

STUDY ON TRAVEL BEHAVIOR WITH PRIVATE VEHICLE DEPENDENCE IN ASIAN MEGACITIES

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In developing countries, owners of private vehicles tend to depend on their own modes and the modal shift couldn't be expected without effective modal-shift measures based on the trip characteristics and issues in the city.

This study aims to analyze the results of Person-Trip surveys conducted in the Asian Megacities focusing on private vehicle dependence and trip length, to understand the mobility's characteristics and problems / challenging in Asian Megacities. The study results are expected to lead to suggestion on effective modal shift measures.

The trip rate (number of trips per person per day) by representative mode and modal share by trip length were examined and differences between car owners and non-car owners are observed. Some cities such as Dhaka and Colombo show significant difference on the trip rate between car owners and non-car owners, and high modal share for walkable distance trip of car owners. These findings suggest that car owners strongly depend on the private cars for their daily trips.

Key Words : Person Trip Survey, Trip Length, Private Vehicle Dependence, Asian Megacities

1. INTRODUCTION

(1) Background

Generally, owners of private vehicles tend to depend on their own modes and don't include other modes as choices for their trips. This trend is more prominent in the developing countries, where the service level of public transport is poor. With the economic growth and motorization, the modal share of the private vehicles has been increased rapidly, inducing serious problems for environment, the quality of urban life and the accessibility of various activities.

In megacities of developing countries, transport projects such as urban rail development are on-going, to ensure public mobility, contribute to effective land use development by building a transport backbone, promote the growth of its influence areas. However, the strong dependency on the private modes would inhibit the expected modal shift and make such transport projects ineffective.

To achieve successful modal – shift, measures based on the trip characteristics and issues in the city must be implemented.

(2) Objectives

This study examines the person trip survey results conducted in Megacities in Asian Developing Countries, focusing on private vehicle dependence. The modal share by household vehicle ownership group are compared to understand the characteristics by case study cities, and modal share for intra-zonal trip (short distance trip) are reviewed as an indicator of private vehicle dependence. For the cities that car-dependent traffic behaviors are observed, these behaviors are analyzed to surmise their motives. The results are expected to be discussed on effective modal shift measures

2. CASE STUDY CITIES

The case study cities are selected according to the following criteria:

- Cities where comprehensive Person – Trip Survey (PT Survey) was conducted by Japan International Cooperation Agency (JICA) recently: For such survey, the sample rate was conventionally about 2.0 % of total households, has been limited to about 1.0 % due to the budget constraint. However, calibration by several supplemental traffic surveys assures the precision in sampling and this paper utilizes the PT survey results ¹⁾.
- Cities with various progress of motorization : The results by vehicle ownership rate are compared and relationship with the private vehicle dependency is examined.
- Cities with and without Urban Railway: urban railway provides significant impact on urban transport characteristics must be compared, to discuss implication on the development of urban railway, which development projects are on-going in many Asian cities.

Based on the above, five cities shown in Table 1 were selected as the case study cities.

3. URBAN TRANSPORT CHARACTERISTICS OF CASE STUDY CITIES

(1) Metro Manila, Philippines⁴⁾

a) City Profile

As the capital region of the Philippines, the population growth and suburbanization have been pro-

gressed and the substantive metropolitan area has 22 million of population.

While the expansion of the urban area has been progressed rapidly, development of transport infrastructure as the countermeasures are slow and there is huge demand-supply gap. People in middle - income group who live in suburban are forced to spend long commute time due to the traffic congestion. Urban development associated with the economic growth is active and high-rised buildings have been constructed without appropriate urban plan, creating high – population density area.

For the characteristics in urban transport fields, Metro Manila has experienced both of rapid motorization and urban railway development at the same time. And there are various road – based public transport, such as bus, jeepney (minibus originally made from U.S. military jeep), tricycle (motorcycle taxi with sidecar), pedicab (bicycle taxi), FX taxi (passenger service by Utility Vehicles), and P2P (premium direct bus service connecting the suburbs to the central business districts).

b) Person Trip Survey and Modal Share

In Metro Manila, Person Trip Survey had been conducted several times and the latest one was conducted by “The Project for Capacity Development on Transportation Planning and Database Management in the Republic of the Philippines (MUCEP)” in 2014 ⁵⁾. Table 2 shows the modal share by Household Car Ownership in 2014. Comparing the members in car own households and non-car own households, there is difference in the share of walking trips (car own households: 14.0 %, non- car own households: 33.5 %).

