

Draft Report

Bangkok Taxi: Managing Behaviors of Cabbies and their Customers

By

**Viroat Srisurapanon
Project Leader**

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Table of contents

1. State of the problems	
2. The current behaviors of cabbies in Bangkok	
3. Methodology	
4. Results	
4.1 Characteristics of households	
4.2 Characteristics of travelers	
4.3 Characteristics of the phone call taxi commuters	
4.4 Performance of the community taxi operation	
4.5 Characteristics of taxi commuters	
4.6 Characteristics of the community taxi users	
4.7 Factors influencing the phone call for a taxi	
4.7.1 Sensitivity of surcharge and waiting time	
4.7.2 Characteristics of the car users who shift to use the CT	
5. Conclusions	
References	
Appendix A	The logit model
Appendix B	Bangkok transportation data
Appendix C	Glossaries

1. State of the problems

In Bangkok, a great number of commuters, 57.5 percent, leave homes daily by private cars even though many organizations have tried to campaign for people to change from driving a private car to using public transport. It sounds like a dream that cannot come true immediately due to the limitations of network services. 'Taxi' is an alternative to overcome this limitation. Taxis can serve passengers directly from their homes to the destination. In addition, it can save people from having to buy a car and cause less traffic congestion than private cars this is because one taxi can serve many commuters during a day, where if each commuter drives a car, the city becomes congested.

Statistics of registered taxi services in Bangkok and its vicinity inform us that the number of taxis has gradually increased in the last three years. At present, the number of taxis is at more than 100,000 and around one million passengers use the service each day. Within one shift of 12 hours, a taxi runs an average distance of 242.26 km, 42% of which, 101.19 km, is an empty cruise for searching passengers. The energy lost due to the empty cruise costs approximately 3 billion baht per year (Srisurapanon et al. 2006). This not only wastes a great deal of energy but also causes more traffic congestion and air pollution problems, especially, when people flag down the taxis along the road that is already congested. **How can we solve these problems?**

From the data analysis of the behaviors of taxi drivers and their passengers, it was found that 80 percent of the taxi drivers can get passengers by cruising while 72 percent of the passengers call for a taxi by flagging down along the road. The rest of the passengers call for a taxi from the taxi radio center by phone.

The biggest obstacle for passengers who use phone calls is the long waiting time. They have to wait for a long time because there is not a lot of taxis available at the taxi stands. To wait at the stand is not a common practice for taxi drivers either as they may have to spend for a long time for dispatch. **So how can we convince the drivers to wait for passengers at the taxi stands instead of searching passengers by cruising?**

One approach that can help to change the behaviors of both parties is to develop a quality taxi-stand system. A good taxi stand should be located at the place that has within 15-minute travel time to pick up passengers and be operated in a user-friendly way when the passenger calls. The taxi-stand system should have the ability to forecast the taxi-demand in advance to be able to allocate taxis to wait at the appropriate stands. When the passenger makes a phone call, the driver promptly goes to pick them up. This system can shorten the drivers and passengers' waiting times since it matches both parties faster. After both parties join this approach, they will start to appreciate the system and then change their behaviors. This system not only saves the empty cruise time but also allows more convenience to passengers to call for a taxi.

The objectives of this study are:

1. Understanding the current behaviors of taxi passengers and drivers in Bangkok.
2. Analyze the factors influencing the phone call for taxi service.
3. Predict the phone call demands of taxi commuters.

2. The current behaviors of cabbies in Bangkok

There are two types of taxi stands, on-street and off-street. For the first one, it is convenient for taxis to drive in and passengers to ride on but it sometimes obstructs the normal traffic on the street. The latter can store more taxis. However it needs a communication system, e.g., radio, to inform the drivers to go to pick up passengers. Recently Bangkok's taxi drivers have only a way to cruise in the urban districts because of limited taxi stands. Even though, in the suburban districts, there are many off-street taxi stands available, a lot of taxi drivers prefer to cruise. Meanwhile, a high rate, more than 10 percent, of passenger cancellation occurs at taxi radio center because the dispatcher can not find a taxi. From interviewing, taxi drivers decide to find taxi stands after cruising without passengers about 40 minutes. This not only wastes much energy but also causes more traffic congestion. At present, the empty cruising distance of taxi has a high portion, 42 % of the total distance traveled one shift, 12-hour operation, as shown in the Table 2.1. This wastes about 3,020 million Baht annually (Srisurapanon et al. 2006).

Table 2.1 Average distance of one shift (12 hours) of Bangkok taxi operation

Total distance (Km.)	Service distance (Km.)	Empty cruising Distance (Km.)	percentage
242.26	141.05	101.19	42%

Taxi drivers have four ways to get passengers as follows:

- ❖ Type 1 : Empty cruising with non radio-based
- ❖ Type 2 : Empty cruising with radio-based
- ❖ Type 3 : Standing with radio-based
- ❖ Type 4 : Standing with non radio-based

Type 1: Empty cruising with non-radio-based

Taxis will cruise in a road network to search for customers and provide transportation services. Drivers are unable to predict accurately when and where the next passenger will need a taxi.

Type 2: Empty cruising with radio-based

During cruising the empty taxis in search of passengers, drivers can answer dispatch calls instantaneously from the taxi radio center.

Type 3: Standing with radio-based

Upon drop-off or completion of service, the taxis will drive to the taxi stands, normally off-street taxi stands, and wait for dispatch calls from the taxi radio center.

Type 4: Standing with non-radio-based

After dropping off passengers, drivers go to the high demanded taxi stand, e.g. hospital, hypermarket etc., waiting for customers nearby the stand. This taxi stand is more beneficial if it can combine with type 3, receiving dispatch calls from the radio center simultaneously. However, it has not existed yet.

The matching process of each type is illustrated in Figure 2.1.

