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NEED OF BOARDING ASSISTANCE DEVICES FOR IMPROVING RAILWAY VEHICLE ACCESSIBILITY

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Abstract: *EU regulations require that public transportation systems be accessible for everyone without any restrictions. This includes not only disabled people, but also elderly, passengers with baby carriages, big sized luggage etc. i.e. all people with some kind of reduced mobility. Assuring accessibility for all is an inevitable future obligation for railway operators. The interface between platform and rail vehicle is one of the largest railway accessibility problems particularly for wheelchair users. Most railway vehicles require special boarding devices to provide accessibility. To advance the current situation a project consortium (PubTrans4All) funded by the EU in FP7 will develop a new boarding assistance system that can be used not only by wheelchair users, but by other people with reduced mobility.*
Key words: *accessibility, vehicle entrance, boarding assistance device, people with reduced mobility*

1. INTRODUCTION

The process of boarding rail vehicles consists of several connected steps: passengers must get to the rail station; they must get to the platform; finally, they must get from the platform to the rail vehicle. Once on the rail vehicle they must have an appropriate space to ride and access to various services. The process of alighting follows the same steps in reverse. The PubTrans4all project - funded by the EU within the 7th framework programme - focuses on the problems of people with reduced mobility in getting from the station platform into the rail vehicle. The project's main goal is development of a better boarding assistance system (BAS).

1.1 MAIN PROBLEM - EXISTING HIGH FLOOR VEHICLES

The main accessibility problem for rail transport operators is that many old trains, suburban or tramway lines have significant vertical differences (e.g. steps) and horizontal gaps between the vehicle and the platform. This problem is accentuated by the fact that rail rolling stock and infrastructure has a very long service life. Railway operators will use their current rolling stock for many more years and therefore, temporary solutions must be found until the fleet can be replaced with modern fully accessible rolling stock.

1.2 DIFFICULTIES - HUGE VARIETY OF PLATFORMS AND VEHICLES

It is difficult to develop a standard accessibility solution because of the huge variety in rolling stock and platform heights. Even on a single rail line several different types of rolling stock are often used and platforms may have different heights and profiles. Moreover, the exact physical dimensions of

rolling stock (e.g. height) can also vary depending on its occupancy and wear. Designers must also consider a safety margin between the train and platform to account for train rocking etc. Finally, accessibility devices must work under all types of environmental conditions (e.g. rain, snow, etc.).

2. EVALUATION CRITERIA

This section presents an overview of all relevant parameters that must be considered when designing a new boarding assistance system. Table 1 presents the importance scores used in ranking the evaluation criteria. Table 2 summarizes the evaluation criteria. Features rated as not important, are not shown herein.

Table 1: Criteria importance scoring

Score	Meaning
1	Very important – critical to successful operation ("must have")
2	Important – high benefit for users and operators ("nice to have")
3	Less important – some benefit for users and operators, but not absolutely necessary

Table 2: BAS evaluation criteria - overview

Criteria	Remark	Importance
User		
User with devices	wheelchair, walking frame, baby prams	1-2
Physical impaired	Walking disabled, with crutch or sticks, elderly, diminutive people	2
User with special needs	Visual and hearing impaired	2-3
General passengers	Passengers with luggage, children, pregnant	2-3
Operation without staff	Operation by passengers themselves, automation	2
Operator		
Reliability of BAS	Prevention of Malfunction	1
Operational quality	Short dwell time, malfunctions must not influence train operations	1-2
Operational effort	Number of staff	1-2
Failure management	Problems easy to solve	1
Manufacturing/ Implementation		
Universalism	The system needs to be universal, retro-fitting allowed	1-2
Costs	Costs as low as possible	1
Manufactur-ing effort	The manufacturing effort needs to be low – especially when retro-fitting	1-2
Safety		
Safety risks	No safety risks to be tolerated	1
Safety features	Optical and audio signals	1-2
Maintenance		
Maintenance effort	Number of personnel required, special tool required	1
Costs		2
Sustainability	recyclability and energy consumption	3
Aesthetics		
Optical design	Aesthetics is important for customer acceptance	2-3
All regulations must be fulfilled (currently according to TSI-PRM) as a minimum standard. Some specifications in project PT4All have been set higher than required.		

Table 3 presents the most important technical and operational requirements that must be considered when designing a BAS.

Table 3: BAS technical and operational requirements

Framework Requirements	limit
***Total duration* for use→** *preparation, use, stowing*	< 2 min
Platform width	> 130 cm
Vertical gap *platform - vehicle*	< 110 cm
Access door width	≥ 80 cm
Access door *resting height from the floor*	> 174cm
Capacity (wheelchair)	350kg
Relative angle platform-vehicle*	< 13.2% or 7.5°

* Transverse gradient of platform and super elevation of track

3. IMPROVEING ACCESSIBILITY

Improving accessibility means either creating level-boarding by adjusting platform height to the vehicle floor height or providing boarding assistance systems (BAS) that enable mobility impaired passengers to reach rolling stock floor levels from platforms at a different level. There are two main types of boarding assistance systems: platform-based and vehicle-based.

Platform-based systems are usually simple manual operated devices. At least one device is needed at each station that is suitable for wheelchair users, and one person per station should be available as BAS operator. Before each train arrives the BAS must be moved at the place where the vehicle adapted for wheelchair users is expected to stop.

The advantage of all vehicle-based devices is that they are always available (i.e. at the right time and place and in all stations), because they are placed in vehicles adapted for wheelchair users. This makes it possible for people with reduced mobility to ride even without making arrangements for travel in advance. This is very important for both the users and the "accessibility for all" policy of the railway operators.

The on-board conductors can operate this equipment, which is more convenient for operators than the case of platform-based BAS.

For each BAS there are two main technologies: ramps or lifts (elevators); and, two sources of power manual or electro-mechanical.

The following sections present a short overview of existing systems that are typically used for high floor vehicles. Existing systems for low floor vehicles (e.g. gap bridging systems) are not part of this paper.

3.1 RAMPS

Ramps are generally the simplest and least expensive BAS devices. However, they can only be used if the vertical difference vehicle floor-platform is not significant (i.e. high), since otherwise the ramp slope would be too great to use safely, or the ram would be very long. Most ramps cannot be operated without the assistance of rail operator staff.

There are five different types of ramp based BAS solutions: platform-based manual ramps, vehicle-based manual ramps, vehicle-based electro-mechanical ramps, vehicle-based horizontal gap closure ramps and platform-based horizontal gap closure devices.

3.1.1 PLATFORM-BASED MANUAL RAMPS

This consists of a movable ramp located on station platforms. They require staff assistance to operate.

Manual ramps must have an ergonomic design both for the wheelchair users' comfort, but also to

ensure good operating conditions for the train staff (weight, manoeuvrability, etc.). If the boarding assistance devices are easy to handle, staff will be more willing to use them.

Several rail transport operators use manually deployed ramps also for high floor vehicles. Figures 1, 2 and 3 show examples of platform based ramps that are also used for larger vertical gaps.

Fig.1. *(left picture) Ramp used in Belgium and the Netherlands - ramp goes around the corner*

Fig.2. *(right picture) Two rail ramp used in Norway – difficulties, huge problems!*

Fig.3. *Ramp used in Germany*

3.1.2 VEHICLE-BASED MANUAL RAMPS

Vehicle-based manual ramps are ramps that are located on the vehicles. They also require the assistance of rail operating company staff to deploy and use. The advantage of vehicle-based ramps is that they provide accessibility to all stations from the trains that have them installed since they are on the train. The ramps may be permanently attached to the vehicle or simply stored on the vehicle.

The figures 4 and 5 show some examples of vehicle based ramps that are also used for larger vertical gaps.

Fig.4. *Ramp used in Austria*

Fig.5. *Ramp used in Latvia*

3.2 LIFTS

Lifts are mechanical lifting devices either attached to the vehicle or mobile lifts placed on the platform. Lifts are used in cases where slopes are too great for ramps.

