UNDERSTANDING HOW PEDESTRIANS INTERFACE WITH TRAMS

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1. Introduction

During 2007 Transport for London (TfL) were considering several new on-street tram systems for London including the proposed Cross River Tram (CRT) and transit along Oxford Street.

The streets of London are congested spaces and such a scheme needs careful planning and design to ensure that the safety and mobility of vulnerable road users is not compromised. Therefore in 2007 TfL commissioned TRL to investigate the interface of pedestrians with trams. The project aimed to provide robust research about how pedestrians interact with trams using the following methods:

- Pedestrian movement analysis from observations of real street environments;
- Case studies of pedestrian friendly on-street tram environment
- Street questionnaires with users to gauge perceptions of trams;
- Statistical analysis of STATS19 data on pedestrian/tram conflict and;
- Interviews with Tram operators and Local Authorities.

For the purpose of this paper, the focus will be upon the observational studies, which aimed to identify best practice from the experience of other tram network operators to optimise safety, accessibility and other aspects associated with the interaction of pedestrians and trams. The observational studies were conducted using a streamlined version of the well established PERS (Pedestrian Environment Review System) tool. PERS assesses the pedestrian environment from a vulnerable pedestrian's point of view. PERS was co-developed with TfL and is now TfLs preferred methodology for pedestrian environment auditing.

2. Aims of the study

The aim of the observational studies was to show how pedestrians interact with trams using examples of other busy centres, enabling TfL to enhance their planning and strategic thinking with respect to pedestrian facilities.

3. Methodology

1.1 Scenarios

In order to capture the most likely scenarios and give a true picture of the impacts that the presence of a tram would have on the designated parts of London, specific attention was given to key areas. Firstly, *Mode Transfer,* this captured pedestrians' movement between large train and bus interchanges and tram stops. *Parks and Open Spaces*- this depicted the likely pedestrian movements in and around trams traversing public spaces. *Peak Events,* this allowed observational studies of pedestrian movements during a peak event such as concerts, theatres and pub closing times. Further scenarios included *retail and pedestrian zones* as well as *high street environments*.

1.2 Locations

The project undertook observational studies of pedestrian interaction with trams using PERS in specific scenarios (e.g. outside a station, busy retail street) in six cities: Manchester, Nottingham, Dublin, Frankfurt, Amsterdam and Vienna. Nottingham, Manchester and Dublin were intended to provide examples of retail areas, town centres and pedestrian zones. Frankfurt Station was an example of mode transfer. Vienna and Amsterdam provided examples of parks and open spaces. Amsterdam provided an example of a peak event via its busy bars and restaurants.

3.2 Assessment

The assessment of the pedestrian and tram interaction involved using a streamlined version of PERS. PERS has a modular approach which splits up different aspects of the street environment. Areas within the designated city centres were audited in terms of four of the six possible components; links (footways), crossings, public transport waiting areas and public spaces. Within each component further parameters and checklist factors were discussed which helped to determine the level of interaction between pedestrian and tram movements. The four components which were used are described below:

1. *Links*: Links were considered as footways, footpaths or highways and were divided into sections if the level of service varied significantly along them. If the service was consistent then it was reviewed in total. The link component includes parameters such as the *effective width* of the footway, *obstruction*s and *user conflict* and was assessed in relation to the width pedestrians have alongside tram lines and whether conflict is likely to occur often as a result of obstructions, high pedestrian flows or narrow effective widths.

   Links are also assessed against parameters such as surface quality, gradient and maintenance amongst others. These are important in considering the interaction between the modes, for example because tram tracks are not flush with the surrounding footway/carriageway trip hazards are more likely to occur. Finally, links are assessed against the level of provision for sensory impaired pedestrians, and this is seen through parameters such as colour contrast and tactile information. This allows partially sighted pedestrians to distinguish between the designated footways and the tram areas. tracks.

2. *Crossings* were assessed in the audit area as any formal or informal crossing where a pedestrian desire line intersects a highway. Parameters within the crossing component, which were particularly important when assessing the interaction between pedestrians and trams, include crossing provision and performance. Other useful parameters within the crossing component of PERS include deviation from the desire line, which looks at the directness of the crossing, legibility, which looks at how easy it is for pedestrians to know that a crossing exists (e.g. by visible road markings, tactile information), and legibility for sensory impaired pedestrians which assesses the level of provision for those with sensory impairments and looks to see if tactile paving, audible information and rotating cones are present.