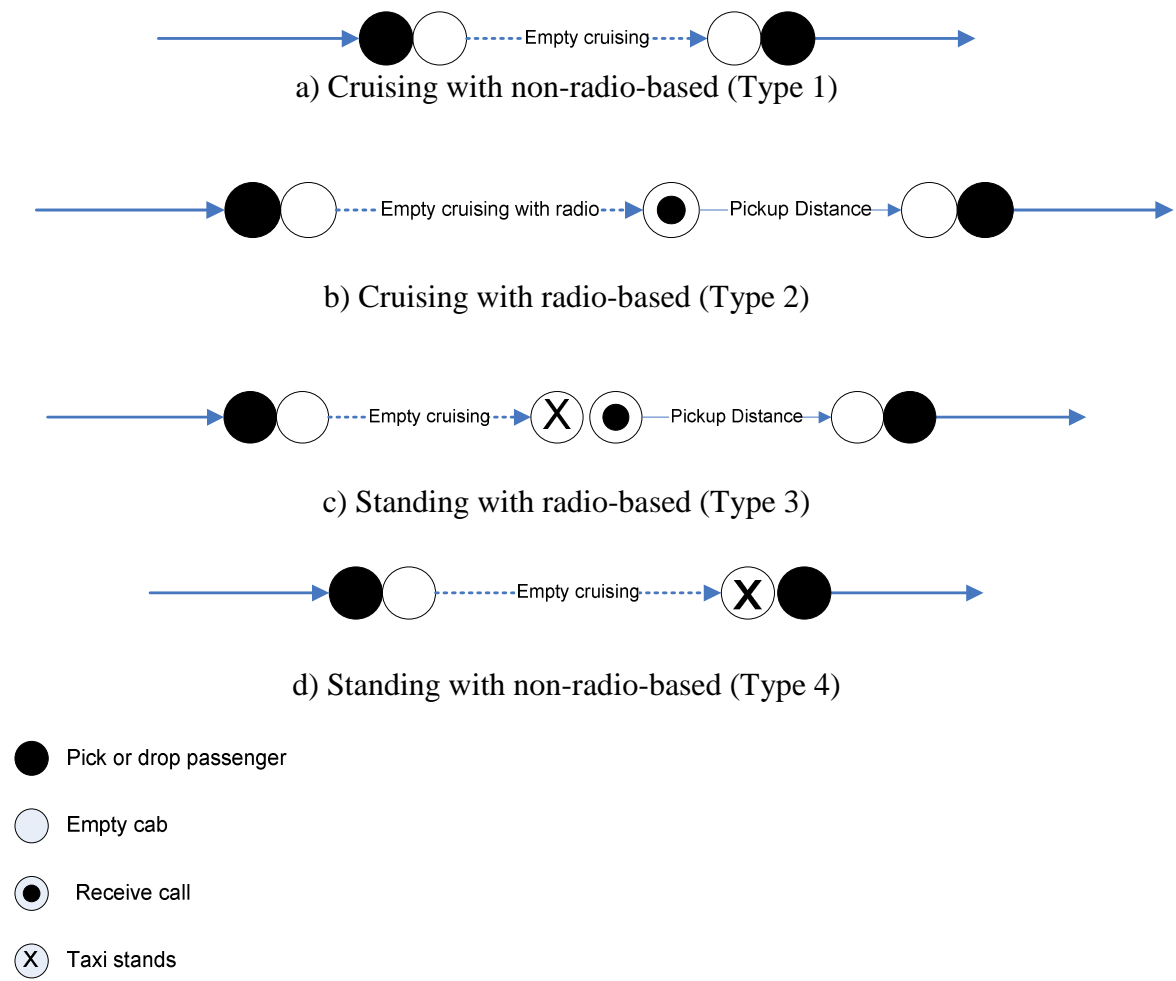


Figure 2.1 Four types of getting customers

From the previous study, the number of trips classified by ways of getting passengers is shown below.

Table 2.2 Number of trips classified by type of getting passengers

Type	Number	Percentage
1 Cruising with non-radio-based	507	75
2 Cruising with radio-based	31	4.5
3 Standing with radio-based	94	14
4 Standing with non-radio-based	45	6.5
Total	677	100

Most of drivers, 75 % of total number of trips, get passengers by cruising with non-radio-based around Bangkok and surrounding area (Type 1) while types 2 and 3, radio-based, are popular only in the area located outside the inner-ring road. Type 4 is a special case normally located at hypermarkets, hospitals or places that serve on-demand customers. Average distance and time used by each way of getting passengers are shown in Tables 2.3 and 2.4. For the current operation, type 3, waiting at taxi stand for a call from radio center, has the worst performance since drivers normally use only one or two taxi stands. After they drop passengers off, they will go back to their familiarized area. Furthermore, they go to wait without predicted passenger demands so they often have to wait for a long time. This causes unpopular for taxi driver to go to wait at off-street taxi stand.

Table 2.3 Average empty cruising distance

Type	Distance (Km.)			
	Search for passenger	Go to stand	Go to pickup passenger	Total
1	8.57 (2.01)	-	-	8.57
2	4.82 (1.65)	-	3.59 (0.82)	8.41
3	-	9.30 (1.74)	5.10 (1.02)	14.4
4	-	2.89 (2.75)	-	2.89

() = Standard deviation, SD.

Table 2.4 Average empty cruising time

Type	Time (min.)				
	Search for passenger	Go to stand	Wait at Stand	Go to pickup passenger	Total
1	27.21 (4.81)	-	-	-	27.21
2	23.90 (7.76)	-	-	7.22 (1.37)	31.12
3	-	13.91 (1.06)	52.59 (24.99)	8.59 (1.45)	75.09
4	-	8.04 (7.86)	21.61 (8.59)	-	29.65

() = Standard deviation, SD.

However, the possible improvements of Type 3 that were confirmed by previous study (Suwan, 2010) can be done by two ways: physical and informative provisions. For the former provision, the stands should be provided in all zones that have high demands. For the latter provision, the demands for each taxi stand are periodically predicted and informed to drivers so they can go to the recommended taxi stand directly after dropping passengers off.

For this study, we establish the community taxi center which serves for households at Soi Puttabucha 36 in Thung-Khru district, located in the south-western part of Bangkok, to observe changes of the behaviors of cabbies and their passengers.



Figure 2.2 Study area

3. Methodology

For this study, three interview surveys and one field experiment are conducted as follows:

- Household survey
- Field experiment of the community taxi (CT) center
- Taxi commuter survey
- The CT customer survey

The expected information for each survey is shown in Table 3.1.

Table 3.1 The expected information for each survey

Activity	Number of samples	Expected information
Household survey	83 households	The proportion of travelers by mode.
Field experiment of the community taxi (CT) center	598 serves	Behaviors of cabbies and their passengers under two conditions: short waiting time and no surcharge.
Taxi commuter survey	323 persons	Ways of getting taxis. Rating of the CT.
The CT customer survey	118 persons	Satisfaction and willingness to use the CTs, and Influence of two factors: waiting time and surcharge.

From the household survey, we find most of taxi commuters flag down taxis along the street. Some commuters use phone calls for taxis. Two main reasons that make them dislike to make phone calls for taxis are long waiting time and 20-Baht surcharge. This makes taxi drivers have to search passengers by cruising. We think that the empty distance can be reduced if the taxi drivers can stop at some taxi stands and wait for passenger calls.

To motivate taxi commuters to use phone calls for taxis, we establish the new taxi stand so called ‘community taxi’ that has quick serve and free surcharge. The behaviors of cabbies and their passengers can be observed during two-months operation period.

Then, the concept of taxi-stand configuration network and its operation is proposed after understanding the behaviors of both parties.

