POTENTIAL DEMAND FOR BICYCLE TRAFFIC IN RELATION TO EXISTING BIKEWAY NETWORKS

by
Prof. Dr.-Ing. W. Teichgräber/Dipl.-Ing. Ph. Ambrosius
Ruhr-Universität Bochum, Lehrstuhl für Verkehrswesen I
Universitätsstraße 150, 4630 Bochum 1
Germany

1. INTRODUCTION

In transportation planning the bicycle had been neglected for a long time. However, it has gained increasing consideration again during the last years because in many respects it matches with today's requirements for short-distance transportation means. Its main advantages are:

- door-to-door transportation
- no pollution
- no need for fossile energy
- almost no operating costs.

In order to increase the amount of bicycle traffic, the planner has to consider the factors which influence the degree in which the bicycle is used or rejected. These factors are to one part linked to the nature of cycling like exposure to weather or the need for physical activity. To another part they are formed by the environment the cyclist meets, especially by the availability of bikeways. So the German Federal Department of Transportation funded a research project to figure out the influence of the provision of bikeway networks on the amount of bycicle traffic.

2. AIMS AND METHODS OF THE STUDY

This influence is found by investigating and comparing the rate of bicycle use in areas well equipped with bikeways with the respective rate in those areas that have poor or no bikeways facilities. The study limits its investigation to bicycle traffic in larger cities and to only those trip purposes which are of major importance to bicycle traffic. These are:

- school trips
- work trips
- shopping trips
- leisure trips.

The latter are defined as trips to leisure activities, not as the activity itself. Business trips and other purposes can be neglected either in respect to bicycle use or in general.
To collect data most effectively the investigation was carried out in counts and interviews of the terminating traffic at the destinations of the trip purposes mentioned above, which are

- schools
- workplaces
- shopping areas or shopping centers
- public pools.

BICYCLE TRAFFIC by: W.Teichgräber/Ph.Ambrosius

As the possible efforts for collecting data were limited due to the size of the project, the study focused mainly on school and work trips. Here the investigation provided the percentage of bicycle use, some user characteristics and the importance of different reasons for not using a bicycle. By comparing these reasons to the rate of bicycle use and the local bikeway situation, the relative importance and influence of bikeway availability can be extracted.

3. CHARACTERISTICS OF BICYCLE USE

The percentage of bicycle use on all trips varies over a wide range according to trip purpose and location. Aggregated over cities the percentages in home-to-school traffic vary from 10 % to 48 %, in home-to-work traffic vom 1 % to 13 % (tab.1).

City	Inhabitants	Percentage of Bicycle Use School Trips	Work Trips
Bremen	580 000	41.8	9.3
Dortmund	609 000	20.1	2.9
Duisburg	598 000	26.6	11.9
Erlangen	100 000	48.3	10.9
Essen	663 000	10.8	0.8
Köln	980 000	13.9 [1]	6.6
Leverkusen	112 000	31.0	12.4

[1] Study from: Ingenieurgruppe für Verkehrsplanung - Berlin

Tab. 1: Percentage of bicycle use on home-to-school and home-to-work trips

The high percentage of bicycle use in school trips could be expected because of the limited choice students have in private transportation modes. From the figures for work trips a clear potential for bicycle use can be detected, but the variation of the user rate both for school and work trips shows that the demand obviously relates to a local situation. There ist no direct mathematical correlation between bike uses for the two trip purposes, so the variation cannot be explained from a general situation within the respective city but only from purpose-specific conditions.
To evaluate an increase in bicycle use, the possible transfers between transportation modes have to be considered. With school trips, the main transfer is between cycling and walking, with work trips an increase in cycling means a reduced use of public transport and less reduction in car use, although both correlations are not mathematically significant.

BICYCLE TRAFFIC by: W.Teichgräber/Ph.Ambrosius

A random survey in schools and workplaces gives some user-related characteristics of cycling. So a bicycle is available to 93 % of the interviewed students and to 51.5 % of the interviewed employees. The distribution of bicycle use over age or age groups shows a peak for students aged 12 to 14 and a low for employees in the age group 18 to 55 with higher rates for elder employees.

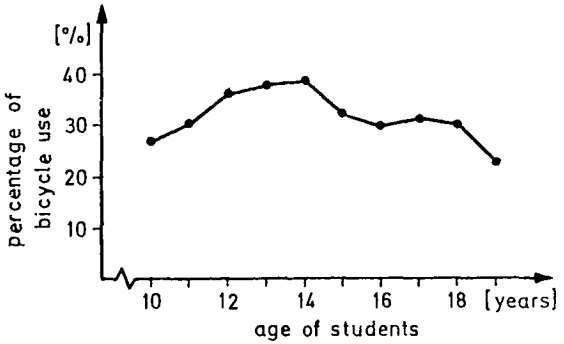

Fig. 1: Percentages of bicycle use in school trips

With school trips the main distances travelled by bicycle are in the range from 0.5 to 3.5 kms, with work trips from 1.0 to 6.0 kms (fig. 2).

