Evaluation of shared use of bicycles and pedestrians in Japan

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Abstract

Shared use of bicycles and pedestrians on sidewalks can be commonly seen all over Japan. Cycling on sidewalks in Japan was permitted from 1978 following deregulation of the Road Traffic Law, which was urgent treatment to secure cyclists' safety due to a lack of road space. This was permitted on sidewalks with appropriate width and traffic conditions. Although bicycles are still regarded as a vehicle and cyclists have to use the carriageway along with motor vehicles according to the Road Traffic Law, many bicycle users prefer to use sidewalks.

Cycle/pedestrian shared use would surely be disadvantageous related to the safety and amenity of pedestrians, and to the reduction of cycling speed. Shared use with pedestrians, however, has advantages of safety and freedom for utility cyclists, which seems to be related to the fact that Japan has a high level of the modal share of bicycles used for going shopping or to school. In addition, the number of women or aged users tends to be high compared with major motorized countries.

The aim of this study is to evaluate the level-of-service of shared use by pedestrians and bicycles, from the viewpoints of users' safety and comfort considering traffic volume in shared use space. By using a video survey of shared use streets, the authors analyzed the relationship between cycling speed, frequency of hindrance and traffic density or traffic volume of street users. In conclusion, the author proposes the conditions necessary to apply shared use of bicycles and pedestrians on the sidewalks, considering the traffic flow of pedestrians and bicycles per width of sidewalks
Keywords: bicycle, shared use, level-of-service, Japan.

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1 Introduction

Shared use of bicycles and pedestrians on sidewalks can be commonly seen all over Japan as shown Figure 1. Cycling on sidewalks in Japan was permitted from 1978 following deregulation of the Road Traffic Law when Japan was suffering from an increase in traffic fatalities due to rapid motorization.

Figure 1: Shared sidewalk of bicycles and pedestrians in Japan.

It was an urgent measure taken in order to secure cyclists' safety under the condition of a lack of road space. Although cycling is permitted only on sidewalks with appropriate width and traffic conditions, and bicycles have to use the carriageway if cycling on sidewalks is not permitted, many bicycle users prefer to ride on sidewalks. Such cycle/pedestrian shared use causes problems related to the safety and amenity of pedestrians.

Figure 2 shows the change of accidents recorded for bicycles and pedestrians. Although the number of accidents is very few compared to the total number of accidents, which is over 1 million per year in these years, it increased rapidly and the ratio of serious injuries in accidents also increased, because of the aging of Japanese people.

On the contrary, shared use with pedestrians has advantages of safety and freedom for utility cyclists, which seems be directly related to the fact that Japan has a high level of the modal share of bicycles used for going shopping or to

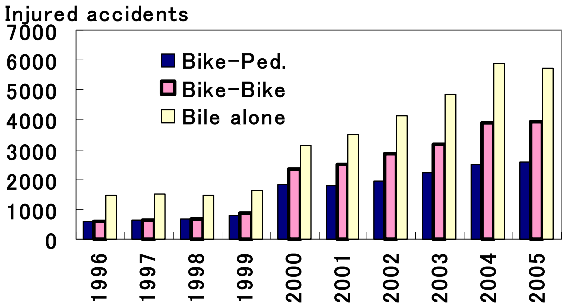

Figure 2: Number of accidents involving bicycles and pedestrians in Japan.

school. In addition the number of women and aged people is great compared with major motorized countries.

Figure 2 shows the modal share of Tokushima Urban Area (population: 480,000). Not only do students under 22 going to school or university cycle, but around 20% of women older than 60 still use bicycles in this city and it is quite a lot higher than the same age men's proportion. The Netherlands has a modal share of about 25% in aged (60–64) women, but it is less than the aged men's share of 28% according to 1989 statistics [1]. Britain has only 1.3% of aged women and it is also less than the men's share (2.1%)

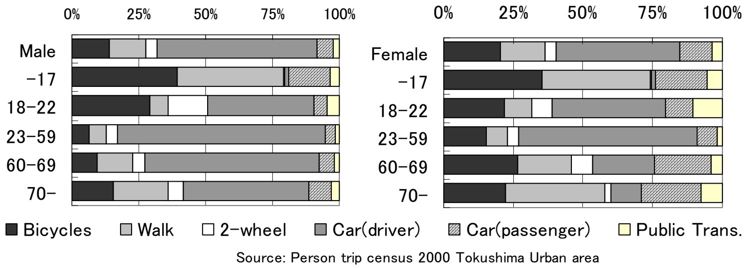

Figure 3: Modal share of Tokushima Urban Area by gender and age.

