between bus and flight. If passenger waiting time is very short in ten minutes, we can find the passenger can choose the nearly time-point of bus schedule to arrival/departure airport. If the waiting time over 10 minutes of waiting time, they can take one more buss of the chance. However, passengers don't choose too long waiting of above thirty minutes, they will change another access mode to arrival/ departure airport.

2) The arrival/departure flight coverage at peak hour/non-peak hour

The coverage rate of bus service is very important key index of measuring the level of bus serving flight during different waiting time, the more percent (number) of bus serving flight different waiting time, the better level of bus serving flight different waiting time. The Table 5 shows that the time point of airport bus stop some bus frequency and connection time problems between scheduled bus and scheduled flight.

Table 5 The coverage rate distribution of current bus service for passenger waiting time

		0 minutes		0-5 minutes		0-10 minutes		0-15 minutes		0-20 minutes		0-25 minutes		0-30 minutes	
Time period	A:D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
7:00-7:59	4:0	0.0%	-	0.0%	-	25.0%	-	50.0%	-	75.0%	-	75.0%	-	100.0%	-
8:00-8:59	8:7	12.5%	14.3%	25.0%	28.6%	25.0%	28.6%	25.0%	42.9%	37.5%	57.1%	50.0%	57.1%	50.0%	57.1%
9:00-9:59	5:7	20.0%	42.9%	40.0%	42.9%	40.0%	42.9%	40.0%	71.4%	40.0%	71.4%	60.0%	71.4%	60.0%	85.7%
10:00-10:59	4:4	25.0%	50.0%	50.0%	50.0%	100.0%	50.0%	100.0%	75.0%	100.0%	75.0%	100.0%	75.0%	100.0%	100.0%
11:00-11:59	4:5	0.0%	40.0%	0.0%	60.0%	0.0%	60.0%	25.0%	100.0%	25.0%	100.0%	75.0%	100.0%	100.0%	100.0%
12:00-12:59	2:4	50.0%	0.0%	100.0%	0.0%	100.0%	25.0%	100.0%	25.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
13:00-13:59	9:4	0.0%	0.0%	0.0%	25.0%	0.0%	50.0%	0.0%	50.0%	0.0%	50.0%	0.0%	75.0%	11.1%	100.0%
14:00-14:59	4:6	25.0%	0.0%	25.0%	0.0%	25.0%	0.0%	50.0%	0.0%	75.0%	0.0%	75.0%	0.0%	75.0%	0.0%
15:00-15:59	4:4	0.0%	20.0%	0.0%	60.0%	0.0%	60.0%	0.0%	60.0%	0.0%	60.0%	0.0%	60.0%	0.0%	80.0%
16:00-16:59	5:5	20.0%	0.0%	20.0%	0.0%	40.0%	0.0%	60.0%	0.0%	60.0%	0.0%	100.0%	40.0%	100.0%	40.0%
17:00-17:59	5:4	0.0%	25.0%	0.0%	25.0%	40.0%	50.0%	40.0%	75.0%	80.0%	75.0%	80.0%	75.0%	100.0%	75.0%
18:00-18:59	7:4	0.0%	0.0%	0.0%	50.0%	28.6%	50.0%	28.6%	50.0%	42.9%	100.0%	42.9%	100.0%	42.9%	100.0%
19:00-19:59	8:9	0.0%	0.0%	0.0%	11.1%	0.0%	11.1%	0.0%	22.2%	0.0%	66.7%	0.0%	66.7%	0.0%	66.7%
20:00-20:59	5:8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
21:00-21:59	0:2	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%
Total	74:74	8.1%	13.5%	13.5%	24.3%	24.3%	28.4%	29.7%	39.2%	37.8%	52.7%	45.9%	56.8%	51.4%	62.2%

A: arrival flights. D: departure flights.

The bus service coverage rate for departure flights is better than the bus service coverage rate for departure flights in many hours except 12:00-12:59 occupy the 100% bus service coverage for two arrival flights. There are scheduled buses of three time points (such as 12:25, 12:35, and 12:50) will arrive and depart the airport bus stop during the non-peak hour. The peak hours such as 13:00-13:59, and 19:00-19:59 time periods, there are no

scheduled bus arrangement. Another peak hour of 8:00-8:59 yet arranged two time point of 8:20, and 8:30 to be very concentrated and closed, not equilibrium distribution. The bus service coverage rate for arrival flights are always lower than bus service coverage rate for departure flights in different passenger waiting scale, reflect not to meet the passenger traffic demand and friendly for first time to visiting tourists. These shortages of allocating time points between peak hours and non-peak hours pay to improve.

