Strategic Analysis of Bikeway Needs on National Highways: Methods and Insight

S. Lee*[1] & K. Kim[2]

[1,2]Department of Civil Engineering, Korea Advanced Institute of Science and Technology, Daejeon 34141, Korea

ABSTRACT

The Korean government started to pay attention to the bicycle as a green transportation means to solve urban traffic problems caused by its automobile-centered road traffic policy and is establishing a plan for installing bike lanes in urban areas and more developed areas around national highway. However, there has been lack of analysis of the effects and feasibility of bikeway on national highway. In particular, demand forecast should be conducted to evaluate investment. In this regard, this study established a demand forecast methodology for bikeway on national road and applied it to the site. In this study, the previous studies were reviewed, and the conventional 4-step method applicable to forecasting of demand for bikeway in the areas around national road and sketch planning method that can help forecast new demand for bikeway were both adopted. The methodology reviewed in this study is expected to help establish final investment priority and plan according to economic analysis with cost estimation based on demand forecast and field survey.

Keywords: *National Highway, Bikeway, Demand Forecast.*

I. INTRODUCTION

The Korean government has established automobile-centered road transportation policy in line with economic growth and the advancement of scientific technology, which led to some side effects such as severe traffic congestion in urban area, environmental pollution, and energy scarcity and "low-carbon green growth," a key project led by the Korean government to solve urban area problems has been spotlighted. In particular, the bicycle has drawn attention as a green transportation means. After that, Promotion of the Use of Bicycles Act was enacted and Rules for Structure and Standard of Bike Use Facilities was applied when installing bikeway. In addition, many cities with interest in the bike and awareness of its importance are making great efforts to expand bike facilities in housing land development projects, new town projects, and road maintenance projects. However, there are no sufficient bike lanes and related safety facilities on local highways and accordingly almost no use of bicycle.

National highway is road that connects different areas as its main function and around it, life zone (housing, commerce, education, industry, etc.) is developed and road network is built systematically, so the environment is good to construct bikeway. The government is establishing a plan for installing bikeway first in the more developed life zones, but there is still lack of relevant feasibility analysis. In addition, demand forecast shall be conducted before investment evaluation and feasibility analysis, but research on the methodology of bike traffic demand forecast has been insufficient. In this regard, this study aims to establish a demand forecast methodology suitable to bikeway on national road and apply it to the site.

II. BODY

1) Review of previous studies

Bikeway traffic demand forecast method based on conventional 4-step method for traffic demand forecast should be applied by revising the model and algorism for each step suitable to the characteristics of bike trip. To accurately estimate modal split between general transportation means and bicycles, disaggregate demand model should be established based on wide-ranged survey on the travel characteristics and preference of means of transportation among residents around the project site and general public.

In the case of bike lanes, as population and Housing Census and socio economic indicators are used to directly calculate bike trip generation, traffic demand forecast consists of only three steps—trip generation, trip distribution, and trip assignment—excluding modal split. In cases where bike lane network is clearly set on the existing road and there is data on bike trip (O/D) by target year for analysis, 4-step forecast method including the modal-split method can be applied.

In NCHRP (the National Cooperative Highway Research Program) 7-14 "Guidelines for Analysis of Investments in

Bicycle Facilities," the calculated targets in relation to the existing bike use demand include the number of commuters using bike, total adult bike user per day, and the number of bikes for kids per day.

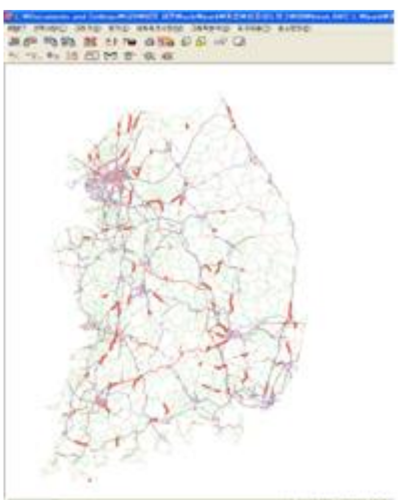
In the basic plan for maintenance of bike facilities made by Busan Metropolitan City government, indirect demand estimation was performed by identifying the number of bikes parked as it was impossible to identify the number of bikes being operated on the road. Based on the number of parked bikes observed for each survey point and KTDB corrected mode share ratio, basic demand against the number of workers in the traffic zone to which the survey point belong and demand for north- and south-bound transfer against public transportation transfer users were estimated in the minimum to maximum range and summed to predict the number of parked bikes.

