POTENTIAL NETWORK FOR THE IMPROVEMENT OF BIKEWAY IN BANGKOK

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Abstract: This paper aims to lay out a prototype process for designing a potential network for cycling in Bangkok. Dindaeng District, situated in the central Bangkok, was selected as a case study. The district is covering the area of 7 sq. km. Currently, no bikeway networks or facilities have been provided in the area. The basic data collection about users and their traveling behaviors have been acquired through interviews. The information includes income, trip purpose, frequency, destination, etc. The analysis of gathered information leads us to the description of two very important components critical to bikeway design which are characteristics of people and potential traveling demands. 17 percent of the subjects use bicycle, 60 percent of which feel unsafe using existing facilities not specially designed for cycling. More than half of them will definitely use bicycles if facilities were to be improved. Then the trip assignment is the result of the process of traveling demand analysis proposed. The routes with high traveling demands are selected to create a network for potential bicycle use. As a result, the prototype processes for constructing a potential network for cycling was obtained.

Key Words: potential bicycle network, bicycle, bikeway

1. INTRODUCTION

Due to the modernization of the city, non-motorization became more popular. In Thailand some footpaths were improved and modified to be just linkages or bikeway corridors without much consideration on access to and from their home. In many cases, the bicyclists have to risk their lives riding since road networks were not planned systematically to accommodate bikeway networks. Most of bicyclists simply share a path with motorists along a road. This can easily cause accidents especially at intersections. Even though, designers can learn and follow some design standards and guidelines mainly available in the developed countries, the bikeway satisfaction of the users cannot be guaranteed. Most of the guidelines give much more emphasis on geometric design without any supports for traveling demands and public acceptance.

Bangkok Metropolitan Administration has been constructing bikeways with no sufficient guidelines. It is a good time to prepare guidelines for bicycle facility improvements since a big change of life styles will come up after the new mass rapid transit subway starts its operation. This research aims to develop guidelines for the improvement of bikeway networks in Bangkok. Four types of trip purposes, for work, school, shopping and leisure, are taken into consideration. Seven sq km of Dindaeng District, which has a high population density of 20,193 persons per sq km was selected as a case study. There is no evidence of any formally designed bikeway network in the study area.

Home interviews were used to survey the characteristics of dwellers' traveling. The number of questionnaires, 2724 samples, was proportional to the number of population in each zone. The basic items, i.e., income, trip purpose, frequency, destination of traveling, etc., were interviewed. At present, proportion of bicyclist was 17 % of total interviewees, in the area. It showed a good tendency that about 52% of them would like to use bicycles if the bicycle facilities are improved. With the surveyed data and the secondary data collected by the National Statistical Office, the candidate routes in a bikeway network were identified.

2. STUDY AREA

This is the first attempt to develop bikeway networks in Bangkok Metropolitan Area (BMA). Seven sq km in Dindaeng District located in the central of BMA was selected as a case study for developing the bicycle network. It had high population density, 20,193 persons per sq km. There are some reasons for analyzing a potential network in Dindaeng District.

- It had an appropriate size and suitable distance for cycling. It was noted that between 1 and 3.7 km, the bicycle was most frequently used transport mode (Rietveld,2001)
- Some bicyclists were occasionally observed in the study area. People who live in the area could travel by using public transport, not only bus but also subway which is going to operate in the year 2004.

The potential network would be analyzed for this area. The procedure could be used as guides to analyze the potential network in other areas of BMA.

3. CHARACTERISTICS OF PEOPLE

3.1 General Profile

In the study area, there are 147,366 persons, 68,288 males (46%) and 79,078 females (54%) shown in Table 1. The population density is about 20,193 persons per sq. km., with 46,346 households. Most of people are between 16 and 35 years old shown in Table 2. About 66% have high school certificate (grade 12) or lower shown in Table 3.

