STUDY ON INFLUENCES OF PARATRANSIT ON MASS TRANSIT CONNECTIVITY IN DEVELOPING COUNTRIES: A CASE STUDY OF BANGKOK *

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1. Introduction

Many metropolitans of developing countries have implemented mass transit systems to relieve traffic congestion in the past decades such as Bus Rapid Transit (BRT) in Jakarta, Seoul, and Curitiba as well as Rail system, LRT/MRT/Subway in Bangkok, Delhi, and Manila. Unfortunately, some of mass transits implemented can not well-achieve their expected targets. The obstructions are not only an increase in motorization and poor planning on land use, but also the disadvantages of higher fare, poor connectivity with other existing transportations and access difficulty. These shortcomings dissatisfied commuters and led to low system performance and level of patronage as occurred in two rail systems of Bangkok, and MRT3 of Manila[9].

In developing countries, there are few systematic feeders provided for mass transit systems. At present, there are many ways to access mass transit stations i.e. walking, driving, bus and varieties of paratransit. Most of paratransit services have emerged to deal with the access difficulty[3)-6)-11)]. Paratransit, currently plays important role as an access mode in urban transportation, consists of (1) the flexible for-hire service (Ojek in Jakarta; Motorcycle-taxi, in Bangkok and Rio de Janeiro) and (2) fixed-routed service (Songtaew in Bangkok; jeepney in Manila). It is because of the advantages of vehicle size and unrestrained operation that make paratransit response to fluctuate demand and effectively shuttle people up and down the narrow alley areas off the main streets left by conventional public transports. Although paratransit services enhance urban mobility not only compensate public transit unfilled areas but also move commuters to public transits, their quality of services are only acceptable but not satisfy user's needs[2)-6)]. This dissatisfaction causes from unsafe services, uncomfortable, inconvenient and unreliable services. However, people are still willing to use paratransit services because they offer ease in accessibility and low fare.

Mass transits have been recommended for the future urban transportation plans of developing megacities. Nevertheless, most of the strategies are mainly focused on expanding the mass transits' network coverage, but improving connectivity, both passenger accessibility and connection to the stations, has been usually put low priority. To expand the mass transit networks is very difficult and requires long time considering many obstructions, not surprisingly, from the limited budget and political constraints. Therefore, improving mass transit accessibility might be one of the helpful solutions to enhance the existing mass transit performance and hopefully for the future. Currently, paratransit shows their capability as both complementary mode and feeder mode to other public transits, especially in the areas left by the public transits [3)-6)-11)]. Therefore, an idea of implementing paratransit as a feeder system for mass transits not only provides easy connectivity to mass transits, but also utilizes existing resources, advantages and performances of paratransit that should not be overlooked. The advantages of paratransit must be effectively utilized and the shortcomings need to be minimized.

Future of public transits based on their performances as well as how the people perceive their service qualities. Not only operation performance outcomes but also measurement of public perceptions can helpfully assess quality of service and reveal problems that need to be considered. As mentioned above, paratransit has a potential to carry people to public transits; however, the existing paratransit services are considered informal, not well-organized and dissatisfied. Therefore, public perceptions are strongly required to study on opportunity for implementing paratransit as a feeder system. It is important to know how public become aware of existing paratransit operations. Service attributes assessed by travelers such as safety and security, comfort, convenience, and etc must be captured and evaluated. Moreover, perceptions should be classified for each user group in order to understand traveler's attitude on service attributes. It is important to identify the potential strength, weakness, and commuters' satisfaction of paratransit services. Hence, the mismanagement to solve the accessibility difficulties can be handled in the effective way.

This study aims to investigate the potential of paratransit as a feeder mode at present, and to explore the effects of commuters' satisfaction on two types of paratransit to attitudes concerning mass transit connectivity among different commuter's income levels. Structural Equation Model (SEM) is introduced to investigate the mentioned objectives.

*Keywords: Paratransit, Mass transit, Connectivity, Developing Countries, Bangkok

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Bangkok, Thailand, is selected as a case study. It is because varieties of paratransit are functioning, and extension plans for mass transit are under process. Moreover, the related secondary target is to determine the important attributes of paratransit service that affects mass transit connectivity. If such attributes are effective in improving connectivity and enhancing mass transit ridership, they will be useful information to draw the improvement policy for utilizing existing paratransit, managing feeder system, and enhancing urban transportation performance.

2. Paratransit in Developing Countries and Its Opportunity

Paratransit provides a variety of services from door-to-door collectors (taxi-like i.e. Ojek in Jakarta; Motorcycle-taxi and Songtaew in Bangkok; Motorcycle-taxi in Rio de Janeiro) to intermediate line-haul (bus-like i.e. Minibus in Jakarta; Vans in Bangkok and Rio de Janeiro). Currently, it plays an important role in urban transportation in developing countries. Around 20 to more than 50 percent of travel demand from captive riders and car dependent users are handled by motorized paratransit services[3)-6)-11)]. According to advantages of vehicle size and unrestrained operation, paratransit can admirably respond to the fluctuated markets, fill voids of poor areas left by conventional public transports at relatively low fare, and substitute for public transit without subsidies required. Besides, it recognized as an efficient road-utilized carrier, low cost service, fleet-footedness (maneuver ability), and users' gratifying mode (high frequency and guaranteed seat) [3)]. Paratransit services seem to satisfy captive rider's needs in terms of mobility especially in feeder function. However, the qualities of services are only acceptable but not satisfy user's needs. Nevertheless, users are still willing to use paratransit.

