Priority for Public Transit in Germany

Werner Brilon
Wolf Laubert

Priority for public transit includes a large variety of measures, including improvements to infrastructure and vehicles. For vehicles, the low floor concept is of particular importance. The central points of priority measures, however, are improvements of traffic control by traffic signals. Here, an improved sensitivity regarding public transit vehicles is the key to a remarkable reduction of factors causing delay. Different techniques for a traffic actuated signal control and different strategies regarding the degree of priority are applied. Thus, especially the reliability of public transit operations is increased. The priority efforts must be embedded in an integrated plan covering the whole urban or metropolitan transportation system.

Introduction

Public transit (PT) has a high priority in public policy pursuing better conditions of transportation and environment in cities and towns. There is a wide agreement among all political groups in Germany that public transit should be improved as far as possible. It is evident that only public transit by light rail transit, trams and buses can guarantee a sufficient accessibility to the downtown areas in cities. Moreover, public transit should play an important role on the radial arterials of the networks. The necessity of public transit is substantiated by the land consumption of increased car traffic and by the objective of reducing emissions of pollutants caused by car traffic in urban areas.

Because travel time is the most important factor in competition with private cars, the operation of light rail transit (LRT), of trams and buses must be accelerated. Of course, this public transit priority (PTP) can also be supplemented by an increased comfort of public transit vehicles (PTV), by more frequent departures, by punctuality and reliability of operations, by attractive tariffs and by an improved prestige of public transit.

In the 1970's, PTP mainly concentrated on building tunnels for trams below the downtown areas, thus changing trams into LRT

Dr.-Ing. Werner Brilon is full Professor and Head of the Institute for Transportation Engineering at the Ruhr University, Bochum, Germany. Dr.-Ing. Wolf Laubert is Technical Manager with the public transport company Stuttgarter Stassenbahnen AG in Stuttgart, Germany.
systems. Many medium-sized towns in Germany now have an underground tram system with very few tunnel sections and long sections of normal surface tram operations or the arterials approaching the cities. The lesson which was learnt during the 1980's however, was that the reduction of travel time achieved by short tunnel sections was sometimes quite limited and moreover that the costs of investments and maintenance were extremely high. Moreover, tunnel stations impair the accessibility to the trains. Also the safety against crime and vandalism in underground stations is rated by the public to be lower than at normal surface stations.

On the other hand, surface operation of trams and buses can be accelerated substantially by a variety of different measures. Here, one simple principle has to be kept in mind: A remarkable reduction of travel times can only result from avoiding many short periods of delay. This delay could be caused by:

a) the internal organization of public transit
b) interference from other road users.

Fig. 1 gives an impression of the reasons for lost times in bus and tram operations due to operations of transit vehicles within the same street space with private cars. Fig. 2 shows similar results. However, here we see results from LRT lines, which on the longest part of their lines operate on normal street levels.

Objectives

Before we get to technical details, the objectives of PTP have to be defined. These objectives could be:

- Reduced travel time

A shorter travel time could contribute to an improved modal split. Moreover, if the travel time reduction along a whole transit line could be increased by as much as one headway interval, a complete tram or bus including staff could be saved along this line. Thus, the priority could contribute to a significant reduction of costs.

- Improved reliability

Interferences with buses and trams from other road users generate many small delays which cause deviations from the

Figure 1. Distribution of Delays in PT Operations.
a) Buses, city of Braunschweig (Brenner, 1990). Average daily values; b) Buses, town of Lippstadt (Eickers, 1992). Southern direction; c) Buses, city of Bochum (SNV, 1988). Average values of 7 bus lines; d) Trams, city of Bochum (SNV, 1988). Average values of 5 tram lines. "slow and go" means travelling at lower than the desired speed; "stop on open space" means a complete stop outside stations. Both types of delay are due to external impediments caused by other road users.
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- Combined effects

With great standard deviations of travel times (cf. fig. 3), the time reserves needed within the turning times at the terminal stations are quite long. Improved reliability enables a reduction of these time buffers within the schedules. Therefore, a combination of reduced travel times and better reliability could be the key for reaching the threshold to save at least one vehicle along the PT line.

In the early days of PTP, the expectations were concentrated on the first aspect. Meanwhile, experience has shown that a significant reduction of the entire travel time along a line by 10 or more minutes (which often is the headway interval between successive PTVs) could only be achieved along very extended lines, e.g. with a round-trip travel time of 90 minutes or more, and with rather bad travel conditions in the before period. Therefore, the desired significant reduction of costs by saving a complete PTV along a line could only be realized quite seldom under normal conditions.

Nevertheless, the reduced variation of travel times is also important enough to increase the efforts regarding PTP, due to its benefit for the operators as well as for the passengers. One extremely important effect of PTP is to make operations independent of volume-related travel times, which occur in normal street traffic due to the varying traffic volumes during the day. Another important effect of these priority measures is to demonstrate the priority of public transit to all road users in order to improve the overall appearance and prestige of this travel mode. Therefore at present, most of the efforts concentrate on the second objective.

Catalogue of Measures

PTP can generally be achieved by a variety of measures. For a better overview, they can be grouped as follows:

- Improvement of the PT infrastructure
- Improvement of PT vehicles
- Improvement of traffic signal operation
- Introduction of a computerized control system for PT operation

The decision of which type of measure should be applied in a certain case strongly depends on this specific, individual case. Normally, a

Figure 2. Composition of the Whole Travel Time by Different Components on 3 LRT Lines in Stuttgart.
combination of different types of measures is useful. It is obvious that different measures can also bring about different costs. The following text will briefly describe various possibilities. Moreover, it gives some bibliographical references which by no means claim to be complete. The relevant articles concerning PTP published in German have meanwhile become so numerous that this paper does not offer enough space for a complete description. The most recent status seems to be documented (in German) at the conference HEUREKA (1993).

Before PTP can be carried out, the situation has to be analyzed thoroughly. The reasons for delays and for travel times which are too long all together can be so different that, in most cases, a standardized procedure does not seem to make sense.

**Improvement of the PT Infrastructure**

The total travel time of the PTVs normally consists

- 19 up to 21 percent dwell times (passengers getting in and out)
- 2 up to 15 percent lost time due to traffic signals
- 2 up to 10 percent lost time due to other disturbances.

Therefore, only during 65 and 75 percent of the total travel time, the PTV is really moving. (cf. fig. 2). Improvements can only be achieved by changing the peripheral physical conditions. An important factor for short travel times is the density of stations (stops) which should not be too high. An optimization procedure for station spacing was given by Theiss (1985). Moreover, the operation of the PTV between the stops should not be obstructed by individual traffic and its congestions.

One fundamental feature for PTP, therefore, is the existence of exclusive lanes for trams or buses (fig. 4). If the street space allows this solution, exclusive lanes are installed especially for trams. For buses, this solution could mainly be used alongside arterials with high bus volumes and frequent traffic jams. Conditions for the installation of exclusive bus lanes are mentioned in RAS-ÖE2 (1979). Today however, exclusive bus lanes could be introduced whenever the frequency exceeds one bus every 10 minutes.

Another key to PTP is the treatment of those stations and stops in the central city areas with the highest traffic volumes. A great deal of PT delay can be caused by the internal operation of these stations. Two examples should be mentioned:

- Multiple stops should be avoided as they cause longer dwell times per vehicle.
- Fork junctions for trams should be separated into several tracks (fig. 5) so that turning trams and those moving straight on do not obstruct each other.
Another measure for bus operation which is quite popular these days is to change existing bus stop bays into street based stop areas called "buscapes". This means that the bus can continue traveling quite straight along the street. The passengers can board the bus from an elevated platform (18 cm above street level) at the curb. While the bus stops, the car traffic is stored in a queue behind the bus. Therefore, on its departure, the bus can accelerate without any delay and - in addition - the street space ahead is free of cars. Advantages for the bus and increased delays for private cars as well as their balance are discussed by Brilon and Eickers (1992).

Figure 4. Example for Exclusive Bus Lanes at an Intersection (RAS-OE2, 1979).

Figure 5. Tracks at a fork junction of a tram line before the intersection. The tram station for both directions should be in the depicted area. The minimal solution c) enables a second tram to approach the station while another tram stops. Without the prelocated switch, the second tram has to wait outside the station until the first one has left it (RAS-OE1, 1977).

Improving Boarding Times

The time needed by passengers entering or leaving the buses or trams is in the range of 20% of the total travel time of the PTVs within city lines. Here, time can be saved by accelerating entry and exit. A measure for achieving this acceleration is the way of regulating the tariffs, e.g. the drivers of buses and trams should not have to sell tickets and give information.