2) Methods adopted in the study

The conventional 4-step method is suitable to car demand forecast as it has long been used for many products and studies but it is difficult to determine whether the method is appropriate to forecast demand for bike of which users' behaviors are different from the automobile users while sketch planning specified in NCHRP 7-14 is easy to apply as basic data and formulas are simple but its accuracy has not been proved. In addition, in Busan city government's indirect bike demand forecast method, the number of parked bikes is deemed very different from actual bike use demand. Therefore, this study adopted hybrid approach of the conventional 4-step method, which has been most commonly used for traffic demand forecast, and sketch planning method, which can help estimate new demand for bike, in order to forecast demand for bikeway on national highway.

3) Demand forecast and field application

The basic 4-step model predicts future demand through a process of trip generation, trip distribution, modal split, and trip assignment, but in this study, the modal split step was excluded in forecasting bike O/D.



<Establishment of bikeway network >

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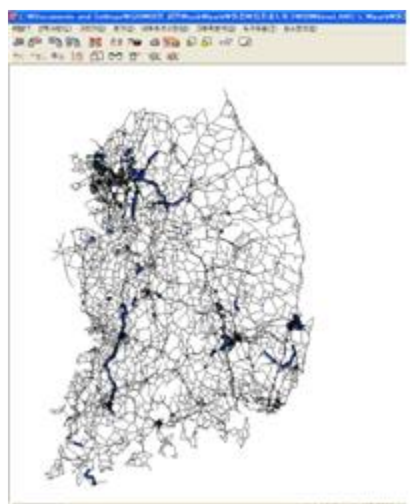

<Trip assignment on bikeway >

To estimate bike trip generation, the basic unit method was used. The basic unit was calculated based on bike traffic volume and resident registered population provided by "Future Demand Forecast for Metropolitan Area and Research of Countermeasures, 2009, Metropolitan Transportation Authority, and the basic unit of bike trip generation was applied to the subject areas for basic plan after categorizing areas, for example, Seoul and Incheon in one category and Gyeonggi Province divided in several categories by population.

<Results of calculation of basic unit of bike trip generation >

Area		Basic unit of generation	Basic unit of arrival
Seoul, Incheon		0.0410	0.0441
Gyeonggi Province	Less than 100,000	0.0758	0.0732
	Less than 200,000	0.0324	0.0331
	Less than 300,000	0.0327	0.0325
	Less than 400,000	0.0350	0.0351
	400,000 or more	0.0449	0.0444

To estimate the distribution of bike trip generation and arrival calculated with the basic unit, a gravity model was established to predict trip distribution and also Frata model was applied to correct both generation and arrival predicted in the trip generation step. Applied gravity model and estimated parameters are as follows:

Where is bike traffic volume between zones
is bike trip generation in the zone
is bike trip arrival in the zone
$f(C_{ij})$ is resistance function.

As a resistance function, reverse power function was applied and function type and the estimated parameters are as follows. R^2 was 0.81, which indicates that the model is statistically significant.

$$f(C_{ij}) = \alpha(d_{ij}^{\beta})$$

where, $f(C_{ij})$ = resistance function

α : -2.0873, β : 0.5152

New potential demand was estimated using Sketch Planning method presented in NCHRP 7-14. NCHRP 7-14 proposed the way of calculating the existing bike use demand: the number of daily existing bicycle commuters, total daily existing adult cyclists, and total daily bicycles. The number of daily existing bicycle commuters is proportionate to the number of local residents and bicycle commute ratio of the area and ratio of nationwide adult bike commute are required. In the case of commute ratio, the existing census data obtained through survey can be used.

