BUS OPERATIONS IN THE DEVELOPING COUNTRIES ...CASE STUDIES OF BANGKOK AND KARACHI

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INTRODUCTION

The significant role of bus transit in providing mobility in capital cities of the developing countries need not to be further elaborated as most of their commuters do not have the luxury of having automobiles for their travel needs. Bangkok as well as Karachi are not exempted from this phenomenon of bus transit. Buses have been playing the major role in transporting people in both cities for many decades. However, they are also facing similar problems... the deficiency in bus services which resulted to the overcrowded of bus passengers, excessive waiting time, unreliable services, insufficient numbers of fleet size, duplication of bus routes and etc.

While the bus services have been deteriorating, traffic congestion, on the other hand, in both Bangkok and Karachi, are growing steadily worse. In Bangkok, one of the reasons that caused the congestion being often commented is the lack of adequate public transportation services. Many suggested to solve the congestion problems through the improvement of the public transportation system, particularly by improving the bus services. However, it is unfortunate that most of them never recommended any solutions to improve the bus services. This paper presents the research studies [1,2] conducted by the Asian Institute of Technology on the bus operations in Bangkok and Karachi. The main aims are to examine the service characteristics of both bus systems and to recommend remedies for improvement of bus services in Bangkok and Karachi.

1.BUS OPERATIONS IN BANGKOK AND KARACHI

Bangkok bus services are operated mainly by the state-owned enterprise so called the Bangkok Mass Transit Authority (BMTA) which has been established since 1976. Moreover, additional services are also being provided by the privately-owned organizations. Together they operate with 5,235 regular buses (BMTA 3,904 buses) and 749 air-conditioned buses (480 BMTA buses) covering 146 regular and 19 air-conditioned bus routes throughout Bangkok and its surrounding provinces.

Similar with Bangkok, buses in Karachi are also being

operated by both public and private operators. Public buses are under the responsibility of the Karachi Transport Corporation (KTC) which operates the standard-single deck buses. While the Karachi Bus Owners Association (KBOA) is providing private bus services which consist of not only the additional standard buses but also the mini buses. Altogether, at present they operate with 150 bus routes of which 63 routes are minibuses routes. Although, the stated numbers of buses are 6,789 buses, actual numbers running on the roads are only 4,032 buses.

2.DATA COLLECTION

In order to achieve the aims of this paper, information pertaining to bus operations and services such as bus headways, average travel time and travel speed and bus layover time were collected for both Bangkok and Karachi. Due to limited spaces allotted for this paper, only single selected bus route from each city were chosen and analyzed in this research. For Bangkok bus operations, bus route no. 4 (Klong Toey - Paseecharoen) which has the intermediate travel distance of 14.4 km , was chosen as a representative route. While bus no.6 (City Garden - Tower Terminal) was selected for Karachi case. This private bus route covers a distance of about 17.6 km. These two selected bus routes operate through congested areas and connecting outlying places to central business district in each respective capital.

To collect the travel time and headway data, besides the two ends of both bus terminals, along each respective bus route, strategic bus stops were also selected as the intermediate survey stations. By employing the license plate technique, the surveyors were assigned in each observation station to record the license plate numbers together with the arrival time of buses in determining the bus headways and travel time. Other teams were stationed at both ends of the terminals to record the buses actual arrival and departure time in determining the bus layover time.

In both studies, data were collected for three periods. Surveys were extended to cover both morning (0700 - 1000 hr.) and evening (1530 - 1830 hr) peak periods and as well as the off peak period (1130 - 1330 hr).

3.BUS OPERATIONAL CHARACTERISTICS IN BANGKOK

3.1.Bus Headways

Analysis of bus headway of route no. 4 during the observation periods indicated a rather consistent mean

headways for all three periods and for both directions. The mean headways were found to range from 2.4 - 3.4 minutes during the observation periods as shown in Table 1.

