2 summarizes the existing fields of paratransit studies in relation to Asian developing countries. Previous definitions of the term “paratransit” are reported in Section 3, and a new term and definition are proposed. In Section 4, we develop a better taxonomy for the paratransit system and describe its important elements. We discuss the key strategies for sustainability of the paratransit system in Section 5. Section 6 concludes.
2. PREVIOUS STUDIES

Studies on the paratransit sector have become more popular in the last decade, particularly in relation to Asian developing countries. The fields of study, the study area, the authors, and the year of publication are summarized in Table 1. Early studies focused on the benefits of minibus services and operations in Kuala Lumpur, Malaysia (Walters, 1979). Then, the physical and operational characteristics of various paratransit systems in several Asian countries were broadly reviewed by Shimazaki and Rahman (1995, 1996). Similarly, Cervero (2000) provided further discussion on the market, organization, and policy background in relation to paratransit services from a global viewpoint. Joewono and Kubota (2005) studied the characteristics of paratransit and non-motorized transport in Bandung, Indonesia, including an analysis of user load factors and their ability and willingness to pay for paratransit services.

Table 1 Summary of existing studies of paratransit services in Asian developing countries

<table>
<thead>
<tr>
<th>Study fields</th>
<th>Country/Area</th>
<th>Authors</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical and operational characteristics of paratransit, and its position in</td>
<td>Asian</td>
<td>Hokao and Tanaboriboon</td>
<td>1993</td>
</tr>
<tr>
<td>transportation system</td>
<td></td>
<td>Shimazaki and Rahman</td>
<td>1995</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>Shimazaki and Rahman</td>
<td>1996</td>
</tr>
<tr>
<td></td>
<td>World</td>
<td>Cervero</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Joewono and Kubota</td>
<td>2005</td>
</tr>
<tr>
<td>Policy &amp; regulation, cost &amp; benefit, and market structure of paratransit</td>
<td>Malaysia</td>
<td>Walters</td>
<td>1979</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Bayan et al.</td>
<td>1995</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Diaz and Cal</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>World</td>
<td>Cervero an Golub</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>Anjali Prabhu et al.</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>Bangladesh</td>
<td>Newaz et al.</td>
<td>2014</td>
</tr>
<tr>
<td>The role of paratransit as feeder services to a transit system, and paratransit performance in transportation system</td>
<td>Philippines</td>
<td>Okada et al.</td>
<td>2003</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>Satiennam et al.</td>
<td>2006</td>
</tr>
<tr>
<td></td>
<td>Hong Kong</td>
<td>Loo</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>Tangphaisankun et al.</td>
<td>2009b</td>
</tr>
<tr>
<td>Fare structure of paratransit</td>
<td>Indonesia</td>
<td>Nugroho et al.</td>
<td>2012</td>
</tr>
<tr>
<td>Safety and Security of paratransit</td>
<td>Indonesia</td>
<td>Joewono and Kubota</td>
<td>2006</td>
</tr>
<tr>
<td>User perception and the sustainability assessment of paratransit service</td>
<td>Indonesia</td>
<td>Joewono and Kubota</td>
<td>2007a</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Tarigan et al.</td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Sumaedi et al.</td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>Javid et al.</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Okamura et al.</td>
<td>2013</td>
</tr>
<tr>
<td>Paratransit drivers relevant aspects such as drivers’ satisfaction, job performance, and quality of life</td>
<td>Cambodia</td>
<td>Etherington and Simon</td>
<td>1995</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Li et al.</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Nugroho et al.</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Weningtyas et al.</td>
<td>2013</td>
</tr>
<tr>
<td>Paratransit-adaptive transportation policies for transition to sustainability and social &amp; environmental impacts</td>
<td>Nepal</td>
<td>Roy et al.</td>
<td>2001</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Regidor et al.</td>
<td>2009</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>Mani et al.</td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Fujiwara and Zhang</td>
<td>2013</td>
</tr>
</tbody>
</table>

1 Some of previous researches may cover more than one study fields, but authors are only reported once for its most suitable field of study.
2 Other publications including reports from the government or the World Bank might not be included here.
Furthermore, a discussion on how a nonstandard paratransit vehicle (i.e., the FX type) was considered in the Philippines’ public transport regulations and standard classifications was provided by Diaz and Cal (2005). The discussion also included financial and sustainability analyses of the FX service. On a wider scale, Cervero and Golub (2007) provided an extensive review of the costs and benefits, and associated policies and regulation of the paratransit sector worldwide. Few studies have investigated the fare structure of paratransit services. Nugroho et al. (2012) analyzed variations in paratransit fares in Jakarta by observing several factors such as driver and passenger attributes and trip characteristics. There have also been few studies on traffic safety and security issues (e.g., traffic congestion, accidents, and crimes) caused by paratransit operations (Joewono and Kubota, 2006).

Another interesting field of study focuses on the role of paratransit services as feeder services to the mass transit system. Since paratransit still plays a significant role in providing public transport to people in most Asian developing countries (Tangphaisankun et al., 2009a), proper integration strategies (i.e., facilities and fare systems) among public transport modes are needed to ensure seamless transfer and the sustainability of the integrated transport system. Policymakers should consider how to integrate the paratransit system into the overall public transport system (Loo, 2007). For example, Satienam et al. (2006) showed that having a well-organized paratransit feeder service (including parking facilities) to a BRT system would improve the network performance and result in lower emission levels. Improved accessibility and intermodality through the integration of paratransit and mass transit systems has also been shown to increase user satisfaction levels (Okada et al., 2003; Tangphaisankun et al., 2009b).