The Japanese Police Agency and the Ministry of Land, Infrastructure, Transport and Tourism (MLITT) launched a joint campaign for the creation of a "New Bicycle Environment" from 2007. The importance of improvement of the streets system and rules to make the right of way of pedestrians, considering the promotion of bicycle use as an important transport mode, was stressed in this campaign.

The MLITT issued a notification of "Model projects for the environment of bicycles" to the local government and their branches in July of 2007. In this project, around 100 areas were selected to be improved for the safety of bicycles and pedestrians, Measures for traffic separation such as bicycle tracks or lanes, as shown in Figure 4, will be introduced and their effects examined by way of social evaluation and so on.

Figure 4: Cycle lane and cycle track for the Bicycles Model Project.

In order to develop the bicycle network system in Japan effectively, it is important to assess the existing shared use streets with bicycles and pedestrians and improve them according to the condition of shared traffic.

2 Survey of shared use sidewalks

2.1 Surveyed streets

Pedestrian and cyclist behaviour data was collected from highly used sidewalks. Considering the width of sidewalks and the traffic volume of pedestrians and bicycles, 11 streets were selected for the survey in Tokyo, Takamatsu, and Tokushima Cities in Japan as shown in Table 1.

These streets were selected by considering the sidewalk width, total volume of cyclists and number of pedestrians per sidewalk width, and the proportion of cyclists' volume to the total. The width of the sidewalks are classified into three ranks; under 2.5m wide (rank A), from 2.5m to 3.5m (rank B), and 3.5m or wider (rank C). The total volume of cyclists and pedestrians per width of sidewalk varies from 150/h/m to 400/h/m.

2.2 Video survey system

Portable video equipment, which can be set-up at an elevated level, was used for this survey. Portable video cameras, with auto pan/tilt head and their remote

Table 1: Observed streets.

Width Rank	street code	City	Street name	Side walk width (m)	Traffic volume/width (/h/m)		Bicycle ratio	Surveyed hour
					pedestrian	bicycle		
A	A-1	Tokyo	Nishi Ooshima1	2.0	271	64	19	7:40 – 9:20
	A-2	Tokushima	Nikenya	2.5	102	144	59	7:30 – 9:00
	A-3	Takamatsu	Bancho	2.0	212	185	47	7:45 – 9:00
B	B-1	Tokyo	Nishi Ooshima2	2.7	107	56	34	7:30 – 9:00
	B-2	Tokushima	Ichibancho1	3.1	109	61	36	7:30 – 8:40
	B-3	Tokushima	Ichibancho2	3.1	88	78	47	15:55 – 17:00
	B-4	Tokushima	Kachidokibashi	3.3	38	106	73	7:40 – 9:20
C	C-1	Tokyo	Nihonbashi1	4.2	236	41	16	13:00 – 14:10
	C-2	Tokyo	Nihonbashi2	3.6	266	66	20	10:15 – 12:30
	C-3	Tokushima	Motomachi	4.5	164	176	52	16:30 – 18:00
	C-4	Takamatsu	Konyamachi	4.7	76	72	49	11:00 – 13:00

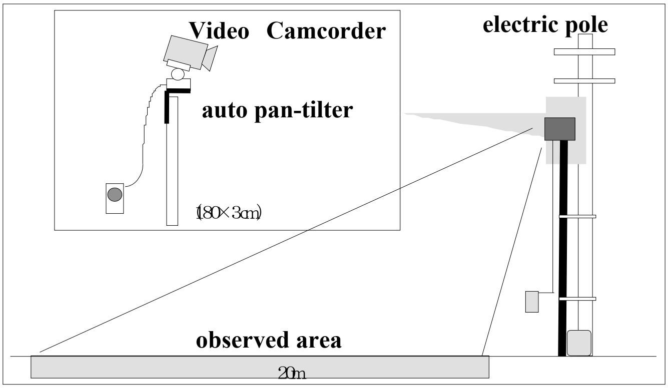

Figure 5: Video survey method.

control units were set-up on a 4m steel pole that could be fixed to an electric power pole (Figure 5).

