



CETRA²⁰¹²

2nd International Conference on Road and Rail Infrastructure
7–9 May 2012, Dubrovnik, Croatia

Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



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RAILWAY INTERIORS IN ORDER TO REDUCE DWELL TIME

Bernhard Rürger

Vienna University of Technology, Austria

Abstract

Today, passenger exchange of trains is mostly insufficient. The most important factor determining exchange times is passenger behaviour which is influenced by traveller characteristics, like age and / or mobility constrictions, the amount of luggage and finally the vehicle's design. On days with high passenger-frequencies prolonged passenger exchange time results in extensive stop-over time. This leads to delays, which can also influence other trains and therefore cause further delays. Any delay reduces customer satisfaction, which, on the other hand, shifts modal split to the disadvantage of public transport.

An extensive investigation at the Institute for Railway Engineering at Vienna University of Technology analyses exactly passenger exchange times and intends to demonstrate potential for improvement.

Keywords: passenger exchange, customer satisfaction, dwell time, railway interiors

1 Introduction

There are two alternatives for designing passenger vehicles. One possibility is to try to obtain the maximum number of seats per wagon in order to increase capacity; the other is to take care of passengers' needs and expectations.

The first case is highly inefficient. Not more than 80% of the seats offered can be taken, the dwell time may triple and safety risks will rise. However more efficient vehicles can be designed by taking actual passenger behavior into account. This is the conclusion reached by Vienna University of Technology (TU Vienna), following 10 years of studies by its Research Centre for Railway Engineering. Passenger vehicles can be divided into three areas with different influences on passenger behavior. Firstly immediate access, secondly the entry area and thirdly the passenger saloon. The general design of all three decides whether the wagon or the whole train can be operated efficiently or not.

2 Access

Too narrow doors, too steep and too many steps cause difficulties especially for the elderly, handicapped or simply for passengers with luggage, prams or bicycles. With regards boarding trains in various situations, i.e. different vehicles combined with different platforms, the problems faced by passengers can be categorised as following:

- 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 rarely struggle when accessing the vehicle. Nevertheless more than 10% do have severe and very severe difficulties, of which 7% need assistance
- Cat 3: access with UIC-wagons and related trains (three steps from platform): Between 10–15% of travellers have difficulties or a lot of difficulties when accessing the train without

luggage and 25–30% when carrying 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 (three to four steps from platform): 20–30% of travellers do have difficulties and severe difficulties without and 50% of travellers with luggage. Approximately 20% of travellers having luggage do need foreign assistance. Approximately 8% amongst the group of 40 to 59 year old, and approximately 20% amongst the group of over 60 year-old, require personal assistance when accessing the vehicle

Figures 1 and 2 illustrate the combinations and connections between parameters such as access type, luggage and passenger age:

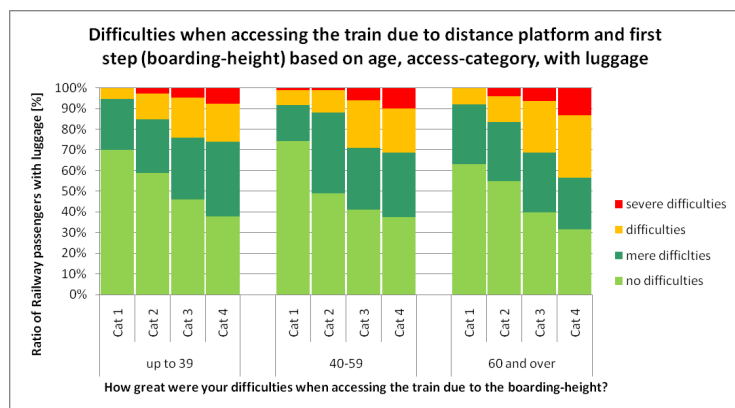


Figure 1 Difficulties encountered by passengers with luggage when accessing trains

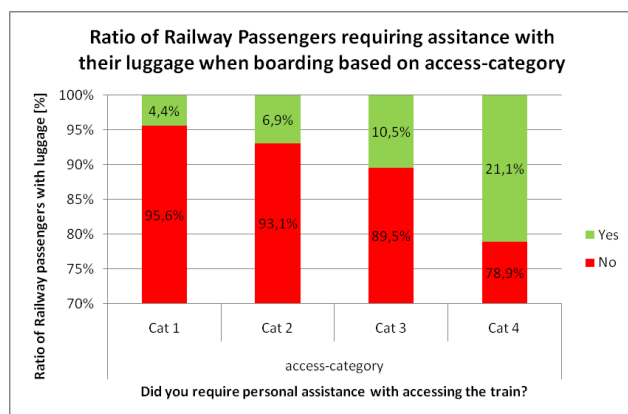


Figure 2 Assistance required when boarding with luggage, based on different access categories

Surveys clearly reveal that the majority of travellers have no trouble when using an access without a step or even just one. However negotiating two steps with luggage is more problematic. To speed up passenger flow in stations to gain shorter dwell times, the most comfortable access possible must be provided – in the best case level boarding, in the worst, two, non-step steps and wider doors (at least 90cm). In addition to the operating benefits, customer satisfaction will rise too.