Both the supply and the demand sides of paratransit services were studied. On the demand side, user perceptions (i.e., satisfaction, perceived service quality, behavioral intentions, and negative attitudes towards paratransit services) are often used as indicators to assess the sustainability of the paratransit system (e.g., Joewono and Kubota, 2007a; Tarigan et al., 2010; Sumaedi et al., 2012). User perceptions of paratransit services were analyzed using various statistical methods including structural equation modeling, binomial logistic regression, and the ordered probit model (e.g., Joewono and Kubota, 2007b, 2007c; Tarigan et al., 2010). On the supply side, Weningtyas et al. (2013) investigated how an improvement in the level of paratransit service would affect drivers’ quality of life, while other researchers focused on the drivers’ job satisfaction and job choice behavior (e.g., Li et al., 2011; Nugroho et al., 2013).

Fujiwara and Zhang (2013, Chapter 6) discussed the importance of paratransit-adaptive transportation policies for improving the sustainability of paratransit services. The authors suggested that paratransit services could not be simply removed from public transportation systems in developing countries because this would increase the unemployment rate among paratransit drivers and reduce mobility for the transportation poor, although it would also lower air pollution. In the Philippines, for example, the impacts of introducing reforms to the paratransit sector (i.e., jeepneys) were studied for Cebu city, where the role of a jeepney as a primary mode of transport (accounting for 65.0% of total daily passenger trips) was redefined after the implementation of the BRT system (WB, 2012). In Indian cities, the significant role of auto-rickshaws in promoting sustainable urban transport was also investigated (e.g., Mani et al., 2012). Moreover, the reengineering of paratransit vehicles and the possibility of upgraded technologies such as electronic vehicle (EV) systems were analyzed in terms of environmental sustainability (e.g., Maharjan, 2002; Regidor et al., 2009; Jalotjot, 2012; Nacino, 2014). The first successful electric paratransit system was introduced in Nepal using Safa Tempos (Roy et al., 2001; KEVA, 2003).

The above studies covered both the demand and the supply sides, and possible policy implications, which provided useful information for transportation planners in formulating
appropriate policies and regulations for sustainable and efficient integrated public transport systems in Asian developing countries. The study areas were predominantly focused on cities in Indonesia (e.g., Bandung, Jakarta) and the Philippines (e.g., Manila, Cebu). The socioeconomic organization of paratransit (cyclo) riders and their employment background in Phnom Penh, Cambodia, has been investigated (Etherington and Simon, 1995). Studies on paratransit services should also be conducted in other Asian developing cities, because city characteristics and paratransit operations will invariably differ, with consequent policy implications.

3. DEFINITION

The term “paratransit” means “alongside transit” (Lave and Mathias, 2000). This term was first used in the mid-1960s to describe transportation services that would approximate the convenience and ubiquity of vehicles, which would ensure the efficiency and economy of public transport (Orski, 1975). “Paratransit is an urban passenger transportation service, usually in highway vehicles, operated on public streets and highways in mixed traffic. It is provided by private or public operators and it is available to certain groups of users or to the general public, but is adaptable in its routing and scheduling to an individual user’s desires in varying degrees” (Shimazaki and Rahman, 1995). Although the term has been used worldwide, understandings of its meaning differ among developed and developing countries. In North America, paratransit is a flexible door-to-door transport service provided specifically for elderly or physically handicapped people (in compliance with the Americans with Disabilities Act) and is another form of demand-responsive service (Lave and Mathias, 2000). In Europe, paratransit refers to particular public transport services including dial-a-ride, ride-sharing, jitneys, and shuttles (Orski, 1975; Mulley and Nelson, 2009). In these countries, paratransit modes include private vehicles and formal transit systems, ranging from taxis to bus lines.

3.1 Existing Definitions

In developing countries, various definitions of paratransit services have been used in the literature (e.g., Joewono and Kubota, 2007b; Tarigan et al., 2010). Cervero (2000) variously describes public transport modes that are privately operated on a small scale as “paratransit,” “low-cost transport,” “intermediate technologies,” and “third-world transport.” Similarly, Neumann (2014, p. 12) defines paratransit as a demand-oriented transport mode mainly used in the cities of the developing world. After considering several aspects of paratransit systems (e.g., types of vehicles, operations, services), it is often easier to define the term “paratransit” in an abstract way rather than in one sentence. Joewono and Kubota (2007a) refer to “paratransit” as a mode of transport owned and operated by private companies and individuals. It is a public mode of transport that operates in mixed traffic with fixed routes, but without a fixed schedule, on urban streets (Joewono and Kubota, 2007c). Elsewhere, “paratransit” is defined as a group of mainly urban transport services somewhere between private passenger transport and conventional public transport in terms of cost and quality of service (Etherington and Simon, 1995). “Paratransit” is a transport mode that is not quite full public transit, utilizing smaller vehicles, and its operation can be either legal or illegal as defined by local rules and regulations (Weningtyas, 2013). In some cases, paratransit is known as the “informal public transport mode” that has developed to fill the service void left by private vehicles and conventional mass transit systems where there is no official authorization.
required for transport services (Cervero and Golub, 2007). Further definitions of “paratransit” can be found in Neumann (2014, pp. 181–184).

### 3.2 Proposed Term and Definition

Paratransit is known by its local name in developing countries (e.g., angkot, jeepneys, remorks, songthaews). Although various descriptions have previously been provided, there is no common definition of “paratransit” that covers all modes and types of operation of paratransit services in Asian developing countries. In this paper, we propose the following common definition of “paratransit”: indigenous public transport modes that are locally adapted, modified, and advanced for a certain transport service in a particular city or region. This definition is based on the term “Locally Adapted, Modified, and Advanced Transport (LAMAT).”