This system could be set-up within a few minutes and was able to record traffic behaviour along a 20m long street section by using a standard video camcorder. Video recording was done from an elevated point from viewpoints where a clear view of the movement of road users could be achieved. Figure 6 shows video scenes of the surveyed streets.

2.3 Data collection on traffic behaviour from the video survey

By using a computer controlled video recorder, time was automatically entered as a number of video frames of 1/30th of a second. When the position of street users are input via computer keyboard at the point, where they were on the marking lines which are set on the street by marking tape at 5m intervals with 5 lines, making a section length of 20m. We can calculate traffic volume, density, and speed at any intervals from this database.

Figure 6: Scenes from the video survey.

2.4 Hindrance behaviour survey

By using video survey, hindrance of pedestrians and cyclists was observed using the following categories.

Pedestrian
1: Stop stop at once to avoid other traffic
2: Body twist twist one's whole body to avoid other traffic
3: Arm traffic twist one's body at shoulder to avoid other traffic
Cyclists
1: Stop stop to once or brake to avoid other traffic
2: Steering turn to avoid other traffic
3: Body twist twist one's body at shoulder to avoid other traffic

3 Characteristics of bicycle speed in shared use sidewalks

Figure 7 shows a bicycle's speed in streets with few pedestrians. According to the value of 15-percentile and 85-percentile speed, 70% of bicycles run at between 9 km/h and 20 km/h. Bicycles on the carriageway run 12% faster than those on sidewalks, regardless of gender and age. Although, adults' average cycling speed on sidewalks is less than 13 km/h, high school students' speed is about 15 km/h. It's not difficult to run at 15 km/h on carriageways, but cycling at 15km/h on a sidewalk is too fast thus causing pedestrians to feel unsafe.

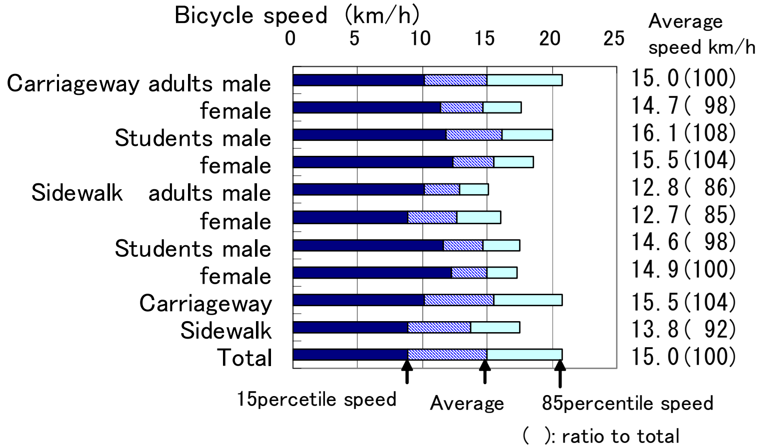

Figure 7: Average cycling speed with few pedestrians.

Figure 8 shows the average speed of bicycles on the shared use sidewalks observed by video survey. Average speed of bicycles without pedestrians is about 12km/h, which is lower than the above mentioned average speed on the carriageway due to pavement conditions and so on.

The greater the traffic density of pedestrians (number of pedestrians per sidewalk area unit, with an average index of every 5 seconds), the slower the bicycles' speed is. When there are few pedestrians (less than 5 persons per $100m^2$), the speed of bicycles is almost the same as that without any pedestrians walking on the sidewalk, if the traffic density of bicycles is no more than $6.0/100m^2$.

When the pedestrians' density is between 5 and 10 per 100 m^2, increase of bicycle density affects the bicycle speed rather than in case of more congested situations with over $15/100m^2$ pedestrians' density. In case of high pedestrians' density, variance of bicycle speed becomes smaller as well due to the constraint of cycling behaviour to avoid pedestrians.

