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Prof. dr Dušan Stamenković
dr Branislav Bošković, docent
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Tehnička priprema / Technical preparation

Miroslav Mijajlović, dipl. inž. maš.
Milan Banić, dipl. inž. maš.

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SADRŽAJ / CONTENTS

Plenarna sednica / Plenary Session

Radovi na engleskon / Papers in English

XIV SCIENTIFIC-EXPERT CONFERENCE ON RAILWAYS RAILCON'10

PASSENGER BEHAVIOUR IN BOARDING SITUATIONS AND RELATION BETWEEN PLATFORM HEIGHT AND ROLLING STOCK FLOOR HEIGHT

Aleksandar RADOSAVLJEVIĆ[1]
Bernhard RÜGER[2]
Simo MIRKOVIĆ[3]

Abstract *– This paper deals with passenger change over time and passenger behaviour in different boarding situations. Some difficulties for passengers when boarding are going to be explained upon surveys made recently in Serbia and other countries. Overview of platform heights on some European networks is going to be discussed in accordance with UIC regulation. An overview of floor heights on passenger coaches, DMUs and EMUs for suburban and regional railway transport will be shown. This paper will focus on the differences of passenger behaviour, difficulties and the time need in different boarding situations.*

Keywords - passenger behaviour, dwell time, platform height, railway, DMU, EMU

1. INTRODUCTION

A large number of passengers have got problems when boarding a train. Especially people with reduced mobility – these can be walking disabled, elderly, but also passengers with luggage or baby carriages – have got troubles when boarding classical high floor vehicles. Beside the problems passengers can meet also the operators can have difficulties with bad boarding situations because of the longer dwell time.

This paper will focus on the differences of passenger behaviour, difficulties and needed time in different boarding situations. Here, especially the influence of possible high differences between the platform and the vehicle floor will be analysed.

All the information in this paper is part of many years of investigation at the Vienna University of Technology and of analyses done by CIP Institute of Transportation. Further, special passenger surveys from Serbian railway passengers are taken into account.

2. BOARDING SITUATIONS

Regarding to the question what difficulties passengers have when boarding a train in different boarding situations - different vehicles combined with different platforms - can be categorised as following.

2.1. Difficulties for passengers when boarding

Fig.1 to Fig.4 are showing the combinations and connections between parameters such as access type, luggage and passenger-age [1]:

- **Cat 1:** Level Boarding, one stair step max.: travellers of all ages, with or without luggage, rarely have difficulties.
- **Cat 2:** Access with two stairs, wide doors, and stairs with flat angles: travellers with luggage independently from age have rarely difficulties when accessing the vehicle. Nevertheless more than 10% of travellers with luggage do have severe and very severe difficulties, of which 7% do need assistance.
- **Cat 3:** Access with RIC wagons and related trains (3 stairs from platform): Between 10-15% percent of travellers have difficulties or a lot of difficulties when accessing the train without luggage and 25-30% when having luggage. Whereas only between 1 and 2% need assistance for themselves, more than 10% need assistance for their luggage.
- **Cat 4:** Old-type vehicles, steep stairs (3-4 stairs from platform): 20-30% of travellers do have difficulties and severe difficulties without stairs and 50% of travellers with luggage, this group including up to 20% that have a lot of difficulties. Approximately 20% of travellers having luggage do need foreign assistance. Approximately 8% amongst the group of 40 to 59 year

[1] Aleksandar Radosavljević, Ph.D., Institute of Transportation CIP, Belgrade, Serbia, radosavljevica@sicip.co.rs
[2] Bernhard Rüger, Ph.D., Vienna University of Technology, bernhard.rueger@tuwien.ac.at
[3] Simo Mirković, B.Sc., Institute of Transportation CIP, Belgrade, Serbia, smirkovic@sicip.co.rs

old, and approximately 20% amongst the group of over 60 year-old, require personal assistance when accessing the vehicle.

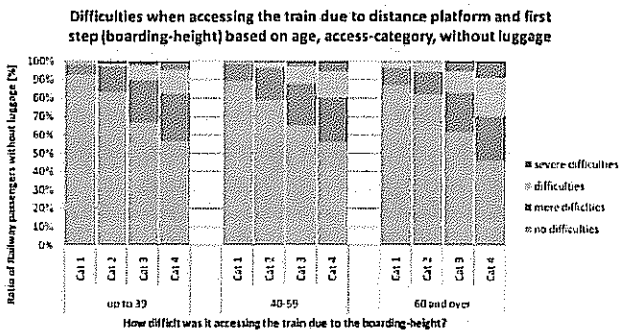

Fig.1. Difficulties of passengers WITHOUT luggage when accessing the train

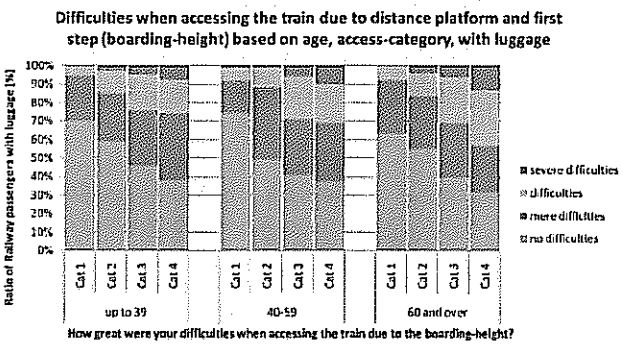

Fig.2. Difficulties of passengers WITH luggage when accessing the train

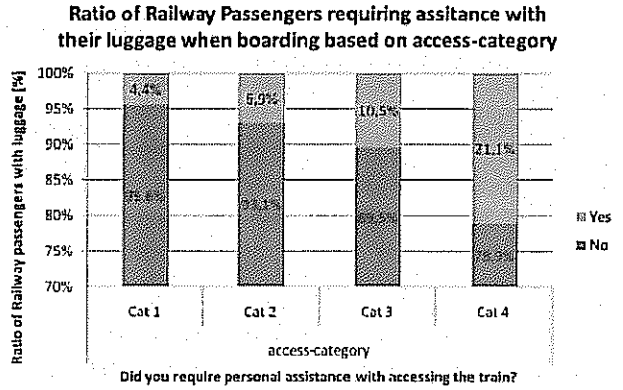

Fig.3. Needed help when boarding with luggage based on different access-categories

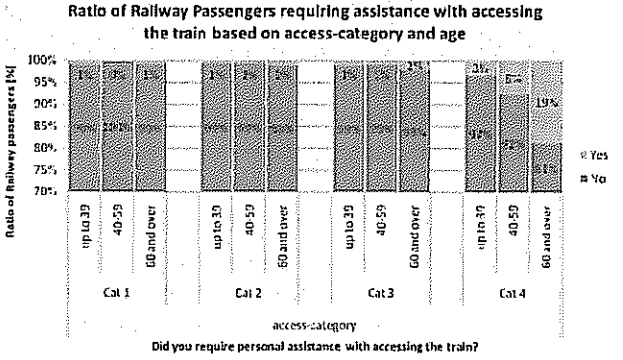

Fig.4. Needed personal assistance when boarding based on different access-categories and on the age

The survey clearly shows that the great part of the travellers have no problem when using an access with no step or even one step. With two steps are to be passed in combination with luggage the difficulties are growing rapidly.

Especially elderly and small children have got big problems when they have to pass a vertical gap of about more than 250mm. Fig.5 shows a step high of about 400mm and the difficulty small or older passengers have.

Fig.5. Difficulties for elderly and small children with a large vertical gap

Fig. 6 shows many different platform heights that exist in Europe. The EU-standard is 550mm and 760mm. Many new vehicles – especially for local traffic – have got a vehicle floor high of about 550mm. So this situation allows level boarding. Also double decker trains offer level boarding over these platforms. They can also be used for long distance InterCity-traffic. Platform height of 760mm is typical for high speed trains. So, there usually remain only two steps. Some high speed trains have got a lower vehicle floor, like TGV or Spanish Talgo-trains. Here passengers do only have to pass one step or to get into from level boarding.

- 150 mm
- 250 mm
- 300 mm
- 380 mm
- **550 mm (EU-Standard)**
- **760 mm (EU-Standard)**
- 840 mm (NL)
- 915 mm (GB)
- 960 mm
- others

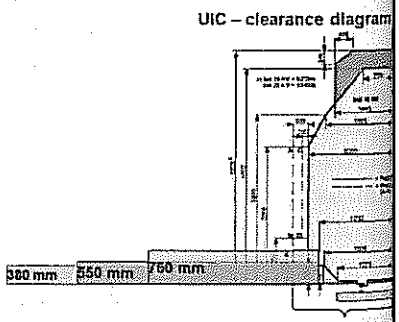

Fig.6. Variety of typical platform high in Europe – combined with the UIC clearance diagram

2.2. Whish of technical help when boarding

For better understanding of passenger problems it has also been asked if passengers would prefer to get technical help for easier boarding – like ramps or mobile lifts.

In situations of level boarding and boarding situations with only one stair, almost nobody would make use of a technical aid. Regardless the luggage situation, 14% of women would use a technical accessibility aid, and 17% of women would make use

of it when using a classic train (see Fig.7).

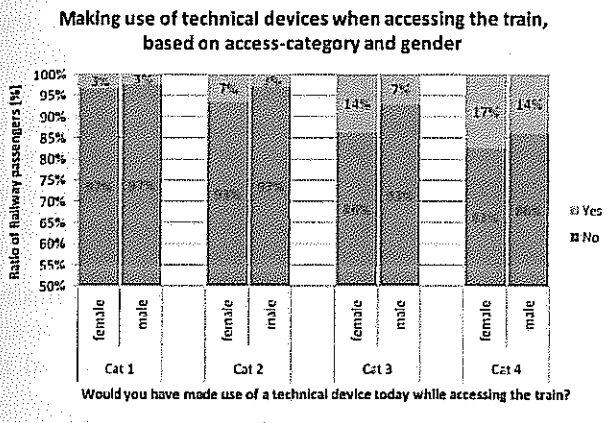

Fig.7. Whish of making use of a technical device based on the access-categories and gender

2.3. Boarding time need depending on the access

For train operation the boarding time is a very important criterion of quality. The boarding and alighting time has got a strong influence on the dwell time and so on the timetable and the punctuality.

The whole vehicle has got a strong impact on the time need. The important areas are the passenger room, the interiors, the entrance area and the immediate entrance – the link between the platform and the vehicle. Here the door width in combination with the number of steps on one hand and the total height on the other have the main influence. Beside the infrastructure of course also the passenger, his age, any mobility reduction or luggage etc. do have a strong influence.

But in the whole system the platform height influences the time need because lower platform means a larger vertical gap. In general we can say that level boarding is the optimum that can be reached with 550mm high platforms and today's vehicles easily. One remaining step is also good for most passengers. Two steps are the limit that can be accepted, but only if we have doors wider than 800mm, so at least 900mm. More than two steps are a very bad solution.

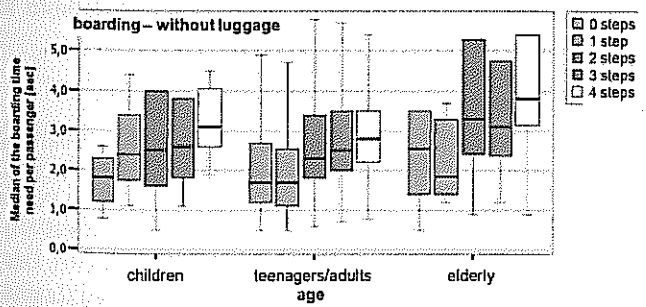

Fig.8. Time need of boarding passengers WITHOUT luggage depending on the number of step

Fig. 8 shows the influence of the number of steps on the boarding time needed by passengers of different age. Here only passengers without luggage are compared. It is also shown clearly that level boarding or boarding over one step are the most time efficient situations. Passengers that have to pass three or four steps need about double the time of passengers who can choose level boarding.

If passengers have to carry luggage (see Fig.9) the influence is even stronger. Passengers with much luggage need up to four times longer when they have to pass 4 steps compared to level boarding [2].

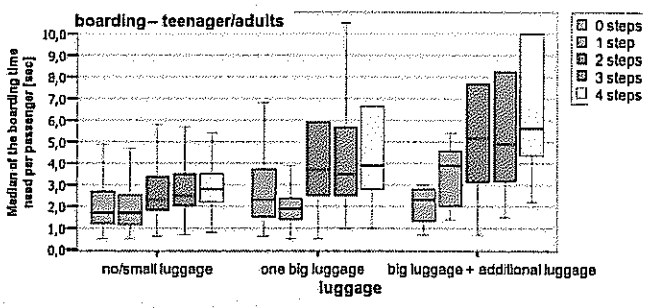

Fig.9. Time need of teenagers and adults when boarding depending on the luggage

3. SERBIAN RAILWAYS ROLLING STOCK AND PLATFORMS

Electrified lines together with lines planned for electrification in near future have 276 service points from which 111 have no platforms at all. Four stations are with high platforms (960mm), 13 have platforms of intermediate heights (350mm<H<550mm) and the remaining are with low (300mm<H<350mm) platforms or have no platforms at all.