Table 1: Mean Headways of BMTA Bus Route No.4

Period	Item	Klong Toey to Paseecharoen				Paseecharoen to Klong Toey			
		Klong Toey	S'pore Market	China Town	Pasee-Charoen	Pasee-Charoen	China Town	S'pore Market	Klong Toey
Morning Peak	N	71	71	70	68	70	65	71	74
	H	2.5	2.5	2.5	2.5	2.6	2.5	2.4	2.4
	Min	0	0	0	0	0	0	0	0
	Max	8	8	11	9	6	9	12	13
	S	1.4	1.8	2.3	1.9	1.2	2	2.7	2.7
Off-Peak	N	42	43	42	42	39	33	45	46
	H	2.7	2.8	2.8	2.8	3	3.4	2.6	2.5
	Min	0	0	0	0	1	0	0	0
	Max	7	10	19	16	7	15	17	10
	S	1.7	2.7	3.2	2.9	1.4	2.7	2.9	2.6
Evening Peak	N	65	68	62	62	64	58	54	64
	H	2.8	2.6	2.9	2.9	2.8	2.8	3.3	2.9
	Min	1	0	0	0	1	0	0	0
	Max	6	7	16	19	13	10	20	13
	S	1.1	2.6	2.6	3.2	1.9	2.1	3.4	2.7

Note: N: No. of Sample; H: Average Headway, seconds;
S: Standard Deviation

However, when considering the minimum and maximum headways, the discrepancies were quite substantial. The lowest headway obtained was 0 minute which implied the bunching condition of BMTA buses. This situation caused longer waiting time for bus passengers and overloaded problem to the following bus. While the maximum headway found in this route was 20 minutes during the evening peak period. This phenomenon on the irregularity of bus arrivals has so far been the major cause of inconsistencies of BMTA bus services, which have been frequently complained by the public commuters. Considering these findings regarding to the services provided to the public, it can be concluded that BMTA has fulfilled the objectives as indicated to a rather consistent mean headways at each location of the study. In other words, they have

accomplished the sufficient number of trips to be provided to the public. However, the irregularities of bus arrivals have reflected the inappropriate scheduling of buses and poor driving attitude of bus drivers. This inappropriate scheduling is further elaborated in the next following sub-sections.

3.2.Comparison of Departure Headways at the Terminals

Buses at the terminals are released by dispatchers according to the schedules provided by BMTA. These schedules are based on the hourly service frequencies varying with the time periods of the day. Hourly frequencies were acquired from BMTA time-keeper records and compared with the survey results. Overall, similar results were obtained for this selected bus route and for all study periods as shown in Table 2.

Table 2: Comparison of Bus Frequencies between the Observed Data and BMTA Time Keeper's Record

BUS ROUTE NO. 4								
Time Period	BUS TERMINALS							
	KLONG TOEY				PASEECHAROEN			
	Data Observed		BMTA Schedules		Data Observed		BMTA Schedules	
	F	H	F	H	F	H	F	H
0700 - 0800	29	2.1	31	1.9	28	2.1	28	2.1
0801 - 0900	19	3.2	20	3.0	22	2.7	22	2.7
0901 - 1000	24	2.5	24	2.5	21	2.9	20	3.0
1130 - 1230	19	3.2	22	2.7	23	2.6	22	2.7
1231 - 1330	24	2.5	24	2.5	17	3.5	17	3.5
1530 - 1630	26	2.3	24	2.5	23	2.6	23	2.6
1631 - 1730	22	2.7	23	2.6	24	2.5	25	2.4
1731 - 1830	18	3.3	19	3.2	18	3.3	16	3.8

Note : F: Hourly Frequency H: Headway in minutes

This indicated that the dispatchers at both terminals had performed their assignments accordingly. However, it must be noted that the scheduling procedures employed by BMTA are concentrated on the hourly frequencies basis. Without any consideration on the time of releasing, they released their buses according to the provided hourly frequency schedules. Irrespective to the releasing time of the buses which could only be achieved by the ***"even headways"*** (e.g. 2, 2.5, 3, 4 min., etc.), BMTA just considered the hourly frequencies and oftentimes these frequencies did not produce the ***"even headways"***. Results obtained from the BMTA time-keeper records as shown in Table 2 clearly revealed that the frequencies of 7, 9, 11, 13 and 19 buses at certain hours were employed to release their buses from the terminals. These frequencies of 7, 9, 11, 13 and 19 buses per hour resulted to the headways of 8.6, 6.7, 5.45, 4.6 and 3.16 minutes, respectively. It can be seen that releasing the buses, for an example, at 8.6 min. interval and other uneven headways were extremely difficult for any bus drivers to comply with. As such the time-keepers/dispatchers just released the buses as long as they confirmed to the hourly frequency schedules. Consequently, these resulted to the bunching of buses along the routes and irregularities of arrivals at the bus stops.