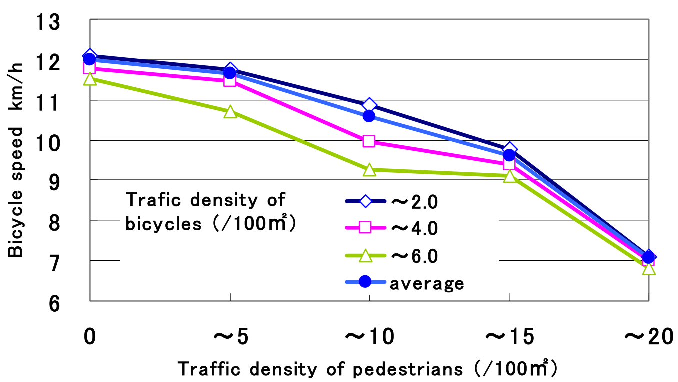

Figure 8: Average cycling speed compared to traffic density on shared use.

4 Hindrance behaviour in shared use sidewalks

When the sidewalk is crowded, the hindrance occurs. That is to say, bicycles and pedestrians avoid each other or stop in order to prevent collisions. Figure 9 shows the relationship between frequency of such hindrance, and traffic volume per width of pedestrians and bicycles. The index of traffic volume per width can be regarded as being the traffic density, if we can assume that street users' speed is constant. The volume index can be obtained more easily by traffic counting survey than the index of traffic density as well.

In using the index of average frequency of discrete variables such as hindrance, selection of duration time is important to explain the actual situation. Because hindrances occur between 1 to 5 cases in total per minute among the 20m long observed road section, and the traffic volume per minute changes quite a lot, we selected the average index every one minute after checking other duration time cases.

The tendency that the more pedestrians, the more hindrances of pedestrians and bicycles occur can be also seen. When the volume of pedestrians is under 0.5 persons/minute/m, the hindrance of pedestrians seldom occurs and does not increase, regardless of the traffic volume of bicycles, although cyclists' hindrance occurs and increases due to the increase of bicycles volume. In case of less than 1.0 pedestrians/minute/m, the hindrance index is less than 1.0. But the pedestrians' hindrance increases along with the increase of bicycle's volume.

In case of the medium traffic condition of pedestrians from 1.0 person/minute/m volume to 2.0 person/minute/m, hindrances' occurrences exceed 1.5 per minute, when bicycles' volume is over 1.0 person/minute/m, When pedestrians' traffic volume exceeds 2 person/minute/m, the hindrance becomes close to 3.0 per minute, which is also regardless to bicycles' traffic volume. Moreover, when pedestrians' volume exceeds 3.0 person/minute/m, the hindrance index reaches 4.0 per minute, especially and not only pedestrians but also bicycles stop or apply brakes to avoid collision.

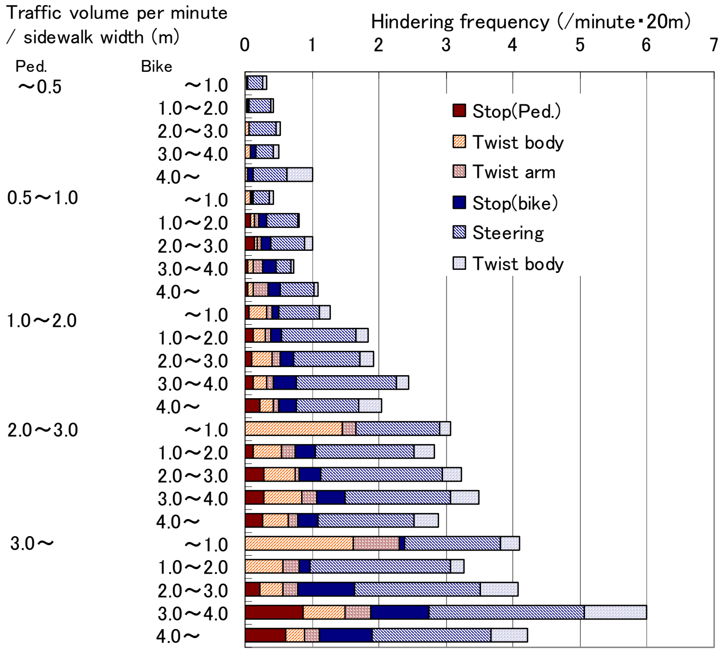

Figure 9: Hindrance frequency by traffic of pedestrians and bicycles on shared use sidewalks.