Therefore, formulas are as follows and NCHRP 7-14 applied W (nationwide adult commute ratio) based on 2001 NHTS: National Household Transportation Survey. It assumes that 80% of the residents is adult population, out of which 50% is commuters in the total daily existing bicycle commuters, and average value is 0.4.

- Daily existing bicycle commuters = R × C × W(0.4) (Formula 1)

where, R: number of residents, C: bike commute ratio, W: nationwide adult commute ratio

However, as the above formula estimated the number of bike users by applying average bike commute ratio (C), there is a limitation that features according to change of bike use rate cannot be reflected. 2001 NHTS applied coefficient T differently by dividing commuter ratio into area with high commuter ratio, moderate commuter ratio, and low commuter ratio. In the area with high ratio of commuters, approximately three times more commute is generated than the area with low ratio of commuters, and the weights are 60% and 40% for the area with high ratio and moderate ratio, respectively.

- Total daily existing adult cyclists = R × T × 0.8 (Formula 2)

T(high) = 0.6 + 3C
T(moderate) = 0.4 + 1.2C
T(low) = C
where, T: adults' bike use ratio

Since clear ground is not presented when applying T value, this study adopted T (moderate) for estimation. As for bike commute ratio, 1.53% of bike mode share proposed by "A Study of the Calculation of Transportation Indicators for Gyeonggi Province, 2009, Gyeonggi Research Institute. Regarding the bike commute ratio (C), there is no accurate data surveyed in Korea, so bike mode share was applied.

The number of residents (R) applied in this study include population, number of workers, and number of students in the areas adjacent to the target section for basic plan. If the sum of the three indicators is applied, overlapped reflection can occur, and therefore, the highest value among population, the number of workers, and the number of students was applied in this study. Nationwide adult commute ratio was set at 0.366 based on demographic data by age group published by the National Statistical Office (population ratio of 15-64 age group: 71.6%) and demographic data on commute to workplace and school (nationwide adult commute, student ratio: 51.1%). In case new bikeway and facilities are installed based on the above-calculated number of the existing commuters and adult and children demand, new demand generated by influenced area is calculated as follows:

- New Commuters = ∑existing commuters × (L(d) - 1) (Formula 3)
where, L(400m) = 2.93, L(800m) = 2.11, L(1,200m) = 1.39

If all the estimated new cyclists use bikeway, the possibility of over-estimation of bikeway users exists. Therefore, in this study, the estimated value was corrected by applying ratio of response that non-bike users for trip will ride a bike if bike way is built (56.7%). If the 56.7% is applied to the year of launching (2014), a possibility of over-estimation exists, so 8.8% for 2014, 14.0% for 2019, 22.3% for 2024, 35.5% for 2029, and 56.7% for 2034 were applied based on the increase rate of cyclists in Portland in the U.S.A.

The results of per-route demand forecast using the above method are as follows:

<Results of per-route demand forecast >

No.	City, county	Route no.	Length (km)	2014	2019	2024
1	Yeongam-gun	2	11.0	3,353	4,047	5,350
2	Chilgok-gun	4	21.0	3,637	4,227	4,638
3	Namyangju-si	6, 45	30.2	2,403	2,879	3,488
4	Daegu	5	12.5	3,659	4,199	4,980
5	Mungyeong-si	34, 59	10.4	1,633	1,828	2,060
6	Yeoju-gun	37	4.2	3,364	3,820	4,469
7	Icheon-si	42	15.4	2,187	2,487	3,117
8	Nonsan-si	23	7.0	1,425	1,589	1,952
9	Hadong-gun	2	2.7	3,282	3,877	3,865
10	Yeongin-si	45	12.2	2,228	2,498	2,879

III. CONCLUSION

This study established a demand forecast methodology for analysis of effects and feasibility of bikeway installation in areas with developed life zones around national highway and applied it to the site. To do so, the previous studies were reviewed, and the conventional 4-step method applicable to forecasting of demand for bikeway in the areas around national highway and sketch planning method that can help forecast new demand for bikeway were both adopted as a hybrid approach. It is deemed that demand forecast proposed in this study and cost estimated by field survey can help establish final investment priority and plan according to economic analysis.

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