# Intention of Paratransit Drivers to Operate as Feeder Service of Public Bus in Phnom Penh

This paper investigates the attitudes of paratransit drivers towards the newly-introduced public bus in Phnom Penh and their intention to operating as feeder service of the bus. We developed a structural equation model using data collected from drivers of Motodops and Remorks. We found that Motodop drivers intended to operate as feeder service of the bus, regardless their attitudes towards the bus. Remork drivers cautiously anticipated the negative impacts of the bus on their livings and accordingly, they had no intention for its feeder service. A better regulation on paratransit service was likely to encourage intention of feeder service.

***Keywords*** | ***Feeder service, Mass transit, Paratransit, Phnom Penh, Structural equation modeling***

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## 1——Introduction

Paratransit plays a significant role in urban mobility context in Asian developing countries, because it provides flexible and personalized transport services to general citizens in needs with certain levels of service quality and reasonable fare. Paratransit assists the social economic activities through its service availability and job opportunities for the poor or low-skilled people[1]. In addition, the operations of paratransit require little policy intervention and public investment or subsidy[2]. To some extent, the paratransit operations yield negative effects such as traffic congestion, traffic accidents, and air pollution[3].

The concept of paratransit differs among developed and developing countries[4]. Paratransit often refers to demand-responsive transport services for the elderly and disabled in the developed countries[5]. In Asian developing countries, paratransit refers to indigenous public transport mode that is locally adapted, modified, and perhaps advanced (i.e., LAMAT) for a certain transport service in a particular city or region[6]. In Phnom Penh, paratransit includes Cyclo, Motodop, Remork, and Long-tailed Remork.

In Asian developing countries, the existing paratransit system is not thoroughly established and managed for easy coordinated services with mass transit system[7]. Lack of connectivity among public transport modes increases transfer time and travel time, which in turn, reducing satisfaction for intermodal passengers. In most cities of Asian developing countries, the operations of public transport modes are independent among operators. The independent operations often cause competition among modes, while possibly contributing to duplicated transport services and uneconomical operations[8]. These issues would become more critical, since the governments of many Asian developing countries have considered the operations of modern mass transit system, including bus rapid transit (BRT), light rail transit (LRT), and mass rapid transit (MRT). Either a newly introduction or an expansion of a mass transit system has substantial impacts on the existing paratransit services. Consequently, questions are raised whether the paratransit system should be eliminated, or it should be promoted with better service performance and less negative impacts[9].

The impacts of mass transit on paratransit services would be regarded as serious without appropriate countermeasures provided to the impacted operators. When the impacted operators have bigger strength opposing to the implementation plan of the mass transit system, it would possibly derail the project itself. This shows the importance of the co-existence among urban public transport system (paratransit and mass transit). The co-existence should be made when the impacts of mass transit on paratransit are satisfactorily minimized and when the consensus among all transport operators is properly established. Alternatively, transport policy makers should consider how to integrate the paratransit system into the whole public transport system[10]. In fact, when mass transit system is considered and implemented, paratransit could function as feeder mode by filling the gaps of transport services between mass transit system and private

vehicles[4), 11)]. Since the paratransit services have been established to facilitate the poor accessibility in Asian developing countries, the potential role of paratransit as feeder mode of a mass transit system should be considered because it provides at least five benefits. First, paratransit provides intermodal passengers with easy accessibility and better connectivity among modes. Second, paratransit supports the last mile solutions to the development of fixed transit system in term of collecting/distributing passengers from/to the stops or stations. Third, feeder service could promote the ridership for both paratransit and mass transit. Fourth, paratransit fulfills the transport needs by general people with reasonable fare and service quality. And fifth, paratransit maintains the employment opportunities within paratransit operators.

A number of studies can be found for feeder services[12), 13)], but only a few exists in Asian developing countries. For example, Satiennam et al.[7)] demonstrated that having a good organizing feeder and parking facilities for paratransit to a BRT system would improve the route network performance with lower emission of air-polluting level. The improvements on accessibility and connectivity, through the integration between paratransit and mass transit systems, are also shown to increase user satisfaction level[14), 15)]. While several studies assessed the sustainability of paratransit service from the viewpoints of passengers[2), 16), 17)] (e.g., user satisfaction, perceived service quality, and behavioral intention), only few paid attention to the paratransit operators-related aspects such as job satisfaction, job mobility, and quality of life[18)-20)]. Moreover, previous studies assessed the possibility of implementing paratransit as feeder mode to a mass transit system from the user perspective[14), 15)] (e.g., user satisfaction). However, there is no known study simultaneously investigating the attitudes of paratransit divers (from the operator perspectives) towards the implementation of mass transit system as well as their intention of operating paratransit as feeder mode of that system.

This study explores the attitudes of paratransit drivers towards a newly-introduced mass transit system and their intention to operate as feeder service of mass transit system. Phnom Penh, the capital city of Cambodia, is selected as a case study. The recently introduced public bus service in Phnom Penh in early 2014 might have brought concerns to the existing paratransit drivers, especially those who operate along the bus routes[21)]. In line with this situation, we are interested on how do drivers perceptually react to the recent bus service in the city; more specifically, whether they have intention to provide feeder service to the bus stops. The attitudes of paratransit drivers are investigated under a structural equation modeling (SEM), using data collected from an interview survey with paratransit drivers in Phnom Penh. The targeted paratransit modes are Motodop (1-2 passengers) and Remork (2-6 passengers), which provide flexible transport services to general citizens on a non-fixed route, non-fixed timetable, non-shared ride, and negotiable fare basis. The outcomes of this study provide transport relevant authorities/planners with useful information about the intention of feeder service to the new implementation or expansion of a mass transit system, from the viewpoints of paratransit drivers.

## 2——Public Transport in Phnom Penh

### 2.1 Public Bus

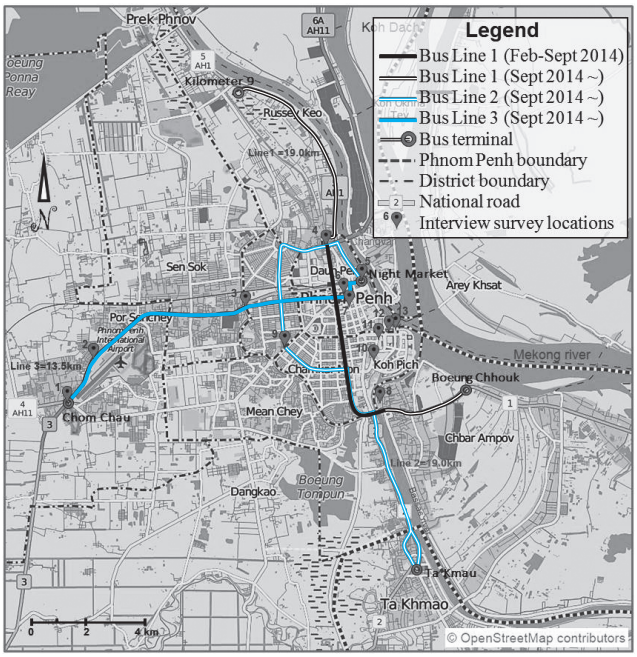
After the Khmer Rouge Regime and civil war in the 1970s, more transport infrastructures in Phnom Penh have been gradually reconstructed and improved. Phnom Penh is now home for more than two millions citizens, while increasing trend of urban motorization is observed. The number of registered vehicles is more than 3.7 times compared to 2000[21)]. Like other Asian developing cities, Phnom Penh faces serious traffic problems such as traffic congestion, traffic accidents, and air pollution[22)-24)]. The problems have increased the travel time and cost, and slowed down the economic activities. To remedy the problems, the government has considered several alternative modes of mass transit systems (e.g., BRT, Tramway, Public bus), but only the public bus service has been actually introduced in the city.