A LAMAT mode may initially be adopted in its original form (i.e., a vehicle imported without physical alterations) for domestic operation and service (e.g., motorcycle taxis, taxis, or minibuses). The mode may then be modified (i.e., physical conversion of vehicles) in accordance with the transport needs of local people (e.g., remorks, jeepneys, or songthaews). Later, the mode may be advanced using affordable technology to improve service quality (i.e., comfort, safety, and environmental impact) and to sustain passenger demand (e.g., COMET e-jeepneys or e-tuktuks). Here, the use of the term “advanced” refers to the prospective use of available technologies (e.g., electric vehicles, electronic fare systems, and information and communication technology) to enable a LAMAT mode to survive. LAMAT modes include all intermediate modes between private transport and conventional mass transit systems ranging from non-motorized two-wheelers (bicycle taxis) up to motorized four-wheelers (minibuses) with a maximum seating capacity of about 25 passengers. Figure 1 shows some typical examples of LAMAT modes in Asian developing countries. LAMAT services are provided along either flexible or fixed routes and on either flexible or fixed schedules. Apart from taxis, the cost of travel by LAMAT is relatively cheap, with the level of service quality ranging from low to moderate depending on local modes. Most LAMAT modes are privately operated as either a fleet of vehicles or an individual vehicle. LAMAT vehicles often deliver low performance because they are older used vehicles that have been modified for the intended services (e.g., vehicle and engine sizes, capacity, and with or without roof).

![Figure 1 Examples of typical LAMAT modes in Asian developing countries: a) sidecar in Myanmar, b) remork in Cambodia, and c) multicab jeepney and tricycle in the Philippines.](image)

### 4. LAMAT SYSTEM

#### 4.1 Classification
Despite the fact that the characteristics of LAMAT modes vary across cities in Asian developing countries, they generally have some common attributes such as low energy consumption, low fares, high labor intensity, and small areas of service coverage (Shimazaki and Rahman, 1995). However, classification of the LAMAT system is not an easy task because of variations in vehicle designs and standards, services, and operations, which do not always comply with the public transport regulations in each country or region. In the Philippines, for example, Diaz and Cal (2005) discuss how the FX LAMAT mode was classified within the country’s standard classification system for public transport.

Previous researchers have tried to classify the LAMAT system based on its key features such as type of vehicle, engine, service route, and vehicle capacity. Shimazaki and Rahman (1995) distinguished a motorized LAMAT system from a non-motorized one by providing further details on a range of vehicle capacities (i.e., individual types with a seating capacity of \( \leq 4 \), shared types with a capacity of 5–10, and collective types with a seating capacity of \( \geq 11 \)) for LAMAT modes in several Asian developing countries. Cervero (2000) created five classes for LAMAT modes that operate informally based on vehicle size, ranging from the smallest and slowest vehicles (pedicab/horse-drawn cart, Class V) to the largest and fastest ones (conventional bus, Class I). Because of the range of operations and services provided, each class was also subdivided based on other aspects such as whether the vehicles were motorized, were collective carriers, operated on a fixed route, or offered a flexible schedule. The public transport system can also be broadly categorized into “formal” and “informal” modes depending on several dimensions (e.g., scheduling, vehicle type, trip distance, and legal status of the transport services) related to the supply side, the demand side, and the government’s role (Cervero, 2000). In this paper, we provide a more comprehensive classification of the LAMAT system by considering the most important features including power supply, number of wheels, and vehicle type (Table 2). For detailed descriptions of the physical and operational characteristics of LAMAT modes in Asian developing countries, see Shimazaki and Rahman (1995, 1996) and Cervero (2000).

In some countries, a conventional bus might be conceptualized as a LAMAT mode when it is operated as a feeder service to a mass transit system (e.g., MRT, LRT, or BRT). This might be the case in some cities in Asian developing countries including Bangkok, Jakarta, and Manila, where there are urban rail and BRT systems. In developing countries that do not have a proper mass transit system, a conventional bus is not regarded as a LAMAT mode, but rather functions as a mass transit system. Further, the taxi is regarded as a special form of LAMAT because taxis are commonly available in most countries worldwide. Taxis mostly offer personalized transport with higher service quality for a higher fare.

4.2 Vehicles and Services

4.2.1 Non-motorized vehicles

Non-motorized LAMAT modes are those that are either animal- or human-powered (either hand-drawn or pedal-driven). These modes are slow, have a small service coverage area, and often disturb the flow of general traffic (e.g., the becak in Indonesia). Non-motorized modes are often banned from entering the central business districts in some cities (e.g., rickshaws in Dhaka), whereas in other cities they are mainly used for tourism-related purposes (e.g., cyclos in Phnom Penh and kalesas in Manila).
Table 2 Classification of LAMAT modes in Asian developing countries

<table>
<thead>
<tr>
<th>Engine type</th>
<th>Wheeler</th>
<th>Vehicle</th>
<th>Seat capacity</th>
<th>Route</th>
<th>Schedule</th>
<th>Example of local LAMAT names (Country)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-motorized</td>
<td>Two-wheeler</td>
<td>Bicycle Taxi</td>
<td>1-2</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Kangdop (Cambodia), Ojek Sepeda (Indonesia)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pulled Rickshaw</td>
<td>1-2</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Man-pulled rickshaw (India)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Animal-cart</td>
<td>2-6</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Andomg/Delman (Indonesia), Calesa (Philippines), Dokar (Bangladesh), Tanga (India, Pakistan)</td>
</tr>
<tr>
<td></td>
<td>Three-wheeler</td>
<td>Cycle Rickshaw</td>
<td>1-2</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Becak (Indonesia), Cyclo (Cambodia, Vietnam), Pedicap (Indonesia, Philippines), Rickshaw (Bangladesh), Samlor (Thailand), Sidecar (Myanmar), Trishaw (Malaysia)</td>
</tr>
<tr>
<td>Motorized</td>
<td>Two-wheeler</td>
<td>Motorcycle Taxi</td>
<td>1-2</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Habal-habal &amp; Skylab (Philippines), Motodop (Cambodia), Ojek (Indonesia), Xe Om (Vietnam)</td>
</tr>
<tr>
<td></td>
<td>Three-wheeler</td>
<td>Auto Rickshaw</td>
<td>2-4</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Baby taxi/CNGs (Bangladesh), Bajaj/Bemo/Helicak (Indonesia), Jambo (Laos), Tricycle (Philippines), Tuktuk (Thailand), Tempo (Nepal, India), Trishaw (Sri Lanka)</td>
</tr>
<tr>
<td></td>
<td>Four-wheeler</td>
<td>Motorcycle Rickshaw</td>
<td>2-6, 12-20²</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Motorela (Philippines), Remork (Cambodia)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taxi³</td>
<td>3-4</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Taxi or Taximeter (in general)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Microbus</td>
<td>4-14</td>
<td>Fixed</td>
<td>Semi-fixed</td>
<td>Angkot (Indonesia), FX (Philippines) Nilo/Setu microbus (Nepal), Selman (Vietnam), Songtaew (Thailand), Wagon (Pakistan)</td>
</tr>
<tr>
<td></td>
<td>Minibus</td>
<td></td>
<td>12-24</td>
<td>Fixed</td>
<td>Semi-fixed</td>
<td>Jeepney (Philippines)</td>
</tr>
<tr>
<td></td>
<td>Conventional Bus³</td>
<td></td>
<td>25-60</td>
<td>Fixed</td>
<td>Fixed</td>
<td>City bus or Public bus (in general)</td>
</tr>
</tbody>
</table>