4. Results

4.1 Characteristics of households

Each interviewee represents one household. In the survey, a total of 83 families and 287 residents were investigated. The questionnaire includes the basic information of family, such as number of household members, ownership of cars and so on. The average household size is 3.46. Most of the households, 85 percent, have at least one car.

Table 4.1 Number of Samples

Village name	Number of Households	Number of Samples		Sampling Rate
		Household	Persons	
Alicha Place	96	28	98	30%
Sarunthorn	67	24	89	35%
Prukha Village	160	31	100	20%
Total	323	83	287	26%

Table 4.2 Number of households by size

Household Size (Person)	Number of Households			Total
	Alicha Place	Sarunthorn	Prukha Ville	
1	2	0	0	2 (2.4%)
2	6	3	9	18 (21.7%)
3	3	6	10	19 (22.9%)
4	12	8	9	29 (34.9%)
5 or More	5	7	3	15 (18.1%)
Total	28	24	31	83 (100%)

Table 4.3 Number of households by number of car ownerships

Number of car ownerships	Number of Households			Total
	Alicha Place	Sarunthorn	Pruksa Ville	
None	2	0	3	12 (14.5%)
1	15	12	25	44 (53.0%)
2	8	6	2	17 (20.5%)
3	0	5	1	6 (7.2%)
4or more	3	1	0	4 (4.8%)
Total	28	24	31	83 (100%)

4.2 Characteristics of travelers

The basic information of travelers are sex, age, trip purpose, mode choice, occupation and personnel income. Of 287 people, 44% are males, females account for 56%. Most of these are 26-55 years old.

Table 4.4 Number of samples by sex

Sex	Number (Percentage)			Total
	Alicha Place	Sarunthorn	Pruksa Ville	
Male	46	36	46	128 (44.5%)
Female	52	53	54	159 (55.5%)
Total	98	89	100	287 (100%)

Table 4.5 Number of samples by age

Age	Number (Percentage)			Total
	Alicha Place	Sarunthorn	Pruksa Ville	
Less than 16	16	10	18	44 (15.3%)
16 – 25	10	12	9	31 (10.8%)
26 – 35	18	25	42	85 (29.6%)
36 – 45	20	19	17	56 (19.5%)
46 – 55	20	12	10	42 (14.6%)
More than 55	14	11	4	29 (10.1%)
Total	98	89	100	287 (100%)

The trip purpose is mainly for work and school, 63% and 20% respectively.

Table 4.6 Number of samples by trip purpose

Trip purpose	Number of sample		Total	Percentage (%)
	Male	Female		
Work	90	90	180	62.7%
Study	22	34	56	19.5%
Shopping	3	19	22	7.7%
Other	12	17	29	10.1%
Total	127	160	287	100%

Among the various types of traffic mode choice behavior, the proportions to choose private car, public transport, car taxi, and private motorcycle are respectively 57.5%, 13.6%, 8.0%, and 5.6%. The travel ratios by other modes, motorcycle taxi and non-motorized transport, are respectively 0.7% and 10.1%. It is noted that 4.5% of the residents do not travel.

Table 4.7 Travel mode selection

Travel mode	Number of sample		Total	Percentage (%)
	Male	Female		
Not travel	6	7	13	4.5%
Private car	88	77	165	57.5%
Private MC	8	8	16	5.6%
Public transport	11	28	39	13.6%
Taxi	2	21	23	8.0%
MC Taxi	2	0	2	0.7%
Non-motorized	10	19	29	10.1%
Total	127	160	287	100%

Most of people get salary 5,000-40,000 Baht. It is noted that 34.8% who have salary less than 5,000 Baht are housewives and students.

Table 4.8 Number of samples by income

Income (Baht)	Number of samples		Total	Percentage (%)
	Male	Female		
Less than 5000	35	65	100	34.8%
5000-10000	12	10	22	7.7%
10000-20000	32	44	76	26.5%
20000-30000	19	18	37	12.9%
30000-40000	9	11	20	7.0%
40000-50000	10	7	17	5.9%
50000 or more than	10	5	15	5.2%
Total	127	160	287	100%

Table 4.9 Number of samples by occupation

Occupation	Number of samples		Total	Percentage (%)
	Male	Female		
Housewife & Children	11	28	39	13.6%
State enterprise & Government official	12	8	20	7.0%
Employee of company	39	49	88	30.7%
Student	26	35	61	21.3%
Business	36	31	67	23.3%
Temporary Employee	3	9	12	4.2%
Total	127	160	287	100%

4.3 Characteristics of the phone call taxi commuters

33 persons out of 64 taxi users used to call taxi from the radio center. Most of them, 57.6%, are 26-45 years old. The four main reasons of calling taxi from the radio center are: 1) the long distance from the street to hail, 2) security, 3) many baggages, and 4) being able to reserve.

Table 4.10 Taxi radio users by age

Age	Number of samples	Percentage
Less than 16	0	0.0%
16-25	3	9.1%
26-35	10	30.3%
36-45	9	27.3%
46-55	6	18.2%
More than 55	5	15.2%
Total	33	100%

Table 4.11 Reasons of calling taxi from the radio center

Cause	Number of samples	Percentage
The only way he/she can	1	3.0%
Be able to find loss	1	3.0%
Be able to reserve	4	12.1%
Far from the street to hail	7	21.2%
Security	5	15.2%
Many baggages	4	12.1%
Weather	1	3.0%
Other	10	30.3%
Total	33	100%

Three barriers of the usage of radio-based taxi call are: surcharge, passengers' waiting time, and telephone fee. Among these, the waiting time is the most serious one.

Table 4.12 Barriers of calling taxi from the radio center

Barrier	Number of samples	Percentage
Surcharge	6	18.2%
Waiting time	16	48.5%
Telephone fee	2	6.1%
Don't have a barrier	9	27.3%
Total	33	100%

Most of them agree the current surcharge, 20 Baht, and telephone fee when calling taxi from the radio center but 39.4% disagree the current waiting time. The acceptable waiting time is less than or equals 15 minutes. If the surcharge is free, the waiting time is reduced to 5-10 minutes, or the telephone fee is free, the proportion of radio-based passengers will increase from 21.9% to 30.3%, 45.5%, or 48.5% respectively. These result was used as a guide to set the surcharge for the operation of the community taxi project.

