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INTEGRATION OF PUBLIC PASSENGERS TRANSPORT SYSTEM AND CYCLING

Key Words

Public passengers transport; Bicycle; Multimodal transport; Integration

Abstract

The integration of public passenger transport (PPT) and cycling is a good approach to solving problems in cities. A bicycle as a mode of transport can be a way of accessing the PPT, especially at distances beyond the user's ability to walk to the station. Global experience has shown that the integration of PPT and cycling leads to increased use of PPT and reduced use of cars, and consequently traffic congestion in cities. Therefore, PPT can play an important role in improving spatial accessibility and enhancing the quality of the environment.

1. INTRODUCTION

In view of the increasing demands of passengers, nowadays, it cannot be ignored that there are problems in public passenger transport (hereinafter referred to as PPT). Road networks are facing increased traffic congestion, sometimes even traffic jam, and the quality of accessibility for economically important content is significantly decreases. On the other hand, it seems that PPT systems are unable to cope with changes in the passenger transport market and to respond to

customer demands. That is why capacity building, promoting PPT and integrating cycling represents are a good approach to problem solving in cities.

When talking about cycling, the simple construction of the bicycle and its wide applicability have led to its use in daily life. Based on the analysis, it is estimated that there are over one billion bicycles in the world, however, this data does not rank place the bicycles among the most used means of transportation. Cycling as a mode of travel has expanded rapidly in both developed and underdeveloped countries. This type of activity is becoming more and more relevant in Europe, given the high price of derivatives, it is expected that this trend will continue. A bicycle, on the one hand is a means of transport and on the other, plays a major role in a healthier lifestyle in humans. In addition to its environmental and health benefits, it is often used for relaxation and sports purposes in free time.

In many cases, cycling can be combined with other modes of transport. Combining this most often occurs in the form of bicycle integration with the PPT system, which is nowadays show a highly current multimodal transport. Whether privately or publicly owned, bicycles within the transportation system itself form an important link in the travel chain.

Before commencing the journey, each passenger makes a series of plans that relate to the calculation of the time required to arrive from a departure point to a destination with available transportation options, finances with the choice of a different transport network. There are certain distances where it is more economical for cyclists to travel one part of their travel by another mode of transport. The complete infrastructure system, as well as the existence of parking and other facilities with accessories for storing and care bicycles, should allow customers to make the best decisions regarding the choice of travel modes. The integration of bicycles and public passenger transport systems could be an effective approach to solving part of the problem of people mobility.

The paper presents the characteristics of bicycles and regular PPT systems that are important for the physical integration of these two modes of transport. The paper also provides a comparative analysis of the experience of developed cities in Europe in integrating bicycles and regular PPT systems.

2. MULTIMODAL TRANSPORT

Multimodal transport is representing the use of two or more different modes of transport for one trip between which the passenger must make a transfer. The mode of transport can be defined according to the type of vehicle or organization of transport of passengers. The part of the trip that is traversed by one mode of transport is calling the section of travel. Typical examples are trips where a bicycle is used to access a railway station or to trip from a railway station to a final destination.

Transfer is a key segment of multimodal transport, because passengers have to change mode of transport. Transfer increases the trip time and trip costs, thereby seriously damaging the quality of the transport service.

Walking is always part of the trip and passengers must always walk to and from the public interchange station, car and parking lot, and the distances are usually short. Walking can be considered a basic component at the beginning and end of any trip, so it is not considered a special mode of trip. By definition,it does not represent a particular mode of trip and does not enter into the definition, unless the walking part exceeds major part of the total distance in relation to the total length [1].

Multimodal transport consists of: Transport service integrator and transport service organization. The transport service integrator decides about choice on the modes of transportation used for a particular trip. The role of the transport service integrator is usually performed by the passenger himself, but can also be performed by a third countenance, most often the agency. The organization of PPT services can be organized at the city, regional or national level, while the commercial transport services (car, bicycle, etc.) are organized by the passenger himself, that is, passenger determines the trip times and the route of trip [1].

3. INTEGRATION MODEL OF BICYCLE AND PPT

Multimodal trip can be defined as a "chain", which links travel to different modes of transport. Spatially observed travel of each customer in the PPT system consists of at least three components (simple trip):

- Access system – moving (often walking) from home-basic leg to bus stop.
- In-vehicle travel time PPT.
- Trip from bus stop to activity-basic leg [2].

If two or more PPT regular lines are used for the trip then the trip chain is further complicated. PPT is not door-to-door, apropos PPT users must travel from the home-basic to the PPT bus stop and finally from the PPT stop to the destination. The integration of cycling with the PPT system enables users to access the PPT system and leg from bus stop to final destination is realized by bicycle. Travel time is reduced when the PPT system has a ROW B dependency or an independent ROW A route [2]. The well-executed integration time travel becomes competitive with the passenger car, which is especially emphasized in major cities where congestion and deficit of parking area to car. Access to the system (home-basic leg) and moving from the exit bus stop to the destination of the trip are the components in the PPT "chain" trips of which passengers has the most benefit after integrating the bicycle and the PPT. Full integration of bicycle and PPT systems must include all three forms of integration: physical, tariff and logical. Physical integration is a basic form that must be fulfilled for multimodal trips to be feasible. Physical integration must, first and foremost, provide adequate means and infrastructure (vehicles and bus stops) and associated services in depending on the size of the customers requirements. Depending on the technical characteristics of the PPT, different variants of multimodal trip are also possible. The first option implies that the bicycle is transported along with the passenger. Such vehicles have space for accepting bicycles in the vehicle (as on figure 2) or there is a system for accepting bicycles outside the vehicle (as on figure 1). In the

first option, the customer is able to access the system and travel to the destination by bicycle [4].

Figure 1. Bicycle on bus

Figure 2. Bicycle in train

In another option, the passenger parks his bicycle at the PPT station. In this option of immediate the PPT station it is necessary to provide adequate infrastructure for the safe parking of bicycles or ancillary services that will enable bicycle rental [4].

In accordance with the previously stated for the successful integration of bicycle and PPT, it is necessary to provide suitable vehicles, specialized PPT stations and additional services at the PPT stations. In integrated systems, at the PPT stations there are three kinds of services:

- Rental bicycles: Bicycles that are managed by a specific company and are rented and returned to the same location (mostly for tourist purposes);
- Shared bicycles: An important form of public transport, shared bicycles allow for trips linked to public transport and increased public transport range and are similar to rental bicycles, but organized on a larger scale. Kiosks or stations are located throughout the city to allow users to circulate shared bicycles. Often rented for short periods of time through a membership system, bike-share serves both tourists and commuters;
- Bicycle taxis (pedicabs): Three-wheeled human-powered vehicles that operate as feeders to public transport.

On another hand at the PPT station the following is necessary:

- Bicycle parking: Secure parking of adequate capacity for PPT users and other bicycle users;
- Bicycle stations and objects: Enhanced bicycle facilities in key locations with various services, used as a multimodal transfer station. Services may include key card access bicycle parking, locker rooms, showers, rental, and retail facilities.

During the public transport travel PPT must provide:

- Bicycles on buses: Provision of bicycle racks on the front of or within buses (as on figure 1), where public transport relies mostly on bus-based systems or in them (as on figure 2);
- Bicycles on rail systems: Provision of space and permission to enter rail vehicles in specific times and locations, for large cities with rail-based systems (in major cities with a rail passenger transport system) [4].

When passenger decide trip time and how to make the trip, they take into account: time, simplicity and cost of service. Delays and transfers increase travel time. Estimate and calculating delays is an important part of structuring overall trip. If the PPP service is frequent, the waiting time will be minimal. If finding bicycle parking takes a long time, the transfer time should be longer. Cycling time only from home-basic to destination can be equally to a trip that includes transfer, especially for short trips (as on figure 3) [4].

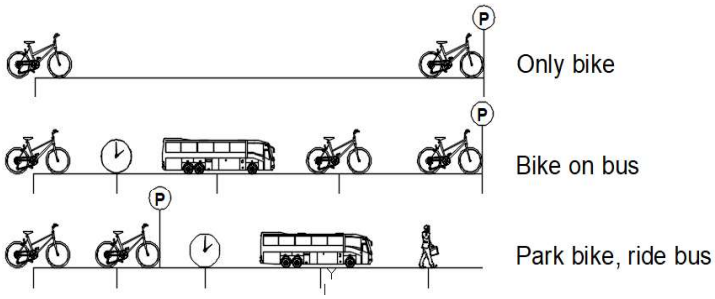

Figure 3. Comparison of the temporal structure of different variants of multimodal trip [4].

Bicycle trip exponentially increases the gravitational area around an integrated PPT station. Ten minutes is used as an acceptable time to access the system PPT high quality of service (BRT, LRT, or Metro). Man can walk about 800 meters in 10 minutes moving at an assumed speed of 5 km/h. However if access to the PPT system performed by bicycle (assumed speed of 15 km/h) at the same time the user exceeds a distance of 2.5 kilometers. If a bicycle is used, the length of acceptable access to the system is increased by three times, while the gravitating area is increased ten times (as on figure 4) [4].