In recent years, researches focused on paratransit performance, service quality and user satisfaction have become popular for study. The performance to be integrated with urban mass transit as a feeder system has been gradually revealed and suggested. Numbers of actions are necessary to put into practice for managing efficient use of paratransit and improve urban mobility in developing countries as mentioned by Shimazaki and Rahman[11)]. The strategy of establishing jeepney terminals adjoining the MRT3 stations was proposed as one solution of MRT3's performance improvements[9)]. The result from people's demand of the proposed strategy was considered high priority for improvement reflecting high weight score of convenient level of access to stations. Moreover, a well integrated paratransit as a feeder of Bangkok's BRT project was proposed along with density land use allocation and controlling parallel existing local bus as a set of solutions for improving BRT performance[10)]. The proposed solutions were used to gather traveler's mode choice behaviors and assess overall BRT operations. It showed that the proposed strategies can improve traffic network conditions and air pollution emissions. Performance of paratransit (resident coach services) to be integrated into overall public transport system and to get people out of their car was shown in a case study of Hong Kong[3)]. It is explored that the future of paratransit depends on its service quality and passenger satisfaction as a case study in Bundung, Indonesia[6)]. Even they feel dissatisfied and tend to move to other beneficial modes easily, passengers still want to use it.

As have been reviewed, the dominant roles of paratransit should not be overlooked on the way to urban transportation planning goals especially in terms of feeder system. In brief, paratransit not only possibly improve ease of accessibility, but hopefully enlarge mass transit catchment areas and might offer potential latent demands to mass transit and other public transits as well.

3. Study Approach

To achieve the target of introducing paratransit as a feeder system, the potential to be integrated as feeder system, and interrelations and influences of commuter attitudes on paratransit service to mass transit connectivity satisfaction must be clearly understood. However, the part studies just focused only on paratransit's passenger opinions, and only travelers' behavior of riding mass transit was observed to develop mode choice model. The key question is how travelers, not only passengers, perceive paratransit services that might affects mass transit connectivity satisfaction and level of patronage. It is also important to understand the preferences of different groups of commuters especially based on the economic status.

Therefore, this study is proposed to investigate the relation between attitudes concerning paratransit services and attitudes concerning accessibility to mass transit from the viewpoint of overall commuters. The effects of paratransit attitude to mass transit connectivity satisfaction are also determined based on types of paratransit service measurements and commuter's income levels. Both flexible for-hire, motorcycle-taxi, and fixed route, Songtaew, are evaluated in each service measurement. Moreover, the present service capability and important attributes of paratransit as a feeder are observed. Bangkok, Thailand, is selected as a case study. Both flexible for-hire and fixed route paratransit are functioning, and extension plans for mass transit are under process. Structural Equation Model (SEM) is applied to obtain estimate the influences of paratransit service satisfactions on the overall satisfaction of mass transit access trip. To formulate SEM model, the overall framework can be explained below:

- Determine study areas and perform survey and data collection
- Investigating characteristics of present access trip, mass transit access trip and commuter's satisfaction
- Factor analysis and SEM model development
- Examine influences of important attributes for both mass transit connectivity and paratransit

4. Bangkok Mass Transit and Access Mode

In Bangkok, two rail transit systems, operated mainly in the central areas of the city, are widely known as BTS and MRT in 1999 and 2004, respectively. BTS is elevated rail system that comprises two main lines with the total of 23.5 kilometers, and operated by The Bangkok Transit System Company (BTSC) under the concession from Bangkok Metropolitan Administration, BMA. MRT is the subway line operated by Bangkok Metro Public Company Limited (BMCL) under the concession from The Mass Rapid Transit Authority of Thailand (MRTA) on the 20 kilometer-service length. Moreover, network extension plans are under process to be implemented. Presently, both rail transit systems have not yet achieved the main goals to reduce the number of private vehicle use and attract more riderships. The three main reasons are recognized as (1) incomplete and small network that generally follow middle- and high-income residential areas, (2) lack of connections to main transportations, and (3) difficulty in accessibility[4]. Furthermore, traffic congestion in high density CBD areas and low level of connectivity discourage commuters to use mass transit. To achieve more rider patronages, not only expanding the service coverage but connectivity improvement, passenger accessibility, and connection to the stations, must be considered as well. However, the solution on improving connectivity has been usually put low priority comparing with the extension of rail networks even though it is considered necessary.