Table 1 Profile of Profiles of Case Study Cities

Indicators		Metro Manila (Philippines)	Ho Chi Minh City (Vietnam)	Yangon (Myanmar)	Dhaka (Bangladesh)	Colombo (Sri-Lanka)	Cities in Japan (as References)		
							Tokyo Metropolitan Area	Chukyo Metropolitan Area	
Urban Profile	Urban Area (km ²) ²⁾	1,580	1,489	544	2,161	223	8,547	3,704	
	Population (000, in 2016) ²⁾	22,930	10,075	5,320	16,235	2,195	37,750	9,113	
	Density (/ha)	145	68	97.8	75.1	98.4	44.2	24.6	
	Per Capita GRDP (USD) ³⁾	6,039	3,161	2,286	1,212	3,919	34,000		
Transport Characteristics ⁴⁾	Modal Share (% , excluding Walking / Bicycle)	Motorcycle	12.3	91.1	9.7	19.9	34.2	1.6	13.3
		Car / Taxi	13.4	2.9	19.3	12.9	14.3	42.2	70.3
		Public (Road)	62.2	3.3	65.0	64.3	48.1	4.7	1.5
		Public (Rail)	6.2	-	1.5	0.3	3.4	51.6	13.5
		Others	5.9	2.8	4.5	2.6	0	0	1.4
	Trip Rate (/day) *	Including Walking	2.0	3.0	2.0	1.9	1.87	2.6	2.4
		Excluding Walking	1.4	2.7	1.2	1.2	1.54	2.0	2.1
Vehicle Ownership (unit /000 pop)	Car	94	69	45	28	42	232	689	
	Motorcycle	58	794	34	53	134	35	15	
Person Trip Survey	Source (Year)	MUCEP (2014) ⁵⁾	METROS (2013) ⁶⁾	YUTRA (2013) ⁷⁾	DHUTS ⁸⁾ (2008) RSTP ⁹⁾ (2014)	CoMTranss (2012) ¹⁰⁾	6 th Person-Trip Survey (2018) ¹¹⁾	5 th Person-Trip Survey (2011) ¹²⁾	
	Sample Rate (%)	1.0	1.0	1.0	0.67	2.3	3.5	2.9	

* Number of trips per population aged 5 or over

Table 2 Modal Share in Metro Manila, by Household Car Ownership (2014)⁵⁾

		Car Own HouseHolds		Non-Car Own HouseHolds		Total		
		(000/day)	(%)	(000/day)	(%)	(000/day)	(%)	
Walking		709	14.0	10,201	33.5	10,910	30.5	
Bicycle		24	0.5	708	2.3	732	2.1	
Private	MC	As Driver	258	5.1	2,012	6.6	2,270	6.4
		As Pax	86	1.7	586	1.9	672	1.9
	Car	As Driver	1,596	31.5	223	0.7	1,819	5.1
		As Pax	578	11.4	493	1.6	1,071	3.0
	Others		42	0.8	320	1.1	362	1.1
	Subtotal		2,560	50.5	3,634	11.9	6,195	17.4
Semi-Public	Taxi		59	1.2	246	0.8	305	0.9
	Tricycle		445	8.8	5,170	17.0	5,615	15.8
	Pedicab		41	0.8	590	1.9	631	1.8
	Subtotal		546	10.8	6,006	19.7	6,552	18.5
Public	Railway		193	3.8	1,290	4.2	1,483	4.2
	Bus		211	4.2	1,822	6.0	2,032	5.7
	School bus		135	2.7	197	0.6	332	0.9
	Jeepney		614	12.1	6,140	20.2	6,754	19.0
	Others		74	1.5	446	1.5	520	1.5
	Subtotal		1,227	24.2	9,894	32.5	11,121	31.3
Total		5,067	100	30,443	100	35,510	100	

(2) Ho Chi Minh City, Vietnam**a) City Profile⁴⁾**

Vietnamese Cities show very high ownership rate of motorcycles. The Vietnamese traditional residential blocks consist of middle rised housings (3-5 storeys) and narrow street (2 – 3 m of width) and accessibility is provided only for motorcyclists and door-to-door movements are ensured by on-street parking. These environment enhances the usage of motorcycle in the daily life. Although these trend has been increasingly significant in recent years, the number of private cars also has been increased.

b) Person Trip Survey and Modal Share

In Ho Chi Minh City, Person Trip Survey was conducted in two times by JICA, “The Study on Urban Transport Master Plan and Feasibility Study in Ho Chi Minh Metropolitan Area (HOUTRANS)” in 2002¹³⁾ and “Data Collection Survey on Railways in Major Cities in Vietnam (METROS)” in 2013⁶⁾.