Table 4.13 Attitudes on the surcharge

Attitude	Number of samples	Percentage
Agree	19	57.6%
Quietly	11	33.3%
Disagree	3	9.1%
Total	33	100%

Table 4.14 Sensitivity of the surcharge

Increasing the taxi demand?	Number of samples			
	Discount 10 baht	Free surcharge	Surcharge 10 baht	Surcharge 30 baht
No	9 (27.3%)	23 (69.7%)	30 (90.9%)	33 (100%)
Yes	24 (72.2%)	10 (30.3%)	3 (9.1%)	0
Total	33	33	33	33

Table 4.15 Attitudes on the waiting time

Attitude	Number of samples	Percentage
Agree	13	39.4%
Quietly	7	21.2%
Disagree	13	39.4%
Total	33	100%

Table 4.16 Appropriate waiting time

Waiting time (minute)	Number of samples	Percentage
Less than 5	2	15.38%
5-10	9	69.23%
10-15	2	15.38%
Total	13	100%

Table 4.17 Sensitivity of the waiting time

Increasing the taxi demand?	Number of samples influenced by waiting time (Minute)			
	Less than 5	5-10	10-15	15-20
No	8 (24.2%)	18 (54.4%)	28 (84.8%)	32 (97.0%)
Yes	25 (75.8%)	15 (45.5%)	5 (15.2%)	1 (3.0%)
Total	33	33	33	33

Table 4.18 Attitudes on the telephone fee

Attitude	Number of samples	Percentage
Agree	18	54.5%
Quietly	12	36.4%
Disagree	3	9.1%
Total	33	100%

Table 4.19 Sensitivity of the free telephone fee

Increasing the taxi demand?	Number of samples	Percentage
No	17	51.5%
Yes	16	48.5%

4.4 Performance of the community taxi operation

The community taxi stand located near Soi Puttabucha 36 operated 9 weeks from 22 May 2011 to 21 July 2011. The operation time was from 6.00 a.m. to 11.00 a.m. on weekday and from 6.00 a.m. to 15.00 a.m. on weekend. The daily calls of the community taxi varied from 5 to 21 times except Sunday and holiday as shown in Figure 4.1. The average number of trips per day is 12 on weekday and Saturday while the average number of trips per day is only 5 on Sunday and holiday. The total number of calls are 598 times served 174 customers by 405 taxis during the project. There are 17 VIP passengers who called at least 9 times and 15 VIP taxi drivers who served the passengers at least 4 times as shown in Tables 1 and 2. The VIP customers shared 310 calls, 50 % of total calls, while the VIP taxi drivers served 129 trips, 20 % of total trips, shown in Tables 4.21 and 4.22, and Figures 4.2 and 4.3.

The maximum service distances 2.5 km from the taxi stand with no surcharge of calling. The average waiting time for each customer is 11 minutes 42 seconds.

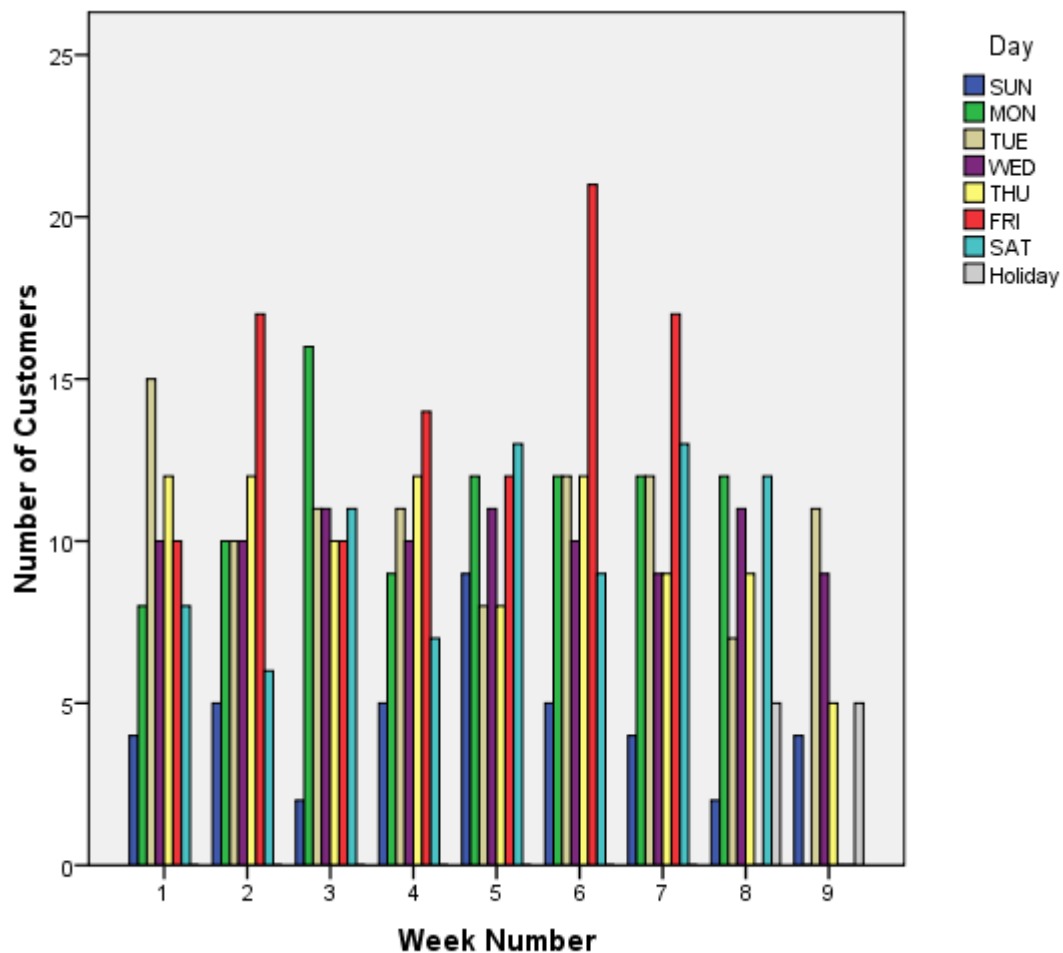


Figure 4.1 Daily calls

Table 4.20 The average number of the community taxi users

Day	Number of Trips	Number of days	Average number of trips per day
Sunday	40	9	4.44
Monday	91	8	11.38
Tuesday	97	9	10.78
Wednesday	91	9	10.11
Thursday	89	9	9.89
Friday	101	7	14.43
Saturday	79	8	9.88
Holiday	10	2	5.00
Total	598		9.80

Table 4.21 The number of customers by frequency of calls

Frequency of calls	Number of customers	Percent	Cumulative Percent
1	103	59.2	59.2
2	23	13.2	72.4
3	15	8.6	81.0
4	4	2.3	83.3
5	4	2.3	85.6
6	4	2.3	87.9
7	2	1.1	89.1
8	2	1.1	90.2
9+	17	9.8	100.0
Total	174	100.0	

Table 4.22 The number of taxi drivers by frequency of serves

Frequency of serves	Number of taxi drivers	Percent	Cumulative Percent
1	326	80.5	80.5
2	53	13.1	93.6
3	11	2.7	96.3
4+	15	3.7	100.0
Total	405	100.0	