Therefore, this study proposed the bi-level fuzzy multi-objectives model to improve the current bus timetable of airport bus stop show as Table 6 and Table 7. Both models not only mainly enhance the bus service coverage rate but and improve the bus service coverage rate for arrival flights. Both models will reach 51.4%-55.4% bus service coverage rate for arrival flights and departure flights before 0-15 minutes of passenger waiting time, but current bus timetable only reach 29.7%-39.2% bus service coverage rate for arrival flights and departure flights before 0-15 minutes of passenger waiting time. The enhance efficiency of bus service coverage rate of fuzzy multi-objectives model is more significant and better than the efficiency of bus service coverage rate of bi-level model. Thus, the bus service coverage rate of peak hours (8, 9, 13, 18, 19, and 20 pm) for bi-level2 and bi-level-fuzzy 2 models fuzzy are better than current bus timetable. The performance of bi-level-fuzzy 2 is improving more than the performance of bi-level 2 in peak period.

Table 6 The coverage rate distribution of bus service with bi-level 2 model

		0 minutes		0-5 minutes		0-10 minutes		0-15 minutes		0-20 minutes		0-25 minutes		0-30 minutes	
Time period	A:D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
7:00-7:59	4:0	50.0%	-	50.0%	-	50.0%	-	50.0%	-	75.0%	-	100.0%	-	100.0%	-
8:00-8:59	8:7	25.0%	28.6%	37.5%	42.9%	50.0%	57.1%	75.0%	71.4%	75.0%	71.4%	87.5%	71.4%	100.0%	71.4%
9:00-9:59	5:7	60.0%	42.9%	60.0%	42.9%	80.0%	57.1%	80.0%	85.7%	100.0%	85.7%	100.0%	100.0%	100.0%	100.0%
10:00-10:59	4:4	25.0%	50.0%	50.0%	50.0%	50.0%	75.0%	50.0%	100.0%	50.0%	100.0%	75.0%	100.0%	100.0%	100.0%
11:00-11:59	4:5	75.0%	0.0%	100.0%	20.0%	100.0%	20.0%	100.0%	20.0%	100.0%	80.0%	100.0%	100.0%	100.0%	100.0%
12:00-12:59	2:4	50.0%	50.0%	50.0%	100.0%	50.0%	100.0%	50.0%	100.0%	50.0%	100.0%	50.0%	100.0%	100.0%	100.0%
13:00-13:59	9:4	44.4%	0.0%	55.6%	0.0%	77.8%	25.0%	88.9%	25.0%	88.9%	50.0%	88.9%	75.0%	88.9%	100.0%
14:00-14:59	4:6	0.0%	0.0%	0.0%	33.3%	25.0%	50.0%	50.0%	50.0%	50.0%	100.0%	50.0%	100.0%	75.0%	100.0%
15:00-15:59	4:4	0.0%	20.0%	0.0%	40.0%	0.0%	40.0%	0.0%	40.0%	25.0%	40.0%	50.0%	40.0%	50.0%	40.0%
16:00-16:59	5:5	60.0%	0.0%	80.0%	20.0%	100.0%	20.0%	100.0%	20.0%	100.0%	20.0%	100.0%	20.0%	100.0%	60.0%
17:00-17:59	5:4	0.0%	25.0%	0.0%	25.0%	20.0%	75.0%	20.0%	75.0%	40.0%	75.0%	40.0%	100.0%	40.0%	100.0%
18:00-18:59	7:4	28.6%	0.0%	28.6%	25.0%	42.9%	25.0%	42.9%	25.0%	42.9%	25.0%	71.4%	25.0%	100.0%	75.0%
19:00-19:59	8:9	25.0%	22.2%	25.0%	33.3%	37.5%	33.3%	37.5%	44.4%	37.5%	44.4%	37.5%	55.6%	37.5%	77.8%
20:00-20:59	5:8	0.0%	25.0%	0.0%	25.0%	0.0%	25.0%	0.0%	37.5%	0.0%	37.5%	0.0%	37.5%	0.0%	62.5%
21:00-21:59	0:2	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%
Total	74:74	31.1%	20.3%	37.8%	33.8%	50.0%	43.2%	55.4%	51.4%	60.8%	60.8%	68.9%	67.6%	77.0%	79.7%

A: arrival flights. D: departure flights.