However, it is more important to minimize the height difference between the floor of the vehicle and the platform. A research program...
Bogesta (1987) showed that the average time each passenger needs to enter a bus is 2.4 s if the difference between street level and bus floor is 46 cm, whereas 2.9 s per passenger was measured if the difference is 86 cm. Depending on the number of passengers, lower levels of vehicle floors or higher platforms could reduce the time for entry and exit by up to 20%. Other examples of this effect have been observed at two stations in Stuttgart (fig. 6).

Case 1: Low platform
- 14 cm above rails
- 35 cm first stage of vehicle
- further steps within the vehicle

Case 2: Elevated platform
- 90 cm above rails
- 0 cm vehicle floor
- no more steps within the vehicle

Figure 6. Average Dwell Times and Variation Before and After Changing of Platform at Two Stations in Stuttgart.

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With LRT lines, a difference of 5 cm between the levels of vehicle floors and platforms is acceptable for new installations. This difference may become nearly zero during the following years of tram operation due to subsidence as well as wear and tear.

For buses and trams, the "low floor concept" has become very popular all over Europe. A level of the vehicle floor of 35 cm above the street surface for buses and of 33 cm above the rail for trams is the standard solution. The producers of buses and trams had to take great efforts of technical innovation to fulfill that request. Meanwhile, however, nearly all new buses and trams ordered for inner-urban use in Germany fulfill this "low floor concept". Thus, these new vehicles contribute to reduced travel times and, of course, to improved comfort for passengers. Both effects, however, are only obtained if the whole floor, also below the seats, is on a low level. Some of the low floor buses provide only low floors in the aisles. Here the seats are mounted on elevated platforms, which makes it difficult for passengers to enter and leave their seats. Thus, this type of construction could also produce the adverse effect of an acceleration. Not only is the level of the bus floor important, but also the position of the doors within the bus is of significance for the boarding times (Weidmann, 1992).

Traffic Signal Operation

An even more important factor for the reduction of delays for buses and trams is to cut down the time these public transit vehicles (PTV) have to wait for the green light at traffic signals.

Hardware

Here it should be noted that transit buses, trams and light rail (on streets) in Germany normally have their own signal displays. Therefore, their signal timing is not restricted to the signals for private car traffic. Other necessary devices for PTV are detection systems which transmit the information of an approaching PTV to the signal controller. For rail-based PTV, the same inductive transmitter which also controls the system of automatic switches could be used. However, special transmitter systems similar to normal inductive loops proved to be more reliable (Boscherhoff et al., 1990). Here, the line code of the PTV and other information could be exchanged between the PTV and the local controller. Some of the public transit companies also use roadside located beacons to transmit information from the PTV to the signal controller. In most cases, these beacon systems were introduced for the automated vehicle monitoring system (AVM) of the respective company.
For public transit priority, the traffic signals must be modified from fixed time into traffic actuated operation. To do this, the intersections also have to be equipped with detectors for private car traffic. Here, the inductive loop is still predominant in Germany. Finally, it should be mentioned that this improved type of operation can only be realized with modern microcomputer controllers. Therefore, in many cases, public transit priority provides the incentive for modernizing the entire traffic signal system in the area concerned.

**Conventional Signal Timing**

Experiences with public transit priority in many cities and towns showed (Brenner, 1990) that better conditions for PTV at traffic signals in a fixed time signal system could also be achieved by conventional strategies such as:

- short cycle times
- long green times for PTVs
- avoidance of traffic jams in the parallel car traffic
- prohibition of left-turning movements which cross tram tracks
- reduced application of multiple signal stages with exclusive turning signals (which is quite popular in Germany due to its safety benefits)
- PTV-adjusted signal coordination;

Here, it is important in computerized optimization procedures (like TRANSYT) for area-wide premised signal systems to put much weight on public transit delays and to include the PTV stops and their expected duration in the optimization procedure (fig. 7). The same should be applied for manually produced coordinated signal timings.

- time of day or traffic-actuated selection of signal timing plans for urban street networks to adjust the basic signal structure to the prevailing traffic conditions, e.g. adjustment to morning or afternoon peak periods.

This PTV-friendly basic signal timing structure is an important precondition to enable priority for individual PTVs without generating too much additional delay for individual car traffic and for pedestrians.

**Control Strategies**

The control strategies for public transit priority have been subject to changes in the past. There are two extreme solutions:

1. The PTV gets permission to enter a conflict area without any delay regardless of the queues this can cause for private cars and regardless of the signal coordination.
2. The PTV is released from its stop line as soon as possible after its request without disturbing the private car traffic too much, e.g., coordination according to the "green wave" system is maintained.

