Travel Demand Forecasting on Bicycle Route under Expressway in Thailand

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***Abstract*—This article intends to present bicycling demand on the pilot area under the Chalong Rat expressway (Ramintra rd. to Rama 9 rd. to Ratchadapisek rd.) according to a master plan of the bicycle network development under the right of way of Expressway Authority of Thailand (EXAT). The study began with a literature review on the current statistical usage of bike travel in Thailand, factors related to the use of bicycles, as well as the bicycle travel demand forecasting methodologies. After that the travel information of people living in a 0.8-kilometer buffer zone along the pilot route has been explored. 528 households were randomly interviewed by a questionnaire from 12 May to 12 June 2014, and then compared the number of bicycle travel demand on the route between with and without project in the year 2016, which is expected to be the first year of operation and the future year of 2017, 2022, 2027, 2032, and 2037. The study results found that travel demand on pilot route will be significantly increased when compared between the two conditions. As well, the difference value of the total cycling will be 19.18, 19.59, 21.78, 24.21, 26.91, and 29.92 thousand vehicle-km/day, in the year of 2016, 2017, 2022, 2027, 2032, and 2037, respectively.**

***Index Terms*—bicycle travel demand, demand forecasting, bicycle route under expressway**

I. Introduction

Travel by bicycle is one of the non-motorized transportation modes which provide several benefits such as car dependence reduction, fuel consumption/ emissions reduction, and health benefits to the cyclists. The trend of cycling usage in Thailand has been continuingly growing over the last couple years. In 2013, the number of cyclists was about 2.25 million people nationwide [1]. Moreover, according to the promotion of bicycle usages from various agencies, such as Bangkok Metropolitan Area (BMA), State Railway of Thailand (SRT), and Airports Authority of Thailand (AOT), the number of cyclists was expected to increase rapidly. Expressway Authority of Thailand (ETA) prepared a master plan for development of the bicycle network under seven routes of expressway with total distance of 207.90 kilometers and then selected the section of the Chalong Rat from Ramintra Rd. - Prasertmanukij Rd. - Ladprao Rd. and Rama IX Rd. (continuous to Makkasan Airport Rail Link Station, Ramkhamhaeng and Petchaburi Road) which has a total length of 18.85 kilometers to develop the pilot bicycle route as shown in Fig. 1 [2].

These developments need to be aware of both current and future bicycle travel demand in order to evaluate the economic benefits from investment. However, Thailand does not have statistical records about the use of bicycles and researches regarding to bicycle travel demand forecasting. Therefore, this article focuses on the study of the bike travel demand on the pilot route which is necessary for the geometric design as well as economic and financial analysis.