In June 2001, Phnom Penh Capital Hall and Japan International Cooperation Agency (JICA) once tested the public bus service as a demonstration for one month. The bus was demonstrated as a part of JICA study in order to comprehensively develop the urban transport system for Phnom Penh. Twenty-three air-conditioned minibuses (29 seats) were operated along two major roads (Monivong Boulevard and a ring road) with the total length of about 17 km[21)]. Two flat fares were implemented: 500 KHR (≅ 0.13 USD, as exchange rate of June 2001) for the first 5 days and the last 8 days, and 800 KHR (≅ 0.21 USD). The daily average numbers of bus users were 4687 for 500 KHR and 2738 for 800 KHR. However, the bus was shut down after one month extension, mainly due to the financial matter[25)].

In February 2014, the Capital Hall and JICA again

tested the public bus service for one month. A fleet of 10 air- conditioned buses (35 seats) was operated along Monivong Boulevard with a total length of 7.5 km[21]. With a flat fare of 1500 KHR (≅ 0.37 US$, as exchange rate of February 2014), the average number of daily bus users was 1546. The bus fare in 2014 was higher than that in 2001. The higher fare was defined based on the increased gasoline price and the users' most acceptable fare level[26]. The bus was introduced, but there are insufficient infrastructures to support its smooth operation. For instance, most of the bus stops are on the roadsides that have been labeled as "Bus Stop" with lane marking and a station pole. Among 36 bus stops, only five of them had shelters and seats. There are no specific (paratransit) stations for intermodal passengers. Further, the bus was operated with slow speed in the mixed traffic. The general traffic volume along Monivong Boulevard has increased by more than 34.0% since 2000, and the average operating speed of the bus was also observed to decrease from 13.9 km/h in 2001 to 9.9 km/h in 2014.

Although the average number of daily bus users in 2014 was lower than that in 2001, the bus service was later extended and the servicing route was expanded from one to three routes, with a total length of 51.5 km and 43 buses[21], see Figure—1. Later, more bus stops have been improved with shelters and seats. From October 2014, a fare discount policy has been implemented. The bus service is free for specific groups of bus users including students, children, and the disabled persons. With this fare policy, the average number of daily bus users for all three bus lines has substantially increased from about 2500 to more than 6000, but about 40.0% of them are free riders. The bus fare alone could not cover the bus operational cost. This time, the government shows strong supports for the public bus service as necessity for the development of Phnom Penh, but the funding sources remain unclear.




■Figure—1 The public bus routes and the survey locations in Phnom Penh

### 2.2 Paratransit

Prior to the availability of the public bus service in Phnom Penh, citizens mainly depend on paratransit as public transport modes. In 2012, the modal share of paratransit was 13.4% and was projected to be 11.4% in 2035[26]. The lower share of paratransit is expected due to the implementation plans of formal public transport modes such as public bus and railway system. Despite the presence of the bus service since 2014, the paratransit services remain indispensable. Figure—2 shows the most popular paratransit modes in Phnom Penh: Motodop and Remork. Motodop, the so-called motorcycle taxi, is the most commonly mode used. With relatively small-sized vehicle, Motodop could provide the fastest and flexible transport services. Motodop typically carries two adults and one child at maximum. Remork was originally formed from a small trailer pulled by a bicycle, which was later substituted by a motorcycle.

Until recent years, Remork, the two-wheeled carriage pulled by a motorcycle, has gained its popularity due to its larger transport capacity of 2-6 passengers, safer transport service, and more comfort[6]. In Phnom Penh from 2001 to 2011, the modal share of Motodop has decreased from 19.0% to 8.0% whereas the share of Remork has increased from 6.0% to 9.0%[27]. The reasons for choosing Motodop include shorter travel time (37.0%), lower fare (36.0%), and no choice (8.0%)[26]. The reasons for choosing Remork include safety (41.0%), comfort (19.0%), and lower fare (10.0%). In addition, Motodops and Remorks can be found anywhere in the city streets, including major intersections, bus stops, and shopping malls.

Besides, Cyclo is a three-wheeled vehicle powered by a human. It could carry two passengers


■Figure—2 Common paratransit modes in Phnom Penh

with movable weather-protected roof. It is used mainly for a short-distance trip. The popularity of Cyclo has gradually declined due to its slow speed, while sometimes it is considered as inhuman working condition. Cyclo is now mostly used for tourism purpose. Other types of paratransit modes include long-tailed Remorks which are operated on fixed suburban roads, mini-trucks which transport factory workers, and Taxi which is available for general people. Among all the existing paratransit modes, this study mainly focuses on Motodop and Remork, the most active public transport modes in Phnom Penh.

### 2.3 Governance of Motodop and Remork

Currently, there is no formal control over the paratransit operations in Phnom Penh. Particularly, owners of Remorks are required to register their vehicles with the Department of Public Work and Transport. In 2012, the total number of Remorks in Phnom Penh was approximately 6000[26]. However, the number of Motodops remains unknown because there is no official control or record over the operations of Motodops (e.g., license and registration). Anyone own a motorcycle can become a driver of Motodop if he or she wants to do so. Some drivers provide the Motodop service only as a secondary source of income. The potential number of Motodops in operations was believed to be close to the number of registered motorcycles in Phnom Penh (e.g., about 828000 in 2011). But this number is not trustworthy.

Currently, the operations of paratransit are partially controlled and managed by paratransit associations (or labor unions), which are self-organized and established with internal rules to ensure the fairness, efficiency, and quality of transport service among members[6]. Each member joint the associations is required to pay a monthly membership fee of 0.0 USD-0.5 USD for Motodop and of 0.3 USD-1.0 USD for Remork[28]. The collected membership fee will be used as financial source for the expenses of the association activities. Up to 2016, there are at least 14000 Remorks registered to six paratransit associations in Phnom Penh. Yet, the number of Motodops registered to the associations remains unknown because one of the biggest labor unions in Cambodia (i.e., Cambodia for Confederation Development Association) could not estimate the number of Motodop members.

Moreover, the government has no specific fare control for paratransit[29]. The fare rate is defined by self-regulatory optimization and negotiation through free market competition. Principally, drivers of Motodops and Remorks define a fare level based on several factors including trip distance, number of passengers, and their working conditions. The average fare levels per kilometer per passenger were estimated to be 1100 KHR (0.27 USD) and 1600 KHR (0.40 USD) for Motodop and Remork, respectively. For the first two-kilometer, the fare levels would be higher: 2800 KHR (0.69 USD) for Motodop and 6700 KHR (1.67 USD) for Remork. Remork charges higher fare due to its higher service quality (e.g., comfort, safety) and higher operating costs (e.g., fuel consumption, maintenance cost).