¹ Classification based on previous studies; e.g., Hokao and Tanaboriboon (1993), Shimazaki and Rahman (1996), and Cervero (2000).
² Typical Cambodian Remork with a long carriage pulled by a motorcycle, having capacity of 12-20 operated on a fixed suburban routes but non-fixed schedule.
³ Taxi or Conventional bus is a special case of LAMAT, see text for explanation.
The popularity of non-motorized two-wheeler LAMAT modes has declined. Before the motorcycle taxi gained its attractiveness in Cambodia as a result of potential trip distance and speed, the service using bicycle taxis, known locally as “kangdop,” was very popular until the late 1990s. However, the bicycle taxi service has not completely disappeared, and is still available in some Asian cities (e.g., Ojek Sepeda in Jakarta, Indonesia). A Japanese invention, the rickshaw, was introduced in 1868 and instantly spread to other Asian countries (Dutt et al., 1994, p. 121). However, the use of the human-pulled rickshaw has now been discontinued in China because it is considered inhumane, whereas this service is still provided in some cities in India (e.g., Kolkata). The rickshaw has since been revolutionized from a human-pulled rickshaw to a bicycle-powered rickshaw, and then to an auto-rickshaw. In some cases, the same terminology might still be used, although it refers to different types of rickshaws. For instance, the term “trishaw” in Malaysia and Bangladesh refers to a bicycle-powered rickshaw (non-motorized), but in Sri Lanka it refers to an auto-rickshaw (motorized).

Animal-powered LAMAT modes such as andongs/delmans (horse-drawn carriages) still play a significant role in providing public transport services in small cities in Indonesia (Joewono and Kubota, 2005). Basically, these modes are not suitable for urban streets mainly due to the carriage size, low speed, and the animal itself, but they are frequently seen in tourist areas.

Non-motorized three-wheeler LAMAT modes seem to have a higher acceptance by the public than two-wheelers for short trips, and these modes are still in service in several Asian developing countries including becaks in Indonesia, pedicabs in the Philippines, and sidecars in Myanmar. All non-motorized modes operate daily on flexible routes and schedules for travel distances of less than 20 km and carry up to 25 passengers (Shimazaki and Rahman, 1995).

4.2.2 Motorization

Motorized LAMAT modes are powered by various fuels including gasoline and diesel (e.g., remorks in Cambodia and jeepneys in the Philippines), compressed or liquefied natural gas (e.g., baby taxis in Bangladesh, and tuktuks in Thailand), and electricity (e.g., Safa Tempos in Nepal). Motorized LAMAT modes are able to provide a faster service over longer distances, and more humane working conditions. According to Shimazaki and Rahman (1995), motorized LAMAT modes travel more than 70 km and carry more than 40 passengers daily, with an average trip length of more than 3 km. The average number of passengers per trip ranges from 1.1 for motorcycle taxis in Bangkok to 19.5 for jeepneys in Manila. In Cambodia, motodops and remorks are the most common public transport modes used by citizens in Phnom Penh, although a public bus service was introduced early in February 2014 (Phun et al., 2015). The average total travel distance by motodop is approximately 60 km for 15.5 trips per day carrying an average of 1.2 passengers per trip (JICA-PPUTMP, 2014). The remork, a typical four-wheeler LAMAT mode, is a combination of a motorcycle and a carriage (domestically manufactured), and carries from two to six passengers. On average, remorks travel from 30 km to 50 km over 4.4 trips per day carrying an average of 2.5 passengers per trip.

LAMAT vehicles are generally old and in poor condition, with many being imported second-hand or in modified/converted forms. For instance, jeepneys in the Philippines are equipped with reconditioned diesel engines (Regidor et al., 2009) and songthaews in Thailand are in the form of converted pick-ups (Tangphaisankun et al., 2009b). The operation of these vehicles has been seen as a cause of high levels of air-polluting emissions, frequent traffic accidents, and low service quality (Cervero, 2000).
4.3 Service Routes

LAMAT service routes are broadly categorized into fixed and non-fixed routes. The patterns of operating routes for LAMAT are closely linked to the local market. From the literature, except for conventional buses, it is observed that most LAMAT modes with a seating capacity of greater than four are operated on a fixed route to a partially fixed timetable, and have no specific stops/stations. LAMAT modes operating on fixed or semi-fixed routes are often larger-sized vehicles (e.g., microbuses, minibuses) collecting distinguished passengers heading in the same general direction. The pick-up and drop-off points along the operating route can be anywhere depending on passenger demand and local and operator regulations. In some cases, drivers may make a minor detour in order to pick up or drop off a passenger upon request.