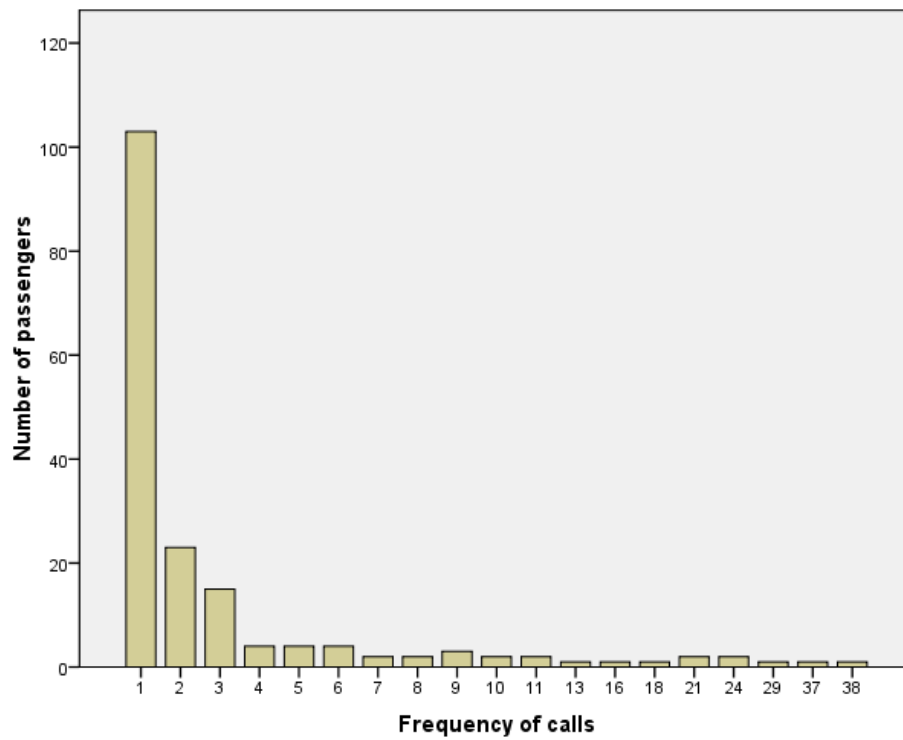


Figure 4.2 The number of customers by frequency of calls

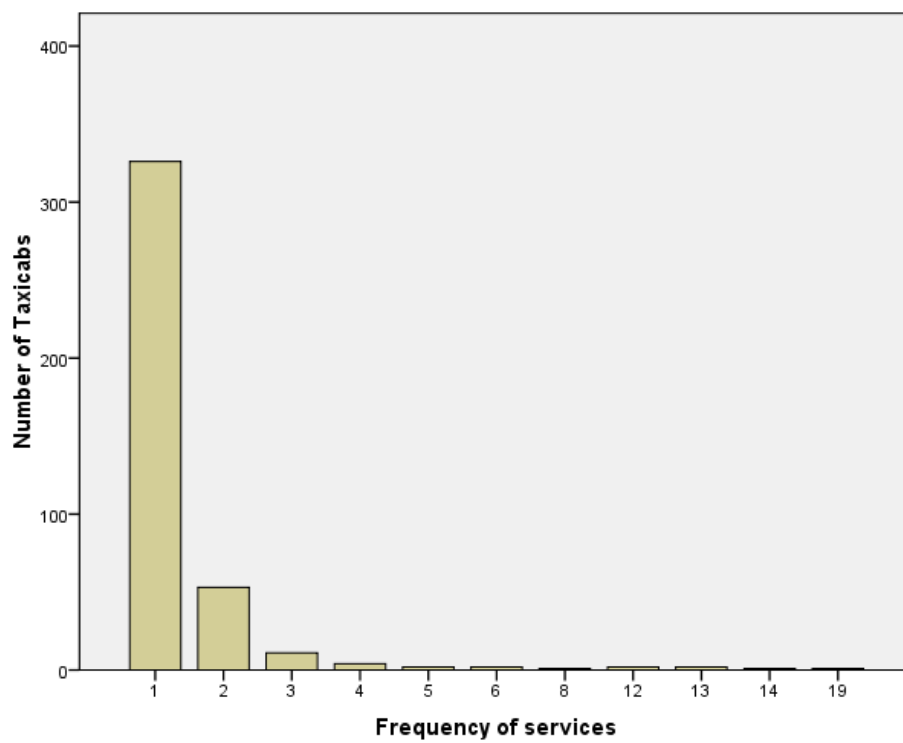


Figure 4.3 The number of taxi drivers by frequency of serves

The 5-level score is used to measure the satisfaction of the usage of the community taxi. The score varies from poor, improve, fair, good to excellent levels scaled from 1 to 5 respectively. For 139 CT samples, 6 are missing data. Everyone who used the CT are satisfied the system at least level 4. The average score is 4.3.

Table 4.23 Satisfaction of the CT

Level	Number	Percentage
Good	92	69.2
Excellent	41	30.8
Total	133	100.0

4.5 Characteristics of taxi commuters

Most of the frequent taxi users favor to travel between 6.00-10.00 a.m., especially before 8.00 a.m., on both weekday and weekend. For the infrequent taxi users, the average call is 3.17 times per month.

Table 4.24 The frequent taxi users' departure times on weekday

Departure times	Frequency	Percent
06.00-8.00	20	57.1
08.00-10.00	8	22.9
12.00-14.00	1	2.9
16.00-18.00	6	17.1
Total	35	100.0

Table 4.25 The frequent taxi users' departure times on weekend

Departure times	Frequency	Percent
06.00-8.00	6	46.2
08.00-10.00	3	23.1
10.00-12.00	1	7.7
12.00-14.00	3	23.1
Total	13	100.0

Table 4.26 The frequency of using taxis by the infrequent taxi users

Times per month	Frequency	Percent
1	58	26.2
2	66	29.9
3	30	13.6
4	34	15.4
5	8	3.6
6	1	.5
7	3	1.4
8	6	2.7
10	8	3.6
12	5	2.3
14	1	.5
15	1	.5
Total	221	100.0

Ways of calling a taxi

People can call a taxi by phone or street hail. By phoning, 28% make a direct call to a taxi driver or call a taxi from the taxi-radio center. For the street-hailing, 72% hail a taxi along the street or make a call to a guard man to hail a taxi as shown in Table 4.27.