Table 1. Population and Samples Classified by Gender

Gender	Population		Sample	
	Number	(%)	Number	(%)
Male	68,288	46	1,211	44
Female	79,078	54	1,513	56
Total	147,366	100	2,724	100

Table 2. Population and Samples Classified by Age

Age	Population			Sample		
	Number	(%)	Cumulative (%)	Number	(%)	Cumulative (%)
Less than 16	25,845	18	18	317	12	12
16-25	34,573	23	41	675	25	37
26-35	33,187	23	64	691	25	62
36-45	23,675	16	80	619	23	85
46-55	14,330	10	89	277	10	95
More than 55	15,756	11	100	145	5	100
Total	147,366	100		2724	100	

Table 3. Population and Samples Classified by Educational Background

Educational Background	Population			Sample		
	Number	(%)	Cumulative (%)	Number	(%)	Cumulative (%)
Primary School	57,302	39	39	869	32	32
High School	40,314	27	66	1054	39	71
Technical College	7,319	5	71	170	6	77
Bachelor Degree	26,805	18	89	570	21	98
Higher	2,850	2	91	34	1	99
Others	12,776	9	100	27	1	100
Total	147,366	100		2724		

In the study area, there are 140 zones (number 17-150, 152-155, 158-159) following the National Statistical Office. Number of population is uniformly about 1,000 people in each zone. Twenty subjects were randomly surveyed in each zone. Total numbers, 2,724 samples, were interviewed. The samples were composed of slightly more females (as are the

population in Dindaeng) and it is reasonably distributed according to ages and educational background.

3.2 Bicycle Use and their Attitude

It was guided by AASHTO (1999) that caution should be exercised when using bicycle counts as a measure of current demand. This number can considerably underestimate potential users. Traffic generators along the prospective route should be evaluated. The higher traffic can be generated, given better conditions for bicycling. The current use of bicycle and the willingness to use bicycles according to their age were shown in Tables 4. It was found that 471 samples, 17 % of people, used bicycle. About 1,427 samples, 52 % of people, would use bicycle if the bicycle facilities were improved. It was noted that more than 60 % of people declaring to be current and potential users of the bicycle were between 16 and 45 years old.

Table 4. Current and Potential Use of Bicycle Classified by Age

Age	Current Use	(%)	Would you use bicycle?				Total
			Yes	(%)	No	(%)	
Less than 16	77	16	168	12	72	9	317
16-25	95	20	365	26	215	26	675
26-35	96	20	397	28	198	24	691
36-45	123	26	323	23	173	21	619
46-55	59	13	125	9	93	11	277
More than 55	21	4	49	3	75	9	145
Total	471	100	1427	100	826	100	2724

Table 5 presents relation between occupation and willingness to use bike for some trips. The result shows that more than half of the people in all occupations selected Yes. High potential for users in the area does exist.

Table 5. Current and Potential Use of Bicycle Classified by Occupation

Occupation	Current Use	(%)	Would you use bicycle?				Total
			Yes	(%)	No	(%)	
Government Official	9	2	76	5	52	6	137
Private Officer	46	10	180	13	99	12	325
Merchant	83	18	293	21	172	21	548
Student	124	26	379	27	191	23	694
Housewife	95	20	189	13	100	12	384
Others	114	24	310	22	212	26	636
Total	471	100	1427	100	826	100	2724

From the survey, about 74.6% of people have income less than 10,000 Baht shown in Table 6. It was noted that income was insignificant to bicycle use. Furthermore it was found that 49% of people in the area have bicycles while 25% of them owned cars shown in Tables 7 and 8.

Table 6. Current and Potential uses of Bicycle Classified by Income

Income	Current Use	(%)	would you use bicycle?				Total	(%)
			Yes	(%)	No	(%)		
Less Than 5,000 Bath	214	45	576	40	343	42	1,133	42
5,000-9,999 Bath	163	35	496	35	241	29	900	33
10,000-14,999 Bath	64	14	212	15	139	17	415	15
15,000-19,999 Bath	15	3	68	5	49	6	132	5
20,000-24,999 Bath	7	2	41	3	23	3	71	3
25,000-29,999 Bath	5	1	10	1	9	1	24	1
More than 29,999 Bath	3	0	24	1	22	2	49	1
Total	471	100	1,427	100	826	100	2,724	100