Most LAMAT modes with a capacity of six or fewer passengers are flexible public transport services operating on non-fixed routes and schedules. These modes use smaller vehicles and their services are more demand responsive. Drivers often have a common pick-up point (e.g., at a major road intersection or near a transit terminal), or may cruise looking for passengers. Drivers pick up passengers at a demand point and drop them off at a desired destination (i.e., door-to-door service) via a selected route. In other cases, the trip’s destination is predetermined either by the driver or by the first passenger entering the vehicle. Drivers then look for additional passengers along the service route who are heading in a similar direction.

4.4 Operators

Like other public transport systems, the LAMAT system can be viewed from two aspects: the demand side and the supply side (Cervero, 2000). The demand side covers all sorts of passengers, ranging from the lower-income group to higher-income people. The supply side mainly includes LAMAT operators and vehicle owners, although other stakeholders may be involved (e.g., the government). In this paper, the LAMAT operators are those drivers who provide transport services to passengers. LAMAT services are normally provided by many small-scale operators who lack capital and management skills. There are three main types of LAMAT operators: single operators, franchisees, and route associations (Neumann, 2014, p. 14).

A single operator owns only one LAMAT vehicle and offers the transport service by himself, either full-time or part-time on a daily basis. In this case, the driver collects all revenue and is responsible for all expenses. In some cases, the driver might rent his vehicle to another driver for a part-time operation. A single operator often competes with other drivers seeking passengers in public places. In franchisee arrangements, a businessman, possibly a former driver, owns several LAMAT vehicles and leases the vehicles to other drivers who cannot afford a vehicle of their own. The lease can be on a daily or a weekly basis.

A route association is a group of LAMAT drivers (single operators and/or franchisees) that is created to avoid open competition with other drivers within a defined service zone (e.g., pick-up spots near an airport or a transit terminal). A route association is a form of self-organization and has its own internal rules (e.g., facility and passenger sharing) to ensure the fairness, efficiency, and quality of the service among its members. The association leader observes whether the rules are firmly exercised and helps in solving problems that the members encounter. A qualified driver who wants to join the association is required to pay a small membership fee, which covers the association’s expenses.
4.5. Organization and Regulation

Although most LAMAT modes are operated informally on the city streets in Asian developing countries, they often have their own organizational structures and regulations for providing realistic public transport services (Cervero and Golub, 2007). For example, a route association is the most common form of LAMAT organization, applying internal regulations to effectively manage driver operations within the service zone. The management of LAMAT services can be influenced by the internal regulations within the association and/or external regulations such as local police requirements and national laws. Single operators might enjoy more freedom in providing services outside the internal regulations, but they still face open market competition when seeking passengers. Whether they are members of a route association or not, the service production of LAMAT drivers frequently relies on interpersonal as well as interoperator relationships and fellowships.

To ensure a balance between supply and demand, the growth in the number of LAMAT operators should be controlled by various strategies including approval, prohibition, and regulation (Cervero, 2000). Where there is a lack of government regulation and enforcement, many new LAMAT drivers commence operation without legal registration. In these circumstances, the route associations are responsible for controlling the growth in the number of drivers in their service zones to ensure profitability at a reasonable level of service. Regarding single operators, it is difficult to control their growth in the open market without any policy to regulate them. Uncontrolled growth in the LAMAT sector would not only affect the drivers’ quality of life, but also result in a more competitive market and more traffic disorder/accidents and air pollution. Relying on the numerous route associations to administer LAMAT operations might not be the most effective and systematic way to provide LAMAT services. Instead, the government should consider setting up a common driver association that has sufficient capacity to manage and regulate all types of LAMAT services in the city or region. This would improve LAMAT service performance and its potential role in the overall public transport system.

4.6 Working Conditions

The working conditions of LAMAT drivers vary considerably, depending on the operating areas and LAMAT modes. For instance, the drivers of motorcycle taxis might work longer hours in urban areas (including at night) and work shorter hours in suburban areas, mainly for safety reasons (e.g., the possibility of robbery). Most LAMAT drivers have a low education level, and their daily income is uncertain. Some drivers are willing to work longer hours than usual in order to earn a minimal income, which is sufficient to support them. Generally, the service hours range from 10 to 12 hours a day for six or seven days a week for motorized LAMAT modes, and from 70 to 80 hours per week for non-motorized ones (e.g., cycle rickshaws) (Cervero, 2000). Traffic accidents, weather conditions, and air quality are among issues that always concern LAMAT operators, because these issues affect the drivers’ income and quality of life.

4.7 Fare Structure

Generally, the fare structure for public transport is categorized into flat and differentiated fares, and this is also the case for LAMAT. The flat fare is a fixed transport fee regardless of the trip distance or quality of service, and is more applicable to LAMAT modes that operate
on fixed routes (e.g., songthaews in Thailand). For non-fixed routes, the flat fare can be in the form of a negotiated fare for a given trip (e.g., tuktuks in Thailand).

The differentiated fare is a flexible transport fee based on the trip length, time of day, type of passenger, speed, or quality of service. It can also be a time-based fare (i.e., the total time a passenger spends using the transport service). The implementation of differentiated fares requires more sophisticated technologies such as fare collection and fare verification systems (e.g., meters, magnetic strips, or smart card technology). However, with the exception of taxi meters, such technologies are unaffordable for most LAMAT operators in Asian developing countries. With this in mind, the transport fee is generally predetermined by a route association or can be negotiated with the drivers. Basically, a driver may come up with a fare for a given trip based on his association’s guidelines and the passenger’s appearance. When there is a decline in daily demand leading to insufficient income, the driver might raise the fares slightly. In these circumstances, the initially quoted fare might be negotiable to some extent. Further, drivers might charge different fares for journeys of the same distance depending on the location, for example, the fare will be higher for a journey from the airport than in other places because drivers need to pay a higher parking/station fee.

