REGARDING TO PASSENGER BEHAVIOR- BASICS FOR OPTIMISING RAILWAY INTERIORS

Bernhard Rüger[1]

Summary: Passengers hardly behave as designers want. The knowledge of actual passengers' demands and how they behave in reality is basic for designing optimised railway interiors. This paper points out basics of this knowledge and shows the most efficient ways to enlarge both, passengers' comfort and railways' efficiency.

1. Introduction

In order to be able to operate long distance rail travel efficiently, attempts are often made to increase the number of seats in the carriages, in order to increase the capacity. The consequence, however, of maximising the number of seats is that only the overhead racks are available for storage luggage. An extensive study at the Institute for Railway Engineering at the TU-Wien, which was carried out on long distance trains in Austria, deals with the actual behaviour of the passengers under a great variety of conditions. An intrinsic result of this study were the two following points. Firstly, travellers would like to avoid having to lift their luggage and so are prepared to put up with disadvantages for other passengers as well as themselves, in order to avoid the lifting up of luggage. Secondly, passengers always want to be able to see their luggage.

If these two basic principles are disregarded when a train is being built then serious disadvantages arise for the passenger and the operator during the daily operating of the trains, which lead not only to increasing dissatisfaction but also to a drop in efficiency.

2. Behaviour of the passengers

If it seems at all possible, passengers try to avoid lifting medium sized and large pieces of luggage. The consequence is that all those areas on the floor or near to the floor, which can come into consideration, are used to deposit luggage. If there are no suitable areas, like sufficient room between the seats or individual luggage racks on the floor, then there are the areas in the aisle and the entrance, free seats and the floor in front of seats.

[1] Bernhard Rüger, Institut für Eisenbahnwesen, Verkehrswirtschaft und Seilbahnen, TU Wien
Karlsplatz 13/232, A - 1040 Wien, Tel.: +43 1 58801 23212, Fax.: +43 1 58801 23299
Email: bernhard.rueger@tuwien.ac.at

Fig 1: Luggage blocks the aisle, seats and the entrance although over head racks are free. Some seats are theoretically free for passengers, though some persons cannot sit! Passengers and the board service will have many difficulties.

3. Effects of passenger behaviour and an incorrectly designed interior.

3.1 Utilisation rate

As a rule, the displacement of the free seats is done in such a way that they can only be made free at great expense, and so are unusable. As well as the passengers having to sacrifice comfort this has the result that the maximum possible utilisation rate of the seats in the carriage comes to between 70 and 80%. In this way at least 20% of the seats are unusable and this means that more passengers have to stand up, despite the fact that there are theoretically free seats (compare to fig. 2)

3.2 Queues

Luggage, which is left in the aisle and near the entrances, stops those passengers who wish to move about on the train. This problem gets worse when the passengers have luggage as well. A further difficulty turned out to be that the aisles were too narrow. With a constant width of less than 60 cm passengers find it a great deal more difficult to carry their luggage.

When people are getting on, these circumstances quickly lead to queues, which form even more quickly the more difficult it is for passengers to find free seats and suitable areas to put their luggage.

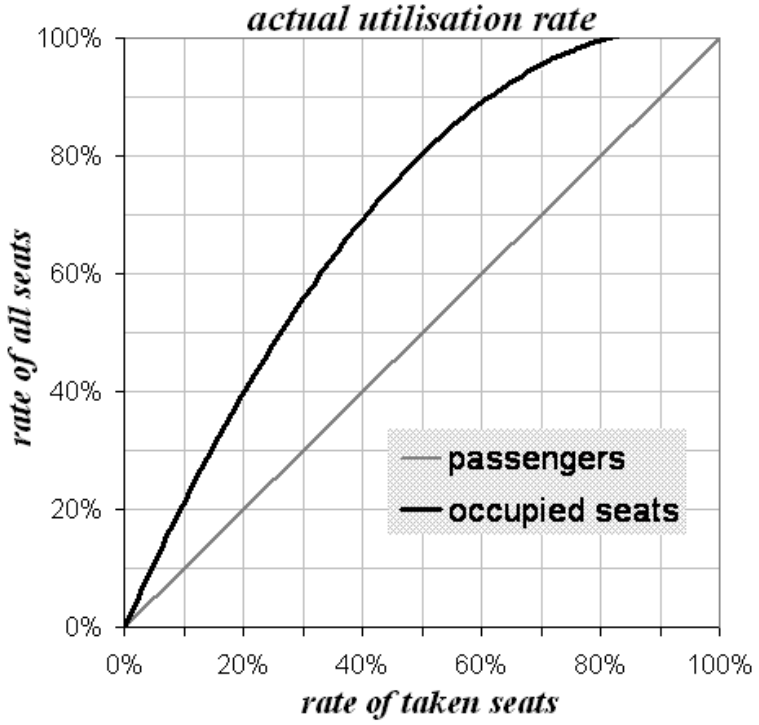

Fig. 2: Actual utilisation rate of usual open saloon coaches

3.3 Passenger changeover time

The queue which is caused by the usual badly designed interior, as well as entrances which are too narrow and often the large number of steps to be negotiated (sometimes up to 5) when people are getting on and off, lead to increased passenger changeover times at stations and at peak travelling times. The delay of a train increases a few minutes with every station. Depending on the distance, this can add up to delays of up to one hour. This has effects on approaching and following trains and on the timetable arrangements for a whole day.

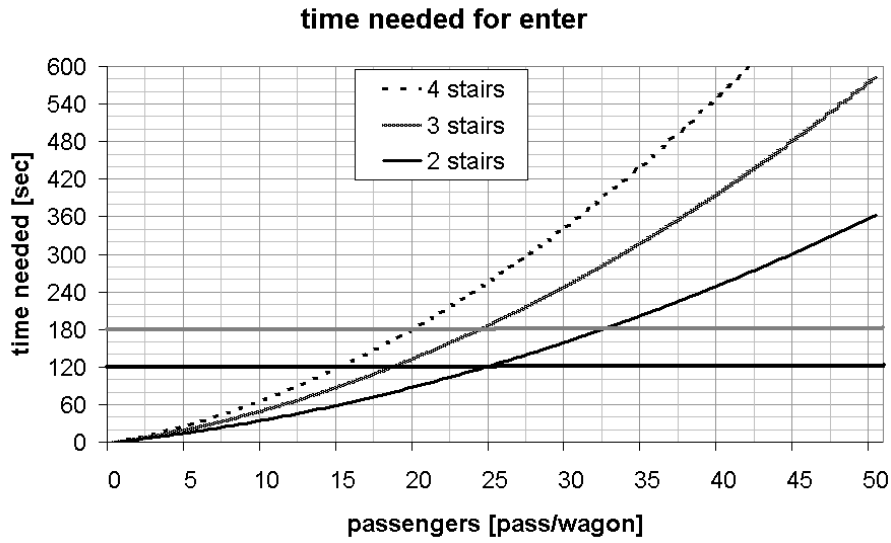

Fig. 3: Changeover-time depends on the entrance situation (example for usual coaches)

3.4 Risk to safety

Alongside the fact that unsuitably placed luggage blocks the flow of the passengers and also causes a great deal of difficulty for the staff like the on board service, they often block the various emergency exits which represents a high risk to safety in cases of danger. The emergency exits are further restricted by aisles, which are too narrow. The usual layout of the doors at both ends of the carriage has a similarly disadvantageous effect, since the emergency exits for people who sit in the middle of the wagon are a long way off.

4. Optimising the interior of the space in the train

Suitable ways of optimising potential can be drawn from the study we have mentioned of passenger behaviour and if we pay attention to these they can lead to a marked improvement in those faults we have mentioned. The two main critical points refer to passengers getting on and the seating arrangements in general.

4.1 Entrance area

The position of the doors in newly built trains should be reconsidered. If the two entrances are put at the respective quarter points instead of at the end of the carriages the flow of passengers can be better spread, which

leads to a tangible reduction in the queues. In order to speed up passengers getting on, the entrance doors must have a minimum width of 90 cm.
Of equal importance is the number of steps which need to be negotiated from the platform to the interior of the train. Depending on the luggage that is carried, negotiating four steps takes two to three times longer than two steps before one passenger can follow another. A passenger takes on average with a heavy case 12 seconds to negotiate 4 steps. The same passenger needs on average 5 seconds to negotiate 2 steps.

Fig. 4: Favourable entrance situation; 2 steps, 90 cm door width, gentler gradient in the angle of the steps.

A gentler gradient in the angle of the steps contributes just the same to a reduction in the changeover times. When getting on to an ICE train with a door width of 90 cm and a step ratio (height/depth) of 21:23 cm., a passenger needs on average 15 to 20% less time than when getting into a RIC-carriage with a door width of 80 cm and a ratio of 23:20 cm
In order to avoid queues, the immediate entrance area inside the train must fulfil the function of taking on and distributing passengers. It is therefore necessary that this area is not too narrow. Passengers with luggage must be able to pause there. As a further consequence, the width for access between the seats must be at least 60 cm in order not to restrict the passenger too much.

4.2 Maximum number of seats/ Number of luggage racks

The maximum number of seats should not be aimed at on the wishes of the operator, which is to offer as many seats as possible. The basis for the maximum sensible number of seats is set by the passenger and his behaviour under various conditions. Most passengers have luggage with them, which sometimes takes up a lot of space. This is to be observed especially in trains, which serve airports or holiday destinations. The amount of luggage however on business journeys may in no way be underestimated. The figures referred to here show the average distribution of passenger destinations, which is the rule on long distance trains in Austria. These are 12% holiday journeys, 15% longer private journeys, 38% short journeys and the rest are business trips of one or several days.

Each traveller has on average 0,8 pieces of luggage. These are big or medium sized cases, travel bags or rucksacks. Each passenger has in addition 0,7 pieces of hand luggage. These are small cases, travel bags and rucksacks with a volume like the normal hand luggage allowed for air travel.

The area needed to deposit luggage will be demonstrated on a new, fictitiously chosen train. We are dealing with a second-class open saloon coach with some face-to-face seating and some seating in rows. The seat grid pattern is about 92 cm. Making full use of the seating arrangements, a maximum of 88 seats can be built in the compartment and in this case there is no space to deposit luggage near the floor and only overhead racks are available for depositing luggage.

If you transfer the actual behaviour of passengers to this train, then depending on the distribution of the destinations, 20 to 30% of the seats are unusable, since as we have said before, are blocked off by luggage. Even if all passengers were prepared to lift their luggage and stow it in the overhead racks, there would not be enough luggage space on those days with an increased number of holidaymakers. Since there are many passengers anyway who are not prepared and often not in the position to lift up their heavy luggage, then only the light pieces of luggage and clothing are lifted up and the heavy luggage stays on the floor on or in front of the seat.

Accordingly, in this compartment only 70 of the 88 seats would be available. On holidays there would be even less!

If you took out 6 seats to create space for 3 luggage racks, you could put in 82 seats, but of these however only a maximum of 77 could be used. According to this you would have 7 more seats, but in point of fact there are 6 less available. The degree of efficiency to be expected is 94% on holidays to 89%. The upper limit for seats to be built in, in order to get

around 100% efficiency, is about 80 in this type of carriage on an average travel day. In this case 4 luggage racks can be built and on the basis of the analysis of passenger behaviour, you can reckon a possible seating efficiency of 100%.
Thus, by giving up 8 of the 88 seats, there will be 10 more available seats! This increases not only the efficiency, and with this the economy, but also passenger comfort and customer satisfaction!

4.3 Arrangement and formation of the luggage racks
The luggage racks must not be situated in the immediate vicinity of the entrance areas at both ends of the carriage. Passengers only accept these racks grudgingly even though they offer storage space on the floor. The reason lies in the fact that the passengers always want to keep an eye on their luggage and this is not the case when the racks are arranged near the entrance.
In normal trains (with doors at both ends of the compartment) it is best to arrange the luggage racks in the quarter points of the carriage opposite each other, whereas to get optimum efficiency they should be placed next to each other. This arrangement guarantees the best possible flow of passengers who are getting on and in this way reduces the queues.

4.4 Implementation of the luggage racks
The final choice of number and size of luggage racks depends on the respective conditions e.g. the distribution of the destinations. As a general rule the installation of 4 luggage racks each with an inside width of at least 100 cm has proven to be most advantageous. One must be aware that the bottom rack, which is mainly meant for large and heavy pieces of luggage,

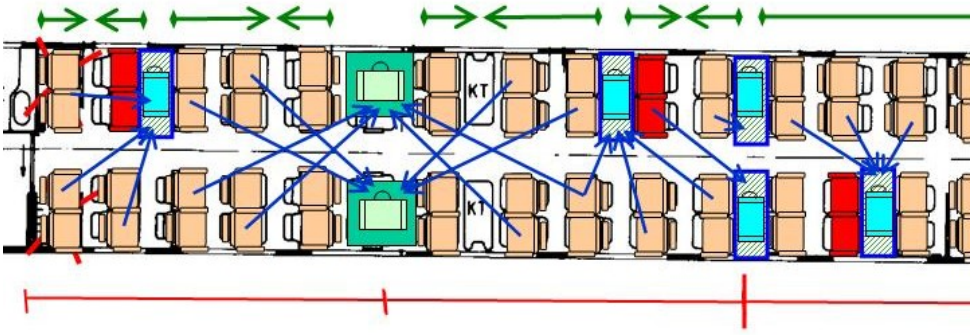

Fig. 5: Optimal implementation of the luggage racks (good view contact to own luggage)

is at least 75 cm height. Above this are 2 racks arranged with an interior height of 55 cm and 45 cm and here the smaller upper rack is suitable for travel bags and rucksacks.
It has turned out that you need to keep to the minimum measurements mentioned here, since otherwise the racks cannot be used efficiently.
When building the racks one must take care to have them sloping backwards so that the luggage does not fall down.

4.5 Using the angle of the seat/ racks between the seats
Since the backrests have a certain angle, one can use the space that is left between the 2 back rests for storing luggage. The passengers like these areas and gladly make use of them. One must not make the mistake however, that the headrests of the seats are next to each other. In this case the space left is much too small and cannot in any sense be used. The seating arrangement is only efficient if there is space left, measuring from the floor, to a height of 60 cm and a width of 35 cm.
If the side fittings of the racks do not go down to the floor then the load is carried through to the back area, then the angle of the seats can be used for a broader area on the floor to store luggage.

Fig. 6&7: Space between the backrests; ÖBB-2nd-Cl open saloon coach: enough space for storing luggage; SBB-2nd-Cl. Open saloon coach: The space is much to small for storing medium or large luggage items!

5. Summary

When the interior of a carriage is being planned it is a benchmark that 10% of the maximum possible number of seats must be replaced by luggage racks in order to get about 100% seating efficiency. The luggage racks should not be in the entrance areas but in the quarter points, that is to say placed opposite and next to each other. Furthermore, the measurements in this article should be adhered to.

When considering seat distribution, consideration should be taken of the sizes of the normal passenger groups and the various behaviour patterns of the passengers.

The studies have shown that if the ideas used in this article are used to their full potential, then rail services can be optimised and managed more efficiently in many areas.

6. References

Rüger, B.; