Examination of Method for Gaining Information on Traffic Safety in Bicycle Traffic Spaces Through On-Site Travel and Surveys

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1. Introduction

While the total number of bicycle accidents has fallen by half over the past 10 years, there are still issues, such as the flat trend in the number of bicycle-pedestrian accidents, and calls for the development of bicycle traffic spaces have increased. In relation to the development of bicycle traffic spaces, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the National Police Agency drafted Guidelines on Creating Safe, Comfortable Environments for Bicycle Usage in November 2012 and demonstrated design thinking in line with the road traffic situation, based on the perspective that bicycles should travel on roadways as a main principle. However, although bicycle traffic spaces have been developed until now, the total developed length remains at approximately 2,900 km as of the end of March 2020, and about 70% has been developed in the form of a mixed-use roadway.

One factor preventing further development of bicycle traffic spaces is the difficulty in forming agreement and the lack of clarity in the effects of developing bicycle traffic spaces, but visualizing the effects of development is necessary for promoting development.

This paper examines indicators for gaining information about the effects of development from the perspective of traffic safety in bicycle traffic spaces and reports on observation results from travel experiments.

2. Considering indicators based on a literature survey

We collected domestic and international papers, guidelines, and other literature pertaining to gaining information on safety relating to bicycle traffic.

As indicators, the domestic literature used statistical data and observed values, such as the number of bicycle-related accidents, the rate of bicycles driving in the correct direction on roadways, and bicycle speed and traffic volume, and also questionnaire survey-based objective evaluation values, such as the sense of danger, and heart rate to indicate the degree of physical effect. By contrast, the international literature used data relating to the structure of the bicycle traffic spaces and traffic regulations, such as the width composition, road surface state, and speed regulations.

Next, we selected the indicators and influencing factors for the organized data, based on ease of measurement and data acquisition and their generality as indicators (table 1). Incidentally, we defined the indicators as those that may allow us to directly gain information on safety relating to bicycle traffic, and the influencing factors as those that may influence safety.

Table 1. Results of consideration of indicators

Indicators used in literature		Suited for adoption in this study/survey method		
Subjective value	Sense of danger	Adopted	"Evaluation indicator" directly representing safety	Questionnaire survey
	Comfort			
	Times danger was felt			
Accidents, behavior	No. of bicycle-related accidents			Statistical data
	Behavior changes (times)			Video survey
Road structure traffic conditions	Rate of correct driving direction			
	Mean speed		"Influencing factor" indirectly influencing safety	
	Traffic volume			
	Large vehicle inclusion rate			
	No. of vehicles parked on street			On-site check
	Width			
	Road surface conditions, etc.			
Physical effects	Heart rate fluctuations	Not adopted	Issues with ease of measurement	
Integrated indicators	Bicycle service level		Not yet established as suitable model	
	Sense of safety assessment model		Model at research stage	

3. Verifying indicator validity by travel experiments

We conducted travel experiments with 10–11 subjects on four routes with contiguous sections (fig. 1) that had been developed in different forms (path for bicycles alone, mixed-use roadway, no development) and summarized the indicators and influencing factors selected in section 2 through video and questionnaire surveys. We verified the validity of these indicators and influencing factors through a comparative analysis of the different routes and development forms and a correlative analysis between indicators. The results concerning the indicators are discussed here.

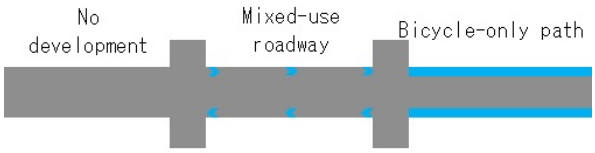

Fig. 1. Image of the surveyed routes

For the comparative analysis between development forms, the comparison results for sense of danger, rate of correct driving direction, and and number of bicycle-related accidents are shown as representative indicators among those shown in table 1.

For the comparative results for the sense of danger, the five-point scale evaluation by the subjects have been scored (with lower scores indicating greater danger), and the average for each of the routes and development form have been used for comparison, with bicycle-only path, mixed-use roadway, and no development having the lowest to highest sense of danger for all routes (fig. 2).

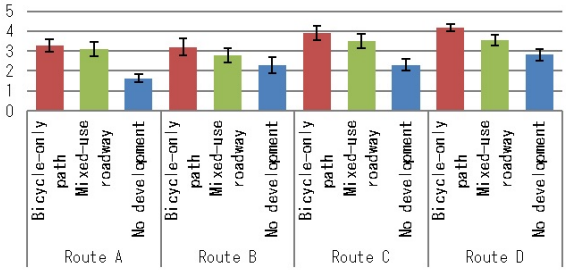

Fig. 2. Sense of danger by route and development form

For the rate of correct driving direction (the proportion of the total bicycle travelers who drive in the correct direction on a roadway or bicycle traffic space), the size relationship of the indicator between development forms is reversed for some routes (fig. 3). As it was confirmed from video footage showing actual travel on routes where the size relationship of the indicator was reversed that riders were traveling on the footpath to avoid parked cars, it is possible that the presence or absence of on-street parking may influence the indicator.

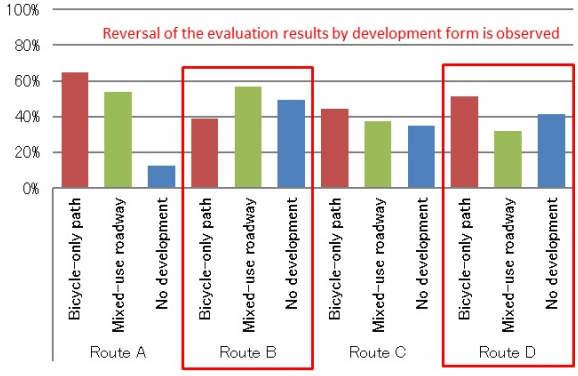

Fig. 3. Rate of correct driving direction by route

and development form

For the comparison results for the number of bicycle-related accidents, the indicators varied widely between routes and development forms (fig. 4).

The factor leading to this is thought to be the low number of bicycle accidents. Moreover, if the year under evaluation is less than a certain period of time after the development of the bicycle traffic space, it may not be evaluated appropriately.

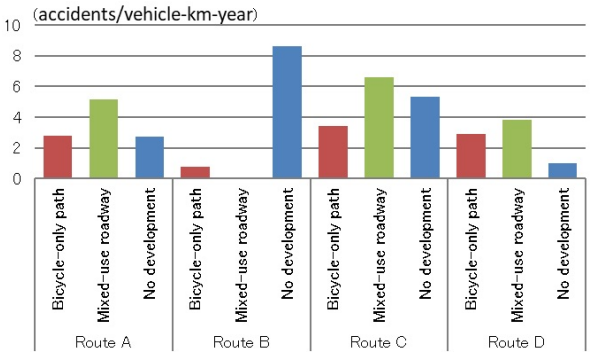

Fig. 4. Number of bicycle-related accidents by route and development form

Furthermore, table 2 shows the results of the correlative analysis between indicators.

We confirmed that there was a “strong to fairly strong correlation” between sense of danger, comfort, number of times danger was felt, number of changes in behavior (wobbling and weaving), and rate of correct driving direction, thus obtaining the expected result representing safety with regard to bicycle traffic.

The above suggests that sense of danger, comfort, number of times danger was felt, number of changes in behavior, and rate of correct driving direction are likely to be valid as indicators for evaluating safety with regard to bicycle traffic.

Incidentally, the number of bicycle accidents did not necessarily show a strong correlation with any of the indicators, but as discussed above, this is thought to be caused by the low number of bicycle accidents.

Table 2. Correlative analysis between indicators

	Sense of danger	Comfort	Times danger was felt	No. of behavior changes	Rate of correct driving direction	No. of bicycle-related accidents
Sense of danger	–	0.966	-0.743	-0.659	0.447	-0.117
Comfort	–	–	-0.592	-0.646	0.492	-0.313
Times danger was felt	–	–	–	0.628	-0.128	-0.302
No. of behavior changes	–	–	–	–	-0.538	-0.026
Rate of correct driving direction	–	–	–	–	–	-0.040
No. of bicycle-related accidents	–	–	–	–	–	–

4. Conclusion

This paper presented efforts in visualizing the effects of development of bicycle traffic spaces.

By clarifying the effects of developing bicycle traffic spaces and sharing these between the people involved, we hope to link to the promotion of developing bicycle traffic spaces.

☞See here for detailed information

1) 66th Proceedings of Infrastructure Planning (29-01)
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