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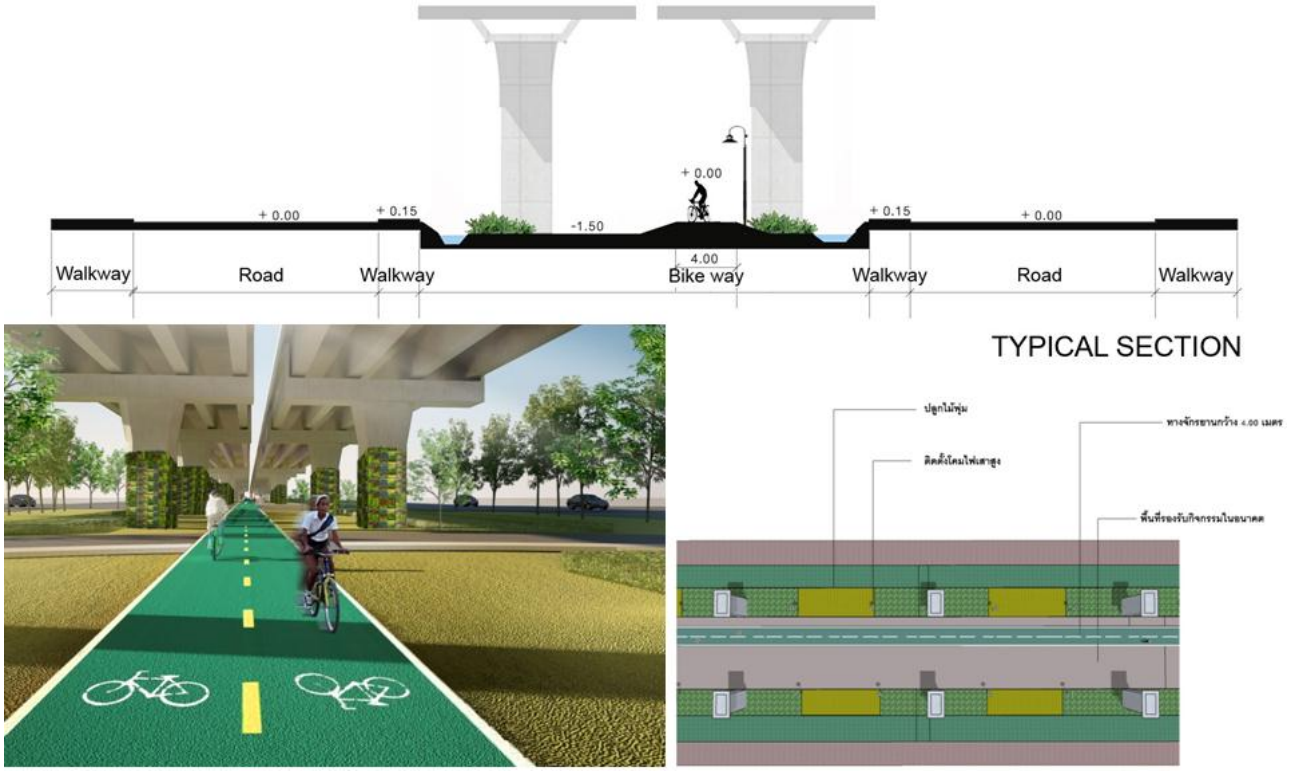

Figure 1. General conceptual design of bicycle path under expressway in Bangkok [2]

II. Literature Review

A. The Number of Cyclists

The Number of cyclists. In 2013, there were 2.25 million cyclists in Thailand while 150,000 cyclists were found in Bangkok, 2.1 million people rode bikes in other provinces. Moreover, about 260,000 people used cycling as the main mode for travelling purpose. In addition, those who use bicycles more often in their daily lives is expected to increase up to 2.7 million people in 2014 [1].

In Bangkok, several campaigns have continually provided to encourage the use of bicycles. The most well-known campaign is the Bangkok Car Free Day (Bkk-CFD) event which was the first held in 2000 [3]. In 2013, more than 20,000 cyclists participated the Bkk-CFD greater than the record of 2,000 people in Bkk-CFD-2007. So, it can be obviously seen that the number of cyclists in Bkk-CFD has increased about 10-fold during the past seven years, (the number of cyclists in Bkk-CFD-2005 was only 150 people).

In addition, many Thai government agencies have also prepared public bicycling spaces for recreation and exercise, for example bike path in Wachirabenjathus Park by SRT allowing 850 and 2,000 cyclists per day on weekdays and holidays to access the site, and green bike routes around the Suwannabhumi international airport offered by AOT which was opened in March 2014. The commencement of AOT bike route was initiated to serve about 300-500 cyclists per day derived from the area around the airport [4]. However, the number of cyclists was dramatically increased especially during weekends and public holidays. It was between 3,000-4,000 cyclists per day, whereas a maximum was 7,167 cyclists per day on June 8th, 2014 [5].

B. Factors Affecting the Bicycle Travel Behavior.

In order to provide an understanding of the behavior of bicycle modal choice, many researches and papers related to factors enhancing the bicycle use as mode choice for trips were reviewed. The results of the review [6] - [10] can be grouped into 4 main factors.

1) The socio-economic characteristics factors consist of age, gender, educational level, average monthly income, number of household members, bike / motorcycles and car ownership.

2) The trip characteristics factors comprise trip purpose, cost of travel, length of trip, travel speeds, travel time, and travel distance.

3) The general characteristics of the route include the bike path location, lane width, parking, bike repairing shop and bike renting point, connectivity to other transportations, security, and continuity of the path.

4) Other factors, such as policies to promote the use of bicycles weather.

C. Bicycle Travel Demand Forecasting

Bicycle travel demand forecasting. Austroads [11] gathered and summarized analytical approaches for bicycle travel demand forecasting that can be categorized into 8 methods, as shown in Table I.