Of course, there are a variety of intermediate strategies between these two extremes, e.g.:

3. Only a delayed PTV gets priority according to strategy 1.
4. Strategy 1 is applied unless queuing in private traffic is raised above a specified level. It is normal that only maximum red periods of up to 2 minutes are tolerated for pedestrians and private cars.
5. Strategy 1 is applied; however, a special clearance program is started after every PTV departure to dissipate queues in the traffic crossing the PTV route.

6. Individual solutions.

Currently, the trend goes towards strategy 1. However, attempts to keep the drawbacks for private cars within specified margins are usual, especially solution 4.

Possibilities to achieve strategy 1 are:

1.1 Release of the PTV on demand by switching its green time on request

In this case, if the PTV is detected by the system, the controller switches to a green time for the PTV as soon as possible. If there is a PTV station upstream of the signal, the green time is extended until the PTV is clear for departure. The green time is terminated after the PTV has left the conflict area. The controller either returns to the point of the signal timing plan at which it was left or, if the timing of the controller has run forward, it goes to an arbitrary point the timing plan has just reached at the end of the PTV green, hoping that this will maintain the "green wave" coordination to some degree. Another idea is to start with green for the traffic crossing the PTV route. In each case, of course, the intergreens (clearance intervals) have to be observed. During the PTV green, other movements can get a green time as well, provided that they do not conflict with the PTV route.

The distance D from the entrance detector to the stop line is in accordance with the longest duration T which could occur in the signal timing plan to switch it over to the PTV green. T depends on the intergreen times (clearance intervals), on minimum green time etc. D then is T x V, where V is the operating velocity of the PTV. This simple technique could also be modified to take into account variable travel conditions.

This technique has a couple of drawbacks, including variable cycle time, coordination problems, reduced capacity and increased delays for non-priority movements, especially for pedestrians.

A possibility which rather tends towards strategy 2 is:

2.1 Extending green times for PTVs on request within specified margins

With this solution, the fundamental structure of the pretimed signal plan is maintained. In case that the detected PTV passes the stop line within the margin for the longest possible expansion of its green, the PTV does not suffer any delay. In case that the PTV reaches the stop line outside the specified margin, it has to stop. Then it is delayed until the earliest possible beginning of its next green time. To realize this strategy, the PDM (phase-calling procedure with decentral modification) method (see below) is applied.

The drawback of this strategy is that delays for PTVs cannot be avoided completely. However, the impediments for car traffic are almost not noticeable.

Techniques

For the design of traffic signals for PTP at an individual intersection, the first step is to define the signal stages. A stage is an interval within the signal timing during which the signals are not altered. In other words: a stage describes all signals which can be combined in a basic signal state and which do not conflict with each other. Tolerable conflicts (e.g. permitted right turning cars versus parallel pedestrians) are allowed in a stage in Germany. Thus, all signals of one stage can be switched to green simultaneously.

As an example, this is illustrated at the intersection in fig. 8. Here, two tran lines fork at an intersection. For this intersection, 7 stages are defined (fig. 9). If no tram approaches, the car traffic gets stages I to III. Each driving direction of the tram represents a separate stage which also includes all car traffic streams and pedestrian crossings which are compatible with the tram. Each of the specific tram stages (V to VII) is activated if the corresponding tram approaches the intersection.

In the next planning step, the transitions between the stages must be drawn up. This makes it necessary to determine the intergreen periods (clearance intervals) between all pairs of incompatible signals. In Germany, a complicated calculation technique is prescribed for this determination (RILSA, 1992). This technique uses kinematic methods to calculate the time from the end of the green time to the clearance of the conflict zone. This procedure must be carried out for the conflicts of all movements of car traffic, pedestrians and PTVs at the intersection. In fig. 8 and fig. 9, these are 12 car movements, 9 pedestrian crossings and 4 tram movements which could theoretically result in a maximum of 600 conflicts, 130 of which really occur. The clearance interval must be evaluated for each of these conflicts. The clearance times for conflicting movements then have to be assigned to the signals concerned. Here they are included in the transition programs. For our example with 7 stages, we have to evaluate 42 transition programs. These specific transition programs P_{k} must be run by the intersection controller to alter the signal from one stage i to another stage k. The longest duration of the transition programs determines the time T.
Figure 8. Intersection for the Following Example.