Table 7. Current and Potential uses of Bicycle Classified by Bicycle Ownership

Bicycle Ownership	Current Use	(%)	Would you use bicycle?				Total	(%)
			Yes	(%)	No	(%)		
Yes	388	82	646	45	311	38	1345	49
No	83	18	781	55	515	62	1379	51
Total	471	100	1427	100	826	100	2724	100

Table 8. Current and Potential uses of Bicycle Classified by Car Ownership

Car Ownership	Current Use	(%)	Would you use bicycle?				Total	(%)
			Yes	(%)	No	(%)		
Yes	100	21	344	24	248	30	692	25
No	371	79	1083	76	578	70	2032	77
Total	471	100	1427	100	826	100	2724	100

Table 7 shows current and potential use of bicycle and willingness to use bike according to bicycle ownership. About 57% of people, who do not own a bicycle, would like to use it.

Table 8 shows current and potential use of bicycle and willingness to use bicycle according to car ownership. There is a high potential for the bicycle use for both who do and do not own a car.

Table 9 represents the preference of cross section. 66% preferred bikeway to shared sidewalk. It implies that people feel unsafe to ride on a shared roadway. This conforms with their attitude, only 64% of them feel that the existing use of bicycle is risky shown in Table 10. About 32% of people used to get accident at least one time. The main reasons, shown in Table 11, are their carelessness, lacking of skill and deficiency of physical facility.

Table 9. Preference of Bikeway Cross-Section

Type of Bikeway Cross-Section	Frequency (Persons)	(%)
Sidewalk Bikeway	1,785	66
Shared Roadway	939	34
Total	2,724	100

Table 10. Attitude of Bicycle Path and Accident Experience

Attitude	Did you get accident?				Total	(%)
	Yes	(%)	No	(%)		
Safe	277	10	666	24	943	35
Not Safe but it is not dangerous	204	7	423	16	627	23
Dangerous	382	14	746	27	1,128	41
Uncertain	9	0	17	1	26	1
Total	872	32	1,852	68	2,724	100

Table 11. Reasons of Accident that Bicyclist faced in the Area

Reason	Frequency (Persons)	(%)
Careless	278	10
Illegal	8	0
Unskillful	228	8
Deficiency of Facilities	195	7
Hit by Other persons	136	5
Other	27	1
No Accident	1852	68
Total	2724	100

Moreover, most people, 51%, like to ride no longer than 3 km as shown in Table 12. Table 13 shows about 39% like to ride between 15 and 30 minutes and 30% like to ride between 30 and 60 minutes. In addition, the opinion of bicycle prices that are found reasonable are shown in Table 14.

Table 12. Attitude of Riding Distance

Riding Distance	Frequency (Persons)	(%)
Less than 1 Km	289	11
1-3 Km	1,346	51
3-5 Km	620	24
5-10 Km	254	10
More than 10 Km	115	4
Total	2,624	100

Table 13. Attitude of Riding Time

Riding Time	Frequency (Persons)	(%)
Less than 15 Min	265	10
15-30 min	1,058	39
30-60 min	829	30
1-2 hours	432	16
More than 2 hours	140	5
Total	2,724	100

Table 14. Attitude of the Bicycle Price

Opinion	Frequency (Persons)	(%)
Cheap	388	14
Reasonable	1,663	61
Expensive	555	20
Uncertain	118	4
Total	2,724	100

4. TRAVEL DEMAND ANALYSIS

Travel demands of potential use of bicycle were analyzed and summarized into three steps, estimation of potential use, trip generation and trip assignment.

4.1 Estimation of Potential Use of Bicycle

20 subjects are selected as samples for each zone. Total number of potential users was 1,898 out of 2,724 samples, about 69%. The proportion was used as a factor to multiply total population in each zone. Numbers of potential users in each zone were estimated and shown in Table 15. Numbers of potential users and numbers of their activities in each zone were compiled and shown in Table 16. Among all activities, shopping is the most popular one.