According to the Person Trip Survey in 2013, the household motorcycle ownership ratio was more than 90 %. In this paper, the modal share by personal availability of motorcycle and car was compared as shown in Table 3. Even for non-vehicle available group, modal share of motorcycle is nearly half of total trips and the most of them are picked up and dropped off by others. The number of samples in car available group is limited but more than 40 % of there trips are made by private cars.

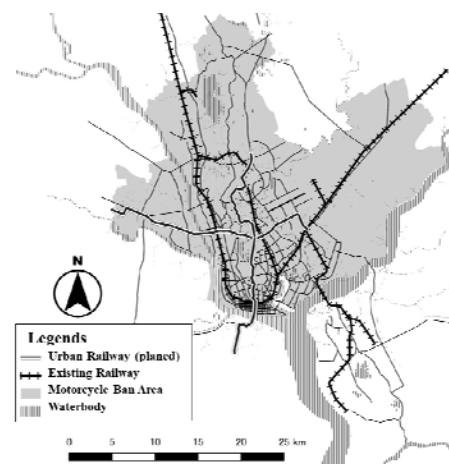
Table 3 Modal Share in HCMC, by Personal Vehicle Availability (2013)⁶⁾

			Car Available		Motorcycle Available		Non-Vehicle Available		Total	
			(000/day)	(%)	(000/day)	(%)	(000/day)	(%)	(000/day)	(%)
Walking			42	3.6	2,267	6.3	3,657	21.9	5,966	11.0
Bicycle			5	0.5	141	0.4	2,879	17.1	3,012	5.6
Private	Motorcycle	As Driver	367	30.9	30,991	85.6	1,876	11.2	33,234	61.4
		As Pax	23	1.9	1,285	3.5	5,721	34.2	7,029	13.0
	Car	As Driver	493	41.6	164	0.5	16	0.1	673	1.2
		As Pax	37	3.1	199	0.5	158	0.9	393	0.7
	Others		194	16.3	412	1.2	184	1.1	790	1.4
	Subtotal		1,114	93.8	33,051	91.3	7,955	47.5	42,119	77.7
Semi-Public	Taxi		7	0.6	90	0.2	139	0.8	237	0.4
	MC Taxi		5	0.4	163	0.5	687	4.1	854	1.6
	Subtotal		12	1.0	253	0.7	826	4.9	1,091	2.0
Public (Bus)			14	1.2	505	1.4	1,422	8.5	1,941	3.6
Total			1,187	100	36,218	100	16,725	100	54,130	100

(3) Yangon, Myanmar**a) City Profile⁴⁾**

Yangon, the former capital of Myanmar with a population of 5.2 million (as of the 2014 census), is the country’s largest commercial hub. The population growth and urbanization have been progressed rapidly. Although the population density of the whole city is not high, there is downtown area which was developed in the colonial era and low-density area being expanded in suburbs. Myanmar shifted to democrasization from long military administration and has been exposed to the waves of internationalization, and Yangon has experienced rapid urbanization and motorization.

Bus transport plays major role of urban transport and carry about 2 million pasengers a day. It is partly due to the restriction of motorcycle use in urban area. Considering the importance of bus service, the Government has committed to reform the system drastically but further improvement is required in many fields.

**Figure 1 Transport Map in Yangon City¹⁴⁾**

b) Person Trip Survey and Modal Share

As a part of the Project for Comprehensive Urban Transport Plan of Greater Yangon (YUTRA, 2013⁷⁾), Person Trip Survey was conducted. Table 4 shows the modal share by Household Car Ownership. The share of walking trip for members in car own households is higher than other cities.