3 Entry area

The entry area must also function as retention area. Since passengers always walk in a row, a wide space is unnecessary – it is more important that passengers need to go a longer way before they enter the passenger saloon.

For example, in compartment coaches passengers normally need to walk further to reach the first compartment, but also many trains such as the German ICE have a longer route at least at one car end because of the toilets. Even more effective entry areas are those leading to a division of the passenger flow, as occurs in the old Danish IC3 trains or generally in double deck trains.

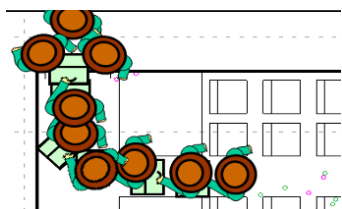


Figure 3 Entry area as retention room

A missing retention area causes an earlier passenger tailback from the passenger saloon plus dwell times may rise considerably. Vehicles with well-designed entry areas and the possibility of passenger flow division deliver shorter dwell times than conventional wagons. This time difference can be up to 100%.

4 Passenger saloon

The passenger saloon is the area in a train where most design mistakes can be found. A too narrow aisle, too little space for luggage and a uniform adjustment of seats lead to trouble with passenger flow, strongly reduce the number of available seats and increase passenger dissatisfaction.

4.1 Passenger behaviour, difficulties, needs & expectations

Passengers behave differently depending on their age, group size, gender and especially luggage. Most travelers on high-speed or long distance trains have luggage. This circumstance is not taken into account in most of the trains in service today. Approximately every passenger has one medium or large bag plus hand luggage. Regarding luggage storage, this raises two points:

- passengers do not want to lift up their bags
- passengers want eye contact with their bags

The fact is that for each passenger approximately the space for one item of luggage must be offered. Otherwise travelers will store their belongings on or in front of seats, in the aisle, etc. This occurs not only when there is no or insufficient space for the luggage but also when storage is badly designed. As mentioned above, passengers must not be coerced into lifting up their bags. Most of them won't do it. Similarly they want to keep an eye on their possessions. And if they can't, they will once again store it close by. Both facts result in the following behavior – if there are no luggage racks nearby, offering comfortable storage, passengers will store all their belongings, including large items, close at hand on the floor.

Interior designs providing unsuitable and insufficient space for luggage will increase dwell times because of a rapidly forming tailback caused by bags in aisles, as well as passengers

trying to store them in the overhead rack and blocking the path of others. So where is the ideal space for storing luggage? Two possibilities are efficient and appreciated by travelers:

- Luggage racks in the saloon
- Space between seat backrests

To meet the need for eye contact, the racks must not be in the entry area. Passengers also hardly ever use them if the wagon is fully occupied and there is no space for bags in the saloon. Additionally, racks in the entry impede passenger flow and so impact dwell times. The same is true for those located just inside the saloon at the entrance. In both cases we have 'lost space' because passengers rarely make use of it.

The best solution is to provide racks fitted around the quarter points of the saloon. This location provides good eye contact and causes minimum disruption to passenger flow.

The space between back-to-back seats is also likely to be used. The big advantage here is that there is no need to raise bags, plus they can be stored close to their owners and within eye range.

Besides the location of storage space, its size is important too. Just a few centimeters determines whether the space is efficient or not. For example, if the backrest distance at the top of the headrest of standard seats is approximately 30cm, 95% of all suitcases can be stored upright. If the distance is 20cm, only 20% of large- and medium-sized suitcases can be stored upright, and all of them in a tilted position. When the gap is only 10cm, no more than 20% of medium-sized suitcases can be stored upright. And if one seat is located direct to the other with no distance between the headrests no medium or large luggage items can be stored at all. And unfortunately this is the situation in most rolling stock today!



Figure 4 Lost space for luggage



Figure 5 Old Greek waggon with much and comfortable space for luggage

The same applies to luggage racks. If they are designed 5 to 10cm too low, 50% of suitcases cannot be stored. Likewise if the racks are narrow. For efficient luggage storage every centimeter counts! To ensure efficiency, it is important to take into account the estimated mix of travel purposes then design the storage space on demand. The vast amount of research findings gathered by TU Vienna is proving extremely helpful for precise and efficient designs, which are demonstrated by several research studies.