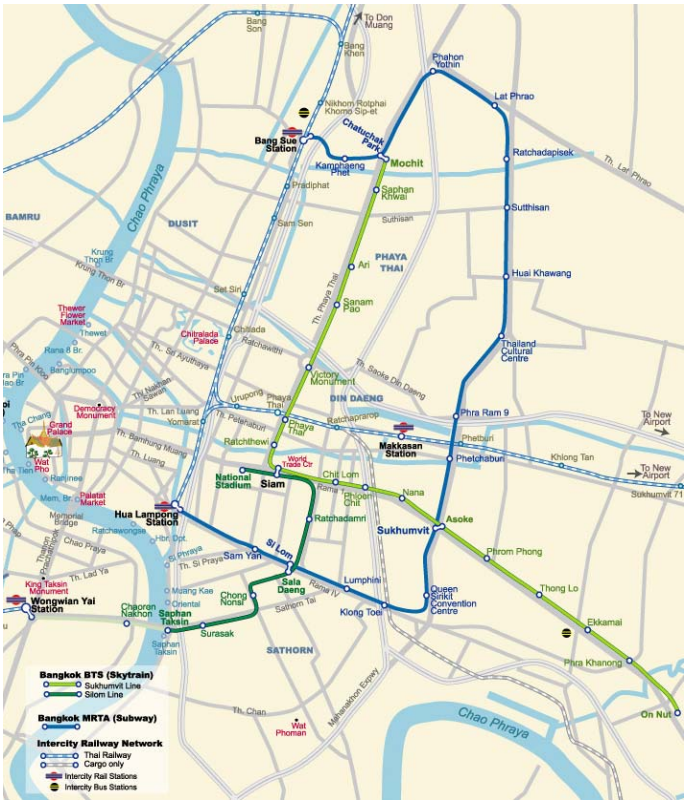

Figure1: Present Bangkok's mass transit

http://johomaps.com/as/thailand/bangkok/bangkokmetro.html

From the beginning of BTS, a total of 13 routes of free shuttle bus feeder service were provided by BTSC, and they yielded quite good performance. It could handle approximately 20,000 passengers/day based on BTS interview. Unfortunately, shuttle bus service was reduced to 6 routes in 2001, 4 routes in May 2004, and finally only 1 route left in September 2004 under the responsibility of private company as a result of financial problem. Unlike developed countries, there are many ways to access mass transit stations other than walking and conventional public bus in present i.e. motorcycle-taxi, Tuk-tuk, Songtaew, Silor-lek, and taxi. It is a result of the unique characteristics of Bangkok's Soi Superblocks, numerous narrow alleys off the main streets, with poor connectivity of roads. BTS and MRT riders access to the stations by four main modes; walking, private vehicle (car and motorcycle), public bus, and paratransit (motorcycle-taxi, Songtaew, Silor-lek, Tuk-tuk, and taxi). Three most popular access modes to BTS and MRT stations are walking, bus, and motorcycle-taxi within a 2-kilometer radius from stations[4]. They founded that motorcycle-taxi become the dominated access mode in the distance beyond 900 meters. Moreover, other motorized modes such as Songtaew (a converted pick-up truck), Silor-lek (a small 4 wheel vehicle), bus, car dependent, also become more preferable than walking beyond the distance of 1 kilometer. Among those paratransit, this study focused mainly on 2 types that are (1) flexible for-hire service - motorcycle-taxi, and (2) fixed-route service - Songtaew.

Motorcycle-taxi service: More than 73,000 motorcycle-taxis, in 2007, having main role of shuttling people up and down the Sois, are managed by private associations. Its fare is more expensive than other paratransit on short trips and cannot be controlled by government, but it offers the fastest service. Motorcycle-taxi enjoyed the lion's share among access modes. It is because of the usefulness in beating traffic jams according to its advantages of flexibility, taxi-like service, compact size, and speed. Therefore, motorcycle-taxi is tailored for operating in high density areas. However, Trade-off between safety and less travel time is generally made by the travelers. In present, the BMA finally stepped into clean up the industry in 2003. The operators are required to register with the police. They must attend training sessions before official licenses are given and different colored vests are assigned to indicate areas where they work.

Songtaew service: A pick-up truck specially adapted to take passengers on the back with an overhead cage, two row seats, and steps up the back that can move up to 14 passengers or more[2]. Each route concession is awarded to the operators from Bangkok Mass Transit Authority, BMTA. All operating vehicles have to register for a license also and fares are controlled by BMTA. The services are managed by the concessionaires however. Though, Songtaew is a cost-effective mode, and has advantages over motorcycle-taxi on lower fare, longer service range and more carrier capacity, it offers long travel time and unreliable waiting because of its size and suffering from traffic congestion.

5. Survey and Data Collection

The areas within the distance up to 5 kilometers from mass transit stations along BTS and MRT lines were selected. It is for grasping an influence of Songtaew services, 3-5 kilometers[2]. The surveys focused on connectivity including access trip from home to mass transit stations and egress trip to destinations. The attitudes and perceptions as well as present travel pattern of all travelers were also collected. All commuters were asked to explain their access and egress trips especially for access trip to mass transit stations in order to gather the current connectivity patterns. The target groups are the commuters who regularly travel for work and study, and not only BTS/MRT users but also conventional public transport users (bus, passenger van and etc) and private vehicle users.

Access and egress trips were classified into three main parts as illustrated in figure 2. *Part 1* is going from home/destination to find feeder services, *Part 2* relates to the uses of feeder services i.e. motorcycle-taxi, Songtaew, Silor-lek, bus etc, and *Part 3* is a section to the mass transit stations/bus stops/van terminals after getting off the feeder. Commuters were requested to express their satisfaction levels related to each part.

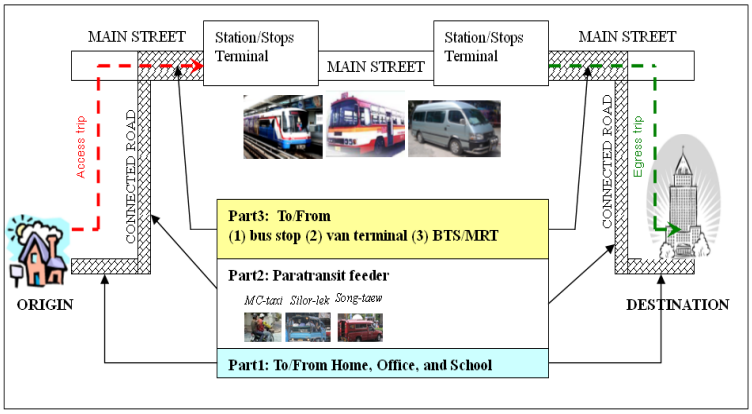

Figure2: Connectivity Definition (access and egress trips)

Both direct interview and pick-up & drop-off surveys were performed by both household survey and on-site survey. The on-site survey was conducted around the station areas in the evening (4.00 pm – 8.00 pm) during their return trips in order to earn ease of participation and gather the commuters living in specific areas. The questionnaire contained 4 sections, namely general section, present trip pattern, mass transit access trip, and attitudes and intention to use BTS/MRT including paratransit modes, only motorcycle-taxi and Songtaew were focused in this study.