Table 4 Modal Share in Yangon Area, by Household Car Ownership (2014)⁷⁾

	Car Own HouseHolds		Non-Car Own HouseHolds		Total		
	(000/day)	(%)	(000/day)	(%)	(000/day)	(%)	
Walking	406	28.3	5,120	45.5	5,526	43.5	
Bicycle	107	7.4	1,503	13.3	1,610	12.7	
Private	Motorcycle	39	2.7	502	4.5	541	4.3
	Car	416	29	131	1.2	547	4.3
	Taxi	137	9.6	392	3.5	530	4.2
	Truck	14	1	97	0.9	111	0.9
	Subtotal	606	42.2	1,122	10	1,729	13.6
Public	Railway	3	0.2	81	0.7	84	0.7
	Bus	310	21.6	3,307	29.4	3,616	28.5
	Water Transport	4	0.3	130	1.2	134	1.1
	Subtotal	316	22	3,518	31.2	3,834	30.2
Total	1,435	100	11,264	100	12,699	100	

(4) Dhaka, Bangladesh

a) City Profile⁹⁾

Dhaka City is the capital of the People's Republic of Bangladesh. The Metropolitan Area called RAJUK, as the name of the Capital Development Authority, has 14.8 million residents in 1,500 km² of its area. With the very high population density, various urban problems including serious traffic congestion can be observed. Due to the rapid motorization, difficulty of land acquisition, and financial and institutional matters, the traffic problems seem to be difficult to solve.

b) Person Trip Survey and Modal Share

Household Interview Survey were conducted by "Preparatory Survey Report on Dhaka Urban Transport Network Development Study in Bangladesh (DHUTS)" in 2009⁸⁾ and "The Project on the Revision and Updating of the Strategic Transport Plan for Dhaka(RSTP)" in 2014⁹⁾. Both Studies were founded by JICA, and the former collected only the city area and latter was conducted to supplement to collect samples in suburban Area.

Table 5 shows the modal share by household car ownership. For the members of Car Own Households, the share of private mode is high and walking trip is much lower than non-car own households group. And rickshaw (bicycle - taxi) has a significant role in mobility for the citizens in both groups.

Table 5 Modal Share in Dhaka, by Household Car Ownership (2014)^{8), 9)}

	Car Own HHs		Non-Car Own HHs		Total		
	(000/day)	(%)	(000/day)	(%)	(000/day)	(%)	
Walking	115	5.8	11,618	41.5	11,733	39.1	
Bicycle	5	0.3	271	1.0	276	0.9	
Private	Motorcycle	39	2.0	536	1.9	575	1.9
	Private Car	1,067	53.9	257	0.9	1,324	4.4
	Truck	0	0.0	23	0.1	23	0.1
	Others	1	0.0	37	0.1	37	0.1
	Subtotal	1,107	55.9	852	3.0	1,959	6.5
Semi-Public	Taxi	10	0.5	54	0.2	64	0.2
	Rickshaw	354	17.9	6,879	24.6	7,233	24.1
	M/C Taxi	105	5.3	1,455	5.2	1,560	5.2
	Subtotal	469	23.7	8,388	29.9	8,857	29.5
Public	Railway	2	0.1	31	0.1	33	0.1
	Bus	249	12.6	6,340	22.6	6,589	22.0
	Schoolbus	33	1.7	292	1.0	326	1.1
	Water Transport	1	0.0	219	0.8	219	0.7
	Subtotal	285	14.4	6,882	24.6	7,168	23.9
Total	1,981	100	28,012	100	29,993	100	

(5) Colombo, Sri-Lanka

a) City Profile¹⁰⁾

Colombo Metropolitan Area is the largest metropolitan area in Democratic Socialist Republic of Sri Lanka. The population was 3.7 million inhabitants in 2012.

Current traffic congestion becomes serious during the morning and evening peak periods in the city centre and the surroundings.

Less utilization of high occupancy vehicles, a lack of facilities for pedestrians and bus passengers, an insufficient capacity of public transport and poor enforcement of traffic rules aggravate the situation.

b) Person Trip Survey and Modal Share

Under "The Urban Transport System Development Project for Colombo Metropolitan Region and Suburbs (CoMTrans)"¹⁰⁾, Home Visit Survey was conducted to collect the latest travel activity information of the residents along with the socio-economic information in 2013. Table 6 shows the modal share by household car ownership. The members of Car Own Households tend to rely on the private mode and the share of walking trip is just 4.7% much lower than non-car own households group, 19.9%. For non car own households members, the share of motorcycle is high, reflecting the high ownership of motorcycles.