3. Public Transport Waiting Areas were considered as any designated area where people wait for public transport. This includes both tram stops and bus stops. Waiting areas are important to consider in terms of interaction between pedestrians and trams because they provide the meeting point and aid transition between being a pedestrian to becoming a tram passenger or vice versa. One of the key aspects we assessed was how much information is available for pedestrians who are unfamiliar with the area when they are attempting to navigate to the tram stop and how much information is available for them once they reach the stop. These aspects were addressed by the information to the waiting area parameter and information at the waiting area parameter.

Another key parameter which was tested was boarding public transport. This looked at how easy it was for pedestrians to access the trams from the waiting area. Aspects such as the gap between the tram carriageway and the platform, surface quality and assistance for mobility impaired are all addressed. Further to this, waiting area capacity and waiting area comfort are addressed.

4. Public Spaces were categorised within the audit areas as spaces which allow the public to informally rest and enjoy. Spaces can range in scale from a small plaza to a city park. It was important to assess these spaces if trams went through them as pedestrians act differently within an open space when they are not constrained by footways and carriageway, so it was interesting to observe how they interacted with trams within these environments. Parameters from the PERS tool which were particularly applicable included moving in the space and legibility.

The table below lists all parameters within each PERS component:

Link review	**Crossing review**	**Route review**
Effective width	Crossing provision	Directness
Dropped kerbs	Deviation from desire line	Permeability
Gradient	Performance	Road safety
Obstructions	Capacity	Personal security
Permeability	Delay	Legibility
Legibility	Legibility	Rest points
Lighting	Legibility for sensory impaired people	Quality of the environment
Tactile Information	Dropped kerbs	
Colour contrast	Gradient	
Personal security	Obstructions	
Surface quality	Surface quality	
User conflict	Maintenance	
Quality of the environment		
Maintenance		
Public transport waiting area review	**Interchange Space review**	**Public Space review**
Information to the waiting area	Moving between modes	Moving in the space
Infrastructure to the waiting area	Identifying where to go	Interpreting the space
Boarding public transport	Personal safety	Personal safety
Information at the waiting area	Feeling comfortable	Feeling comfortable
Safety perceptions	Quality of the environment	Sense of place
Security measures	Maintenance	Opportunity for activity
Lighting		
Quality of the environment		
Maintenance and Cleanliness		
Waiting area comfort		

Table 3.1 Review parameters

Each review form required the auditor to score and comment on each parameter which is summed to create an overall score for each link, crossing, waiting area or space. Parameters were scored from -3 to +3, where +3 is the highest score and -3 the lowest. For a parameter to score +3 it would need to be exemplary and of a standard to be identified as best practice. Scores were quantitatively analysed after the observational studies using the PERS software.

4. Findings and Recommendations

This research allowed the project team to make recommendations about designing tram systems that are pedestrian friendly and in line with best practice from around the UK and Europe. The following sections highlight the key principles which should be considered when addressing pedestrians in light of any new tram schemes.

4.1 Mode transfer

Crossing the tramway

Pedestrians using the interchange areas outside large railway stations often have to cross busy, complex junctions which can be confusing (as shown in Plate 4.1). When designing the street environment for trams in these areas, the delay and safety of pedestrians should be considered. If pedestrians have to wait too long at a controlled crossing or are not sure which direction traffic is coming from, their safety may be compromised. Crossings should be situated on natural desire lines. Puffin-style crossings should be used to ensure that the pedestrian 'green man' is long enough for all users to complete their crossing. Waiting times should be kept to a minimum and pedestrian signals linked so that there is a continuous pedestrian phase across all sections of a crossing.

Plate 4.1: Junctions outside railway stations can be complex

If trams need to make turns at large junctions then the design should consider any informal pedestrian movements that may be made and avoid pinch points (as shown in Plate 4.2).

Plate 4.2: Ensure that pinch points are avoided

Legibility

Many users at large railway stations will be new to the area and may not be expecting trams. The street environment should provide information about the presence of trams using signage and surface delineation and maximising sightlines as seen in the below plate taken in Manchester city centre.

Plate 4.3: Good legibility to local tourist attractions in Manchester

High quality pedestrian way-finding systems such as the 'Legible London' system that was recently piloted at Bond Street should be installed in 'mode transfer' areas where many pedestrians will be new to the space and may find it hard to orientate (Plate 4.4). Pedestrians will be safer if they are able to orientate easily and can concentrate on the street environment.