In the general question, the respondents were asked about their socio-economics, residential area's characteristics, and experiences and frequency of using mass transits and paratransit. In the present trip pattern, the respondents were asked to explain their trip patterns and details of access trip, egress trip, and return trip such as a number of modes used, walking time, waiting time, in-vehicle time and costs. In mass transit access trip, all respondents were requested to explain how they go to the station in details as explained in the present trip pattern part. Moreover, they were asked what station they selected, and reasons for selections. In the attitudes and intention to use part, all respondents were asked about their knowledge for both mass transits and paratransit, their attitudes with access trip to mass transit stations and paratransit service quality, and their intentions to use mass transit and paratransit as an access mode. All respondents were requested to rate their attitudes on four-point satisfaction scale, with rating ranging from "1 = very dissatisfied" to "4 = very satisfied" with the purpose of avoiding the "no opinion" answer. The questionnaire asked respondents whether they would decide to use paratransit (motorcycle-taxi and Songtaew) for their access trips, and mass transits in the future.

6. Survey Findings

(1) Respondent and Household Characteristics

Both household and direct interview obtained a total of 200 effective samples from 600 questionnaires due to the limited survey duration and difficulties in approaching commuters' houses. The findings of personal socioeconomics and household attributes from questionnaire are presented in table 1 and 2.

(2) Present access trip characteristics

Among public transit passengers, 57% are mass transit users, there are four most popular access modes that are walking, bus, motorcycle-taxi and Songtaew as illustrated in table 3. Walking have the highest share especially for users of conventional public transits, bus and passenger van. It can be concluded that commuters prefer to go to the nearest conventional public transits. The second mode is motorcycle-taxi; the third are bus and Songtaew that their shares are relatively high among mass transits users comparing with conventional public transits. Consequently, both motorcycle-taxi and Songtaew handled around 40% of the access trips that revealed their service capability as a feeder.

(3) Mass transit access trip characteristics

Table 4 shows the shares and numbers of mode used to access mass transit stations of the respondents. Among all commuters, the three most popular modes are walking, bus and motorcycle-taxi that correspond to the previous study[4]. Walking is the dominant mode within the distance of 1 kilometer. Motorcycle-taxi is the most famous mode in the distance of 1-2 kilometers. Songtaew, bus and drive alone become preferable from the distance more than 2 kilometers.

Most of people use only 1 access mode within the distance of 2 kilometers, but the share of 2-access mode users become significant in the longer distances.

This study classified commuters into 3 main groups based on availability of data that are (1) low income- who earn less than 10,000 bath per month, (2) middle income - whose income is 10,000-20,000 baht, and (3) high income - who obtained monthly of more than 20,000 baht. Table 4 revealed that lower income commuters use bus and Songtaew more than the higher income group. Bus and Songtaew are dominant modes for low income among commuters. The reasons are low income people tend to live in the longer distance, and both services offer lower expenses. The average distances to the stations are 1.56, 2.14 and 2.19 kilometers for high, middle and low income commuters, respectively. For the commuters in middle level, motorcycle-taxi and bus own larger shares. High income people prefer walking, drive alone and motorcycle-taxi. However, walking and drive alone own the largest portion for the high income comparing with the others. High income group prefers using motorcycle-taxi to other motorized access modes except their own cars, because it offers faster travel time and the fare is acceptable. Based on the survey results, paratransit show their potential to serve as an access mode to the mass transits. Both flexible for-hire and fixed route show their capability to handle around 30% - 45% of mass transit access trips especially for the distance of 1-3 kilometers. Moreover, motorcycle-taxi can carry around 26% of middle and high income groups, and Songtaew serves 18% of commuters who earn less than 10,000 baht per month.

Table 1: Respondent characteristics

Individual characteristics	Category range	Respondents	
		Number	%
gender	Male	82	41.00%
	Female	118	59.00%
Age	< 20 years old	29	14.50%
	21-40 years old	156	78.00%
	> 40 years old	15	7.50%
Education	Lower than bachelor	49	24.50%
	Bachelor or higher	151	75.50%
Occupation	Government officer	19	9.50%
	Private employee	94	47.00%
	Business owner	16	8.00%
	Student	53	26.50%
	labor	18	9.00%
Monthly income (Baht)	< 10,000	63	31.50%
	10,000 – 20,000	62	31.00%
	> 20,000	75	37.50%
Car ownership	No	135	67.50%
	Yes	65	32.50%
Motorcycle ownership	No	176	88.00%
	Yes	24	12.00%
Mass Transit Experience	No	11	5.50%
	Yes	189	94.50%
Motorcycle-taxi Experience	No	26	13.00%
	Yes	174	87.00%
Songtaew Experience	No	73	36.50%
	Yes	127	63.50%

Table 2: Household characteristics

Household characteristics	Category range	Respondents	
		Number	%
Household member	1	27	13.50%
	2	45	22.50%
	3	29	14.50%
	4	52	26.00%
	More than 4	47	23.50%
Household type	Private house	90	45.00%
	Rental apartment	79	39.50%
	Private condominium	25	12.50%
	Others	6	3.00%
Household car	None	82	41.00%
	1	64	32.00%
	2	31	15.50%
	More than 2	23	11.50%
Household commuter	1	52	26.00%
	2	71	35.50%
	3	37	18.50%
	More than 3	40	20.00%

Table 3: Present access mode classified by public transportation users

Public transit user classification	Number of users (person/percent)	Walking	Ride sharing	Bus related	MC-taxi related	Songtaew related	Silor-lek related	others
Mass transit	77 / 57%	27.03%	9.46%	16.22%	25.68%	13.51%	2.70%	5.41%
Conventional public transit	58 / 43%	46.94%	4.08%	4.08%	26.53%	8.16%	4.08%	6.12%
All public transit users	135 / 100%	34.96%	7.32%	11.38%	26.02%	11.38%	3.25%	5.69%

Table 4: Mass transit access characteristics of all respondents classified by distance from stations and income levels