Table 7 The coverage rate distribution of bus service with bi-level-fuzzy2 model

		0 minutes		0-5 minutes		0-10 minutes		0-15 minutes		0-20 minutes		0-25 minutes		0-30 minutes	
Time period	A:D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
7:00-7:59	4:0	25.0%	-	25.0%	-	50.0%	-	50.0%	-	75.0%	-	100.0%	-	100.0%	-
8:00-8:59	8:7	12.5%	42.9%	25.0%	57.1%	62.5%	57.1%	62.5%	71.4%	62.5%	85.7%	100.0%	85.7%	100.0%	85.7%
9:00-9:59	5:7	20.0%	57.1%	60.0%	57.1%	80.0%	57.1%	80.0%	100.0%	80.0%	100.0%	80.0%	100.0%	80.0%	100.0%
10:00-10:59	4:4	25.0%	50.0%	25.0%	75.0%	25.0%	75.0%	25.0%	100.0%	25.0%	100.0%	50.0%	100.0%	100.0%	100.0%
11:00-11:59	4:5	75.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	20.0%	100.0%	40.0%	100.0%	40.0%
12:00-12:59	2:4	50.0%	25.0%	50.0%	75.0%	50.0%	75.0%	50.0%	75.0%	50.0%	75.0%	50.0%	75.0%	100.0%	75.0%
13:00-13:59	9:4	44.4%	0.0%	55.6%	0.0%	77.8%	25.0%	88.9%	25.0%	88.9%	50.0%	88.9%	75.0%	88.9%	100.0%
14:00-14:59	4:6	0.0%	0.0%	0.0%	33.3%	25.0%	50.0%	50.0%	50.0%	50.0%	100.0%	50.0%	100.0%	75.0%	100.0%
15:00-15:59	4:4	0.0%	20.0%	0.0%	40.0%	0.0%	40.0%	0.0%	40.0%	25.0%	40.0%	50.0%	40.0%	50.0%	40.0%
16:00-16:59	5:5	20.0%	0.0%	20.0%	20.0%	60.0%	20.0%	60.0%	20.0%	60.0%	20.0%	80.0%	20.0%	80.0%	60.0%
17:00-17:59	5:4	40.0%	50.0%	40.0%	50.0%	80.0%	50.0%	80.0%	75.0%	100.0%	75.0%	100.0%	75.0%	100.0%	100.0%
18:00-18:59	7:4	28.6%	0.0%	28.6%	50.0%	57.1%	50.0%	57.1%	100.0%	57.1%	100.0%	71.4%	100.0%	100.0%	100.0%
19:00-19:59	8:9	25.0%	44.4%	25.0%	55.6%	37.5%	55.6%	37.5%	55.6%	37.5%	55.6%	37.5%	66.7%	37.5%	100.0%
20:00-20:59	5:8	0.0%	25.0%	0.0%	25.0%	0.0%	25.0%	0.0%	37.5%	0.0%	37.5%	0.0%	37.5%	0.0%	62.5%
21:00-21:59	0:2	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%
Total	74:74	25.7%	25.7%	32.4%	40.5%	52.7%	43.2%	55.4%	55.4%	59.5%	63.5%	70.3%	67.6%	78.4%	79.7%

A: arrival flights. D: departure flights.

3) The relationship between number of bus serving flight, bus coverage rate, passenger waiting time and peak hours

This study used 105 samples for each current bus timetable, bi-level model and fuzzy bi-level model to analyze the relationship between coverage rate of flight arrival/departure, waiting time, flight traffic type (arrival or departure), and peak hours to improve the operation for current bus timetable. The Dummy variables of waiting time less 30 minutes, such as waiting time of 0 minutes(W0), 1-5 minutes(W5), 6-10 minutes(W10), 14-15 minutes(W15), 16-20 minutes(W20), 21-25 minutes(W25), and 26-30minutes(W30). Number of arrival flight type(FA), number of departure flight type(FD), the ratio of arrival/departure flights (FA/FD), coverage rate of flight arrival/departure (CRA,CRD), number of bus serving arrival/departure flights(BSFA,BSFD), and the Dummy variables of peak hours(PH) such as 8,9,13, 18,19 and 20 are employed. Table 8 show that the relationship between connection time and peak hour are not significant in two model. Meanwhile the relationship between connection time and waiting time, flight arrival/departure type are significant in two models.

Table 8 shows the correlation coefficient of current bus timetable is not significant with peak hours and the ratio of arrival/departure flights. These figures of bi-level 2 and bi-level-fuzzy 2 indicate that the arrangement bus serving arrival/departure flights are

significant with peak hours and the ratio of arrival/departure flights. The bi-level-fuzzy 2 indicate the arrangement bus serving arrival/departure flights are significant with waiting time of 0 minutes, 6-10minutes, and 11-15minutes. Therefore bi-level-fuzzy 2 can suggest some strategies to reschedule current timetable shortages.