## 3——Hypotheses

The resumed operation of public bus in Phnom Penh has brought concerns to many paratransit drivers, especially those who have provided transport service along the bus routes. The concerns include fewer daily passengers and lower monthly income. These concerns would become more critical when the bus service will be further expanded or a new mass transit system (e.g., BRT, LRT) will be implemented. Even so, paratransit service might not be simply eliminated from the public transport system due to the stability of social economy (e.g., job opportunities for the poor and low-skilled people) and inevitable needs for transport poor[9]. For instance, the coach service in Hong Kong cannot be easily eliminated from the overall public transport system because passengers have different preferences for transport modes, although alternative mode (i.e., franchise bus) was considered for the substitution of the coach[10]. In Cebu, the operation of Jeepneys has been re-defined and the resulting effects were examined in response to the implementation plan of BRT system[30]. In Metro Manila, passengers did not use the railway service (MRT3) because there was no connection going to a desired destination (41.0%) and inconvenient transfer between MRT3 and other transportation modes (22.0%)[14]. Subsequently, researchers suggested ways to integrate the coach and Jeepney with whole public transport system. Particularly, operating them as feeder modes to a mass transit system would promote a sustainable urban public transport in term of easy connectivity and transit ridership[7]. It should be noted that coach and Jeepney are fixed-route and shared ride paratransit modes with transport capacity 12-24 and regulated fare structures.

This paper investigates the attitudes of Motodop and Remork drivers towards the public bus service as well as their intention to provide feeder service to the bus in Phnom Penh. The three bus

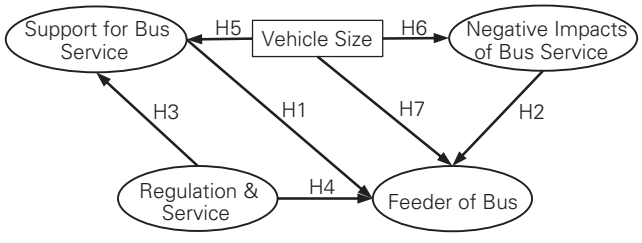
lines in the city would make up just a fraction of the existing road network and are likely to have little charm for general citizens as many still prefer a door-to-door trip. The bus service is still quite new and the flat fare of 1500 KHR (0.37 USD) is relatively cheaper than the fare of a paratransit mode. Since the bus charges flat fare, using the bus is much cheaper for cross-town trip than the traditional paratransit alone. Among all bus users, 30.4% claimed that they previously traveled by a paratransit mode[21]. In addition, the share of bus users who had an access/egress distance of more than 400 m was 32.5%, of which 11.5% traveled to a bus stop using a paratransit mode. This suggests that the combined trips between a paratransit feeder and the bus could provide a superior transport service to certain users compared with either of the options alone. The conceptual SEM is illustrated in Figure—3. The driver attitudes are decomposed into two latent constructs: one that measures the positive attitude (i.e., Support for Bus Service in the city) and another that measures the negative attitude (i.e., perceived Negative Impacts of Bus Service on their livings). Either positive or negative attitude the drivers might have, paratransit should provide feeder service because the bus is necessary for citizens and the future of Phnom Penh. The presence of the bus could improve the overall economic activities and ease the current traffic congestion in the city. Paratransit drivers might not fully understand the necessity of the recent bus service. Accordingly, they might not be so ready to change their business strategies in order to maintain their profits. For example, they might not be familiar with the feeder service to the bus, since there is no proper space allocation for paratransit services near the bus stops. We test their attitudes towards the recent bus service with the following hypotheses:

H1: Support for Bus Service has positive effect on Feeder of Bus
H2: Negative Impacts of Bus Service has positive effect on Feeder of Bus

It is also important to include in the SEM the driver perspectives on paratransit regulation and service. Regulation that can control the growth of paratransit drivers in a serving zone ensures the balance between supply and demand[3]. This growth control gives opportunities to the existing drivers to work more efficiently with reasonable service quality and to maintain their living conditions. Likewise, the management of paratransit services can be strongly influenced by internal regulation of a paratransit association, the most common form of paratransit organization. The internal regulation might require drivers of a paratransit association to having a uniform that shows their driving career and operating zone. This would help registered drivers to clearly notice other registered drivers within the operating zone, and hence avoiding an open market competition with other members. Moreover, the paratransit fare is currently not regulated by the government. The fare is defined by the paratransit drivers, and is negotiable by the passengers who want to use the service. The fare might be higher during the national holidays or for passengers who appear to be rich. When the fare is not affordable, passengers would switch to the other drivers. Accordingly, the drivers who fail to define a reasonable fare might face a decrease in number of their daily passengers (or revenue). The fare negotiating process could also increase total travel time, slow down the general traffic, and cause longer exposure to air pollution. The use of a fare-meter system might be an option to remedy these problems[31]. To this end, drivers who expect better regulation and paratransit service would also support for the public bus and its feeder service in order for them to maintain the passenger demand.

H3: Regulation & Service has positive effect on Support for Bus Service
H4: Regulation & Service has positive effect on Feeder of Bus

Furthermore, it is interesting to see the attitudes of drivers of different vehicle sizes towards the bus service as well as its feeder intention. Different vehicle sizes refer to different paratransit modes. Previous study by Fujiwara and Zhang[9] found that the use of small paratransit vehicles (i.e., Becak, Ojek, and Bajaj) as feeder modes to mass transit system did not promote public transport for current paratransit users in Jabodetabek, Indonesia. Yet, it was suggested that the operation of such small-sized vehicles should not be immediately eliminated for the sake of social stability (i.e., jobs for the poor), and they should be operated as main modes for short-distance trips in local communities and their neighborhoods.




■**Figure—3 Conceptual SEM for testing the hypotheses**

Alternatively, larger-sized paratransit vehicle (i.e., Angkot) as feeder to bus was preferred. In contrast, Thangphaisankun et al.[15] found that the convenience/comfort of smaller-sized paratransit (i.e., motorcycle taxi) as access mode to mass transit significantly increased the commuter satisfaction and ridership in Bangkok, compared with Songtaew. Angkot and Songtaew are shared ride, operating on fixed-route with fare regulated. However, it is unclear whether which argument remains true from the viewpoints of paratransit drivers in other Asian developing cities like Phnom Penh. In this paper, we will test the effects of Vehicle Size with the hypotheses below. Larger Vehicle Size refers to Remork.

H5: Larger Vehicle Size has negative effect on Support for Bus Service
H6: Larger Vehicle Size has positive effect on Negative Impacts of Bus Service
H7: Larger Vehicle Size has negative effect on Feeder of Bus

## 4——Methodology

### 4.1 Questionnaire

This study uses the secondary data from an interview survey with paratransit drivers in Phnom Penh[29]. The interview questionnaire was first written in English and was later translated into Khmer. We used the back translated technique to ensure the consistency between the English and Khmer versions. There were four sections in the questionnaire. Section 1 inquired about general paratransit service and paratransit vehicles. Section 2 inquired about the paratransit fare levels which were defined by drivers for a given trip. Section 3 inquired about the subjective responses regarding the driver attitudes towards the newly-introduced public bus and paratransit services. The subjective questionnaire items were based on a five-point scale rating scores (1: Very unlikely, 3: Neither, 5: Very likely). And section 4 inquired about personal information. This study mainly analyzes the data from section 3 of the questionnaire.