Table 15. Potential Bicycle Users by Zones

Zone Number	Potential Use (Persons)
17	734
18	696
19	518
20	630
⋮	⋮
159	572
Total	91,988

* Zone number from the Survey Population and Housing Census in Thailand 2000

Table 16. Potential Bicycle Users and their Activities

Zone Number	Samples (Persons)	Number of Activities*				
		Work	Education	Shopping	Recreation	Others
17	11/23**	5/6	1/1	9/20	4/4	0/1
18	11/18	4/8	3/5	9/14	4/6	1/2
19	15/16	5/5	1/1	12/12	6/6	4/4
20	14/21	8/11	1/2	12/18	5/6	3/3
⋮	⋮	⋮	⋮	⋮	⋮	⋮
159	10/18	2/7	4/4	9/17	5/5	2/5
Total	1,898/2,724	569/839	521/722	1,503/2,055	660/814	294/361

* One person can do many activities

** Number of samples who would use bicycles / Total samples

4.2 Trip Rate

The average trip rate for each trip purpose was estimated and shown in Table 17. People in the area traveled from their residence for work/school about five times per week, for shopping about 4 times per week and for recreation about 3 times per week.

Table 17. Average Trip Rate for each Trip Purpose

Trip Purpose	Person Trip Rate (Trips per week)
Work	5.63
School	4.82
Shopping	4.19
Recreation	2.98
Others	2.18

4.3 Trip Assignment

To travel to zone j, each sample in zone i was asked and drawn major paths of their activities on a map. For a normal way of their traveling, most of people tried to access a main street that is nearest to their residences at the beginning then traveling to the nearest attraction point along the street. The typical patterns of traveling from zone i to each attraction to zone j could be counted. The proportion of each traveling route pattern, TA_{ij}, could be estimated and used for allocation of potential bicycle users for each route. Trip assignment of potential bicycle demand can be estimated as defined in Equation 1 and shown in Table 18. It was observed that about one third of total number of trip, 222,300 trips per week, was the trip going outside the study area. It seems to be high demands of public transport should be served. For the travel demands inside the area, people liked to attract to ten major zones as shown in Table 19. An example of trip attraction to zone 077, shopping trip, was shown in Figure 1. From the trip assignment in Table 18, a potential bicycle network could be constructed and shown in Figure 2.

$$T_{ij} = P_i \times (T_i / S_i) \times TA_{ij} \times R_j \quad (1)$$

Where;

T_{ij} : Estimated potential bicycle trip from zone i to zone j, trips per week
P_i : Potential bicycle users in zone i, persons (in Table 15)
T_i : Total number of activities made by potential bicycle samples in zone i (in Table 16)
S_i : Potential bicycle samples, persons (in Table 16)
TA_{ij} : Trip allocation along a route from zone i to zone j, percent
R_j : Average trip rate, trips per week (in Table 17)

Table 18. Trip Assignment

(Unit: Trips per week)

Zone	To	17	...	38	...	49	...	77	...	Out*	Total
From											
17		0	...	0	...	2,657	...	1,060	...	0	5,118
18		0	...	0	...	0	...	0	...	6,050	5,324
19		0	...	0	...	1,161	...	293	...	2,440	3,966
20		0	...	0	...	784	...	0	...	5,140	5,272
⋮		⋮		⋮		⋮		⋮		⋮	
159		0	...	0		0	...	0	…	485	5,008
Total		0	...	11,722		194,718	...	22,387	…	222,300	728,531

*Going outside the study area

Table 19. Attraction Zones

Zone number	Attraction Place
038	School
049	Market
064	University
077	Department Store
104	School
115	Department Store
124	Market
125	Market
132	Stadium
146	Super Market

5. SUMMARY AND CONCLUSIONS

This study was the first attempt to estimate the potential demand of the bikeway network in Bangkok. The highlight of the project that differentiates this project to other bikeways in Bangkok is the continuation of the bikeway network. After a thorough study, we found high potential demands in the area. It was confirmed that a highly efficient bikeway could be worked out in the dense and unplanned area of Bangkok. Without a well-planned process and design, the bikeways would not sufficiently be accessible for users.

While the mass transit networks seem to get more attention from governors, the supporting links for people to access to the service is usually of a non-motorized network. And the potential link to the mass transit is currently limited by cars. So the bikeway can be a very highly potential alternative link for the people in the urban area which can expand the serviced area for the mass transit system. Since the study shows that one third of the travelers, 222,300 trips per week, have destinations outside the area. These travelers have a high possibility to access the public transport system by bicycle.