In line with the above, the benefits of integrating bicycles into the PPT system are:

- Door-to-door service, competitive to the passenger car;
- Greater gravitating area of the PPT station;
- Reducing traffic congestion in cities;
- Reduced need for car parking area;
- Less delays;
- Transportation in case of bad climatic conditions;
- Transport in case of a technical failure on a bicycle;

Transport in case of heavy topography characteristics [5].

Figure 4. The gravitating area of the bicycle relative to the pedestrian [4].

4. THE WORLD EXPERIENCE OF INTEGRATION

Depending on the PPT and cycling integration model, as well as from the share bike previous representation in the mode distribution of trips, different effects have been recorded around the world of PPT and bike integration. In this chapter experiences of individual countries are presented and cities from Europe and North America.

In Table 1 presents the share of bicycles in the mode of distribution of access to the PPT system for different cities and countries in Europe. According to the data presented, there is a large difference in the effects of integration depending on the PPT subsystem. The railway and other high-speed subsystems of the PPT have a greater share of integration with cycling than in the bus subsystem. An exception is the United Kingdom, which can be attributed to the fact that the data for bus PPT and bicycle trips are related to the Park & Ride system and not to the classic bus subsystem.

Table 1. Percentage of bicycle use in modal distribution access to PPT system [6;7;8;9]

PPT subsystem	Netherlands	Germany	United Kingdom	Denmark
Regional train	30	16	3	25
Suburban train	-	10	-	22
BRT	14	-	-	12
City bus	6	4	4	4
Metro	1	5	-	-
Total for all subsystems	27	13	2	26

According to other research [10] between 1995 and 2018 PPT trip is increased to 38% in the US and 48% in Canada. However, according to [11] in Canada over the short period from 1996 to 2006 the number of bicycle trips increased by 42%. The

capacity of bicycle parking lot in the United States in 2008 was 24,178 at railway stations and 9005 at bus station. In the same period, Canada recorded a bicycle parking capacity of 2,892 parking lot at train stations and 481 at bus station. Between 2006 and 2008, bicycle parking offers increased 67% in Canada and 26% in the United States. Extremely great influence on the development of Bike & Ride system integration in North America is achieved by promoting the concept of mounting a bicycle rack on the front outside of the bus because the bus PPT has a 60% share of the total number of trips [5].

Another important aspect of the development of the integration of cycling and PPT is the license and provision of access and conditions for the transport of bicycles inside the PPP vehicle. PPT systems that allows bicycles to be transported inside the vehicle are most often LRT, metro and suburban railway, which is not sufficient and other PPT systems should be encouraged. There are some solutions for PPT systems that provide a special car or space for storing and transporting bicycles during passenger travel. Also, there are various structural solutions such as: special hooks, brackets, special surfaces near the door [5].

The Netherlands is a good example of using a bicycle for everyday travel [12]. The Netherlands has been developing cycling since 1970, when it was decided to increase the percentage of non-motorized transport. By 1978, the Netherlands had nearly doubled its cycling network capacity from 9282 km to 18948 km [13]. On the other hand, until 1990, the integration of the bicycle and the PPT system was not level high. Only the railway stations had equipment and facilities for parking and bicycle guard. In the early 1990s, a program was launched to systematically upgrade and extend existing parking lots at all railway stations [6]. As disadvantage of PPT stations is reflected in the small number of bicycle parking lots. Estimates show that only 10-20% of stations are equipped with bicycle parking equipment from all stations PPT in the Netherlands [7].

5. CONCLUSIONS

Multimodal transport based on the integration of PPP and cycling is a good instrument for solving enormous traffic congestion in cities. To encourage PPT users to use the bicycle as a mode to access the system PPT and trip to the final destination, above all, the physical integration of these two modes of transport must be executed. Physical integration is primarily about providing basic conditions for secure bicycle parking at a PPT station but also transporting the bicycle by PPT. Installation of these facilities should be done at key locations in the PPT system according to user requirements. The further growth and development of the use of bicycles in PPT systems in addition to the physical is favorably influenced by other types (kinds) of integration, that is, tariff and information integration.

An analysis of the available experiences of European and North American countries has shown, that the degree of bicycle use in multimodal trips with PPT directly depends on the development of infrastructure facilities that enable and facilitate the successful integration of the two modes of transport.

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