User characteristics	Walking	Drive alone	Ride sharing	Bus related	MC-taxi related	Songtaew related	Silor-lek related	No. of access mode	
								1	2
< 1 km	68.92%	2.70%	1.35%	4.05%	21.62%	1.35%	-	98.63%	1.37%
1 - 2 km	6.25%	16.67%	8.33%	22.92%	37.50%	8.33%	-	95.65%	4.35%
2 - 3 km	-	23.08%	7.69%	28.21%	20.51%	17.95%	2.56%	78.13%	21.88%
3 - 5 km	-	24.62%	9.23%	32.31%	12.31%	18.46%	3.08%	65.31%	34.69%
Overall Commuters	24.34%	15.49%	6.19%	20.35%	22.12%	10.18%	1.33%	86.50%	13.50%
<10,000 baht	18.92%	12.16%	12.16%	22.97%	14.86%	17.57%	1.35%	82.54%	17.46%
10,000-20,000 baht	17.57%	12.16%	4.05%	27.03%	25.68%	10.81%	2.70%	80.65%	19.35%
>20,000 baht	35.90%	21.79%	2.56%	11.54%	25.64%	2.56%	0.00%	94.67%	5.33%

(4) Commuter attitudes and satisfactions

This study observed two main attitudes that are (1) attitudes regarding paratransit, both motorcycle-taxi and Songtaew, and (2) attitudes concerning access trip to mass transit stations. All respondents were asked to express their perceptions on 7 attributes regarding mass transit connectivity, and 15 attributes with regard to service quality of both motorcycle-taxi and Songtaew. So, the total of 37 attributes was observed to each respondent with the satisfaction level ranging as 1 is "very dissatisfied", 2 is "somewhat dissatisfied", 3 is "somewhat satisfied", and 4 is "very satisfied".

a) Mass transit connectivity attitudes and satisfactions

Table 5 shows the average satisfaction scores of 7 attributes of mass transit station's connectivity. Commuters seem satisfied with their access trip to mass transit stations in present; but not so satisfied with the walking time, both from home to find access mode services and after getting off the services to stations which illustrated as part1 and part3 in the figure2. Only the high income stated that they satisfied with later part of walking time. Low income people not so satisfied with the access cost as well as middle income respondents who access by the modes other than walking and private car related modes. However, all commuters dissatisfied on the paratransit facilities provided in the present. Moreover, high income commuters expressed the higher level of satisfaction to mass transit stations based on the access time and part3 walking time comparing with the others. The potential reasons are most of them live closer to the station, as discussed in the average distances to the stations in previous section, and access to the stations by using only one mode such as walking, driving and motorcycle-taxi.

Table 5: The average satisfaction scores of 7 mass transit station's connectivity attributes

Commuter	Access time	Waiting time	Walking time (part1)	Walking time (part3)	Transfer Difficulties	Access cost	Paratransit facility
Overall	3.03	2.98	2.70	2.82	2.92	2.90	2.64
Low income	2.94 / 3.09	2.77 / 3.19	2.58 / 2.66	2.74 / 2.75	2.90 / 2.84	2.77 / 2.84	2.68 / 2.75
Middle income	2.89 / 3.00	2.92 / 3.04	2.68 / 2.60	2.73 / 2.56	2.97 / 2.80	3.00 / 2.88	2.51 / 2.84
High income	3.07 / 3.15	3.04 / 2.98	2.64 / 2.91	3.04 / 3.00	2.93 / 2.98	2.96 / 2.94	2.50 / 2.64

Remark: A/B: A = walking, drive alone and ride sharing; B = bus, paratransit and others

b) Paratransit service attitudes and satisfactions

The average satisfaction scores of 15 paratransit's service attributes are presented in table 6. Both motorcycle-taxi and songtaew service were assessed by three income groups of the respondents. All commuters dissatisfied motorcycle-taxi-service on the safety and security aspects that are riding quality, vehicle condition and safety equipment, and night time security. On the other hand, motorcycle-taxi are satisfactory preferred to Songtaew in terms of comfort & convenience (No. 4 -12), except it can not protect passengers from hot weather and rain. High income respondents expressed high satisfaction level for motorcycle-taxi especially for the ability to reach their destination, less stop, and flexibility. Commuters seem dissatisfied with Songtaew service. In addition, respondents dissatisfied with present fare structures, but Songtaew has advantage over motorcycle-taxi. It is because Songtaew's fare is relatively cheap compare to motorcycle-taxi especially in the distance more than 1 kilometer. However, satisfaction level of Songtaew's suitability of fare is only somewhat satisfied considering its long travel time and waiting time. All respondents dissatisfied on the information services of both paratransit especially the accident insurance.

Table 6: Average satisfaction scores of paratransit services based on respondents's economic status

Paratransit Service Quality Attributes	Low income		Middle income		High income	
	MC-taxi	Songtaew	MC-taxi	Songtaew	MC-taxi	Songtaew
1. Riding/driving quality	2.05	2.48	1.98	2.31	1.88	2.21
2. Vehicle condition and safety equipment	2.32	2.38	2.19	2.13	2.07	2.09
3. Night time security from crime	2.02	2.43	2.03	2.27	1.88	2.12
4. Waiting time for using service	2.81	2.25	2.85	2.13	3.03	2.05
5. Number of stops along the way	3.16	2.16	3.21	1.85	3.33	1.96
6. Protection from air pollution & weather	1.87	2.43	1.58	2.13	1.59	2.27
7. Seat availability and Level of crowd	2.70	2.25	2.68	2.10	2.31	2.01
8. Adequate service and on demand service	3.06	2.43	3.08	2.29	3.24	2.23
9. Availability in night time/early morning	2.95	2.49	2.98	2.32	3.13	2.35
10. Flexibility to change route	3.19	2.17	3.15	2.19	3.23	1.97
11. Ability to reach the exact destination	3.29	2.24	3.26	2.37	3.43	2.19
12. Suitability of present fare structures	2.57	2.84	2.61	2.69	2.41	2.64
13. Service schedule/fare information	2.17	2.24	2.39	2.27	2.35	2.12
14. Service and registration information	2.35	2.44	2.13	2.10	2.00	2.05
15. Accident insurance information	1.98	2.13	1.76	1.87	1.71	1.73

7. Paratransit's Service Influences Investigation

(1) Mass transit access and Paratransit service measurement

This section aims to categorize both mass transit connectivity and paratransit service attributes in term of service measurement. It is not only classify into main service measurements, but also facilitate the model development and accuracy. Factor analysis was applied to perform in the categorizing process by the analysis of moment structures, AMOS5.0[1]. This structure analyzed the total of 37 attributes of paratransit service and mass transit access attitudes by using confirmatory factor analysis procedure (CFA) based on the significant criteria of 5% significance[7]. The model was assessed by multiple fit indices including chi-square (χ^2), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), root mean square residual (RMR), and root mean square error of approximation (RMSEA).