Plate 4.4: High quality pedestrian signage and way finding systems can help pedestrians orientate themselves

Information regarding the location of tram stops should be clearly indicated at interchange spaces; this is to ease the transition between the modes of transport. Directional signage and maps should be located at the interchange point for example at bus stops for those wanting to use the tram after disembarking from the bus and these should indicate where the nearest tram stops are located. Information at the stops should be clear and legible, they should be well maintained and updated frequently as seen below in Manchester's Piccadilly Square (Plate 4.5).

Plate 4.5: Local information boards (which includes transport information) being updated in Piccadilly Square, Manchester

Legibility does not only refer to the provision of signage but is also concerned with the clarity of the tram environment and associated infrastructure. For example if pedestrian flows are expected to be high at night then the legibility of the tramway should be designed to take this into account. An example of good practice includes the lights set into the footway to delineate tramway in a shared surface street (Plate 4.6) at Rembrandtplein, Amsterdam which gives a clear distinction where the tram lines are and aids separation. It can also help partially sighted pedestrians with navigation after dark.

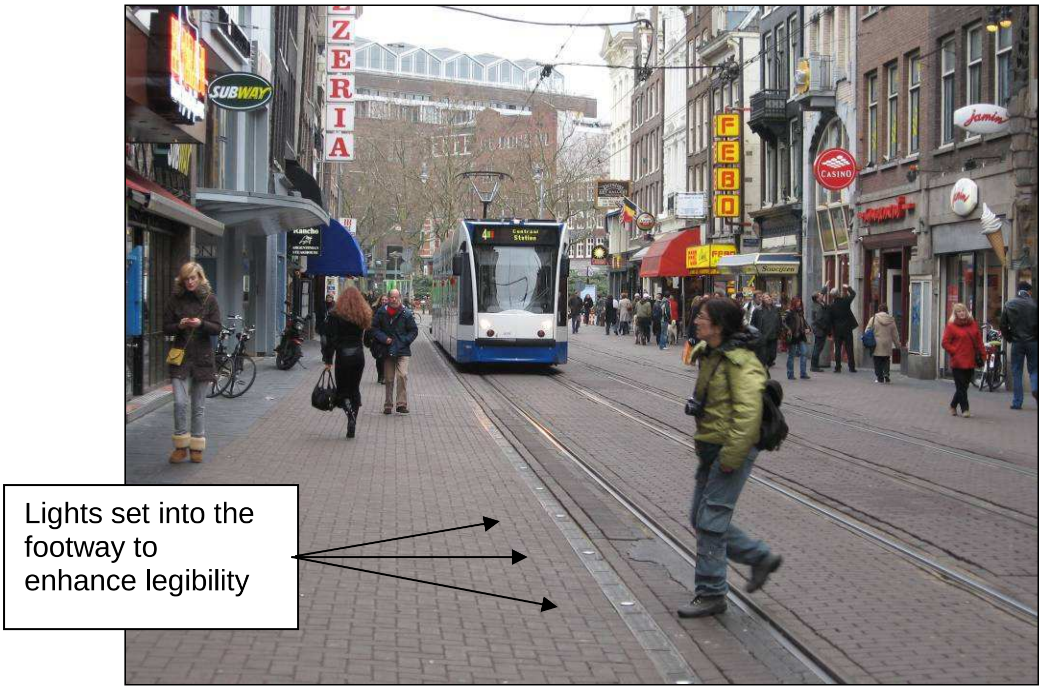

Plate 4.6: Lights set into the footway may enhance the legibility of the space when it is dark

4.2 Tramway design

The observational studies provided significant opportunities to highlight best practice in terms of tram design. One of the key recommendations for future development of tramways would be to have a distinct carriageway colour or surface texture in comparison to the surrounding footway and/or pedestrianised area. The reason for this would be to allow a clear distinction for partially sighted pedestrians and it would enable them to avoid walking on designated tram areas. Further to this, in order to avoid congestion and to ensure that tramway designs are inclusive for those in wheelchairs the effective width must be considered. For example, it is recommended that the footway width beyond the tramway should be a minimum of 1.5m. This, according to Inclusive Mobility (DfT, 2002), would allow a wheelchair user and ambulant person to walk side-by-side. This measurement would also allow obstructions within the footway such as lamp and sign post columns to be catered for.