Table 8 The comparison correlation coefficient between three approaches

Coefficient		FA	FD	FA/FD	CRA	CRD	W0	W5	W10	W15	W20	W25	W30	PH
Current bus timetable	BSFA	.025	-.114	.104	.930(**)	.073	.026	-.066	.119	-.066	.026	.026	-.066	-.139
	BSFD	.170	.153	.124	-.033	.945(**)	.118	.049	-.123	.049	.118	-.123	-.088	.137
Bi-level 2	BSFA	.304(**)	.009	.332(**)	.898(**)	.055	.488(**)	-.103	.028	-.136	-.136	-.070	-.070	.192(*)
	BSFD	.170	.307(**)	.035	.024	.945(**)	.219(*)	.052	-.048	-.081	-.048	-.114	.019	.176
Bi-level-Fuzzy 2	BSFA	.296(**)	-.016	.342(**)	.894(**)	-.101	.343(**)	-.105	.215(*)	-.201(*)	-.169	-.009	-.073	.155
	BSFD	.225(*)	.314(**)	.066	-.140	.937(**)	.308(**)	.075	-.187	.017	-.071	-.158	.017	.237(*)

** Significant at 1% level * Significant at 5% level

4.2.2 The strategy improvement current time point for the airport bus stop

According to above finding, this study considers the bus authorities can think two approaches to improve the shortage of time connection between flight and bus. The short term approach only reschedules time point for the airport bus to apply the bi-level rescheduling time point at normal days (such as Monday to Thursday) and the fuzzy-bi-level optimal rescheduling time point at holiday and weekend days (such Friday to Sunday). These two ways only reschedule time point and roster bus schedule forward /backward time in working hours, not only pay lower cost, but also the rescheduling times better meet the time distribution of passenger demand and arrival/departure flights. The long term approach still arranges the buses to more suitable time point and add the bus service frequencies to enhance the efficiency of green transportation and seamless transportation between airport and bus.

5. CONCLUSION

The preliminary results and recommendations of this study are summarized as follows:

The optimal model shows that the current 23 scheduled buses serving 148 scheduled flights must be improved. The optimal bus timetable is better than the current bus timetable, in terms of minimizing the total connection time and maximizing the coverage of flights. If the passenger waiting time is less than 15 minutes, the optimal bus timetable serves 76 more schedule flights than the current timetable. The number of arriving flights served is different

than the number of departing flights served in 15 minutes of waiting time.

The outcomes show only change the bus arrival airport timetable can improve the service level shortage in peak hours, and the bus company don't add driver wage, hours of service and budget. This study also in the upper level find the optimal available operation time of bus company capacity and working hours are 35 minutes. This model can use this figure to check the time point of bus arrival/departure time are suitable or not. This model also finds the 9:30 and 15:05 two time point of bus arrival/departure time is the same the time-point design of optimal bus timetable, The smaller the connection time between the bus and the flight timetable, the smaller the number of schedule flights are served, but passengers' waiting need must be satisfied with the smaller connected time to improve the bus service performance. With the constraint of a maximum acceptable waiting time for a bus of 15 minutes, some departing passengers do not take the bus if their connection time exceeds 45 minutes and some arriving passengers do not take the bus if their connection time exceeds 30 minutes.

This study integrate the fuzzy multi-objectives model and bi-level model to measure the performance of the arriving/departing flight coverage at peak hours/non-peak hours and the relationship between connecting time, and waiting time. The bus authorities can think our suggestions to improve the shortage of current time points of bus timetable. The short term approach only reschedules time point for the airport bus to apply the optimal-bi-level rescheduling time point at normal days (such as Monday to Thursday) and the fuzzy-bi-level optimal rescheduling time point at holiday and weekend days (such Friday to Sunday). These ways only reschedule time point and roster bus schedule forward /backward time in working hours, not only pay lower cost, but also the rescheduling times better meet the time distribution of passenger demand and arrival/departure flights. The long term approach still arranges the buses to more suitable time point and add the bus service frequencies to enhance the efficiency of green transportation and seamless transportation between airport and bus.

Finally, this paper suggests that the transportation administration of should modify the bus timetable to improve its service to passengers and make greener use of its resources. This is an easy way to increase bus serving effects. This study only focuses on the airport bus stop schedules and the needs of passengers. Services passing Makung airport from Tai Wu, Eagle's Nest, Wu Kan, Lung Mun and Tsing Lo and other bus routes, the demands of community services, the overall capacity of the bus fleet, and staff scheduling were not considered. It is recommended that any future research expand the scope of this study to the management of public transportation.

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