TABLE I. SUMMARIZATION OF 8 TECHNIQUES FOR BICYCLE TRAVEL DEMAND FORECASTING [11]

Method	Description	Key features
1. Comparison studies	Analysis of aggregate data from two areas with an attempt to identify variables that contribute to different levels of bicycle use between areas or times.	- Relatively simple technique - Wide range of applications - Easy to misinterpret results
2. Aggregate behavior studies	Methods that relate bicycle travel to characteristics of the local area generally through regression analysis and other multivariate statistical approaches	- Some statistical expertise required - Moderate data requirements - Can be used to identify importance of variables across different locations
3. Maximal share studies	Market analysis that attempts to identify maximal demand for cycling and likely bicycling demand are included in this category.	- Useful to identify key constraints on cycle use - Requires very detailed surveying of market
4. Sketch-plan methods	Predict use of a facility based on rules of thumb about travel behavior.	- Relatively simple to construct predictive models - Uses secondary data and parameters from previous research - Likely to have significant errors but can run a series of "what ifs" for sensitivity analysis
5. Regional travel models	Generally based on classical four stage models relying on a sequence of estimates of trip generation, distribution, mode share and assignment	- Require considerable technical skills - Models already exist for motor vehicles and transit in most major centers - Do not deal well with bicycle demand due to the focus of the modelling systems and data used - Scope for using these models as a basis for bicycle models in the future
6. Discrete choice models	Models based on observed or stated individual choice behavior	- Well established theoretical basis - Considerable technical skill required - Can use revealed and stated preference data - Wide range of applications (mode choice, route choice, vehicle choice etc.)
7. Other advanced behavioral modelling techniques	Path analysis and structural equation models may be used to gain an understanding of the feedback elements between endogenous variables	- Significant technical skills required - No applications yet in forecasting bicycle demand
8. GIS based approaches	Use of geographical information systems to model and present forecast demand for cycling facilities.	- Increasingly used for local planning - Some good examples in the bicycle demand area - Requires knowledge of GIS software

III. METHODOLOGY

A. Study Area and Data Collection.

According to the master plan, there were seven bicycle routes under EXAT expressway. The section of Ramindra – Rama9 - Ratchadapisek Rd. was ranked and selected as the first pilot study area. A survey of travel information of people living in a 0.8-kilometer buffer zone along the travelshed area for bicycle travel [12]-[14] was conducted. The travelshed area was divided into 35 traffic analysis zones (TAZs). The details of study area was shown in Fig. 2.

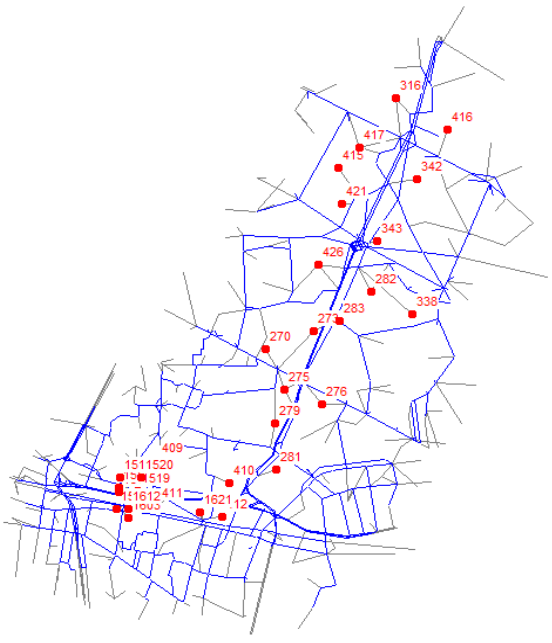

Figure 2. 35 Traffic analysis zones with a 0.8 km buffer zone along expressway

B. Bicycle Demand Analysis

In order to study and analyze the bicycle travel demand and travel behavior of people living in the study area, procedures and techniques of bicycle demand forecasting were reviewed from research papers both

nationally and internationally. As well, factors influencing the bicycle mode choice were considered. Next, a questionnaire for household interview was developed as a tool for the analysis of the current bicycle travel demand and behavior due to the development of pilot project.