### 4.2 Interview Survey

The interview survey was conducted from 19 to 23 December 2014, by four surveyors who were trained to fully understand and administer the questionnaire. We selected the sample size based on the available time and budget. We adopted a simple random sampling technic, and tried to cover most of the operations of Motodops and Remorks in Phnom Penh. At first, the surveyors requested approximately 250 drivers, who were waiting for passengers at their pick-up points (e.g., near bus stops, major road intersections, markets) around the city. Figure—1 shows the interview survey locations. The surveyors did not request every paratransit drivers at each location. Approximately 35 drivers refused to participate in the survey because they were busy, and about 20 drivers refused the survey but did not offer an explanation. The total number of participants was 192. After the information screening process, the data available for further analyses were 186, of which 106 were drivers of Remorks. Each participant received a "Thank-you money" or a reward (a pen and a reflective sticker) after he had completed the questionnaire. This incentive strategy helped more drivers to participate in the survey and to patiently answer to the questionnaire. Approximately 35.0% chose the reward, implying that they did not consider monetary incentive as the major reason for them to participate in the survey. For those who chose the money and who seem to give bias answers, the surveyors would emphasize more about the intended questions. If necessary, the surveyors would repeat the questions to get more reliable answers. It took approximately from 15 minutes to 25 minutes in average for a driver to completely answer the questionnaire.

The sample distributions can be divided into four geographical areas based on the survey locations in Figure—1: 20.4% in the city center (Location 5-7), 12.4% in the North (Location 4), 51.1% in the South (Location 8-13), and 16.1% in the West (Location 1-3). This would cover most of the paratransit operations in the urban areas with high-density population[26]. In addition, the result from one-way analysis of variance shows that the driver intention to provide feeder service to the public bus (Item 2 of Feeder of Bus in Table—2) was not significantly different among the geographical areas [$F(3,182) = 2.08$, $p = 0.1048$]. We also found no differences in the feeder intention between drivers whose pick-up locations were near a bus stop and whose pick-up locations were not near any bus stop [$t(109.7) = 0.6248$]. This suggests that there is no effect of sample distributions across geographical areas on driver intention to provide feeder service to the bus. Because we adopted the geographically stratified random sampling, the sample size of 186 with effective information might be sufficiently reasonable to represent most of Motodop and Remork operations in Phnom Penh. A sample size between 100 and 200 is also said to be adequate and satisfactory in the SEM analysis[32].

### 4.3 Participant Characteristics

The descriptive statistics of the interviewed drivers (participants) were reported in Table—1. Participants were from 23 to 64 years old, with the average age of about 40 years old. Regarding the highest education attainment, 29.6% finished grade 0-6 (primary school or never going to school), 45.2% finished grade 7-9 (secondary school), 24.7% finished grade 10-12 (high school), and others (0.5%). 65.0% were not citizens of Phnom Penh; they came from several provinces across Cambodia. 29.0% were members of five paratransit associations. Up to December 2014, the average working period as the paratransit drivers was approximately seven years, while the longest period was up to 30 years. In daily average, Motodops made 7.9 trips and transported 11.4 passengers. Remorks made 4.1 trips and transported 10.5 passengers per day. Because Remorks had larger-sized vehicle, Remorks could transport more passengers per trip (2.6 = 10.5/4.1) than Motodops (1.4 = 11.4/7.9). But, the operating speed of Remorks (35.7 km/h) was lower than that of Motodops (43.3 km/h). Since Remorks generally charge higher fare rate, Remorks also made higher monthly income (252.4 USD) than Motodops (178.8 USD).

All participants owned each a vehicle. They reported that approximately 75.0% of motorcycles were produced before 2010. The price of motorcycles (≤ 125 cc) was from 110 USD to 2100 USD, with the average of about 830 USD. The price of Remorks (motorcycles with a carriage) was from 350 USD to 3500 USD, with the average of 1415 USD. The lower price of a vehicle implies that the vehicle is more likely in a poor condition (i.e., second-hand vehicle). The price of the vehicles seems to be affordable for most drivers, although some drivers might have a loan from their family or relatives. No information about the leasing contract with any paratransit operators was reported by the participants. It should be noted that the driver characteristics presented here and further information about operational services of paratransit in Phnom Penh can also be found in Phun et al.[30].

■Table—1 Descriptive statistics of participants

| Variables | Mean | SD | Min. | Max. |
|---|---|---|---|---|
| Age | 39.56 | 8.84 | 23 | 64 |
| Motodop | 40.60 | 10.18 | 23 | 64 |
| Remork | 38.78 | 7.63 | 23 | 64 |
| Marital status (1: if married) | 0.95 | 0.22 | 0 | 1 |
| Motodop | 0.95 | 0.22 | 0 | 1 |
| Remork | 0.95 | 0.21 | 0 | 1 |
| Phnom Penh citizen (1: if true) | 0.35 | 0.48 | 0 | 1 |
| Motodop | 0.31 | 0.47 | 0 | 1 |
| Remork | 0.38 | 0.49 | 0 | 1 |
| Drivers with dual jobs (1: if true) | 0.30 | 0.46 | 0 | 1 |
| Motodop | 0.39 | 0.49 | 0 | 1 |
| Remork | 0.24 | 0.43 | 0 | 1 |
| With a driving license (1: if true) | 0.37 | 0.48 | 0 | 1 |
| Motodop | 0.29 | 0.46 | 0 | 1 |
| Remork | 0.42 | 0.50 | 0 | 1 |
| Years of working as drivers till 2014 | 6.88 | 6.15 | 0.02 | 30 |
| Motodop | 7.54 | 6.94 | 0.02 | 28 |
| Remork | 6.38 | 5.46 | 0.06 | 30 |
| Daily working period (Hours) | 11.95 | 2.64 | 2 | 19 |
| Motodop | 11.54 | 2.70 | 3 | 19 |
| Remork | 12.26 | 2.56 | 2 | 18 |
| Daily average number of trips | 5.72 | 4.49 | 1 | 30 |
| Motodop | 7.86 | 5.70 | 2 | 30 |
| Remork | 4.10 | 2.24 | 1 | 20 |
| Daily average number of passengers | 10.88 | 7.98 | 2 | 60 |
| Motodop | 11.38 | 10.27 | 2 | 60 |
| Remork | 10.51 | 5.70 | 2 | 30 |
| Monthly average income (USD[1]) | 219.89 | 105.52 | 37.5 | 700 |
| Motodop | 176.81 | 83.09 | 37.5 | 500 |
| Remork | 252.41 | 109.29 | 50 | 700 |

Note1: 1.0 USD = 4000 KHR is assumed for the exchange rate

### 4.4 Measurement Models

There are four latent constructs and one contextual variable included in the SEM, as shown in Table—2. Each latent construct is operationalized using three indicators, which are the subjective responses evaluated based on the 5-point scale