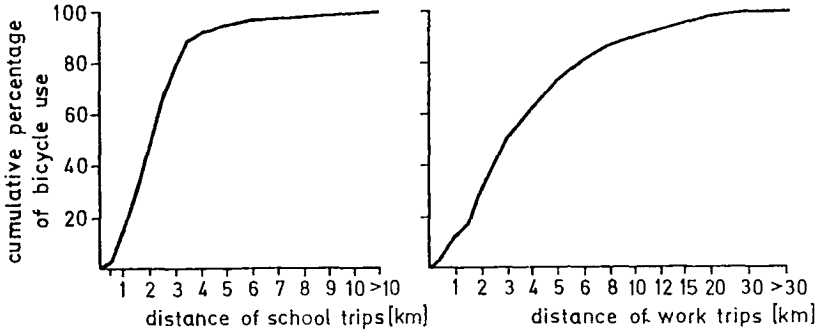

Fig. 2: Distances of school and work trips by bicycle

4. FACTORS DETERMINATING BICYCLE USE

Because the bicycle is highly available or at least easily obtainable, the decision to use it is based on personal attitudes which may or may not correspond with an objective situation. The decision not to use a bicycle can be based on a general attitude,e.g. socially not acceptable, a personal limitation like physical unability or large distance to be travelled or on a local situation like steep grades or danger by exposure to motorized traffic. For the planner the respektive influence of the different factor groups is important, so he can evaluate the effect of an increase in bikeway availability.

To get this influence, in the questionnaire those people who do not use a bicycle were asked for the reasons of their rejection and those people who use a bicycle were asked on what type of roads they travel and if they can use bikeways or not.

4.1 REASONS FOR REJECTING THE BICYCLE

To facilitate the answer of those people not using a bicycle, several reasons for rejection were provided in the questionnaire. These were:

1. too dangerous
2. too much exposed to weather
3. too inconvenient
4. too slow
5. direct public transport available
6. distance too short
7. insufficient provision for storing bicycle at destination
8. danger of damage or theft
9. other reason to be specified.

The possible reason "insufficient availability of bikeways" was not provided in order not to encourage an answer which may seem reasonable to many of the interviewed persons without forming a major factor for their decision.

The analysis of the interviews clearly shows the varying importance of the different reasons. For school trips the main overall reason for rejection is the convenient use of public transport - enhanced by public funding - followed by the fear of damage or theft of bicycles while stored at school and on third position the distance between home and school being too short. Comparing the answer rates for each reason between the different cities in which the interviews were taken the rejections based on local situations, which are

- danger
- availability of public transport
- distance of travel

were generally spread over a wider range than the rejections based on the nature of cycling, which are

- exposure to weather
- inconvenience
- slow speed.

For work trips the main overall reasons are exposure to weather, danger and distance between home and workplace being to far. Inconvenience and slow speed are ranked considerably higher than in school trips whereas the danger of damage or theft is considered almost unimportant. Again the reasons for rejection influenced by local situation vary considerably more from city to city than those influenced by the nature of cycling.

When the answer rates for each reason and each city are compared to the percentage of bicycle trips for the corresponding trip purpose and respective city, only the answer rate for "too dangerous" is in significant negative correlation to bike trips, all other answer rates are independent. The same results can be taken, if answer rates and bike trips are compared not citywise but for the single school or workplace. This proves that the judgement of cycling being dangerous or not has a direct influence on the amount of bicycle use and that by reducing the danger this amount can be increased.

4.2 INFLUENCE OF ROUTE CHARACTERISTICS

In the questionnaire cyclists were asked what types of streets they travel on along their routes no matter what distance. The answering possibilities were

- bikeways
- sidestreets
- major streets, arterials
- sidewalks

As cycling on sidewalks is illegal for all ages over 8 a positive answer here will be a sign for a missing connection or a hazardous situation.

The answer rates on the four different route types are compared to the percentage of bicycle trips to the single school and workplace. For both trip purposes there is a positive correlation between bicycle use and the possibility to use a bikeway and a negative correlation between bicycle use and the need to travel on major streets. For school trips there is an additional positive correlation with the use of sidestreets and a negative with the use sidewalks. These results show the direct influence of route characteristics on the amount of bicycle traffic.

In a next step of the analysis the answer rates for "too dangerous" were compared to both the answer rates for "bikeways" and "major streets" for the respective schools and workplaces to detect whether there is a connection between the availability of bikeways and the subjective perception of danger. As the results show the more often the group of non-cyclists marks "too dangerous" as a reason for rejecting the bicycle the less often the group of cyclists can use bikeways and the more often ist has to use major streets.