A key advantage of lifts is that they are very flexible. Platform-based lifts can adapt to almost all types of rolling stock and stations since they can be moved around on the platform and can bridge variable horizontal gaps and vertical changes. Similarly, vehicle-based lifts can adapt to many different platform heights.

3.2.1 PLATFORM-BASED LIFT

These lifts are operated by railway operator staff and are often pushed around the platform to the train door and then hand-cranked. Similar to manually deployed ramps, these lifts must be ergonomically designed, not only for the wheelchair user, but also for the staff who must move and operate the lift. The following figures show some examples of platform based lifts.

Fig.6. *Platform based lift used in Germany*

Fig.7. *Platform based lift used in France*

3.2.2 VEHICLE-BASED MECHANICAL LIFT

These consist of elevator platforms that extend from trains. They are normally operated by the railway operator staff. Figures 8, 9 and 10 show examples of vehicle based lifts. Figure 11 show an interesting example of a rotating lift inside the vehicle.

Fig.8. *Vehicle based lift in Sweden*

Fig.9. *Vehicle based lift in Switzerland*

Like platform based lifts this BAS can be used to provide access for differences in platform to vehicle floor heights of 1100mm or more. Usually this type of BAS requires a sufficient width of the platform in order to provide enough space for safe wheelchair roll on/roll off, but a little bit less than platform/based lifts. Lifts with parallel to train boarding and alighting also exist.

Fig.10. *Vehicle based lift in Sweden*

Fig.11. *Vehicle based lift in Sweden - Regina train*

An additional advantage of vehicle based mechanical lifts is the possibility to evacuate wheelchair users in extraordinary conditions even on track without platforms.

Vehicle-based mechanical lifts require an energy source and two devices (one on each side of the vehicle) must be provided. The wheelchair platform must be a little narrower then door width. Lifts occupy space at the entrance doors, which is problematic in classical UIC wagons (since space is at a premium).

4 CONCLUSIONS

The goal of the PubTrans4All project is to develop an improved boarding assistance system, and facilitate accessibility of railway vehicles. The project is being completed as part of the EU FP7 Programme.

The project's first step was to develop evaluation criteria for both existing and new BAS. The second step was to complete a comprehensive research study about existing BAS across Europe and the world and to evaluate these BAS using the criteria.

Results of these activities (presented in this paper) illustrate the complexity of developing a universal and standardised BAS solution which will work for all different vehicle and platform conditions,.

The project will focus on the most difficult case of accessibility for classic UIC wagons expecting that the solution for these vehicles will be most universal and also usable on other rail vehicles.

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НЕОБХОДИМОСТ ОТ ПОМОЩНО УСТРОЙСТВО ЗА КАЧВАНЕ С ЦЕЛ ПОДОБРЯВАНЕ НА ДОСТЪПА ДО ПРЕВОЗНИТЕ СРЕДСТВА

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Резюме: *Нормативните документи на ЕС изискват обществени транспортни системи да бъдат достъпни за всички, без никакви ограничения. Това включва не само хора с увреждания, но също така и възрастни хора, пътници с бебешки колички, големи размери багаж и др., т.е. всички хора с някакъв вид намалена подвижност. Осигуряването на достъп за всички е неизбежно бъдещо задължение за железопътните оператори. Интерфейсът между платформата и железопътните вагони е един от най-големите проблеми за железопътната достъпност, особено за тези, които използват инвалидни колички. За да осигурят достъп, повечето железопътни вагони се нуждаят от специални устройства за качване. За подобряване на настоящата ситуация консорциумът на проекта PubTrans4All, финансиран от ЕС по Седма рамкова програма (FP7), ще разработи нова система за помощ при качване, която може да се използва не само от пътници с инвалидни колички, но и от други хора с намалена подвижност.*

Ключови думи: *достъпност, вход на превозно средство, помощно устройство за качване, хора с намалена подвижност.*