■Table—2 Summary statistics of SEM's variables

| Variables | Mean | SD | *Welch's t*-test[1] |
|---|---|---|---|
| Latent constructs[2]: | | | |
| *Feeder of Bus* | | | |
| I want proper stations near bus stops | 4.05 | 1.14 | |
| Motodop | 4.33 | 0.94 | 2.99** |
| Remork | 3.85 | 1.23 | |
| Transport passengers from/to bus stops | 3.67 | 1.20 | |
| Motodop | 3.89 | 1.17 | 2.15* |
| Remork | 3.51 | 1.21 | |
| Bus on major roads, my service at others | 3.84 | 1.26 | |
| Motodop | 4.16 | 1.10 | 3.20** |
| Remork | 3.59 | 1.32 | |
| *Support for Bus Service* | | | |
| I support for the continuum of bus | 2.96 | 1.55 | |
| Motodop | 3.50 | 1.46 | 4.32** |
| Remork | 2.56 | 1.49 | |
| It is good to have public bus in the city | 3.02 | 1.45 | |
| Motodop | 3.48 | 1.34 | 3.93** |
| Remork | 2.67 | 1.44 | |
| Bus helps reducing the traffic accidents | 3.90 | 1.02 | |
| Motodop | 4.14 | 0.88 | 2.84** |
| Remork | 3.73 | 1.09 | |
| *Negative Impacts of Bus Service* | | | |
| Public bus lowers my monthly income | 3.54 | 1.36 | |
| Motodop | 3.26 | 1.47 | −2.36** |
| Remork | 3.75 | 1.24 | |
| Public bus lowers my daily passengers | 3.58 | 1.36 | |
| Motodop | 3.26 | 1.49 | −2.69** |
| Remork | 3.81 | 1.21 | |
| Public bus affects my living conditions | 3.25 | 1.44 | |
| Motodop | 3.00 | 1.51 | −2.07* |
| Remork | 3.44 | 1.37 | |
| *Regulation & Service* | | | |
| All drivers to have paratransit uniform | 4.46 | 1.08 | |
| Motodop | 4.49 | 1.13 | 0.33 |
| Remork | 4.43 | 1.05 | |
| To register/define all drivers each zone | 3.97 | 0.99 | |
| Motodop | 3.90 | 1.09 | −0.79 |
| Remork | 4.02 | 0.90 | |
| To use fare system like Taxi-meter | 3.53 | 1.60 | |
| Motodop | 3.55 | 1.64 | 0.13 |
| Remork | 3.52 | 1.57 | |
| Contextual variable: | | | |
| *Vehicle Size* | | | |
| D_Remork (1: if a driver of Remork and 0: if a driver of Motodop) | 0.57 | 0.50 | |

Note1: To compare different subjective scores between Motodop and Remork
Note2: Value of each subjective questionnaire item ranged from 1 to 5
*$p < 0.05$, **$p < 0.01$

(1: Very unlikely, 3: Neither, 5: Very likely). The intention of paratransit drivers to operate as feeder service of the bus (i.e., Feeder of Bus) is measured by three questionnaire items: how likely do you think that (1) you want to have proper drop-off/pick-up locations for paratransit modes near bus stops? (2) you want to transport passengers from home to bus stops and from bus stops to home, rather than finding them as nowadays? and (3) if bus service is available on major roads, people should use paratransit service on other roads? For each of these questionnaire items, the surveyors further explained drivers about their intention to operate as feeder service to the bus. The additional explanation was to ensure that the combination of these items would represent the driver intention to harmonize with the public bus by operating as its feeder mode (not a competitive mode). For instance, item 2 of Feeder of Bus gives drivers the options to choose whether they wanted to operate as feeder service to bus or they wanted to continue their current transport services, competing to the bus. Similar ways of asking were used for other questionnaire items of the remaining latent constructs.

For Feeder of Bus, the overall average score for item 1 is 4.05, suggesting that drivers had high demand for proper paratransit pick-up/drop-off stations near the bus stops. This accounts for 83.3% of those drivers, whose rated scores were 4 or 5. The average score of item 2 (3.67) implied that majority of drivers (60.8%) wished to transport passengers from/to home and to/from bus stops, rather than acquiring passengers as nowadays. For item 3, 76.4% of drivers demanded that passengers should use their paratransit services at other local roads, if the public bus is operated at major roads in the city. Besides, we performed Welch's *t*-test to test for the different subjective scores between Motodop and Remork drivers. Results showed that the subjective scores (item 1-3) evaluated by Motodop drivers were significantly higher than those evaluated by Remork drivers ($p < 0.05$). This primarily suggests that Motodop drivers had stronger desire to provide feeder service to the bus than did Remork drivers. Regarding the Support for Bus Service, 51.6% thought it was good to have the public bus in the city, 46.8% supported for the continuum of the bus service, and 79.6% expected the reduction in traffic accidents following the bus service in Phnom Penh. For the Negative Impacts of Bus Service, the overall average scores were higher than 3.0, indicating that drivers have substantial concerns over the introduction of the bus service that may affect their livings. The results from Welch's *t*-tests showed that Motodop drivers had significantly stronger support for the bus service in the city, but Remork drivers had more concerns over the bus service.

For the Regulation & Service, the overall average rating scores are relatively high (> 3.5), implying that drivers had strong desire for the better paratransit regulation and service in the future. The majority (89.8%) wanted all paratransit drivers to have uniform showing their career properly, wanted all paratransit drivers in each operating zone in the city to be clearly registered and defined (86.0%), and wanted to use the fare system like the Taxi-meter instead of the current negotiable fare (66.1%). However, results from Welch's *t*-tests show that both drivers of Motodops and Remorks had similar subjective scores in each item of Regulation & Service. This implies that drivers equally supported for the future improvements on paratransit regulation and service.

Previous studies examined the effects of vehicle sizes on feeder service by passengers' perception on different paratransit modes (e.g., Ojek, Bajaj, Angkot). In this study, we created "D_Remork" as a proxy variable to assess the effects of paratransit vehicle sizes on drivers' feeder intention. We operationalize D_Remork as the contextual dummy variable, which equals to 1 if participant is a driver of Remork and 0 if participant is a driver of Motodop. D_Remork captures the effects of different aspects of Remorks (e.g., the physical and operational characteristics of vehicle) on feeder intention, compared with those of Motodops. We preferred the dummy variable here because its effect can easily be observed for the two types of paratransit modes (i.e., Motodop and Remork). Basically, the use of dummy variable might be the better option because the two paratransit types being investigated are in the similar form of motorcycle and operational services. In addition, the estimation of the separated models for Motodop and Remork alone could not be made; it resulted in an empirical under-identification. Since the model is structurally identified, the empirical under-identification is probably due to the small sample sizes used in the separated models for Motodops ($N = 80$) and for Remorks ($N = 106$). Therefore, the effect of Vehicle Size will be discussed based on D_Remork, which is included in the SEM using overall sample size ($N = 186$). Based on the Welch's *t*-tests in Table—2, D_Remork is expected to have a negative effect on Support for Bus Service and Feeder of Bus, and a positive effect on Negative Impacts of Bus Service.