Table 6 Modal Share in Colombo, by Household Car Ownership (2013)⁹⁾

	Car Own HHs		Non Car Own HHs		Total		
	(000/day)	(%)	(000/day)	(%)	(000/day)	(%)	
Walking	72	4.7	1,701	19.9	1,773	17.6	
Bicycle	5	0.3	387	4.5	392	3.9	
Private	Motorcycles	125	8.1	2,050	24.0	2,175	21.6
	Car	845	55.0	262	3.1	1,107	11.0
	Others	2	0.1	73	0.9	75	0.7
	Subtotal	971	63.2	2,385	27.9	3,357	33.3
Semi-Public	Motorcycle Taxi	64	4.1	467	5.5	531	5.3
	Taxi	5	0.3	20	0.2	25	0.3
	Subtotal	69	4.5	488	5.7	556	5.5
Public	Company Bus	29	1.9	165	1.9	193	1.9
	School Bus	148	9.6	623	7.3	771	7.6
	Bus	211	13.7	2,564	30.0	2,775	27.5
	Railway	32	2.1	239	2.8	271	2.7
	Subtotal	419	27.3	3,591	42.0	4,011	39.8
Total	1,537	100	8,552	100	10,089	100	

(6) Comparison of Trip Rate by Travel Mode

Figure 2 visualizes the trip rate (the number of trips per population aged 5 or over) by household car ownership in Case Study Cities. Contribution by representative travel mode is also illustrated. Generally, the trip rates for members in car own households are higher than non-car own households members. On the other hand, the walking trip rate is much lower in car own households members.

The difference on the walking trip rate by car ownership varies by city. Among the case study cities, Dhaka and Colombo show especially significant difference. It implies that car owners in the cities strongly depend on the private cars and use their private mode for very short distance.

In Yangon, the difference in the walking trip rate by car ownership group is small. The registered vehicles per population is still low and car-dependent lifestyle may not be established among people yet.

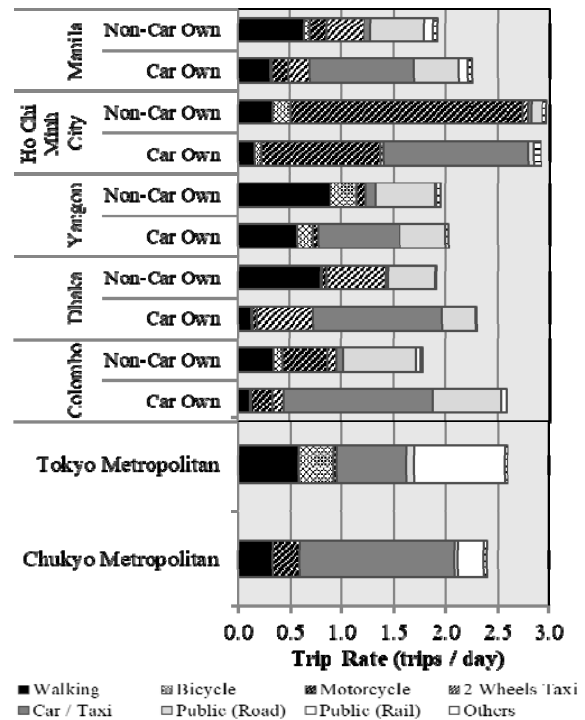



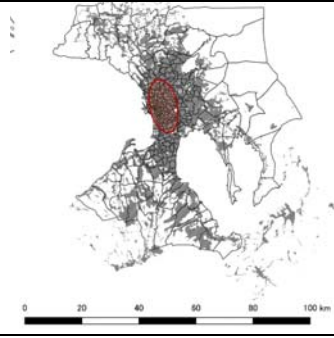

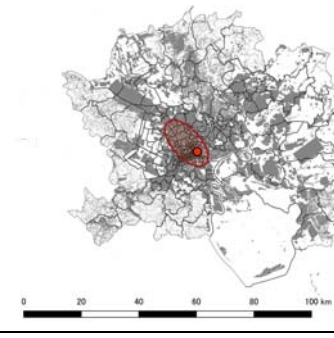
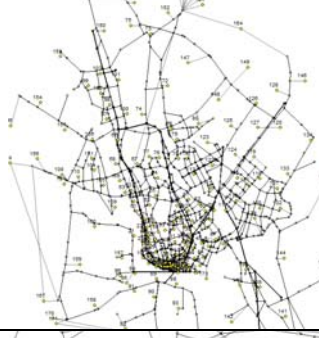
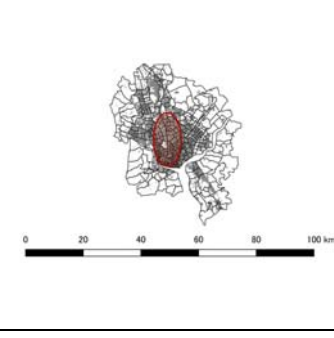