3.3.Bunching of Buses Along the Route

To determine the phenomenon of bus bunching in Bangkok, the arrival time of bus route no. 4 at all observation stations including both terminals were recorded. For the terminal of origin, departure time of buses were utilized instead of the arrival time. The results indicated that at certain instances two buses came together resulted to the zero (0) minute headways as already mentioned earlier in the previous sub-section. The zero minute headways indicated bus bunching phenomenon along this particular route and commonly noticed among many other bus routes in Bangkok.

Furthermore, some buses were found to overtake the preceding buses for the same bus route. This situation should not be allowed as it may cause not only the irregularity of bus services but could endanger the passengers' safety. Results of the number of buses that overtook the preceding buses were calculated as a percentage of the total buses being operated during the observation periods. They are summarized as shown in Table 3.

High irregularities of bus operations along route no. 4 were observed particularly from Paseecharoen to Klong Toey direction. As much as 61% of the irregular bus operations were found along this route. Furthermore, these irregularity

driving behaviors were observed consistently in all study periods at both directions. Thus, this overtaking problem together with the bunching phenomenon should be totally eliminated.

Bus drivers should be informed and trained to react promptly under certain restrictions. There should be no overtaking if possible to maintain proper headway between successive buses. It is highly recommended that in order to minimize bus bunching problem, BMTA should set a guideline to prohibit drivers from overtaking the preceding bus except when break down occurs.

Table 3: Percentages of Irregular Bus Arrival at Different Observation Stations Along Bus Route No. 4

BUS ROUTE NO. 4						
Direction	Period	Total no. of observed buses	No. & Percentage of irregular arrivals at survey Stations			Percentage of regular arrivals at Terminal
			Station 1	Station 2	Terminal	
Kloeng Toey	M-Peak	37	4 (11)	15 (41)	18 (49)	19 (51)
to	O-Peak	20	7 (35)	8 (40)	8 (40)	12 (60)
Paseecharoen	E-Peak	31	1 (3)	9 (29)	13 (42)	18 (58)
Paseecharoen	M-Peak	32	10 (31)	16 (50)	17 (53)	18 (47)
to	O-Peak	17	4 (24)	6 (35)	8 (47)	9 (53)
Klong Toey	E-Peak	33	7 (21)	17 (52)	20 (61)	13 (39)

Note : Values in the parenthesis ( ) represent the percentages of irregularity

3.4.Travel Time and Travel Speed

Results of the travel time surveys for bus route no. 4 clearly indicated that variations in travel time were generally observed for all study periods and for both directions. Consequently, the average corresponding speeds on this particular bus route were found to be varied between 10 to 14 kph as shown in Table 4. Though, number of contributing factors could have affected the bus travel time, the most significant factor may arise from the severely congestedtraffic conditions in Bangkok. As it can be clearly seen from Table 4 that bus travel speeds in Bangkok were extremely low reaching maximum speed of less than 15 kph. This has magnified the insufficient services being provided

due to the inability to utilize the bus fleet effectively and efficiently. Many buses were caught in the traffic and unable to return to provide sufficient services. During peak hours, these delays amounted to more than 30% of the travel times. In addition, delays were also observed at both uncontrolled and controlled signalized intersections. In fact, all these resulted to the unpredictable travel time spent on each trip and consequently low travel speeds.

This unpredictable travel time phenomenon can be easily suspected by any bus commuters in Bangkok. In another research study conducted by AIT on public water transportation system [3], the analysis of express boat travel time showed the contradictory results as compared to the BMTA buses. Boat passengers can patronize the express boats to their destinations within the expected time. This experience perhaps will never be achieved when commuting by BMTA buses.