The χ^2/df value for this model is 2.483, which is less than 3. The fit indices of the established model can be explained by the RMR, 0.04, and RMSEA, 0.08, that satisfy the assess criteria of less than 0.10 and 0.08, respectively. The GFI and AGFI values were 0.79 and 0.75 respectively that means more than 75% of the co-variation in the data could be represented by the given model. The recommended values of GFI and AGFI are 0.90 and 0.80. The indices obtained from CFA could not reach the recommended values. While considering the effects from a small number of respondents and the level of model representation, the model can be implied as acceptable. The 4 main factors, consist of 26 significant attributes, are made based upon the variables that loads on the factor, and classified in to *Mass transit access measurement*, and 3 paratransit's service measurements – *comfort and convenient*, *safety and security*, and *information* – as shown in table7.

Table7: Mass transit access and Paratransit service measurements

Mass transit access Measurement	**Paratransit Service Measurement**		
	Comfort and Convenient	**Safety and Security**	**Information**
1. Total access time	1. Waiting time for using service	6. Riding/driving quality	9. Service schedule/fare information
2. Total waiting time	2. Number of stops along the way	7. Vehicle condition and safety equipment	10. Service and registration information
3. Total access cost	3. Adequate service and on demand service	8. Night time security from crime	11. Accident insurance information
4. Transfer difficulty	4. Availability in night time/early morning 5. Flexibility to change route	The 26 attributes are; • 4 attributes of Mass transit access measurement • 2 x 11 attributes of paratransit service measurement	

(2) Influence investigation model specification

The primary objective here is to interrelate attitude concerning services of paratransit, both motorcycle-taxi and Songtaew, to the perception regarding mass transit connectivity. Moreover, the related objective is to determine how commuters consider each service attributes of paratransit service quality and mass transit connectivity. Structural equation model is applied to examine the influences of paratransit services. Total of nine separate sets of models were developed based on three main paratransit service measurements, which are comfort and convenient, safety and security, and information, and each measurement are classified into three groups of income level, *low, middle, and high income*.

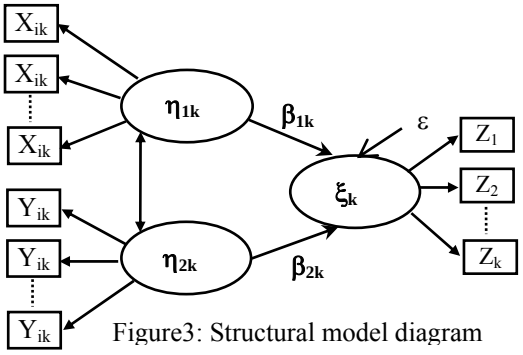

Figure3: Structural model diagram

Each of the model contains one endogenous latent variable for mass transit connectivity attitude (ξ), and two latent exogenous variables for attitudes of motorcycle-taxi (η_1) and Songtaew (η_2) as illustrated in figure 3. The observed variables for each latent variables are listed in the table 8. The observed variables of mass transit connectivity attitude are applied for all paratransit service measurement's models. The models of each measurement can be defined in terms of structural equations model:

$$\xi_k = \beta_{1k}\eta_{1k} + \beta_{2k}\eta_{2k} + \varepsilon_k \qquad \text{(eq.1)}$$

where; ξ_k = mass transit connectivity attitude of paratransit service measurement *k*
η_{1k} = motorcycle-taxi attitude of paratransit service measurement *k*
η_{2k} = Songtaew attitude of paratransit service measurement *k*
β_{1k} = parameter of motorcycle-taxi attitude of paratransit service measurement *k*
β_{2k} = parameter of Songtaew attitude of paratransit service measurement *k*
ε_k = error term of paratransit service measurement *k*
X_{ik} = i^{th} observed motorcycle-taxi's variable of paratransit service measurement *k*
Y_{ik} = i^{th} observed Songtaew's variable of paratransit service measurement *k*
Z_k = observed mass transit connectivity's variable of paratransit service measurement *k*

(3) Model results

a) Models for comfortable and convenient service of paratransit

All income level models were significant at 95% level of confidence as explained by p-values, and contained the χ^2/df values of 1.455, 1.289 and 1.306, which is far behind 3, for low, middle and high income respectively. The RMR and RMSEA of all models were close to the recommended values of less than 0.10 and less than 0.08 respectively. In contrast, the goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) values were not reach the recommended values of at least 0.90 and 0.80; however, their values, as shown in table 9, closed to the thresholds. These fairly fit values are probably caused from the low number of samples. However, it can be implied that all models have a reasonably good fit.

Songtaew has positive effects to mass transit access satisfaction for the low income and middle income with the parameter (β_2) of 0.370 and 0.307 at the level of confidence more than 90%, respectively. But, it is not significant for the high income. The potential of these effects is low and middle income seem to aware on their access cost as expressed the higher weight in table 10, and they ride Songtaew more than high income people. In contrast, motorcycle-taxi positively affects only to mass transit access attitude for the high income group with the parameter (β_1) of 0.485 at the p = 0.007. It implies that high income people pay more attention to the service finding, availability and flexibility of motorcycle-taxi as expressed by the coefficients of Z2, X4 and X5 in table 10 . It is because these attributes offer more convenient, faster access trip and less waiting time. Another potential is riding Songtaew usually take longer and unpredictable waiting time.

Table 8: Model's variables and symbols

Mass transit access trip		
Variable		**Description**
Z1		Total access time (Part1, Part2 & Part3)
Z2		Total waiting time (for feeder & transfer)
Z3		Total access cost (access to the station)
Z4		Transfer difficulty
Paratransit service [MC-taxi (X); Songtaew (Y)]		
Comfortable and Convenient service measurement		
Variable		**Description**
X1	Y1	Waiting time for using service
X2	Y2	Number of stops along the way
X3	Y3	Adequate service and on demand service
X4	Y4	Availability in night time/early morning
X5	Y5	Flexibility to change route
Safety and Security service measurement		
X6	Y6	Riding/driving quality
X7	Y7	Vehicle condition and safety equipment
X8	Y8	Night time security from crime
Information service measurement		
X9	Y9	Service schedule/fare information
X10	Y10	Service and registration information
X11	Y11	Accident insurance information

b) Models for safety and security service of paratransit

Low income and middle income models were significant at 95% level of confidence, but the high income's model was not significant. For the two significant models, their χ^2/df values were far behind 3 as shown in table9. The RMR and RMSEA of both models reached to the recommended values except the RMSEA of the low income model; however, it was acceptable. The goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) values shown in tableX2 were also not reach the recommended values of at least 0.90 and 0.80; however, they were again acceptable and can be implied as reasonably good fit models.

Among the estimated coefficients, only β_2 of the middle income's model is significant that cannot be rejected at the p = 0.004 level. It can be explained that safety and security service of Songtaew has a positive effects to mass transit access satisfaction for the middle income commuters with the parameter $\beta_2 = 0.857$ as shown in table 9. Moreover, from the high value of X7, X8 and Y7, Y8 in table 10, middle income people pay more attention to the vehicle condition and night time security of both types of paratransit comparing with the other groups that mainly consider the driving quality. Though the Y8 of the middle-income is less than the low-income, it still shows its higher value comparing with other coefficients. Even though the coefficients were insignificant, they show the trends that all commuters prefer safety and security service of Songtaew as can be seen from the positive coefficients. Therefore, the interest is importantly required for the motorcycle safety and security service as it posed the negative impact to mass transit access.

c) Models for information service of paratransit

All models concerning paratransit's information service were significant at p = 0.05 level as explained by the fitness indices shown in table 9. Though the RMSEA values were quite high, the all models can be roughly implied good fit as the GFI and AGFI nearly reached the recommended thresholds.

It is again that only β_2 of the middle income's model is significant at 95% of significant. The interrelation shows that Songtaew's information positively influences on the satisfaction level of mass transit access for the middle level commuters. They also put more awareness to their access time, waiting time and out-of-pocket expenses, as obtained from endogenous observed variables (Z1-Z4) in the table 10, that directly relate with operation's information. Moreover, they pay attention to the service's registration of both paratransit corresponding to their safety and security concerns. In addition, the important reason of insignificant influence of motorcycle-taxi is plausibly that all commuters get used to motorcycle-taxi's operating information. As expressed by X9, Y9 and X11, Y11 in table 10, high income people concerned more on the operating information, but very less on the insurance comparing with the other users. It is because they always aware for their time especially for waiting the services, as can be explained from the high coefficient of Z2 for all models, and rarely use paratransit services. In contrast, low income commuters show higher coefficients on registration and insurance information. The potential reasons are that they have to use paratransit more often, and availability of insurance can save their money in the case of accidents based on the surveys and personal interviews.

Table 9: Parameter estimates and fitness indices of SEM models

	a) Comfort and convenience Models			b) Safety and security Models			c) Information Models		
	Low	**Middle**	**High**	**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
β_1	-0.161 (p=0.384)	0.235 (p=0.121)	0.485 (p=0.007)	-0.144 (p=0.535)	-0.143 (p=0.587)	-0.126 (p=0.623)	-0.219 (p=0.352)	-0.109 (p=0.583)	0.004 (p=0.981)
β_2	0.370 (p=0.079)	0.307 (p=0.045)	-0.055 (p=0.728)	0.338 (p=0.164)	0.857 (p=0.004)	0.517 (p=0.064)	0.294 (p=0.204)	0.594 (p=0.007)	0.048 (p=0.753)
χ^2	100.407	95.397	95.306	53.175	45.273	32.579	49.606	46.242	51.279
df	69	74	73	31	32	29	30	31	31
χ^2/df	1.455*	1.289*	1.306*	1.715*	1.415*	1.123*	1.654*	1.492*	1.654*
p	0.008	0.048	0.041	0.008	0.060	0.295	0.014	0.038	0.012
GFI	0.832	0.831	0.853	0.854	0.886	0.927*	0.873	0.881	0.898
AGFI	0.744	0.761	0.788	0.740	0.804*	0.862*	0.768	0.789	0.818*
RMR	0.055*	0.050*	0.048*	0.051*	0.041*	0.037*	0.045*	0.037*	0.044*
RMSEA	0.086	0.068*	0.065*	0.107	0.082	0.041*	0.103	0.089	0.095

*Recommended fitness indices; $\chi^2/df \leq 3.0$, GFI ≥ 0.90, AGFI ≥ 0.80, RMR ≤ 0.10 and RMSEA ≤ 0.08