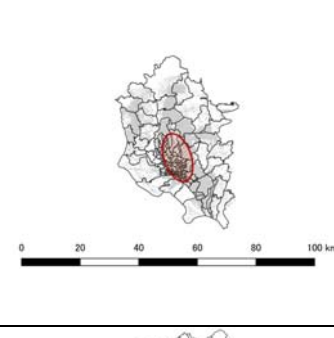

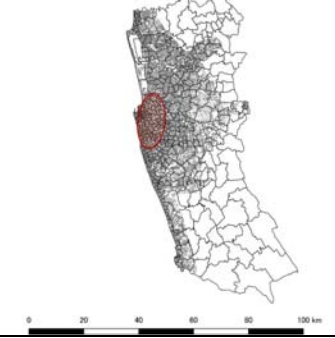
Figure 2 Trip Rate by Representative Travel Mode in Case Study Cities

4. ANALYSIS ON MODAL SHARE BY TRIP LENGTH

(1) Methodology

As the viewpoint of analysis on the mode choice characteristics, modal share by trip length was focused on. If the share of private vehicles are high even in short trip length, the people in the city might depend on their private modes. To estimate the trip length by Origin – Destination (OD) pair, the transport network file (format: JICA STRADA) was utilized. And it must be noted that the mode choice characteristics markedly differ by the location. For example, urban facilities are concentrated in city centre and people can access the destination by walk. On the other hand, facilities are dispersed in suburban area and the share of walking trips tends to be small. Additionally, traffic analysis zones of the Person Trip Survey are larger in Suburban Area and it is difficult to identify the intra-zonal trip is walkable distance or not. In this paper, only OD pairs within the defined urban cores are picked up. The network, picked up urban cores, and selected traffic analysis zones are summarized in Table 7. For the picked-up urban cores, the average land area of the traffic analysis zones ranges from 100 ha (Yangon) to 250 ha (Dhaka). Most of the intra-zonal trips can be assumed as walkable distance.

Table 7 Profile of Profiles of Case Study Cities

City Name	Network	TAZ and Picked Up Area	Total		Picked-up Urban Area	
			No	Area (km ²)	No	Area (km ²)
Metro Manila (Philippines)			350	3,953	161	197
Ho Chi Minh City (Vietnam)			275	6,445	133	199
Yangon (Myanmar)			389	1,529	149	156
Dhaka (Bangladesh)			144	1,554	87	216
Colombo (Sri-Lanka)			462	3,745	138	194