Table 4.27 Way of calling a taxi

Ways of calling a taxi	Frequency	Percent	Valid Percent	Cumulative Percent
Street hail	146	46.2	64.9	64.9
Guard call	15	4.7	6.7	71.6
Radio center	61	19.3	27.1	98.7
Direct call	3	.9	1.3	100.0
Total	225	71.2	100.0	
Missing	91	28.8		
Total	316	100.0		

Waiting time

Most of taxi travelers prefer to hail a taxi along the street and spend a waiting time for a taxi varied between 20 and 40 minutes. The waiting time depends on the way of calling. Street-hail technique trends to have a longer waiting time than other ways of calling.

Table 4.28 The waiting times for taxis

Waiting time (minute)	Way of calling taxi				Total
	Street hail	Guard call	Radio center	Direct call	
10-15	22	3	8	3	36
15-20	24	13	12	1	50
20-30	60	6	26	2	94
30-40	68	2	18	0	88
More than 40	3	3	4	0	10
Total	177	27	68	6	278

4.6 Characteristics of the community taxi users

For the specific survey, 118 CT passengers were interviewed. Combining with the 21 CT passengers from the taxi passenger survey, the total number of the CT passengers is 139. 68% of them are female shown in Table 4.29. The ratio of frequent taxi users to infrequent taxi users is 1:5 shown in Table 4.30.

Table 4.29 Sex of the CT users

Sex	Number	Percentage
Male	44	31.7
Female	95	68.3
Total	139	100.0

Table 4.30 Type of the CT users

Type	Number	Percentage
Infrequent	115	83.3
Frequent	23	16.7
Total	139	100.0

About half of the community taxi customers travel alone.

Table 4.31 The companion on the community taxi

Companion (person)	Frequency	Percent
None	54	52.4
1	28	27.2
2+	21	20.4
Total	103	100.0

Willingness to use the community taxi

After closing the CT project, 323 samples were interviewed in August 2011 from 2 housing development groups, Banmai and Pruksa Ville 17, which are located in Soi Puttabucha 36. Most of the taxi users, 44%, are the infrequent taxi users, the frequent taxi users account for 8%. Others are non-taxi users as shown in Table 4.32.

Table 4.32 Number of taxi users

Type of users	Number	Percentage
Non-taxi user	152	47.6
Infrequent taxi user	141	44.2
Frequent taxi user	26	8.2
Total	319	100.0
Missing	4	
Total	323	

Of 293 samples, two-third knew the community taxi project as shown in Table 4.33. 21 people, 10.7 % of the people who knew the project, already tried to call a taxi from the community taxi center.

Table 4.33 Number of samples who tried to call the community taxi

Experience the community taxi	Knew the community taxi project?		Total
	No	Yes	
Not yet tried	97 100.0%	175 89.3%	272 92.8%
Already used	0 0%	21 10.7%	21 7.2%
Total	97 100.0%	196 100.0%	293 100.0%

All non-taxi users have not tried the CT since some of them do not know the CT project as shown in Table 4.34.

Table 4.34 The number of samples who tried to use the community taxi project by type of users

Type of users	Experience the community taxi	Knew the community taxi project?		Total
		No	Yes	
Non-taxi user	Not yet tried	40	90	130
	Already used	0	0	0
Infrequent taxi user	Not yet tried	47	76	123
	Already used	0	14	14
Frequent taxi user	Not yet tried	10	9	19
	Already used	0	7	7
Total		97	196	293

During the survey, there was a chance to explain the CT project directly. After understanding the CT concept, some non-taxi users would like to use the CT. For the taxi users who had tried to call the CT, almost all of them would like to use the CT again. Most of people who would not use the CT are the non-taxi users as shown in Table 4.35.

Table 4.35 Willingness to use the CT by type of users

Type of users	Willingness to use the CT	Experience the community taxi?		Total
		Not yet tried	Already used	
Non-taxi user	Not use	90	0	90
	Not sure	14	0	14
	Use	7	0	7
Infrequent taxi user	Not use	1	1	2
	Not sure	20	1	21
	Use	52	12	64
Frequent taxi user	Not use	0	0	0
	Not sure	4	0	4
	Use	10	7	17
Total		198	21	219

The CT users are not only the taxi users but also the users from other modes, especially from car users as shown in Table 4.36. It was observed that 44 (31%) of 141 car users would like to use the CT.

Table 4.36 Willingness to use the CT by mode of travel

Mode	Willingness to use the CT			Total
	Not use	Not sure	Use	
Car	72	25	44	141
Motorcycle	4	1	6	11
Bicycle	2	0	0	2
Tuk-Tuk	1	2	3	6
Bus	10	6	15	31
Taxi	1	4	15	20
Motorcycle taxi	2	0	1	3
Total	92	38	84	214

From the survey, we found that two main reasons of willingness to use the community taxis are free surcharge and short waiting time as shown in Table 4.37.

Table 4.37 Reasons of willingness to use the community taxi

Reasons	Frequency	Percentage
Free surcharge	41	46.1
Short waiting time	17	19.1
Safety	9	10.1
Bad weather	2	2.2
Hard to flag down a taxi	7	7.9
Far from the main street	11	12.4
Other	2	2.2
Total	89	100.0

4.7 Factors influencing the phone call for a taxi

4.7.1 Sensitivity of surcharge and waiting time

Under the two conditions, free surcharge and quick service, 174 customers were interested in the use of the community taxi. 118 were interviewed. From the interview survey data, it was found that waiting time is more sensitive than surcharge as shown in Table 4.38. If we can keep the waiting time within 15 minutes, the percentage of the CT users does not decrease much although the surcharge is up to 20 Baht. In contrast, the percentage of the CT users decrease a lot when the waiting time is longer than 20 minutes although it is free surcharge. However, the CT users decrease a lot when the surcharge is 30 Baht. From the results, it can be noted that the demands of taxi users at the CT conditions, free surcharge and 15-minutes waiting time, was about 5 times higher than the demands at the current condition, 20-Baht surcharge and 25-minutes waiting time.

Table 4.38 Sensitivity of calling a taxi form the taxi center

Unit: percent

Surcharge (Baht)	Waiting Time (Minute)		
	Within 15	20~30	45
Free	100	61	12
20	84	19	1
30	6	0	0

Before the CT project, only 14 customers, 11.97 %, used to travel by taxis with the real conditions, 20-Baht surcharge and 25-minutes waiting time, as shown in Table 4.39. After the CT project, back to the real conditions, the number of taxi users increased to 27, 23.08 %. The additional number was the users who shifted from 12 car users and 1 Tuk-Tuk user. Some of them got use the taxi after they had tried to call the CT so they decided to use taxi thereafter.