Figure 9. Illustration of the stages for the intersection shown in Fig. 8. S1 through S4 are the signals for trams. Stage IV displays red at each of the signals, thus enabling an immediate switching into any of the other stages. The "all red" stage IV is the stand-by stage when no traffic is at hand e.g. during nighttime.

(mentioned previously under detection systems). In our example, the longest transition program to enter stage 6 for the tram coming from the east has a duration of 10 s. Another 4 s could be added for the switching of the controller and to enable an emergency stop of the tram in case of a system failure. Therefore, the tram detector must be placed at least 195 m ahead of the tram stop line (the speed of the tram is 50 km/h).

In practice, up to 10 stages at normal intersections are usual and up to 20 stages have been reported in connection with PTP. Thus, an enormous planning effort is necessary. This can only be achieved by suitable, efficient computer programs. Such programs are offered by signal producers and independent consultants. Due to the German specialises concerning the intergreens, a transfer of signal planning software from other countries is nearly impossible.
The third and most complicated step is to determine a logic according to which the separate stages are switched by the intersection controller. This logic must be able to determine a favorable order and duration of the stages according to the respective traffic situation indicated by the detectors. In practice, the development of this logic is a task of the responsible traffic engineer who has to consider the local situation and the general strategy (see above).

The competent judgment of the planning engineer can at best be supported, but never replaced by a computer program. This logic is demonstrated by structural diagrams. The appearance of these structural diagrams is regulated by the RILSA (1992). For their development, the signal producers offer one or more frameworks of computer programs which also enable the transmission of the logic into the intersection controller. Software for checking the logic regarding efficiency and safety is available as well. Nevertheless, the working process with the logic is still very much characterized by the experience and intuition of the person dealing with it. Solutions which systematically guarantee any kind of optimum (e.g. minimum delays or minimum emissions) have not come into use up to now. However, this part of the design job is still under a continuous development by the signal producers and by specialized consultants. Therefore, at the moment, the development has not settled towards a really standardized solution. Instead, the solutions realized for the general logic are still much related to the consultants and hardware producers being commissioned to set the signal system and the PTP into operation.

As an example, the PDM method of the Siemens company (Brenner, 1990) should be mentioned. It is related to strategy 2.1 mentioned above. Here the general structure of the signal stages during one cycle is defined. However, the initiation and the termination of each stage can be modified within a specified margin. The sequence of phases and the margins for the alteration of each stage are marked in a PDM diagram (fig. 10). Of course, these margins have to be checked for feasibility and safety. After the definition of the PDM diagram, this check is performed by the specialized PDM software. This also enables the whole realization of the logic, the intersection controller program and the switching of the signals.

An example for an integrated software and hardware package which enables both strategies mentioned above is the VS system. It has been developed by a Swiss consultant (Albrecht et al., 1993).

**Special Solutions**

In addition to this general outline, there are a variety of special solutions which guarantee the success of PTP measures. Two of these

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Figure 10. This PDM-diagram for a 4-stage controlled intersection indicates the time margins for the earliest or the latest switching into the next stage during a cycle of 100 seconds. The numbers on the left indicate the no. of the stage. L1 and L2 are time margins where pre-specified logic applies for the selection of the optimum phasing.

One example is the so-called time island. Here the passengers of a tram running on a street are protected by a special signal while boarding the tram (fig. 11). This type of signalization can be timed in such a way that no car can overtake the tram even on the downstream street sections. Because the tram has several stops along the arterial, the street space ahead of the tram is emptied of cars. Thus, the tram has a guaranteed free street space, even if the tracks are within an area which can normally be used by cars as well. For buses, the access to the stop line of an intersection could be improved by short bus lanes which also include the bus stop. From the stop area, the bus is released by the signal some seconds in advanced of the car traffic. Thus, at the intersection concerned, the bus can overtake
a whole queue of cars and free space is achieved ahead of it. This could also be combined with a special design to enable left turns of buses from the nearside bus bay ("bus lock", Fig. 12 b).

Figure 11. "Train Island" for a Train (RILSA, 1992).

Figure 12. "Bus Locks" combine short bus lanes with bus stations and a prioritized signalization (RILSA, 1992).

a) Bus exit control with complete bus signal (a) or permissive signal (b).
b) Example for a bus lock with fixed-time signal program.