In terms of Tramway design it should also be considered that overhead equipment should be attached to buildings where possible; alternatively, the masts should be used for other street furniture such as signage, lighting and traffic signal heads. This is to ensure that street clutter is kept minimal and reduce obstructions and to enhance visibility of pedestrians to tram drivers and trams to pedestrians.

Plate 4.7 shows how the tram infrastructure can impose on the area if this is not accommodated for.

Plate 4.7: Tramway infrastructure can dominate the pedestrian environment

Research has also shown that tramway design should also be complemented by relevant signage provision. For example, if the rear of the tram is likely to swing out on a bend, this needs to be clearly marked for pedestrians.

4.3 Tram stops

It is evident that the tram stops themselves can largely assist with pedestrian and tram interaction. A simple yet commonly poorly executed aspect is the provision of signage to the waiting area. The level of this provision greatly affects the level of ease that a bus user will have in getting to and from the waiting area. Poorly visible tram stops can reduce the experience for pedestrians as it can lead them to getting lost or frustrated. This is likely particularly for tourists or elderly pedestrians who may be disorientated with the environment.

Tram stops should also have suitable information at the waiting area. This relates to the ease of use and the quality of the static information that is provided at the waiting area, both on the tram flag post and in the shelter if one is present. Stops should have comprehensive up-to-date real-time information on trams (including location, route maps and timetables) and also local information/maps and signage to local attractions. In addition to the provision being present, factors such as the positioning, visibility, legibility and type of information should also be considered as this is crucial to the user being able to use the information provided. It is also important to consider the positioning and legibility for partially sighted and mobility impaired users. For example, those who may be in a wheelchair may not be able to read timetables if they are high up.

In terms of the location of the tram stops themselves, it is important for them to be as much on the pedestrian desire line as possible but should not sever them where this could result in pedestrians 'cutting' between stationary trams. It is also important to consider the suitability of the footways and pedestrian crossings surrounding the waiting area in terms of the quality of service provided to users in getting to and from the waiting areas.

The tram stops should also have measures to ease the boarding of the tram carriages. Aspects such as the gaps created between the tram and the platform should be minimal in order to aid users who may be mobility impaired (see Plate 4.8). Additionally platforms should be raised to allow step-free access to the trams, with either a railing at the rear or a gentle slope to the footway.

Plate 4.8: Minimal gap between platform and tram

Tram stops should also be installed to a level where pedestrians will feel comfortable waiting. Comfort can be assessed in terms of presence, suitability and quality of the shelters and seating. Consideration should be given to the context in which seating and shelter is provided and the number of people likely to require the provision. The waiting area should also be inclusive with designated areas under the shelter for wheelchair users. The shelter should be transparent to aid visibility and have a back to provide protection from adverse weather conditions. Recommendations on shelter design can be found in Oxley, Barham and Saw (1994).

Plate 4.9: Tram stop offering good capacity but lacks shelter

The location of tram stops and their location in terms of the surrounding environment is also crucial when looking at their interaction. Safety Perceptions and other trigger factors such as the presence of graffiti, proximity of telephones as well as a sense of local ownership can determine how likely pedestrians will want to wait for a tram at a certain stop. The ability to see and be seen from a tram stop and how neglected an environment feels can heighten the fear felt by waiting pedestrians particularly at night time. Security measures (such as CCTV, emergency help point, police presence, presence of shops and passersby) will enhance personal safety.

4.4 Pedestrian crossings

When considering interaction between pedestrians and trams it is also important to consider that other modes may also be interacting at the same time. For example it is likely that buses will use the same carriageway as the trams which was seen at a number of the sites including Amsterdam and Manchester. Therefore it is important that adequate crossing provision is installed in order for pedestrians to negotiate all the vehicular flows. At the most basic level it is important to assess if provision is actually installed. If the provision is installed it is important to establish if it is appropriate, for example is an unsignalised but formal crossing with tactile information sufficient or should a signalised crossing with a pedestrian phase be more appropriate? It is also important to establish whether the crossing has been positioned on the desire line or whether pedestrians must deviate significantly to reach the crossing point or in fact cross informally, which questions the validation of having a crossing point installed.

The capacity of a crossing and its associated waiting areas and refuges are also critical when looking at the interaction between pedestrians and trams (and other vehicles). The reason for this is that if waiting areas are insufficient in terms of their capacity, it may mean that pedestrians will spill or overflow onto the carriageway thus potentially colliding with a tram. It is therefore important, especially in highly congested, high street type environments, that this capacity is adequate for flows and worst case scenario catered for.