Table 4.39 Mode shift of the community taxi users

Previous Mode	Mode selection after the project						Total	%
	Car	Motor-cycle	Tuk-tuk	Bus	Taxi	Motor-cycle taxi		
Car	76	1	0	0	12	0	89	76.07
Motorcycle	0	3	0	0	0	1	4	3.42
Tuk-Tuk	0	0	1	0	1	0	2	1.71
Bus	0	0	0	8	0	0	8	6.84
Taxi	0	0	0	0	14	0	14	11.97
Total	76	4	1	8	27	1	117	100
%	64.96	3.42	0.85	6.84	23.08	0.85	100	

4.7.2 Characteristics of the car users who shift to use the CT

88 private car users who know the CT project and show their willingness to use the CT as shown in Table 4.40 are selected to analyze by the logit model as shown in Appendix A.

Table 4.40 Number of private car users who will to use the community taxi classified by their travel times and travel distances

Travel Time (minute)	Willingness to use the community taxi	Travel Distance (km)					Total
		0-5	6-10	11-15	16-20	21-25	
0-15	No	1	0				1
	Yes	7	1				8
	Total	8	1				9
16-30	No	2	1	0	1	0	4
	Yes	0	17	2	0	1	20
	Total	2	18	2	1	1	24
31-45	No		1	0	0	0	1
	Yes		4	14	9	1	28
	Total		5	14	9	1	29
46-60	No		1	1	0	0	2
	Yes		0	1	15	5	21
	Total		1	2	15	5	23
>60	No			1	1		2
	Yes			0	1		1
	Total			1	2		3

From the logit model, the probability of private car users' willingness to use the CT are estimated as shown in Table 4.41.

Table 4.41 Probability of private car users' willingness to use the CT

Travel Time (minute)	Travel Distance (km)				
	0-5	6-10	11-15	16-20	21-25
0-15	0.88	1	1	1	1
16-30	0	0.89	0.96	1	1
31-45	0	0.90	0.97	1	1
45-60	0	0.43	0.71	0.94	1
>60	0	0.03	0.11	0.44	1

Using 0.5 as a cutting value, the decision zone of the CT use is shown in Table 6. Persons who spend long travel time with a short distance prefer to use their private car. This implies that there is a high possibility to use the private car for people who travel in the congested area, especially when the travel speed is lower than 10 kilometers per hour. By more specific observation, Table 4.42 can be modified to be Table 4.43. If travel time is longer than the minimum time for each certain distance range, they will keep using their cars.

Table 4.42 The decision of taxi use

Travel Time (minute)	Travel Distance (km)				
	0-5	6-10	11-15	16-20	21-25
0-15	Y	Y	Y	Y	Y
16-30	N	Y	Y	Y	Y
31-45	N	Y	Y	Y	Y
45-60	N	N	Y	Y	Y
>60	N	N	N	N	Y

Remarks: Y : use the community taxi
N : do not use the community taxi

Table 4.43 The conditions for commuters preferably to use private cars

Distance (km)	Minimum Time (minutes)
Within 5	15
6 - 10	45
More than 10	60

5. Concluding Remarks

57.5 % of people use the private cars while only 8.0 % of them use taxi to make the trips from their houses.

The great number of private cars is a major cause of congestion. One way to reduce congestion is by shifting mode from car to taxi. Taxi has the advantage which is similar to car sharing concept –many people can use a car.

Most of taxi drivers search for their customers by empty cruising. At the same time, most of taxi users prefer to flag down a taxi along the street. This wastes lot of energy and causes lot of air pollution.

The behaviors of cabbies and their customers can be managed. The CT experiment confirms that taxi demands could be increased by two key factors, reducing the surcharge and shortening the waiting time. From the observation, a lot of new customers like to make phone calls for a taxi. At the same time, many cabbies stop cruising and come to wait at the stand.

From the interview survey, it found that the demands at the CT condition, 12-minute waiting and free surcharge, have 5 times higher than the demands at the current condition, 25-minute waiting time and 20-Baht surcharge. In addition, it is observed that many cabbies also come to wait for serving a customer after trying to pick up one because the waiting time at the CT stand is not so long as the empty cruising.

From the analysis, it is found that at least 31 % of the private car users shift to use the CT. Using the ratio of the frequent taxi users to the infrequent taxi users, 1:5, it can be estimated that about 5% of the car users will shift to use the CT as frequent taxi users.

Moreover, it is observed that there is a high possibility to use the private car for people who travel in the congested area, especially when the travel speed is lower than 10 kilometers per hour. If travel time is longer than the minimum time for each certain distance range, they will keep using their cars.

Considering time and distance from the taxi stand to the pickup point, 20 Baht surcharge is reasonable and it does not affect much to the taxi demands.

In the real situation, the taxi drivers should share the operation costs with the CT center. The share should vary depending on the performance of the CT center and the benefits that the taxi drivers gain from the system. This is an interesting point for further research.

References

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Appendix A The logit Model

Factors affecting mode shift of the private car users

It is interesting to look for the factors influencing mode choice of the majority who decides to use the community taxi (CT). 88 private car users who know the CT project and show their willingness to use the CT are selected to analyze by the logit model.

A1 Mathematics of logistic regression

Probability is the likelihood that something will happen; a probability of 0.40 of taxi use means that there is a 40% chance of taxi use. In the technical sense used here, odds are the ratio of the probability that an event will occur divided by the probability that an event will not occur. If there is a 40% chance of taxi use, then there is a 60% chance of no taxi use; the odds, then, are:

$$\text{Odds} = \frac{\text{prob}(\text{taxi use})}{\text{prob}(\text{no taxi use})} = \frac{0.40}{0.60} = \frac{2}{3} = 0.67 \quad (1)$$

Odds are equal to or greater than 0. For instance, a 60% chance of taxi use has odds of $0.60/0.40 = 1.33$. A 50% chance of taxi use has odds of 1.

A key concept in logistic regression analysis is a construct known as a logit. A logit is the natural logarithm (\ln) of the odds. If there is a 20% chance of taxi use, then there is a logit of:

$$\ln(0.25) = -1.39$$

In the analysis, we examine whether or not people interest to use the community taxi.

$$\ln \left[\frac{\text{prob}(\text{taxi use})}{\text{prob}(\text{no taxi use})} \right] = B_0 + B_1(\text{travel time}) + B_2(\text{travel distance}) \quad (2)$$

In the equation, the log of odds of taxi use is a function of a constant plus a series of weighted averages of their travel time and travel distance. In terms of the odds-of-taxi-use or the probability-of-taxi-use instead of the log-odds-of-taxi-use, this equation may be converted to the following:

$$\frac{\text{prob}(\text{taxi use})}{\text{prob}(\text{no taxi use})} = e^{B_0} + e^{B_1(\text{travel time})} + e^{B_2(\text{travel distance})} \quad (3)$$

or

$$\text{prob}(\text{taxi use}) = \frac{1}{1 + e^{-B_0} + e^{-B_1(\text{travel time})} + e^{-B_2(\text{travel distance})}} \quad (4)$$

A2 Model parameter calculation

Travel time and travel distance variables were converted into a series of variables. In this case, both variables had five categories and had been broken down into four new variables, labeled Rtime(1) through Rtime(4) and Rdistance(1) through Rdistance(4), respectively.