When taken into consideration the DMU service on non-electrified lines 130 service points have no platforms at all. Further, 166 service points have platforms of top of rail height, 111 have low platforms (300mm<H<350mm) and only 3 have intermediate heights (350mm<H<550mm).

Serbian Railways mostly purchased single floor passenger coaches with 1255mm floor height above the top of rail what is in concordance with UIC regulations for wheel diameters of 920mm. Each entrance door has three steps which allow boarding over four stepping points (Table 1).

Table 1. Rolling stock characteristics of SR

Series	Height of floor above the top of rail [mm]	Height of the first step above the top of rail [mm]	Maximum car body width [mm]
412/416	1385	591	2810
712/714	1169	595	2850
812/818	1440	600	3000
710	1230		2878
Car Z A4B6	1255	565	2825

EMU 412/416 is still the only train for urban and suburban transport on network of Serbian Railways. Floor height is 1385mm above the top of rail. Vestibule area has three steps and the lowest is on 591mm resulting in difficulties when boarding in

stations with no platforms or with low platforms.

Train width is just 2810mm which creates boarding and alighting problems even on high platforms because of large gap between the platform edge and the vehicle.

Table 2. Characteristics of some new DMUs

Producer	STADLER	SIEMENS	Bombardier	Metrovagonmaš
Series	GTW 2/6	642	643	RA-731.25
Width [mm]	3000	2830	2925	2934
Low floor height [mm]	585	575	590	-
High floor height [mm]	1000	1250	1130	1270
Powered wheel diameter [mm]	860	770	760	860
Running wheel diameter [mm]	750	710	630	750

DMU RA-731.25 (Table 2) has vestibules with two upper steps which are fixed and two lower movable steps. The upper movable step positioning is in connection with door opening. Its height is 560mm above the top of rail. Only in stations with low platforms and with no platforms at all every single fourth lower movable step is activated separately by electro-pneumatic devices designed for it. The height of the lowest step is 380mm above the top of rail.

Table 3. Characteristics of some new EMUs

Producer	STADLER	SIEMENS	Alstom
Series	FLIRT	Desiro ML	CORADIA
Width [mm]	2880	2820	2920
Low floor height [mm]	570	800	600/760
High floor height [mm]	1120	1000	1080
Powered wheel diameter [mm]	860	850	850
Running wheel diameter [mm]	750	770	780

In technical requirements for procurement of new EMUs Serbian Railways indicated that EMUs must have, on each side of each car, at least one double door for entering and exit of passengers. Entrance and exit must be easily and safely accessible from all indicated platform heights. Height of the floor at the entrance area must be from 550 to 600mm.

The choice of platform heights on network of Serbian Railways and purchasing new rolling stock (Table 3) should take into consideration existing vehicles and platforms together with intention of minimizing gap between platforms and first door step. Further, it is necessary to minimize the number of steps between platforms and vestibule [3]. In accordance to UIC 741 [4] following situations are suggested:

- Urban and suburban trains should have no level difference between platforms and vestibules or maximum one step for accessing the train. The maximum of two steps is allowed when trains are in service out of suburban areas.
- Regional trains should be accessed from platforms with equal height as the vestibules or over one step. Not more than two steps can be consider acceptable for passengers.
- Intercity, inter-regional and high speed trai should not have more than three steps accessing trains from station platforms

Based upon analysis of rolling stock and platfor on network The Serbian Railways Commission Platforms decided that new EMUs/DMUs shou allow easy boarding and alighting of trains passengers over first step:

- At height of cca. 550mm (equal to mediu platform height) for EMUs in regional service an
- At height of 350mm for DMUs in regional a local service (at low platform height).

4. CONCLUSIONS

The best boarding situation that can be offered the passengers is level boarding. All passenge benefit from this situation – passengers with reduc mobility as walking disabled, elderly but al passengers with luggage or baby prams.

Level boarding is not only the most comfortat access for passengers but also the best and most tir efficient situation for the operators. Passenge approximately need double the time when boarding high floor vehicle compared to level boardir Passengers with heavy luggage can need up four tim longer when boarding a vehicle with four steps. T worst situation is to have platforms lower than 250m so that the first step is more than 300mm. Here t influence is even worse.

Quite similar to level boarding is boarding ov step if not higher than 250mm. This situation can handled by the most passengers without a difficulties. Also the time need is very similar to lev boarding, only elderly with luggage and passenge with more than one luggage item need more time.

Having two steps at maximum height difference about 500mm is the worst combination that should allowed. Passengers passing over more than two ste generally have many difficulties. When having tv steps in passenger exchange it is very favourable have a door width of at least 900mm.

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