## 5——Results

### 5.1 Structural Equation Model

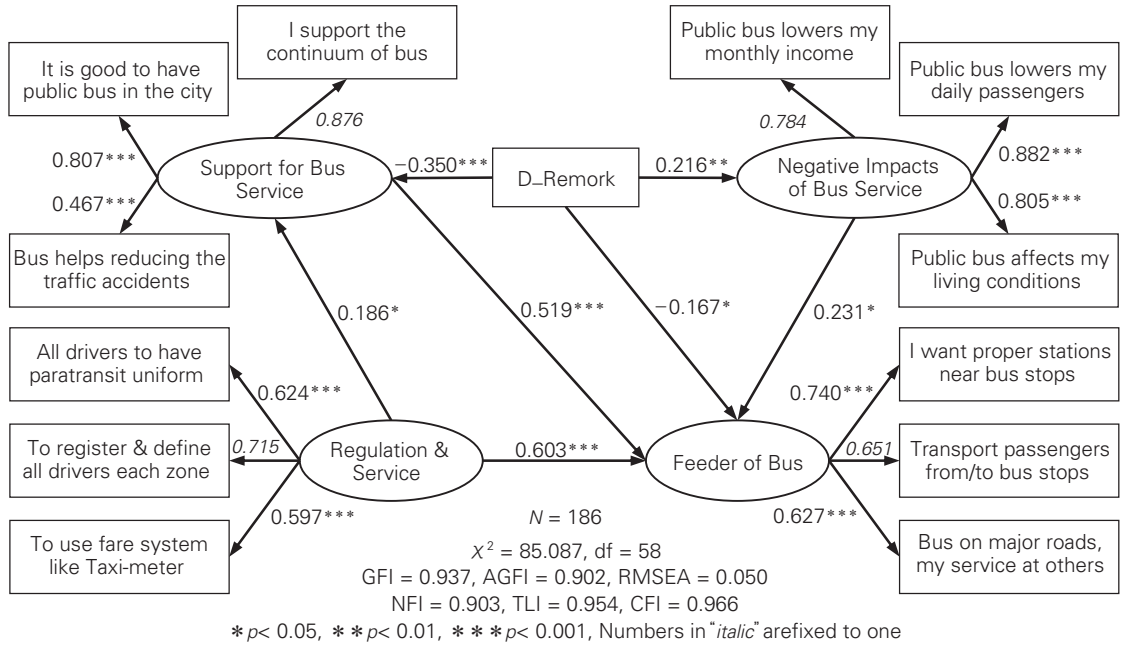
The full structural equation modeling and its estimate results using the statistical package AMOS 7.0 are illustrated in Figure—4. The model's goodness of fit is assessed by multiple-fit indices: $\chi^2$, Root Mean Square Error of Approximation (RMSEA), Goodness-of-Fit Index (GFI), Adjusted GFI (AGFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), and the Comparative Fit Index (CFI)[33]. In the initial model estimation, the modification indices indicated that the model could be improved through specification of an additional correlation between the error variance of Support for Bus Service and that of Negative Impacts of Bus Service. Theoretical justification for this correlation is that paratransit drivers who perceived negative impacts of the bus service were unlikely to support for the bus operation, and vice versa, causing the additional structural covariance between the two latent constructs. The estimated correlation between the two error variances is −0.54 with the critical ratio of −5.253 and $p < 0.001$. After correcting for this correlation and re-estimation, the model fit notably improved.

The $\chi^2$ of this model is 85.087, with 58 degree of freedom. The $p$-value associated with this result is small ($p = 0.012$), which is statistically significant. The $\chi^2$ measures the overall model fit and assesses the magnitude of discrepancy between the fitted covariance matrices and sample. Further, the absolute fit index is explained by RMSEA, which equals to 0.050, being far lower than 0.08 as close fit. RMSEA, one of the most informative fit indices, tells us how well the model would fit the population covariance matrix[34]. The values of other fit indices (GFI, AGFI, NFI, TLI, and CFI) are higher than 0.9, indicating a good model fit[33]. All fit indices for this model are notably high, suggesting that the overall fit of the model is good.

The number attached to each path arrow represents the standardized effect. All standardized effects are statistically significant ($p < 0.05$) with expected signs. Most indicators have standardized effects of 0.6 or higher, suggesting that the latent constructs are well measured by their corresponding indicators.

### 5.2 Effects of Bus Service

There are seven hypotheses tested in this study. The first hypothesis, the relationship between Support for Bus Service and Feeder of Bus, and the second, the relationship between Negative Impacts of Bus Service and Feeder of Bus, were confirmed by positively significant values. Results indicate that, whether paratransit drivers had positive or negative attitude towards the bus service, they basically had intention to operate as feeder service of the bus. The Support for Bus Service construct has a stronger effect (0.519) on Feeder of Bus than the Negative Impacts of Bus Service does (0.231). This lies in the fact that drivers who expected the benefits of bus operations for general citizens had stronger desire to feed the public bus with paratransit service than those who anticipated the negative impacts of bus service on their livings. Drivers might have concerned over their future services when they realized the importance of the bus service which would be unavoidable for the city development and for the future of Phnom Penh citizens. Most of the participants (99.5%)




■**Figure—4 Structural equation model and its estimated results with standardized effects**

could finish high school or lower, making them difficult to get an employment in a highly competitive market of formal jobs. Consequently, their concerns might have encouraged them to provide coordinated transport service to/from the bus stops in order to maintain their living conditions. In addition, responses from subjective questions show that the majority (73.4%) satisfied with their current job as paratransit drivers. Basically, they satisfied with the freedom in work schedules. They (76.4%) also claimed that the driver job was suitable for their capability. Accordingly, they might not be so ready for switching to any other jobs, whereas provision of feeder service to the bus would be one of the options for them to continue their career. The positive intention of drivers towards the feeder of mass transit system would be better off for the efforts in improving on the performance of mass transit system through the integrated public facilities (e.g., park & ride, transfer station) and transport services (e.g., fare, customer service and information).

### 5.3 Effects of Regulation & Service

The third hypothesis, the relationship between Regulation & Service and Support for Bus Service, and the fourth, the relationship between Regulation & Service and Feeder of Bus, were statistically significant, supported by positive values. Results indicate that drivers, who wanted a better regulation and service for paratransit operations (e.g., paratransit uniform, growth control, and standard fare), were likely to support for the bus service as well as to provide feeder service to bus stops in Phnom Penh. This might be true because the better regulation and service would help improve the overall paratransit service quality (e.g., safety, security), balance supply over passenger demand, minimize open market competition among drivers, and more importantly attract more intermodal passengers to use paratransit service. Better regulation and service might also mean that the paratransit service would become formal or be recognized by the government, and that the career as paratransit driver would possibly be more secured. Further, Regulation & Service has stronger influence on Feeder of Bus (0.603) than it does on Support for Bus Service (0.186). This is reasonable because the passenger demand for paratransit service has been gradually declined since the presence of the public bus in the city. Drivers would express stronger intention for feeder service to the bus in order for them to retain the passenger demand. To this end, the more effective Regulation & Service for paratransit operations is likely to encourage more drivers to operate as feeder mode of the bus, minimizing the driver contention to the service expansion of the public bus in the city.

### 5.4 Effects of Vehicle Size

The fifth, sixth, and seventh hypotheses tested the relationship between the Vehicle Size (i.e., D_Remork) and three latent constructs: Support for Bus Service, Negative Impacts of Bus Service, and Feeder of Bus, respectively. Results show that D_Remork has negative effects on Support for Bus Service (−0.350) and Feeder of Bus (−0.167). Remork drivers, who were long time in service, were easily affected by the recent introduction of bus service, and they were likely to have negative attitude towards the bus. This is supported by the positively significant effect of D_Remork on the Negative Impacts of Bus Service (0.216). Compared with Motodops, Remorks have larger-sized vehicle, higher transport capacity, and better service quality. Based on these attributes, Remork service has its charm. The number of daily trips has been slightly decreased from 4.4 in June 2012[26] to 4.1 in December 2014. This is plausible because, before the availability of the bus service in early February 2014, 22.4% of the bus users reported that they were Motodop passengers and only 7.2% were Remork passengers[21]. Despite the presence of the bus service, Remork drivers could still make the monthly revenue of approximately 43.0% higher than Motodop drivers. This might suggest that Remork drivers were happier with their current transport service, rather than operating as feeder mode of the bus. Subjective responses also confirmed that Remork drivers had fairly higher satisfaction scores (4 or 5) with their career; about 87.0% of Remork (79.0% of Motodop) drivers reported that working as paratransit drivers offered them a good living condition. In sum, the results suggest that drivers of larger-sized vehicle (i.e., Remorks) perceived the negative impact of the public bus service in Phnom Penh, they did not support for the bus service, and they were less likely to offer feeder service to the bus.