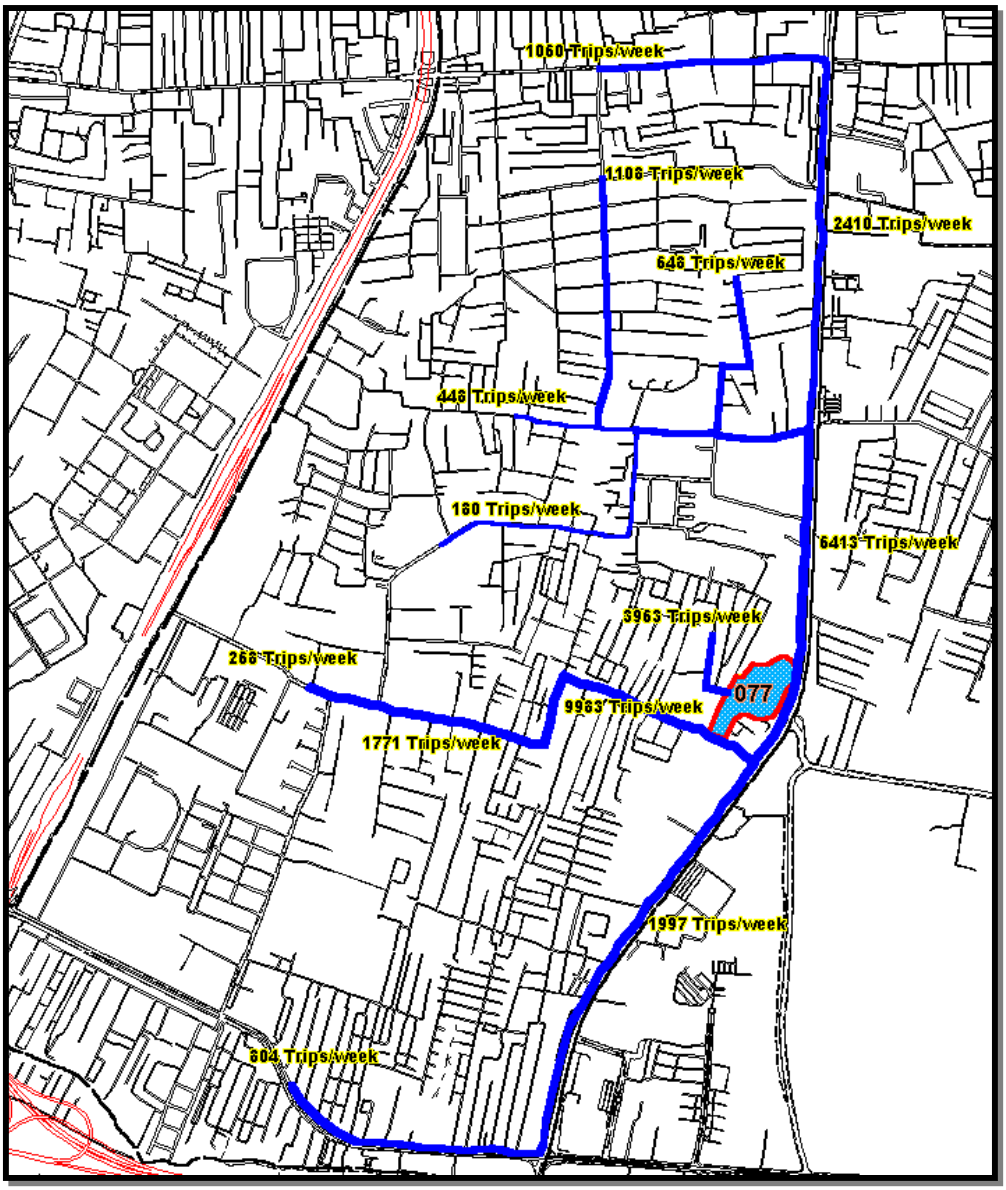

Figure 1. An Example of Bicycle Network for Shopping Zone 077

The prototype processes for design a potential network for cycling was tested in this paper. We hope that if this prototype network can be successfully implemented, which can lay down a foundation for designers and planners in the future. The process can also be adopted to other areas and extend to be used for a larger network.