5 Maximum level of traffic to apply to shared use sidewalks

Considering these results, the authors conclude that the necessary condition for coexistence of bicycles and pedestrians is that less than 0.5 pedestrians/minute/m and less than 3.0cyclists/minute･ m.

Figure 10 shows probability of exceedance of 1 minute traffic volume factor to hourly traffic volume of pedestrians and bicycles, which were obtained from 12 hour survey on the other 12 street sidewalks. When we look at the point of 10% probability of exceedance, the ratio of 1 minute volume to 1 hour volume is

0.039 in case of pedestrians, and is 0.055 in case of bicycle. This means that hourly traffic volumes should be X/0.039 (pedestrians) or X/0.055 (bicycles), if we want to keep that value at only 6 (10% of hour) or less minutes volume it is over X users/minute. Thus the standard for pedestrian/bicycle share use in terms of hourly traffic volume is less than 26 pedestrians / hour and 108 cyclists / hour for 2m wide sidewalks.

As seen from a previous study, for example, Botma [2] in the Netherlands, proposed level of service for pedestrian bicycle path by an analysis on the frequency of meeting and passing events on the lane as is shown in Figure 11. According to this figure the above criteria is located at level D, which is just in the middle level of his figure.

The Netherlands' design guideline for bicycle facilities, describes the criteria to apply shared use of bicycles and pedestrians as being less than 100 pedestrians per hour/m, which seems to permit bic/ped shared use wider.

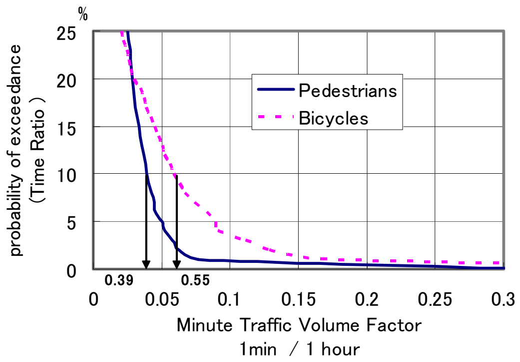

Figure 10: Probability of exceedance of one minute traffic volume factor to one hour volume.

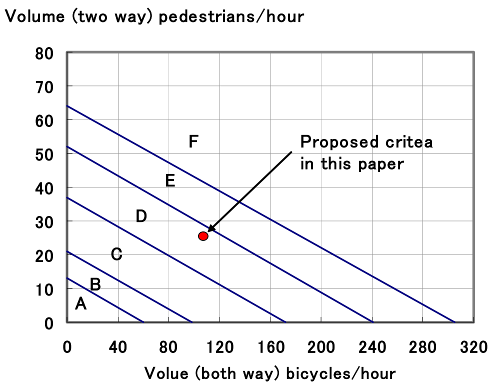

Figure 11: Botma's [2] proposed LOS for bicycle/pedestrian paths.

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6 Conclusion

The authors analysed hindrance behaviour by considering traffic volume per sidewalk width of pedestrians and bicycles, and proposed the minimum level of traffic conditions needed to apply shared use of bicycles and pedestrians on the sidewalks. As a result the necessary condition to coexistence of bicycles and pedestrians was found to be less than 0.5 pedestrians/minute/m and less than 3.0cyclists/minute･ m. The standard for pedestrian/bicycle share use in terms of hourly traffic volume is less than 26 pedestrians / hour and 108 cyclists / hour for 2m wide sidewalks.

In future studies we aim to look at development of education or information methods (signs, road marking, colouring, etc.) on the street for bicycles and pedestrians to ensure the safety and comfort shared use for utility cyclists.

References

[1] Transport For London (2004): Creating a chain reaction The London Cycling Action Plan London, p.7
[2] Hein Botma (1995): Method to determine level of service for bicycle paths and pedestrian-bicycle paths, Transportation Research Record, No.1502, pp.38–44
[3] CTC (2000): Cyclists and Pedestrians - attitude to shared-use Facilities-Research Report, London