It is important to consider sightlines at crossing points, as by increasing the visibility between the modes, there is less chance of collisions. As a result obstructions and crossing infrastructure should be kept to a minimum and located out of the view of pedestrians and tram drivers. Clear sightlines will also allow those pedestrians who do not want to wait for a green man phase on a signalised crossing to informally cross if they believe the crossing to be clear. Although this should not be encouraged it does provide increased safety measures for movements which will inevitably take place.

If sightlines cannot be improved, for instance when buildings obstruct views, then crossings should be made more legible using signage and surface markings for emphasis (as shown in Plate 4.10).

Plate 4.10: Signage and surface markings can improve the legibility of a crossing

Colour contrast can also greatly assist in showing designated crossing areas and can psychologically encourage pedestrians to cross in the allocated space and avoid unnecessary conflict. The examples below are from outside Debenhams in central Manchester on Market Street (seen in Plate 4.11).

Plate 4.11: Good colour contrast at formal crossings with pedestrian phase

4.5 Provision for Disabled Pedestrians

It is important when considering interaction between pedestrians and trams to be inclusive and consider the needs of disabled users. There should be both colour contrast and textured paving which usually comes in the form of lozenge tactile in order to indicate the edge of the platforms. Good examples of lozenge paving were seen at tram stops in Dublin and good colour contrast seen in Remandtplein in Amsterdam (seen in Plate 4.12). Provision should be installed in line with DfT's Inclusive Mobility (2002) guidelines.

Plate 4.12 Best practise lozenge paving in Dublin (left) and good colour contrast at tram stop in Remandtplein, Amsterdam (right)

Additionally, best practice measures in terms of provision for disabled pedestrians can be seen at Manchester, where there are designated access and egress points for wheelchair users marked by paving stones with wheelchair symbols on them at appropriate points on the platform. In addition to the paving, the boarding sign is mounted on the shelter so on approaching the tram stop, wheelchair users can see where on the platform they need to be to board both safely and most easily (both are seen in Plate 4.13).

Plate 4.13: Designated boarding points for disabled users

5. Summary and Conclusions

The research discussed in this paper, included observational studies of pedestrian interaction with trams using PERS in specific scenarios and identified several best practice cases across the UK and Europe. In terms of mode transfer, crossing the tramway and legibility were found to be important as pedestrians using the interchange areas often have to cross a busy, complex junction which can be confusing. Therefore, factors such as delay, desire line and waiting times should be considered when designing the street environment. Moreover, the street environment should offer information about the presence of trams by providing good signage (e.g. at Manchester city centre), good sightlines, well lit environment (e.g. at Rembrandplein, Amsterdam) and surface delineation. Way finding systems such as the 'Legible London' system, which was recently piloted at Bond Street, are highly recommended.

With regards to the tramway design, a distinct carriageway colour or surface texture in comparison to the surrounding footway should be applied. Moreover, the width of the tramway should be taken into account to allow wheelchair users and one other person to walk side by side. This, according to Inclusive Mobility (DfT, 2002), should be a minimum of 1.5m.

Tram stops were also assessed as part of this project. Information to the stop and at the stop should be comprehensive, clear and visible. In terms of design, the tram stops should be at pedestrians' desire lines, should be raised to allow step-free access and any gaps created between the tram and the platform should be minimised. This will especially aid mobility impaired passengers. Other aspects, such as tram stop comfort and safety of the environment were found to be important when designing a tram stop as pedestrians might be more inclined to use a stop if it has shelter and seating and is located in a nice and safe environment. Security measures such as CCTV and police presence will enhance perceptions of personal safety.

Adequate crossing provisions around tramways should be installed in order for pedestrians to safely negotiate all traffic. Firstly, it is important to establish if the current crossing provision is suitable (e.g. should it be signalised or unsignalised?). Secondly, other factors such as crossing capacity, desire line, legibility and sightlines should be considered to allow safe and easy crossing for all users.

Finally, it is important that provisions for disabled pedestrians will be taken into account. Colour contrast and tactile paving should be included as good practice. For example, Manchester city has shown good practice measures by installing designated access and egress points for wheelchair users marked by paving stones with wheelchair symbols on them at specific areas on the platform.

The research findings are not only applicable to London's environment but can be applied as best practice techniques to new tram networks, for example the proposed Edinburgh tram network due to open in 2011. This outlined the main conclusions from the research as well as recommendations on how to design streets that work for both pedestrians and trams.

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