Table 4: Travel Times, Delays and Travel Speeds of BMTA Bus Route No. 4

BUS ROUTE NO. 4			
Direction: Klong Toey to Paseecharoen (Route Length = 13.9 km)			
Time Period	Travel Time (minutes)	Delays (minutes)	Speed (kph)
M-Peak	66.5	19.7	12.54
O-Peak	58.4	13.2	14.28
E-Peak	79.4	28.9	10.50
Direction: Paseecharoen to Klong Toey (Route Length = 14.4 km)			
M-Peak	74.6	33.6	11.58
O-Peak	61.3	23.1	14.09
E-Peak	84.9	34.6	10.18

One common reason that bus travel times in Bangkok are extremely long and inconsistent, is due to the lack of bus preferential treatment. Although, bus lanes do exist along certain routes in Bangkok, lack of strict enforcement has unfortunately turned these bus lanes to ordinary lanes as many cars intruded illegally into the lanes.

Furthermore, it is worthwhile to mention also that BMTA has yet to reconsider their policy which currently allows their buses to stop at every bus stops except for the express services. Common scene that can be easily observed in Bangkok is the number of buses of different routes are queuing to stop at the same bus stops resulting to the unnecessary delay and encourage passengers to board and alight outside the bus stops.

It is therefore recommended that the provision of special bus treatment such as exclusive bus lanes on some sections, if not all of the bus routes, should be considered. Skip-stopping at some bus stops should also be employed to reduce the over-all travel time.

3.5.Bus Layover Time

At the end of each trip, buses usually have a layover time so that they can remain on schedule and also allowing the bus crews to take rest. The average bus layover time analyzed for both terminals of this selected bus route together with the minimum and maximum values are summarized as shown in Table 5.

Table 5: Average Bus Layover time of BMTA Bus No. 4

BUS ROUTE NO. 4					
Terminals	Time Period	N	A.L.O (min)	Min.	Max.
(Origin) Klong Toey	M-Peak	54	24.0	4	38
	O-Peak	29	29.0	9	48
	E-Peak	51	25.0	3	58
(Destination) Paseecharoen	M-Peak	65	8.0	4	15
	O-Peak	39	8.0	2	37
	E-Peak	61	7.0	1	19

Note: A.L.O - Average Layover Time in Minutes
N - Sample Size

Significant differences were found in the layover time between different time periods. Moreover, further analysis on the layover time at both ends of the terminals clearly indicated the large discrepancies in layover time between each terminal for bus route no. 4.

Inconsistent results of layover time obtained from the survey for all study periods have further supplemented the findings on the improper scheduling procedure discussed in the previous sub-section. Not to mention the substantial variations among the minimum and maximum layover time observed in this route. This further reflected the irregular releasing schedules of buses from the terminals.

In order to overcome this problem, BMTA should set up bus timetable at both bus terminals.

4.Bus Operational Characteristics in Karachi

4.1.Bus Headways

Analysis of bus headways in Karachi on the selected bus route no. 6 as shown in Table 6, revealed similar results as obtained in Bangkok's case study. Consistent mean headways were observed at all study periods and for both directions. However, minimum headway of zero minute was also observed in Karachi. In other words, bus bunching phenomenon appeared as well in Karachi's bus operation.

Table 6: Mean Headways of Bus Route No. 6

Period	Item	Direction: City Garden Terminal to Tower Terminal				
		City Garden	Liaqatabad # 10	Guru Mandir	Sea Breeze Hospital	Tower
M-Peak	N	62	59	58	59	55
	M	2.89	1.97	3.00	3.08	3.55
	Min	0	0	0	0	0
	Max	8	10	8	8	13
	S	1.02	1.97	1.64	1.87	3.08
O-Peak	N	31	31	31	32	35
	M	3.84	3.84	3.65	3.66	3.86
	Min	1	1	1	1	0
	Max	7	8	9	9	12
	S	1.25	1.78	1.88	1.90	3.10
E-Peak	N	48	48	48	48	49
	M	3.77	3.54	3.67	3.65	3.94
	Min	1	0	0	1	0
	Max	6	8	8	9	16
	S	0.94	1.83	2.04	2.15	3.43