Figure 7 Wrong dimensions of luggage racks lead to inefficient storage

4.2 Seat preferences

Beside behavioral problems with luggage, passengers also have different preferences for seats. TU Vienna analyzed real-life passenger behaviour in trains in Austria, Switzerland and Germany. On the one hand passengers were given questionnaires about their wishes and expectations; on the other their actual behavior was analyzed. Out of more than 2,000 trains (about 50 different vehicle types) all information on the real behavior of about 120,000 passengers, combined with personal data, was collected. This database provides precise details on where passengers stow their bags, which seat types are preferred, which ones remain free the longest and much more besides. Special data interpretations of vehicles with different seat configurations in one vehicle and with low utilization rates (about 20% or lower) where passengers have total free choice of seats allow conclusions about which seats are preferred by the travelers.

4.3 Open saloon coach or compartments?

If passengers are free to choose, one half prefers compartments and the other open saloon coaches. As they get older, travelers prefer sitting in open saloons: only about 40% of teenagers prefer open saloon coaches, compared to 55% of adults and 60% of seniors. There are no gender differences if travelling in groups of at least 2 persons but there is a major difference depending on the sex of people travelling alone. While more than 50% of male single travelers choose compartments, only about 20% of women do – 80% prefer the open saloon. In the latter, vis-à-vis seats are chosen approximately as often as row seats.

4.4 Window, aisle or against the direction of travel?

About two thirds of passengers prefer sitting in the direction of travel; one third chooses seats against. About 75% prefer window seats, although this depends on whether they anticipate many passengers boarding the train at the next stations. Passengers don't want to be confined. That means if they are sitting in a facing seat group with a table or in a row seat and

they expect many other passengers to board in the next stations – meaning there is a risk someone will choose the neighboring seat – they will opt for aisle seats. Because others also dislike the confined seats at the window then there is a strong likelihood that others will pass by. And if someone wants to take a free seat than the seat at the aisle allows more freedom. About 80% of passengers choose a seat where the neighboring one is empty because they don't want to be disturbed by others. While around two thirds say they also want to use the free seat to store their luggage.

But although passengers don't want to be disturbed, only around 20% of them who are putting luggage on this empty set do so to prevent anyone from using it! And 80% want their luggage close by or don't want to lift it up.

5 Designing around behaviour

The decade of research at the Research Centre reveals that it is vital to take passengers wishes, needs and expectations, plus all knowledge of their actual behavior into consideration when designing new vehicles or redesigning them.

A maximum seat load in a vehicle does not increase the potential capacity. The break point of the maximum possible capacity is about 15% lower than in vehicles in service today. That means that typical, open saloon coaches with about 84 seats only provide capacity of 65 to 70 seats because the others are blocked – mostly by bags that can't be stored because of the lack of space in general or missing storage space to fulfill the passengers' expectations of not lifting up the luggage and having visual contact. Besides the huge 'luggage issue', paying attention to the general behaviour of passengers and their seat choice is also important. Offering a diversified seat arrangement is vital. A good mix between compartments, facing and row seating in open saloon coaches helps meet both passenger wishes but also matches the needs of different group sizes. Fitting interiors for most of the passengers and different groups not only increases satisfaction but also efficiency, since fewer seats will be blocked compared to today. The greatest wishes of passengers that must be taken into account when designing efficient passenger coaches are:

- luggage storage that offers eye contact at floor level
 - most passengers – single travelers or groups – want to isolate themselves from others
 - comfortable access – 90cm wide doors, level boarding or two, non–steep steps (maximum)
 - good mix of compartments, facing and row seating
 - efficiently–designed luggage storage – between seat backrests and in racks. The space between headrests must be at least 20cm in order to efficiently exploit the space for luggage
- This article sums up the key recommendations, but of course there are plenty of others. Nevertheless by following the main suggestions dwell times can be minimized, actual capacity and passenger satisfaction can be maximized and safety risks reduced.

References

- [1] Rüger B, Loibl C.; 'Präferenzen bei der Sitzplatzwahl in Fernreisezügen'; ETR - Eisenbahntechnische Rundschau, 59 (2010), 11; S. 774 - 777
- [2] Rüger B, Mirkovic S, Radosavljevic A; passenger behavior in boarding situations and relation between platform height and rolling stock floor height, 14. Scientific conference on railways, Nis, 08.10.2010
- [3] Rüger B, Cis P, 'Auslastung in Eisenbahnwagen - Kapazität abhängig vom Verhalten des Fahrgastes' ETR - Eisenbahntechnische Rundschau, 3 (2010)
- [4] Rüger B, Plank, V, Tuna D: 'Des voitures plus confortables et fonctionnelles'; Le Rail 160 (2009), S. 16 - 20