Table 10: Standardized regression estimates of measurement equations from SEM models

a) Comfort and convenient Models						b) Safety and security Models						c) Information Models					
Relation			Low	Mid	High	Relation			Low	Mid	High	Relation			Low	Mid	High
Z1	<--	ξ	0.491	0.801	0.605	**Z1**	<--	ξ	0.481	0.772	0.590	**Z1**	<--	ξ	0.475	0.802	0.640
Z2	<--	ξ	0.645	0.787	0.810	**Z2**	<--	ξ	0.638	0.785	0.775	**Z2**	<--	ξ	0.626	0.762	0.746
Z3	<--	ξ	0.649	0.647	0.515	**Z3**	<--	ξ	0.618	0.664	0.563	**Z3**	<--	ξ	0.618	0.620	0.571
Z4	<--	ξ	0.597	0.825	0.591	**Z4**	<--	ξ	0.650	0.840	0.614	**Z4**	<--	ξ	0.674	0.857	0.598
X1	<--	η_1	0.703	0.503	0.660	**X6**	<--	η_1	0.792	0.734	0.749	**X9**	<--	η_1	0.543	0.597	0.676
X2	<--	η_1	0.420	0.540	0.522	**X7**	<--	η_1	0.503	0.802	0.765	**X10**	<--	η_1	0.900	0.955	0.759
X3	<--	η_1	0.957	0.774	0.759	**X8**	<--	η_1	0.609	0.706	0.545	**X11**	<--	η_1	0.712	0.605	0.576
X4	<--	η_1	0.622	0.776	0.916	**Y6**	<--	η_2	0.734	0.749	0.753	**Y9**	<--	η_2	0.747	0.787	0.889
X5	<--	η_1	0.630	0.725	0.842	**Y7**	<--	η_2	0.549	0.814	0.689	**Y10**	<--	η_2	0.915	0.826	0.807
Y1	<--	η_2	0.868	0.802	0.599	**Y8**	<--	η_2	0.780	0.742	0.725	**Y11**	<--	η_2	0.840	0.802	0.491
Y2	<--	η_2	0.824	0.659	0.473												
Y3	<--	η_2	0.615	0.775	0.812												
Y4	<--	η_2	0.604	0.702	0.786												
Y5	<--	η_2	0.508	0.381	0.508												

Note:
All estimated values are significant at 95% level of confidence

8. Summary and Conclusion

Based on the reviews and findings, paratransit, both flexible for-hire and fixed route types, shows their service capability to be implemented as a feeder system with mass transits and other conventional public transits. However, paratransit's performance depends on its levels of service perceived by travelers. Commuters' attitudes are the powerful tools that helpfully assess quality of service and reveal problems that need to be considered for both paratransit and mass transit connectivity. Structural models were developed to gather the influences of paratransit services to attitude concerning mass transit connectivity based on commuters' perceptions. Three important service measurements - comfort and convenient, safety and security, and information - were evaluated according to commuter's income segments. The developed models demonstrate that commuters' satisfactions on service quality of paratransit have positive effects to mass transit access trip.

People in middle income and high income level put more awareness to the waiting and travel time for their access trips to the stations. In addition, middle income group stated higher consideration on the transfer difficulties. This implies that time is very important for middle and high income people. The expense of access trip as well as waiting time are very important for both low and middle income respondents.

Motorcycle-taxi's comfort and convenient aspect presents positive influence for the high income people who always prefer faster and convenient mode to cheaper or safer mode. They evaluated paratransit services mainly on easiness of finding and quick responsiveness. Therefore, flexible for-hire service or motorcycle-taxi is the suitable mode that effectively offer high demand responsive and maneuver ability. From the advantage of fast and flexible, it also shows positive result to the middle income. It should be noted that motorcycle-taxi dissatisfied and posed slightly negative impact for all commuter groups regarding the safety and security attitudes, although the parameters are not so significant. Having been continuously served for a long time and its large number, motorcycle-taxi is get used to by the commuters, and therefore people do not pay attention on operating information. However, the information of service's registration is considered important, and low income people interest in the insurance information more than the other groups.

The fixed-route service, Songtaew, offering lower fare and safer travel shows positive effects to mass transit connectivity satisfaction for both low income and middle income commuter who often use its services. In term of safety

and security measurement, it illustrates optimistic influences from all levels of commuters especially the middle income. All commuters keep in a view mainly for operating and service's registration information, because they strongly relate with travel time, safety and security. Insurance information is taken into account mainly by low and middle income people, but rarely from the high income. It is because they prefer faster service and rarely use paratransit services.

To implement paratransit as a feeder system for mass transit, it is important to understand how paratransit influence the commuters and mass transit connectivity. As in the case study of Bangkok, people especially in middle and high income level prefer the fast and flexible of motorcycle-taxi; yet it is dangerous. All commuters dissatisfied to Songtaew; nevertheless, it shows positive influences to mass transit connectivity satisfaction for all service measurements. As a result, Songtaew capability should not be overlooked. The shortcomings on long travel time and unreliable waiting time must be minimized. Moreover, the improvements regarding safety and security are required not only driving quality of motorcycle-taxi, as it shows the negative effect to the connectivity, but also the vehicle condition and safety equipment of both paratransit. Service information is also important especially operating and registration because they relate direct to waiting time, travel time and security that all commuters stated important. The study presented here attempts to grasp how attitudes toward utilizing paratransit as a feeder system and mass transit connectivity differ across the population, and renders one of important insights for the efforts to attract more patronages of mass transit systems. These results can be used to draw strategies for not only enhancing mass transit performance but also hopefully benefit for other public transits.

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STUDY ON INFLUENCES OF PARATRANSIT ON MASS TRANSIT CONNECTIVITY IN DEVELOPING COUNTRIES: A CASE STUDY OF BANGKOK*

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In developing countries, varieties of paratransit are functioning to connect people to mass transit systems, but people are still dissatisfied with their services. Therefore, understanding attitudes held by the people about paratransit services is important to the plan for introducing paratransit as a feeder system of mass transits. This study attempts to grasp how attitudes toward paratransit and mass transit connectivity differ across the population by applying in Structural Equation Model. The developed models demonstrate that commuters' attitudes on service quality of paratransit have different effects to mass transit connectivity depending on service measurements and commuter's economic status.