Based on how the variable D_Remork was defined, the results equivalently suggest that drivers of Motodops supported for the bus services and intended to offer feeder service to the bus in Phnom Penh. One main reason is that Motodop drivers intended to operate as feeder of the bus in order for them to maintain their revenue and to secure their job. The average number of daily trips made by Motodops has been reduced by about half, from 15.5 trips per day in June 2012[26] to 7.9 trips per day in December 2014. The reduction might involve with the presence of the bus

service, the increase in the number of paratransit drivers in the city streets, and the popularity of Remorks over Motodops in term of service quality. In addition, Motodop drivers might realize the necessity of the public bus for the city development. Since the operation of Motodops is not currently controlled by the government, Motodop service is considered as informal. It is possible that the operation of Motodops will be regulated or restricted from the urban major streets, following the bus service expansion or the implantation of a new mass transit system (e.g., BRT, LRT). Motodop drivers might have concerned over their future transport service, which can be very competitive with other (paratransit) drivers and at the same time with other public transport modes. Moreover, 39.0% of Motodop drivers claimed that they had dual jobs[29]. This could possibly explain that they have already concerned over their unstable revenue from Motodop service. Their concerns might have been gradually intensified after the bus service was introduced. Accordingly, Motodop drivers would consider for some possible alternatives to co-exist with the public bus, for instance, serving as feeder mode of the bus.

### 5.5 Discussion

The overall results of this study implied that, following the newly-introduced public bus in Phnom Penh, the interviewed drivers had intention to provide feeder service to the bus, regardless its anticipated impacts on their livings. Also, the regulations on paratransit growth control in each servicing zones, paratransit operations (i.e., proper driver uniform), and paratransit fare system (i.e., standard fare structure) should be considered by the government and paratransit associations. This is because a more effective regulation for paratransit service & operation would encourage more drivers to operate as feeder of the public bus in a harmonized manner.

Results from SEM revealed that drivers of Remorks did not support for the bus service in Phnom Penh nor intended to operate as feeder mode to the bus. This implied that the drivers preferred their current operations rather than serving as feeder mode to the public bus. The drivers may have observed that most trip origins/destinations of their passengers were not near any bus stops, and thus they had more confidence to remain with their current service. Further, Remorks might not be suitable as feeder mode of the public bus from the viewpoints of passengers. The carriage of a Remork functions as the "protective shell," offering passengers a certain level of safety, comfort, and weather protection. This makes Remorks more attractive, in addition to its flexible door-to-door transport service. A passenger with up to five companions (the average rate of passengers per trip is 2.6) would rather choose Remork to travel in group on a single vehicle, and the travel cost per person would be lower. With this regard, it is not economically or conveniently sound for the group of passengers to reach their destination through the bus transfer. Similarly, passenger(s) with goods would use Remork to transport the goods directly to a desired destination. This sort of transport service is not available by other public modes in Phnom Penh, except Taxi that commonly charges a higher fare. For the case of Indonesia, for example, passengers of bus and MRT were less likely to use the auto-rickshaw (i.e., Bajaj) as the feeder mode in order to reduce travel cost by avoiding intermodal transfer, compared with walking[9]. To this end, it might be better to allow Remork drivers to continuing their current operational service, sometimes competing to the public bus like the cases of Tuktuk in Bangkok, Bajaj in Indonesia, or general Taxi in Asian developing countries.

The results also implied that drivers of Motodops supported the public bus operations and intended to offer feeder service to the bus. This serves as a positive starting point for the government to discuss the role of Motodops in the future. Motodops should be regulated as feeder mode to the public bus in order to promote intermodal ridership. Due to its smaller-sized vehicle, Motodops can flexibly penetrate through small roads and traffic congestion with shorter travel time and relatively low fare compared to Remork or Taxi. Since the bus service is only available on the major roads far from high-density residential areas along the small roads, citizens can reach a bus stop by using the Motodop service. Walking is not popular for general citizens due to the poor sidewalk, weather condition (e.g., hot), safety concerns (e.g., crime, accident), and inadequate control over the on-street parking. Infrastructure supports like paratransit stations might also be necessary for the coordinated services among transport modes. Note that Thailand was the first country in the world that has regulated the motorcycle taxi services since May 2005[35]. The Thai regulation includes operational safety (e.g., helmet for passengers), pick-up stations, driver uniform, driving license, fare rate, and yearly registration tax. Other Asian developing countries including Vietnam and Indonesia have realized the importance of motorcycle taxi service and have already discussed how to regulate the service[31].

The consideration on which size of paratransit

vehicles that should be operated as feeder mode to mass transit remains unclear, because it closely links to the passenger desire and the availability of paratransit modes in a particular area. Motodops are small-sized vehicles and can transport fewer passengers to feed the bus, while Remorks may not be fitted as the feeder mode. Besides, Motodops are not safe. With this respect, the government might want to consider a more systematic feeder mode such as microbus, which should be operated on a fixed-route and shared-ride basis with fare regulated. The fare of this mode is relatively lower than that of other flexible paratransit modes. Microbus includes Angkot in Indonesia and Songtaew Thailand.

## 6——Conclusion

We explored the effects of the attitudes of paratransit drivers towards the bus service, the size of paratransit vehicles, and the paratransit regulation & service on feeder intention to the public bus in Phnom Penh. With the bus service in place, we found that Motodop drivers had intention to provide feeder service to the bus. This result reflected the drivers alone. To arrive at the implementation stage, however, the involving transport authorities must make consensus among public transport operators; especially the paratransit operators who have been long in services. In doing so, it will lead to a successful planning of whole public transport system, minimizing the obstacles to further expansion of the mass transit system. Policy intervention and regulation for better paratransit service should be considered by all relevant parties such as paratransit operators, paratransit associations, and the (local) governments. Although this study found that drivers of larger-sized vehicle (Remorks) had no intention for feeder service of the bus, the choice of vehicle size as feeder mode does not necessarily depend on paratransit drivers. It should depend more on the paratransit passengers, who can decide on which mode they choose as main mode or feeder mode for their trips, among the other available modes.
This is the first study that provides a fundamental piece of evidence regarding the intention of paratransit drivers to operate as feeder of a newly-introduced mass transit system (i.e., public bus). The study on paratransit operators in developing countries remains at initial stage. It requires wider investigation on the supply side such as the impacts of mass transit development plan on paratransit services and operators' quality of life, the ticketing system and fare issues used for coordinated transport services, the more efficient feeder route network, the use of advanced technologies (e.g., ICT), etc. It is obvious that further researches on these fronts are required to discuss more on long-term benefits of paratransit in Asian developing countries and elsewhere.