Alternatively, a mix of both flat and differentiated fares is applied to fixed routes (i.e., a stage fare). A flat fare is charged for passengers traveling within a defined distance, with an extra fee charged for additional travel beyond the defined distance (e.g., drivers of jeepneys in the Philippines charge a flat fare for the first 4 km and an additional amount for every additional kilometer traveled).

4.8 Technology

Most LAMAT vehicles in Asian developing countries are not standard because they are locally assembled in response to local needs and conditions. The vehicles are generally in poor condition, are uncomfortable, and create substantial noise and air pollution as a result of the operators’ limited financial capacity to maintain them (Joewono and Kubota, 2007b). Therefore, LAMAT vehicles are required to be replaced or upgraded using more advanced technologies (i.e., intelligent transport systems, information and communication technologies, electronic fare systems, and alternative fuels) in order to provide better service performance and quality, as well as lower environmental impacts.

Many forms of LAMAT vehicles have been physically redesigned, and alternative fuels have been considered. For example, tricycles and jeepneys in the Philippines have been reengineered and transformed into environmentally friendly modes using alternative fuels such as liquefied petroleum gas and electricity (Regidor et al., 2009).

Figure 2 Examples of E-LAMAT vehicles: a) Safa Tempo in Nepal, b) EV taxi in Laos, and c) COMET e-jeepney in the Philippines (with a reloadable card)

Following the emergence of electric-powered mobility (Dijk et al., 2013), a zero-emissions LAMAT mode, i.e., an electric LAMAT or E-LAMAT, has been in the
development stage. Existing E-LAMAT modes include Safa Tempos in Nepal (www.grilink.org), EV taxis in Laos (www.fusionev.com), e-trikes (www.adb.org) and e-jeepneys in the Philippines (www.getevee.com), and solar-powered tuktuks in Cambodia and Thailand (www.star8.com.au). Examples of some of these E-LAMAT modes are shown in Figure 2. The developed version of some of these LAMAT vehicles might differ from the original form (e.g., e-jeepneys vs. jeepneys and e-trikes vs. tricycles in the Philippines).

The development of an integrated electronic ticketing system for public transport modes (e.g., metro, buses, ferries) in Izmir, Turkey, using smart card technology is one of the up-to-date technologies that is suitable for future use in LAMAT systems (www.worldbank.org). Motives for smart card usage have been to secure the revenue collection system, enable modal and service integration via minimizing the personal and service costs of intermodal transfer, and offer multiple rides for a single fare over a 90-minute period within the metropolitan area, among others. The development of the smart card includes the capacity for automatic vehicle location and management and provision of real-time passenger information. This requires a centralized control system that facilitates, manages, and controls many different operators at the same time. In a modern society, such a centralized control system might be considered for the future of the LAMAT system (e.g., Horn, 2002; Cheung et al., 2008). If that happens, the system will be able to provide service coordination among multiple LAMAT operators by monitoring the positions of all LAMAT vehicles, controlling their movements in response to passenger requests, and connecting operators to the control center (Roos and Alschuler, 1975). However, given the current situation of the LAMAT sector in Asian developing countries, smart card technology or a centralized control system might be more applicable to larger LAMAT vehicles such as car taxis, microbuses, and minibuses, e.g., the next generation of LAMAT vehicles such as COMET e-jeepneys in the Philippines. Larger vehicles are often operated as fleets by common operators, who would be able to operate their fleets more effectively through a control center. Smaller LAMAT vehicles are mostly operated by single operators who lack the financial capacity to upgrade their vehicles and who prefer payments in cash rather than using an electronic fare collection system.

5. LAMAT SUSTAINABILITY

While the LAMAT system causes problems such as traffic congestion and air pollution, its role in providing transport services remains popular and indispensable among Asian developing countries. LAMAT provides not only employment opportunities for unskilled and poorly educated drivers, but also flexible transport services that fill the service gaps left by private vehicles and the formal public transport system. However, as a result of poor management by paratransit operators and the government’s inefficiency in controlling and regulating them, paratransit has failed to realize its potential (Roos and Alschuler, 1975). To realize its potential, the paratransit sector and relevant authorities should address several existing constraints and difficulties. For example, to sustain LAMAT services, Loo (2007) suggested four functional roles of LAMAT: 1) as the general basis for a regional multi-modal transport system, 2) as a specialized service for particular market needs, 3) as a feeder mode to formal transit systems, and 4) as a means of providing high-quality services. The following subsections discuss possible strategies to promote and sustain the LAMAT system in Asian developing countries.

5.1 Service Quality
Poor-quality LAMAT services can lead to lower levels of user satisfaction, and can affect the future of LAMAT. The literature shows that maintaining service quality at a level deemed acceptable by users has the potential to maintain existing demand and possibly to increase usage levels (e.g., Joewono and Kubota, 2007a, 2007c). Improvements in safety, comfort, and accessibility to mass transit systems would increase user satisfaction and hence influence user attitudes towards future use of LAMAT and mass transit services (Tangphaisankun et al., 2009b).

LAMAT usage is also influenced by users’ negative experiences, including long waiting times, inappropriate routes used by operators, and crowding and/or discomfort inside vehicles. Gender issues is one of the causes of negative experiences, especially for women, children, and elderly (WB, 2013). This issue was investigated in relation to LAMAT users in Bandung, Indonesia, by Tarigan et al., (2010). It was found that the propensity of men to make further use of LAMAT services following a negative experience was affected by behavioral factors including fares and accessibility, but this was not the case for women. The possibility of providing separate public transport services for female passengers has already been considered in several Asian developing countries; e.g., women-only coaches in Malaysia and women-only train cars in Indonesia (Bachok et al., 2014).