(Cont'n. of Table 6)

Period	Item	Direction: Tower Terminal to City Garden Terminal				
		Tower	Sea Breeze Hospital	Guru Mandir	Liaqatabad # 10	City Garden
M-Peak	N	54	48	48	47	43
	M	3.54	3.69	3.67	3.55	4.23
	Min	0	0	0	1	0
	Max	12	11	12	10	27
	S	2.63	2.34	2.19	1.94	4.48
O-Peak	N	32	27	28	26	26
	M	3.88	4.11	3.89	4.50	4.46
	Min	1	2	0	1	0
	Max	11	8	10	12	14
	S	2.77	1.79	2.61	2.58	3.92
E-Peak	N	48	42	42	40	44
	M	3.94	4.21	4.17	4.48	3.95
	Min	0	1	0	0	0
	Max	16	14	15	18	21
	S	3.30	3.08	3.36	4.06	4.02

Note: N: Sample Size H: Average Headway in minutes
S: Standard Deviation

Meanwhile, the maximum headway was found to be as long as 27 minutes being reflected in the passengers' unreasonable waiting time at bus stops. It is quite apparent in Karachi that numbers of buses particularly the private buses spent extra and longer time than necessary at each bus stop, hoping to fetch more passengers. Nonetheless, similar concluding remarks like Bangkok can be derived for Karachi bus system that the private bus operators have fulfilled the need to provide the reasonable number of trips to their commuters. However, they also need to train their bus drivers to drive promptly and act accordingly as such bus bunching problem would be minimized. Furthermore, unreasonable long stopping at bus stops should be eliminated to minimize the irregular arrivals of buses.

For both Bangkok's and Karachi's bus operations, it is recommended that in order to minimize bus bunching problems and irregularity arrivals of buses, bus drivers should be given an "arrival plan" at some specified or strategic

locations along the routes. Drivers should follow this arrival plan as closely as possible. They must be trained to act promptly either to speed up in case they are behind schedules, or deliberately slowing down if they are ahead of schedules.

4.2.Travel Time and Travel Speed

In common with Bangkok's bus no.4 findings on the bus travel time, Karachi's bus no.6 as revealed in Table 7, indicated also the variations in their travel time among different observation periods and for both directions of travelling. Travel time varied from 48 minutes to 68 minutes which resulted to the corresponding travel speeds of 16.5 kph to 22.3 kph.

Table 7: Travel Time and Travel Speed along Route No. 6

	BUS ROUTE NO. 6							
Route Section	Time Period	Length (km)	Direction: City Garden Terminal to Tower Terminal					
			N	Mean T.Time (min)	Min	Max	Std	Mean Speed (kph)
City Garden Terminal to Tower Terminal	M-Peak	17.6	46	48.2	39	62	6.44	22.3
	O-Peak		19	64.9	41	75	7.12	16.5
	E-Peak		32	61.7	49	99	9.20	17.4
			Direction: Tower Terminal to City Garden Terminal					
Tower Terminal to City Garden Terminal	M-Peak	17.6	35	52.5	44	63	4.80	20.3
	O-Peak		13	64.6	54	72	4.88	16.4
	E-peak		26	68.3	53	91	8.17	15.7

Note: Mean T.Time - Mean Travel Time
Std - Standard Deviation
N - Sample Size

Though, higher bus travel speed was observed for Karachi than Bangkok case study, inconsistent speeds can still be noticed which is quite common among developing countries' bus services. In fact, the speeds observed in Karachi were slower

during the off-peak period than the peak periods especially the morning peak. This rather unusual trend may due to the reason that there were less numbers of passengers during the off-peak hours,.as such bus drivers spent longer times at bus stops while waiting for potential passengers. This phenomenon is worthwhile scrutinizing further and will be highlighted in the subsequent sub-section.

4.3.Bus Dwell Time

To further verify the effects of bus travel times, on board surveys were conducted on the selected bus route no.6. Information pertaining to bus dwell time and total delays occurred along the route were gathered and the results were summarized as shown in Table 8. It can be seen from Table 8 that average dwell times during the off-peak period were longer than the peak periods for both directions of travel which ranged from 35 to 51 seconds per stop, compared to 25 to 33 seconds during peak periods.