5. INFLUENCE OF BIKEWAY AVAILABILITY

As shown by the analysis described, the availability of bikeways seems to have a positive influence on bicycle use in general by increasing safety in a way that can be recognized by

the cyclist. However, the planner needs a method for nummerative evaluation of the effects a given bikeway network has on bicycle use. Therefore a mathematical correlation has to be found between network quality and bike trips. Previous studies often took the relative length of bikeways to the total length of the street network as a scale. By this method a correlation to the percentage of bike trips can be proved if the figures for cities in total are compared. This method cannot be applied, however, when different areas within one city or single destinations are considered as it has to be done with network planning. On the one hand it is impossible to separate the different catchment areas, on the other hand the respective length ratios do not show the quality of bikeway access to a specific destination. So in this study the bikeway networks are classified by points which not only express the length of bikeways but also the quality of access they provide to a specific destination from all possible directions. The scale ranges from 0 to 20. 0 indicates that there is no bikeway at all within a radius of about 1 km around a school or about 1.5 kms around a factory or business, whereas 20 points indicate that the respective destination is accessible by bikeways from all possible directions and these bikeways form parts of a larger bikeway network.

To justify this method of evaluation the access quality is compared to the answer rates that were given on "too dangerous" being the reason of rejection. This comparison shows a negative correlation which is significant.

Also, the actual trip lengths from a random sample of bike users were taken and compared to the classified access quality. Here the results show a positive correlation. As these two comparisons prove, the classification of access quality used in the study corresponds with the existing infrastructure as well as with the individual perception of this infrastructure.

In the main step of the study the access quality is compared to the percentage of the bicycle trips for the two trip purposes. If the mean access quality for all destinations within one city is calculated, this figure relates to the respective percentage of bike trips by linear correlation (fig. 3).

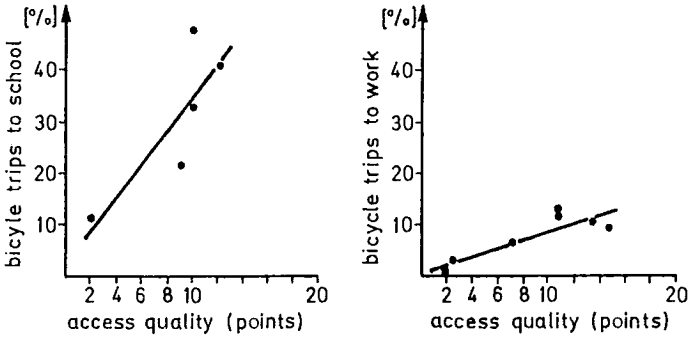

Fig. 3: Access quality and percentage of bike trips for different cities

BICYCLE TRAFFIC by: W.Teichgräber/Ph.Ambrosius

If the two figures are compared for single destinations within one city, no mathematical correlation can be found, but the corresponding values concentrate in specific areas of the co-ordinate system. If several cities are put together, a correlation can be found again. This could lead to a conclusion that a general "bicycle minded environment" ist more important for bicycle use than a specific single bikeway, or in other terms: if a city has very low standards in its bikeway network or almost no bikeways at all, a punctual improvement will not be recognized and therefore does not increase bicycle traffic. If on the other hand a city already has a substantial bikeway network, cycling is highly accepted and people will use their bicycles also on routes which are not covered by bikeways. If this is the case, however, the correlation must be non-linear.
To give mathematical prove to this theory all destinations are classified by their quality of bikeway access and the mean percentage of bicycle trips is formed for each class. The resulting cluster of values within the coordinate system can be approximated by a non-linear logistic curve in the form of a horizontal S where the lower and upper limits are determined by the minimum and maximum percentages of bicycle use (fig. 4). The degree of approximation is higher for work trips and lower for school trips, because on work trips bicycle use depends more on route characteristics then on school trips.

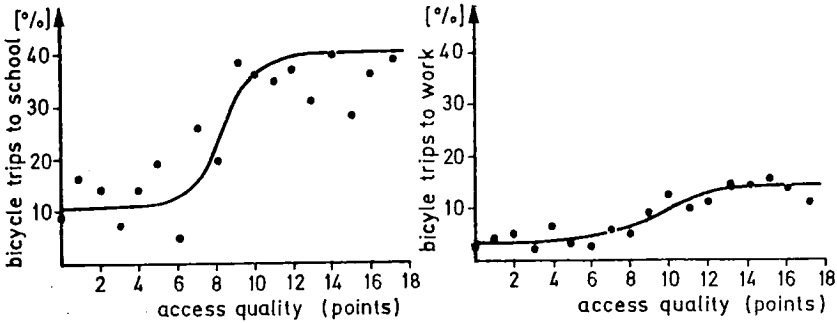

Fig. 4: Correlation between quality of bikeway access and percentage of bike use on school and work trips

Transfered to bikeway network planning these non-linear correlations show that there is a minimum of bicycle traffic even when no bikeways are existent. A slight improve to a poor bikeway network does not affect bicycle traffic significantly until a certain minimum standard is achieved. Bikeway networks of high quality covering large areas of a city in general have already mobilized the potential for bicycle traffic in the particular city. Additional improvements will not increase bicycle traffic any further but nevertheless they will increase the safety of cyclists on these routes.