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### References

1) Cervero, R. and Golub, A. [2007], "Informal transport: A global perspective", *Transport policy*, Vol.14, pp.445-457.
2) Joewono, T.B. and Kubota, H. [2007], "User satisfaction with paratransit in competition with motorization in Indonesia: Anticipation of future implications", *Transportation*, Vol.34, pp. 337-354.
3) Cervero, R. [2000], *Informal transport in the developing world*, United Nations Pubns.
4) Shimazaki, T. and Rahman, M.M. [1996], "Physical characteristics of paratransit in developing countries of Asia", *Journal of Advanced Transportation*, Vol.30, No.2, pp.5-24.
5) Lave, R. and Mathias, R. [2000], "State of the art of paratransit, In: Transportation in the New Millennium", *Transportation Research Board*, Washington DC.
6) Phun, V.K. and Yai, T. [2016], "State of the art of paratransit literatures in Asian developing countries", *Asian Transport Studies*, Vol.4, No.1, pp.57-77.
7) Satiennam, T., Fukuda, A., and Oshima, R. [2006], "A study on the introduction of bus rapid transit system in Asian developing cities—A case study on Bangkok metropolitan administration project", *IATSS Research*, Vol.30, No.2, pp.59-69.
8) Shrivastava, P. and O' Mahony, M. [2006], "A model for development of optimized feeder routes and coordinated schedules —A genetic algorithms approach", *Transport Policy*, Vol.13, No.15, pp.413-425.
9) Fujiwara, A. and Zhang, J. [2013], *Sustainable transport studies in Asia*, Springer, Japan, (Chapter 6).
10) Loo, B.P.Y. [2007], "The role of paratransit: Some reflections based on the experience of residents' coach services in Hong Kong", *Transportation*, Vol.34, pp.471-486.
11) Roos, D. and Alschuler, D. [1975], "Paratransit—existing issues and future directions", *Transportation*, Vol.4, pp.335-350.
12) Chandra, S., Bari, M.E., Devarasetty, P.C., and Vadali, S. [2013], "Accessibility evaluations of feeder transit services", *Transportation Research Part A*, Vol.52, pp.47-63.
13) Mistro, R.D. and Behrens, R. [2015], "Integrating the informal with the formal: An estimation of the impacts of a shift from paratransit line-haul to feeder service provision in Cape Town", *Case Studies on Transport Policy*, Vol.3, No.2, pp.271-277.
14) Okada, H., Doi, K., Gaabucayan, M.S.A., and Hosmi, A. [2003], "Qualification of passengers' preference for improvement of railway stations considering human latent traits: A case study in

metro Manila", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.5, pp.1408-1421.
15) Tangphaisankun, A., Nakamura, F., and Okamura, T. [2009], "Influences of paratransit as a feeder of mass transit system in developing countries based on commuter satisfaction", *Journal of Eastern Asia Society for Transportation Studies*, Vol.8.
16) Tarigan, A.K.M., Susilo, Y.O., and Joewono, T.B. [2010], "Negative experiences and willingness to use paratransit in Bandung, Indonesia: An exploration with ordered probit model", *The 89th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, January 10-14, 2010, pp.1-24.
17) Sumaedi, S., Bakti, I.G.M.Y., and Yarmen, M. [2012], "The empirical study of public passengers' behavioural intentions: The role of service quality, perceived sacrifice, perceived value, and satisfaction (Case study: Paratransit passengers in Jakarta, Indonesia)", *International Journal for Traffic and Transport Engineering*, Vol.2, No.1, pp.83-97.
18) Weningtyas, W., Fujiwara, A., and Zhang, J. [2013], "Does improved level of paratransit service improve drivers' quality of life?" *Journal of Eastern Asia Society for Transportation Studies*, Vol.10, pp.1367-1383.
19) Li, G., Zhang, J., Nugroho, S.B., Linh, T.N., and Fujiwara, A. [2011], "Analysis of paratransit drivers' stated job choice behavior under various policy interventions incorporating the influence of captivity: A case study in Jabodetabek metropolitan area, Indonesia", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.9, pp.1144-1159.
20) Nugroho, S.B., Fujiwara, A., Zhang, J., and Li, G. [2013], "Does paratransit drivers' low job satisfaction lead to job mobility? A case study of taxi-like paratransit drivers in Jakarta city", *The 92nd Annual Meeting of the Transportation Research Board*, Washington D.C., USA, January 13-17, 2013.
21) Phun, V.K., Pheng, P., and Yai, T. [2015], "Using ordered probit modeling to assess perceived bus performance in Phnom Penh", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.11, pp.1155-1172.
22) Furuuchi, M., Murase, T., Tsukawaki, S., Sieng, S., and Yamashita, M. [2005], "Air Pollution in Phnom Penh: Concentration and Chemical Compositions of Ambient Particles", *The 1st International Symposium on Evaluation of Mechanisms Sustaining the Biodiversity in Lake Tonle Sap, Phnom Penh, Cambodia*, December 2005, pp.82-90.
23) Kov, M. and Yai, T. [2011], "Exploring factors associated with motorcyclist accident involvement in Phnom Penh", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.9, pp.1796-1811.
24) Long, B., Choocharukul, K., and Nakatsuji, T. [2011], "Psychological factors influencing behavioral intention toward future sky rail usage in Phnom Penh, Cambodia", *Transportation Research Record*, No.2217-08, pp.63-70.
25) Choocharukul, K. and Ung, M.H. [2011], "Propensity to switch to a new bus service in Phnom Penh using stated preference analysis", *Asian Transport Studies*, Vol.1, No.3, pp.277-287.
26) JICA-PPUTMP [2014], "Project for comprehensive urban transport plan in Phnom Penh capital city (PPUTMP)", Japan International Cooperation Agency, December 2014.
27) Muromachi, Y., Lim, I., Wicaksono, A., et al. [2015], "A comparative study on road-based urban public transport policies in six Asian countries from the viewpoint of governance, urban planning, and financial aspects", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.11, pp.1433-1450.
28) Phun, V.K., Masui, R., and Yai, T. [2015], "The future prospects of paratransit service in Phnom Penh", *Proceedings of the 7th Regional Symposium on Infrastructure Development*, Vol.20, No.7, pp.221-226.
29) The World Bank [2012], "Evaluating the impacts of introducing reforms on Jeepney operations in Cebu city", Philippines, June 2012.
30) Phun, V.K., Lim, I., and Yai, T. [2015], "The characteristics of paratransit operation and fare in Phnom Penh", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.11, pp.1307-1327.
31) Tuan, V.A., and M.-Babiano, I.B. [2013], "Motorcycle taxi service in Vietnam—Its socioeconomic impacts and policy consideration", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.10, pp.13-28.
32) Hooper, D., Coughlan, J., and Mullen, M.R. [2008], "Structural equation modelling: Guidelines for determining model fit", *The Electronic Journal of Business Research Methods*, Vol.6, No.1, pp.53-60.
33) Hair, J.F., Anderson, R.E., Tatham, R.L., and Black, W.C. [1998], *Multivariate data analysis*, Prentice-Hall, New Jersey.
34) Byrne, B.M. [1998], *Structural equation modeling with LISREL, PRELIS and SIMPLIS: Basic concept, applications and programming*, Lawrence Erlbaum Associates, Mahwah, New Jersey.
35) Oshima, R., Fukuda, T., Fukuda, A., and Satiennam, T. [2007], "Study on regulation of motorcycle taxi service in Bangkok", *Journal of the Eastern Asia Society for Transportation Studies*, Vol.7, pp.1828-1843.

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## パラトランジット運転者の端末交通への転換に関する研究

本研究の目的は，プノンペンで新たに導入されたバスを対象に，パラトランジット運転者がバスをどう受け入れるかと，端末交通としての事業運営の意向を明らかにすることである．運営企業であるMotodopsとRemorksの運転者へのインタビュー調査結果を用いて構造方程式を構築した結果，端末交通としての事業運営に対して，Motodops運転者はバスをどう受容するかに関わらず前向きである一方，Remorks運転者は生計への悪影響の恐れから後ろ向きであることが明らかになった．これを踏まえ，端末交通への参加を促すためのパラトランジットへの規制についても考察した．

キーワード；**フィーダサービス，大量輸送，パラトランジット，プノンペン，構造方程式モデリング**