Table 8: Average Dwell Time of Bus Route No. 6

BUS ROUTE NO. 6										
Time Period	Direction: City Garden Terminal to Tower Terminal (Route Length = 17.6 km)					Direction: Tower Terminal to City Garden Terminal (Route Length = 17.6 km)				
	Total Stops	Delays (mins)	Dwell Time			Total Stops	Delays (mins)	Dwell Time		
			Mean (secs)	Min (secs)	Max (secs)			Mean (secs)	Min (secs)	Max (secs)
M-Peak	47	21.9	26	3	845	54	23.1	30	2	380
O-Peak	59	31.4	51	2	390	68	31.9	35	2	396
E-Peak	50	32.2	33	2	265	61	25.7	25	3	338

Moreover, delays were also found to be longer during the off-peak periods except for the evening peak from City Garden to Tower Terminal. Although, various factors contributed to the delays along the route, longer dwell time also contributed significantly. As such, the unreasonable long bus stoppage practice at bus stops should be eliminated. Furthermore, it is unfortunate to mention that bus drivers in Karachi were often found to stop illegally at any locations along the routes which are not the authorized bus stops. This practice

too should be eliminated to avoid the unnecessary delays as well as to ensure safety of the passengers for proper boarding and alighting.

4.4.Bus Layover Time

Layover time for bus route no.6 in Karachi revealed the similar results as obtained in Bangkok's bus operation. Though, the average layover times were found to be fairly consistent among different time periods, substantial variations among minimum and maximum layover times were still evident as shown in Table 9.

Table 9: Layover Time at Origin and Destination Terminals of Bus Route No. 6

BUS ROUTE NO. 6						
Terminals	Time Period	N	A.L.O (min)	Std	Min	Max
(Origin) City Garden Terminal	M-Peak	33	32.33	10.96	18	83
	O-Peak	20	30.20	6.37	20	40
	E-Peak	36	32.36	7.72	9	55
(Destination) Tower Terminal	M-Peak	53	0.60	1.07	0	5
	O-Peak	32	0.66	0.54	0	2
	E-Peal	47	0.72	0.92	0	4

Note: A.L.O - Average Layover Time in Minute
N - Sample Size
Std - Standard Deviation

Moreover, the average layover time at both ends of the terminals also showed large variations. At City Garden Terminal, bus crews had an average of about 32 minutes resting time, however, at the other end of the trip, Tower Terminal, they had only less than a minute (about 0.6 minutes) resting times. In fact, at this Tower Terminal, there were many instances that buses immediately returned to City Garden Terminal without any resting time for their crews as illustrated in Table 9 with zero minute layover time. Reasons that these buses spent much lesser rest time at this terminal may due to the insufficient number of substituting buses and also the limited number of parking spaces. Nonetheless, whichever the reason may well be, they should

impose proper layover time for bus crews in order to ensure safety aspects especially to minimize fatigue of bus drivers. Moreover, having appropriate layover time could also enhance the proper releasing schedules of buses at the terminals so that the dispatchers/time keepers need not to rush in releasing of their buses.

Fluctuating values of layover time observed in both cities' bus operations indicate the irregularity in releasing their buses from the terminals, which in turn affect the round-trip travel times of buses. This paper recommends that both BMTA and KBOA should set up the time table at their respective bus terminals.

CONCLUSION

Despite the significant role of public bus transit in the developing countries' capitals particularly Bangkok and Karachi, their bus services are still far from being efficient and adequate. While the most urgent need of urban rail mass transit system is still to be materialized in neither cities, the needs to improve their bus services are utmost essential. Common results of the findings of both cities' bus operations clearly indicated that there are urgent needs to improve their bus services through the rescheduling of bus frequencies, provision of training for proper bus driving attitude, allocation of bus time table and the provision of bus preference treatments. It is an utmost importance for each respective Government to realize the significant role of moving people rather than the usual concept of moving vehicles.

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