The methodology in this study encompasses the use of the sequential 4-step model to determine the bicycle travel demand of the study area together with the proportion of the modal change due to the development of pilot project. However, researchers have carefully considered only the potential trips that can encourage travel mode change to bicycle use in the pilot project.

For the data collection, a sample of 528 households was proportionally distributed by the number of households of each TAZ. The current bicycle travel behavior, both on weekdays and weekends, and the perceptions of the residents in the pilot project were examined by home interview survey. The concept of total bike demand analysis is combination of 4 groups as in (1).

$$T_i = [T_i^1 + T_i^2 + T_i^3 + T_i^4] \quad (1)$$

where, T_i = Total bike trips for zone i,

T_i^1 = Normal Trips (Workday and Weekend)

T_i^2 = Generated Trips

T_i^3 = External Trips

T_i^4 = Special Trips (Special Event)

However, in this study, the bicycle trip analysis was focused only the first-two groups: 1) the trip rate and cross classification method for normal trips: T_i^1, and 2) the sketch plan method for generated trips due to the pilot bicycling route: T_i^2.

Then the gravity model and logit model were applied in order to find the bike trips among the zones and the modal shift from other modes to bicycle. Finally, the shortage path and all-or-nothing were applied to find the number of bike trips and average travel distance on the project route.

IV. Analysis Results

A. The Current Bicycle Demand.

The number of ordinary bicycle trips can be classified into 2 cases- with and without project development of the pilot bicycling route as shown in Table II. Moreover, the analysis results also illustrated that the average cycling distance of the ordinary trip was 3.5 km/trip.

TABLE II. The Number of Ordinary Bicycle Trips, in Case of with and without Project

Bicycle Demand	Total [Trips/year]	Average [Trips/day]
Without project	330,480	905.42
With project	1,480,680	4,056.66

In addition, the results from bicycle demand analysis found that the average daily generated bike demand was 1,097 trips/day and the average travel distance for the pilot bicycling route was 3.005 km/trip.

B. The Travel Mode Change Due to the Pilot Bicycling Route.

According to the travel mode choice study, the summary of proportions of bicycle trips can be classified by mode and trip purpose as follows:

A classification by trip purpose. Results showed that 23.33 percent of respondents would switch to use bicycle in the pilot route according to "the connection to other modes" purpose; while exercise and social purposes obtained 7.63 and 4.26 percent, respectively.

A classification by mode. Results showed that 8 percent of the existing cyclists are predicted to use the pilot bike lanes, followed by the group of BTS/MRT (5.88 percent). However, for other types of vehicles, the proportion of changing to bicycling was relatively small (less than 2.00 percent.)

C. The Future Travel Demand

The bicycle demand and vehicle kilometer of bicycle travel on pilot project were summarized as shown in Table III and IV.

TABLE III. Bicycle Demand on a Pilot Bicycling Route in each Year

Bicycle Demand [Trip]	Years [Trips/day]					
	2016	2017	2022	2027	2032	2037
Without project-Normal Trip	985	1,006	1,118	1,243	1,382	1,537
With project-Normal Trip	4,414	4,509	5,013	5,572	6,195	6,886
With project-Generated Trip	2,388	2,439	2,711	3,014	3,351	3,725

TABLE IV. Differences of Bicycle Kilometer of Travel between with and without Project

Bicycle Demand [VKT]	Years [1,000 Veh.-km/day]					
	2016	2017	2022	2027	2032	2037
Without project	3.45	3.52	3.91	4.35	4.84	5.38
With project	22.63	23.11	25.69	28.56	31.75	35.30
Different	19.18	19.59	21.78	24.21	26.91	29.92

V. Conclusion

According to the popularity of the bicycle use in Thailand, a master plan of the bicycle network development under the right of way of Expressway Authority of Thailand (EXAT) was developed. However, there had no researches about the bicycle travel demand forecasting in Thailand.

In order to evaluate the economic benefits from the project, this paper shows the comparison of bicycle travel demand on the pilot route (Section of Ramindra - Rama IX – Ratchadapisek Rd.) between with and without the bicycle project. The results found that travel demand on pilot route is expected to significantly increase when compared with do-nothing scheme. Next, the final results were used for preliminary design and the economics and financial feasibility analysis in order to find the suitable investment pattern for pilot bicycle project.

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