Automatic Vehicle Monitoring Systems (AVM) for PT Operations

The German PT companies are increasingly implementing AVM systems. These make it possible to trace the location of every single operated PTV on-line by a central computer. This computer recognizes each delay and other disrupting event. In case of problems, it could also recommend suitable solutions to minimize the effects of the respective
Figure 13: Delay at Traffic Lights Along 5 LRT Lines in Stuttgart Before and After FTP

The graph shows the delay at traffic lights along 5 LRT lines in Stuttgart before and after the implementation of FTP (First-Priority). The FTP system was implemented to improve the efficiency of LRT operations by giving priority to LRT vehicles at traffic lights. The graph indicates a significant reduction in delay after the implementation of FTP, with a notable decrease in the delay for LRT Line 3.

Key Points:
- FTP was implemented to improve LRT operations.
- Significant reduction in delay for LRT Line 3.
- FTP provides priority at traffic lights, enhancing LRT efficiency.

Further analysis and discussion on the benefits and impact of FTP on LRT operations would be valuable for comprehensive understanding.
Political, Administrative and Financial Background

To understand the performance of PTP in Germany, the organizational framework is of great importance. The German PT companies, who operate their PTV within the street space, are normally owned by the communities. The communities also have to pay for the deficits of operation which range between 40% and 70%. These PT companies operate in a protected area with no competition with other firms. This organization is protected by a special law which also specifies a strong supervision of operations, schedules and tariffs by the responsive state administrations.

On the other hand, the streets are owned by the communities, the states (Laender) or by the federal state. However, in towns greater than 80000 inhabitants, the city government is responsible for the whole administration of all these streets. In case that the street infrastructure (including traffic signals) has to be changed for PTP activities, the street administration department must agree and cooperate with the PT companies.

The investments for the whole infrastructure of PT are normally financed by funds granted by the federal government. The communities only have to contribute between 10% and 25% of the investment costs. The PT companies, however, have to pay for the maintenance and operation of the whole infrastructure. Infrastructure here means: complete tram or LRT equipment like rails, bridges, tunnels, signal systems, depots, workshops, electrical power supply etc., exclusive bus lanes, traffic signals. The federal funds are financed by special taxes on fuel paid by the car drivers. Thus, for example in 1992, a total of nearly 5 billion DM was provided for investments in public transit infrastructure all over Germany. Of course, buses, trams and the whole operational costs such as staff salaries have to be financed by the PT companies.

This organizational and financial framework facilitates the development of an integrated PTP system including the financial feasibility. To be successful, this whole concept has to be supported by the community governments and their parliament. Hence, also concepts for public relations and public awareness are necessary to achieve public support for PTP. This integrated concept is one of the basic requirements for a successful PTP program.

Conclusion

Public transit priority (PTP) is a headline for a comprehensive set
of activities and measures. The objective is to avoid unnecessary delays along the routes of the PT lines. These measures concern the construction of buses, trams and light rail transit vehicles. Especially the low floor concept of buses and trams is very successful in many European countries. The construction of stations, for example elevated platforms for LRT and even at busy bus stops, also contributes to shorter boarding times. Separate PT lanes on streets are a very important aspect as well.

However, the minimization of delays at traffic signals is the key element for the acceleration of PT operation in towns. The relation of benefits to costs for this type of PTP activity is much better than it has been for tunneling PT lines. Here a wide range of signalization techniques has been developed, especially by improving traffic actuated signalization.

It is not useful to provide standardized methods for the design of PTP, since the preconditions and problems in each individual town are quite different due to different traditions of PT companies and planning authorities, and due to different vehicle techniques as well as different structural conditions of the townscapes. However, a wide range of experiences has been gained by PT companies and consultants in Germany. The whole planning process must always be based on a detailed analysis of existing reasons for delays, it must be combined with activities of public participation and it must be continued also after the first installation of measures.

For rail-based public transit, a well-established practical knowledge of PTP is available in Germany. Here it is, above all, a question of financial resources to which extent trams and street-based LRT lines are accelerated by PTP. For buses, PTP is common practice as well. However, the set of solutions for buses is still more complex due to the severe interference of buses with private car traffic.

In any case the success of PTP is remarkable. To some extent, this success is represented by shorter travel times. The more important aspect, however, seems to be the increased reliability of PT operations. Based on these improvements, PTP is an important tool for shifting the modal split towards the PT mode in cities and urban regions, which is a considerable advantage for the environment.

References


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