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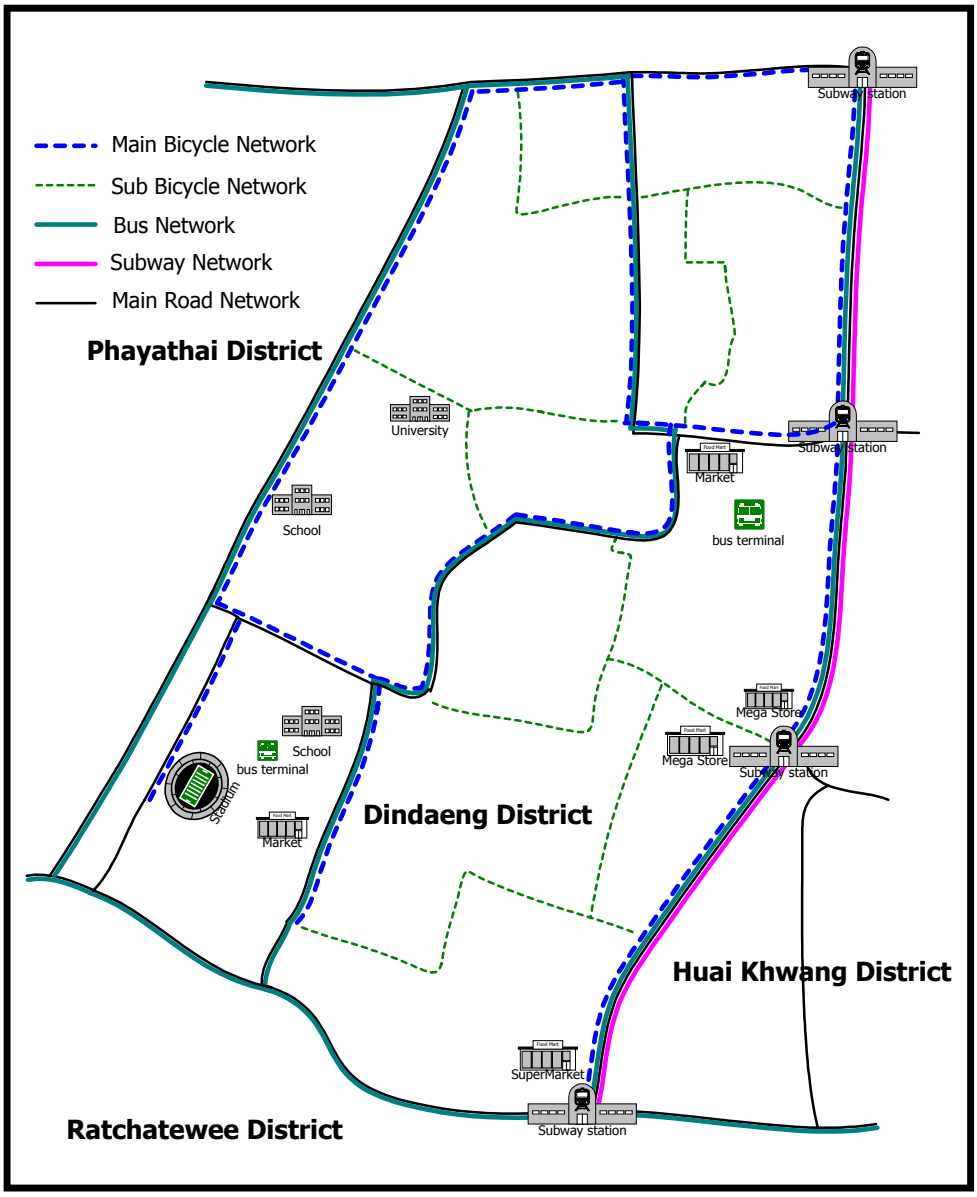

Figure 2. Potential Bicycle Network

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