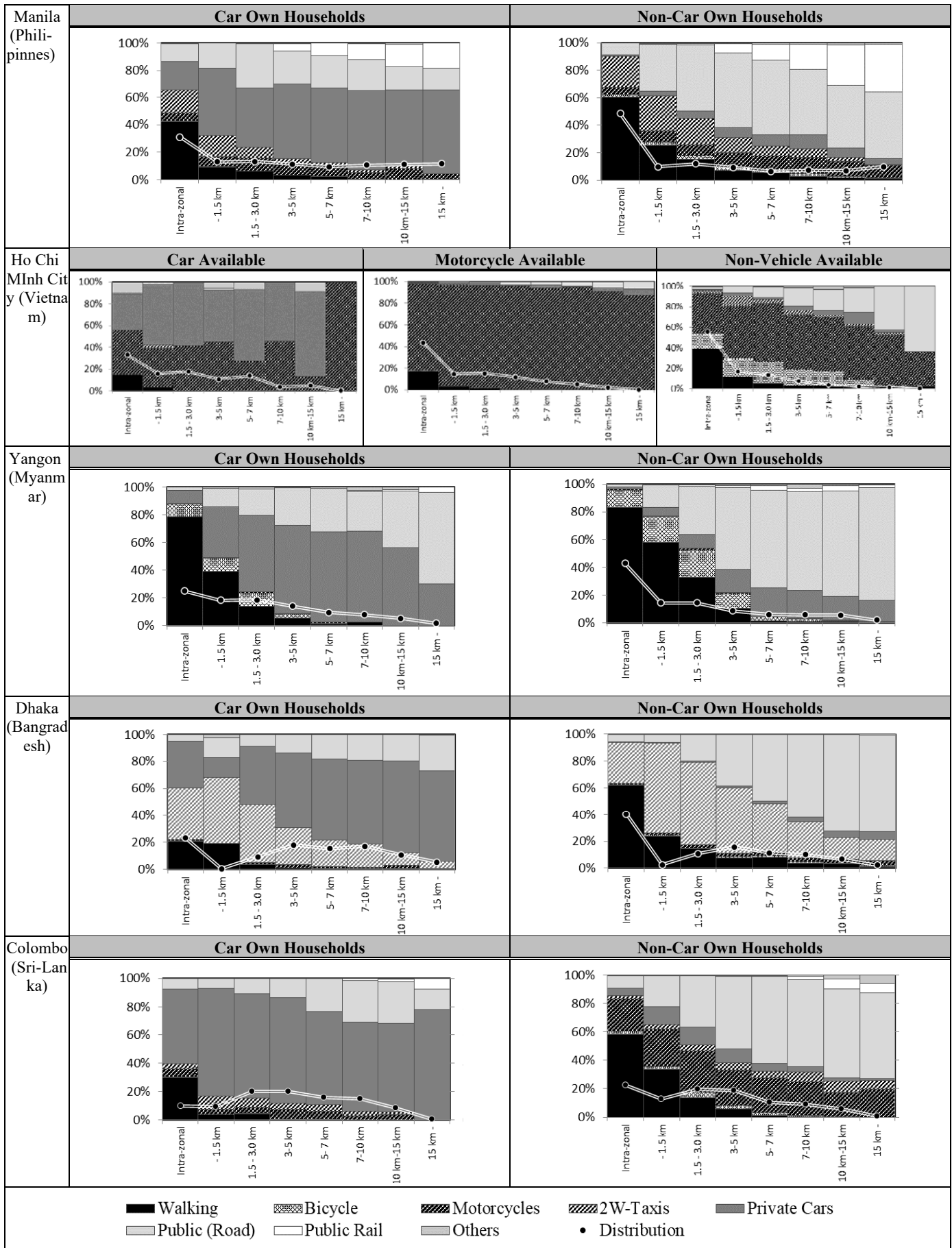


Figure 3 Comparison of Modal Share & Trip Distribution by Travel Distance Range

(2) Findings

The results are illustrated in Figure 3. The line graph shows the distribution of total number of trips by trip length.

Except for Colombo, the inter-zonal (very short distance) trips shows the highest proportion among the trips within the picked up urban core. And the share of walking is more than 60 % for non-car own household group in the most case study cities.

The modal share of intra-zonal trips for car own household group, can be considered as the important indicator of the car dependence in the case study cities. In Metro Manila and Yangon, walking trips account for large portion. On the other hand, car owners in Dhaka and Colombo shows very low modal share of walking trips. The result in Ho Chi Minh City shows isolated characteristics. Even members in non-vehicle available group rely on motorcycles and the share of walking trips is just 40 % in intra-zonal trips.

Not only the trip rate by walking, there is difference on the modal split for intra-zonal trips between car own household group and non-car own household group. As the factors of the results, following can be assumed:

- Walkability of the street
- Availability of private vehicles (number of registered vehicles)
- Availability of parking space and parking fee
- Perception on security and safety during walking trip

The relationship of these factors and the car dependent travel behavior would be investigated.

5. CONCLUSION AND NEXT STEPS

In this study, trip rate by representative travel mode and modal share by travel distance in the case study cities were examined and the differences on share of walking trips between private vehicle owners and non-owners were observed. For the cities with especially significant difference, it can be

pointed out that the car owners might depend on private vehicles strongly, without reasonable judgement for mode choice.

For further studies, the relationship of these factors and the car dependent travel behavior would be investigated. And the background of the car-dependent traffic behaviors must be verified to discuss on effective modal shift measures. .

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