Table A1 Categorical variables coding

Categorical Variable	Frequency	Parameter coding				
		(1)	(2)	(3)	(4)	
Travel Time (minute)	0-15	9	1.000	.000	.000	.000
	16-30	24	.000	1.000	.000	.000
	31-45	29	.000	.000	1.000	.000
	46-60	23	.000	.000	.000	1.000
	>60	3	.000	.000	.000	.000
Travel Distance (km)	0-5	10	1.000	.000	.000	.000
	6-10	25	.000	1.000	.000	.000
	11-15	19	.000	.000	1.000	.000
	16-20	27	.000	.000	.000	1.000
	21-25	7	.000	.000	.000	.000

The model parameters B_i is estimated by the maximum likelihood method. Based on two options, Use or Don't use the community taxi for each traveler i , the dependent variable for the choice result is:

$$Y_i = \begin{cases} 1 & \text{use the community taxi} \\ 0 & \text{don't use} \end{cases} \quad (5)$$

$$L = \prod_{i=1}^n P^{Y_i} (1-P)^{1-Y_i} \quad (6)$$

$$P\{Y = 0\} = 1 - P = \frac{1}{1 + e^{(B_0 + B_1 X_1 + \dots + B_8 X_8)}} = \frac{1}{1 + e^w} \quad (7)$$

$$L = \prod_{i=1}^n \left\{ \frac{e^w}{1 + e^w} \right\}^{Y_i} \left\{ \frac{1}{1 + e^w} \right\}^{1-Y_i} \quad (8)$$

The log-likelihood function is:

$$\ln L = \sum_{i=1}^n (Y_i \ln[P(Y_i)] + (1 - Y_i) \ln[1 - P(Y_i)]) \quad (9)$$

To estimate the probability model and calibrate parameters B_0, B_1, \dots, B_8 by the maximum likelihood method.

A3 Model checking

The general model checking is conducted in two aspects: the Omnibus tests and Change in -2 Log Likelihood. The test of coefficients is also performed but it is not appropriate for the categorical variables.

Table A2 Omnibus tests of model coefficients

Step		Chi-square	df	Sig.
1	Step	8.298	4	.081
	Block	8.298	4	.081
	Model	8.298	4	.081
2	Step	13.546	4	.009
	Block	21.844	8	.005
	Model	21.844	8	.005

Table A3 Test of coefficients

Step		B	S.E.	Wald	df	Sig.	Exp(B)
1 ^a	Rtime			7.131	4	.129	
	Rtime(1)	2.773	1.620	2.928	1	.087	16.000
	Rtime(2)	2.303	1.342	2.945	1	.086	10.000
	Rtime(3)	4.025	1.592	6.390	1	.011	56.000
	Rtime(4)	3.045	1.431	4.527	1	.033	21.000
	Constant	-.693	1.225	.320	1	.571	.500
2 ^b	Rtime			7.811	4	.099	
	Rtime(1)	27.895	1.987E4	.000	1	.999	1.303E12
	Rtime(2)	5.454	2.174	6.294	1	.012	233.714
	Rtime(3)	5.528	2.041	7.333	1	.007	251.621
	Rtime(4)	3.031	1.604	3.572	1	.059	20.709
	Rdistance			3.261	4	.515	
	Rdistance(1)	-43.733	2.463E4	.000	1	.999	.000
	Rdistance(2)	-21.115	1.455E4	.000	1	.999	.000
	Rdistance(3)	-19.919	1.455E4	.000	1	.999	.000
	Rdistance(4)	-17.996	1.455E4	.000	1	.999	.000
	Constant	17.783	1.455E4	.000	1	.999	5.288E7

Remarks: a. Variables entered on step 1: Rtime.

b. Variables entered on step 2: Rdistance.

Table A4 Change in -2 Log Likelihood

Variable		Model Log Likelihood	Change in -2 Log Likelihood	df	Sig. of the Change
Step 1	Rtime	-31.157	8.298	4	.081
Step 2	Rtime	-28.805	17.140	4	.002
	Rdistance	-27.007	13.546	4	.009

Table A5 Percentage correct

Observed			Predicted		
			Willingness to use		Percentage Correct
			Do not use	Use	
Step 1	Willingness to use	Do not use	2	8	20.0
		Use	1	77	98.7
	Overall Percentage				89.8
Step 2	Willingness to use	Do not use	5	5	50.0
		Use	1	77	98.7
	Overall Percentage				93.2

Remark: The cut value is .500

Appendix B Bangkok Transportation Data

In Bangkok, the level of service of public bus is low because the high portion of public demands , 53 %, served by the small number of bus as shown in Table B1 and B2. A lot of people choose to use private cars even though it is very costly.

The major cause of traffic congestion in Bangkok is due to the great number of private cars as shown in Table B1. The average speed of vehicles during morning peak-hours is about 16 km/hour as shown in Table B3.

Recently the number of new car registration is more than 1,000 per day With the new policy in year 2012, Thai government deducts 100,000-baht of tax particularly to the one who buys the first new car sized smaller than 1,500 cc so the number of private cars is sharply expected to increase for this year.

Table B1 The number of vehicles by types

Type of vehicle	Number of vehicles on 30 June 2012	The new vehicles registration (Vehicles)			
		2011	2010	2009	2008
Car	2,938,846	302,072	269,803	183,332	203,466
Motorcycle	2,738,613	389,847	386,474	328,366	370,340
Urban taxi	104,953	9,004	8,564	10,850	10,804
Fixed route bus	24,308	3,639	5,645	2,628	2,447

Source: Land Transport Department, Thailand

Table B2 Travel demands in Bangkok and surrounding areas

Unit: 1000 person-trips per day

Year	Total	Private	(%)	Public	(%)
2010	21,900	10,300	47.03	11,600	52.97
2011	22,347	10,600	47.43	11,747	52.57

Source: estimated by TDL project, OTP, Thailand

Table B3 Travel speeds during morning peak-hours

Year	Veh-kms	Veh-hours	Speed (km/hour)
2010	13,600,900	816,600	16.7
2011	14,002,000	864,800	16.2

Source: estimated by TDL project, OTP, Thailand

Appendix C Glossaries

The community taxi: the taxi that stop at the stand and promptly serve for commuters in the zone, normally within 15 minutes.

The frequent taxi user: the user who frequently calls a taxi, i.e. three times a week.

The infrequent taxi user: the user who calls a taxi not so often, i.e. once a moth.