The quality of LAMAT services can be improved by addressing several aspects including comfort, customer service, fares, safety and security, convenience, and provision of service information. Improving service quality is the responsibility of LAMAT operators. If the operators are able to provide a higher-quality service, they should be able to charge a higher fare. However the majority of users are low-income people or students (Joewono and Kubota, 2007b), and higher fares are likely to reduce demand. Accordingly, LAMAT operators might decide to continue to provide a certain level of service quality in return for a reasonable fare in order to maintain their revenues. Improved service quality can increase user satisfaction, but it does not always improve the quality of life for the LAMAT operators (Weningtyas et al., 2013).

5.2 Integration

Following the development of mass transit systems (e.g., BRT, LRT), the sustainability of the LAMAT system has been questioned by several scholars (e.g., Diaz and Cal, 2005; Mani et al., 2012). For instance, the operation of jeepneys was redefined and the resulting effects were examined in response to the implementation of the BRT system in Cebu city in the Philippines (WB, 2012). In Hong Kong, Loo (2007) investigated whether the coach service should be replaced by franchised bus or railway services when the railway development was completed. It was found that the coach service could not be easily eliminated because users had different preferences regarding transport modes. Therefore, it was suggested that the transport policymakers should consider new forms of paratransit and ways of integrating them into the overall public transport system. In this respect, integrating the LAMAT system into the overall public transport system is the key to sustaining LAMAT services within a harmonized public transport system (Satiennam et al., 2006; Tangphaisankun et al., 2009a).

Conceptual designs for feeder and mass transit networks and seamless intermodal transfer to a BRT station are illustrated in Figure 3. Ideally, integration strategies should be considered in terms of both hardware (e.g., well-designed networks of service routes, seamless intermodal transfer, and shared facilities) and software (e.g., information and communication technology and a universal fare system).
Moreover, Fujiwara and Zhang (2013, p. 145) argued that promoting small LAMAT vehicles (i.e., Bajajs, becaks, and ojeks) as feeder modes to the mass public transport system might not be the best option for passengers in Indonesia. They suggested that the operation of such small vehicles should not be immediately prohibited for the sake of social stability (i.e., jobs for the poor), and small vehicles should be operated as main modes for short trips in local communities and neighborhoods.

5.3 LAMAT and the Environment

The LAMAT sector is often blamed for high levels of air-polluting emissions in Asian developing cities. This is a valid claim, because most LAMAT vehicles are ill-equipped, second-hand imported vehicles in poor condition and poorly maintained. As a means of overcoming the air pollution caused by the LAMAT sector, the promotion of E-LAMAT usage is an important factor in the sustainability of the sector. Following the trend of electric-powered mobility, a range of E-LAMAT vehicles including e-trikes, e-jeepneys, and Safa Tempos has been developed (KEVA, 2003; Regidor et al., 2009). For instance, the Safa Tempo system in Nepal was developed for two main reasons. First, Nepal was faced with fuel scarcity when India imposed an embargo in 1989. This forced stakeholders to explore alternative energy sources for transportation, such as battery-powered vehicles. Second, the rising level of air pollution forced people to think more about air quality. This boosted the popularity of EVs even more. The Nepalese government has supported the development and operation of the Safa Tempo and has banned all motorcycles and diesel-powered three-wheelers from the Kathmandu Valley. However, the arrival of the Safa Tempo has been by “default” rather than by “design” (Moulton and Cohen, 1998; Roy et al., 2001).

EV technology such as battery-powered vehicles, plug-in hybrid vehicles, and hybrid vehicles has been progressively developed in the private automobile sector (Raslavičius et al., 2015), but progress has been slow in the LAMAT sector. Battery technology is the key to improving the performance of EVs, but the cost of EVs is one of the barriers preventing operators from changing from current LAMAT modes to E-LAMAT modes. In the Philippines, the Asian Development Bank (ADB) is working with the government to promote the adoption of e-trikes in cities. Aiming to reduce CO₂ emission levels, the ADB first developed e-trikes using lead–acid batteries. They were later improved by equipping them with lithium-ion batteries, which provided benefits such as lower battery weight, longer battery life, and therefore greater travel range. However, this improvement has increased the
initial costs of the later models from US$3,000 to US$4,000 per unit, which is higher than the costs of ordinary tricycles. In view of this situation, a lease-to-own payment method (costing about US$4 per day) was established for operators seeking to use e-trikes. Recently, the operation of e-jeepneys in Manila has been considered by a group of utility vehicle operators in the Philippines. The promotion of E-LAMAT modes and the construction of supporting infrastructure (e.g., charging facilities) will encourage more local EV manufacturers to produce E-LAMAT vehicles, as well as providing maintenance services.

In conclusion, the future of E-LAMAT implementation is dependent on the development of supporting infrastructure (e.g., electrification), battery technology, regional E-LAMAT manufacturing industries, energy prices, and the electricity sector (see Dijk et al. (2013) for examples of these developments worldwide). The future of E-LAMAT is also closely linked to government policies and incentives, environmental policies, and public acceptance.

5.4 The Government

The government has an important role to play in providing infrastructure to support LAMAT operations, proposing regulations to manage LAMAT operators, controlling LAMAT growth, and formulating policies to sustain LAMAT services. Most LAMAT systems in Asian developing countries operate freely in urban streets, picking up and discharging passengers anywhere they choose, which is a major cause of traffic disorder. First, the government should consider space allocation along the major streets for LAMAT operators to stop their vehicles properly outside the traffic lane. Parking facilities for feeder modes such as LAMAT are definitely needed at mass transit stations to facilitate efficient intermodal transfer (Satienam et al., 2006; Tangphaisankun et al., 2009b). Sidewalk facilities are also required to provide passengers with convenient and safe access to public transport services.

In addition, the government should impose a more effective policy and regulations to better manage and regulate LAMAT operators (e.g., on-street parking regulations, uniforms for drivers that include their ID and service zone). This can be achieved by joint discussions among relevant parties from operators to national-level stakeholders to come up with appropriate mitigation measures in response to various problems (e.g., traffic congestion and air pollution) caused by the LAMAT sector. It might be worthwhile establishing a common driver association in which internal regulations are set up to apply either to a particular region or countrywide. The common driver association should work directly with the government, managing and regulating LAMAT operations. For example, the common driver association for taxi services could impose internal regulations that protect public welfare by ensuring that services are adequately distributed, charge reasonable fares, and are safe (e.g., monitoring of vehicle safety and driver qualifications) (Roos and Alschuler, 1975).

Regulations controlling the growth of the LAMAT sector should be strictly imposed to prevent free market entry and maintain market prices. Such controls will ensure that the equilibrium between demand and supply is maintained, along with reasonable fare levels, safety and security for passengers, and standardized service provision among registered operators. In the Philippines, unlicensed LAMAT operators (known locally as colorum) who are using privately registered vehicles for illegal operations charge similar fares but provide no assurances in relation to passengers’ safety and security (Diaz and Cal, 2005). Controlling the growth of the industry has several benefits, e.g., for licensed operators in terms of maintaining daily demand, for passengers in terms of providing a safe and secure service, and for the government in terms of protecting the public interest.
Further, the E-LAMAT system is considered to be one of the most promising transport modes in terms of environmental sustainability. Therefore, policies in relation to the use of E-LAMAT systems should be promoted by the government through incentives (e.g., tax exemptions) and the provision of supporting infrastructure (e.g., charging facilities). Since E-LAMAT vehicles have begun to be developed in new forms with new design and safety standards, rather than in their original forms (e.g., e-jeepneys), they appear to emit less air and noise pollution, and there has possibly also been a reduction in the number of traffic accidents caused by nonstandard vehicles. Other LAMAT-related policies should also be considered with a view to maintaining the drivers’ quality of life (Nugroho et al., 2012; Li et al., 2014). Phun et al., (2015) reported that the introduction of a public bus service in Phnom Penh has attracted a substantial number of former LAMAT users, i.e., approximately 30.4% of the bus passengers have switched from LAMAT modes. This illustrates the considerable impact of mass transit systems on the LAMAT sector. Therefore, the authorities should consider alternative solutions, e.g., provision of jobs in the mass transit system for the impacted LAMAT operators.

It should be noted that the increasing trend towards motorized transport has led to a remarkable reduction in the use of non-motorized LAMAT modes, e.g., cycle rickshaws are now only used for short trips and particular groups of passengers (e.g., tourists), while bicycle taxi services have almost disappeared. Therefore, the government should develop policies to maintain these non-motorized LAMAT modes by promoting them in specific areas such as popular tourist precincts, otherwise they are likely to become extinct. Classical non-motorized LAMAT vehicles offer environmentally friendly transport modes, as well as maintaining the traditional image of the country.

6. SUMMARY

We conducted an extensive review of the para transit literature by summarizing the existing fields of study, suggested a new term in place of “paratransit” (i.e., LAMAT) with a corresponding definition, created a better taxonomy for the LAMAT system, and examined key strategies in relation to the sustainability of the LAMAT system in Asian developing countries. The existing fields of study covered most aspects of the LAMAT system including vehicle and operational characteristics, user perceptions, drivers’ quality of life, and institutional regulation. In addition, a better classification scheme was established for the LAMAT system, covering all of the existing LAMAT modes. Such a classification is useful for the government when considering the categorization of non-standardized modes within the country’s public transport regulations and standard classifications. In Asian developing countries, where there are inadequate mass transit systems, people will continue to rely on the transport services provided by the LAMAT sector. Recent studies have focused more on the sustainability of LAMAT services and their harmonization with the overall public transport system rather than suggesting that they should be eliminated. The relevant authorities and transport planners have been urged to come up with policies and regulations that facilitate and sustain LAMAT operations.

The existing literature illustrated four main strategies to sustain the LAMAT system. First, improvements in the overall quality of LAMAT services contribute to higher user satisfaction, which in turn leads users to further support LAMAT services, suggesting that future demand is likely to increase. The quality of LAMAT services can be improved by addressing several aspects including comfort, fare levels, and safety and security, provided that improvements do not affect daily demand. Second, the LAMAT system should be
integrated with the overall mass transit system in terms of both hardware (e.g., sharing facilities) and software (e.g., service coordination). Integration strategies support the operation of LAMAT services as feeder modes that collect and distribute passengers to and from mass transit stations. Feeder services should involve larger LAMAT vehicles (i.e., microbuses and minibuses) operating on fixed routes that connect with the mass transit lines. Smaller LAMAT vehicles should therefore operate as personalized transport modes on non-fixed routes. The feeder route network should be included in the urban transport master plan to facilitate cooperation among various public transport modes. Third, the environmental pollution caused by the LAMAT sector can be overcome by the promotion of E-LAMAT systems. The success of E-LAMAT implementation is dependent on battery technology, and thus E-LAMAT vehicle manufacturers should collaborate closely with battery producers to increase their competencies. The future usage of E-LAMAT systems also depends on government policies that promote their use (e.g., a low-carbon transport policy). Finally, the government has an important role to play in providing support (e.g., infrastructure, feeder stations, tax incentives) and imposing controls and regulations (e.g., common driver associations, internal regulations, growth control) to sustain the LAMAT system. These actions should ensure that there is better traffic management, a lower environmental impact, reasonable comfort levels and fares, and safety and security in the LAMAT sector, among other benefits.

We reviewed the existing LAMAT systems and identified key strategies for sustaining these systems, but we did not include a review of the size of the LAMAT market in each city in Asian developing countries. This limitation should be addressed in future studies to determine which LAMAT system is most suitable for each city, all of which have different characteristics (e.g., population size, modal share of public transport). Further research should investigate the impact of newly introduced mass transit systems or mass transit expansion on the LAMAT sector, so that the responsible authorities can determine how to minimize the impact. To this end, it is important to provide a standard LAMAT service for a reasonable fare, provided that the operators’ quality of life and the users’ satisfaction levels are both at an acceptable level.

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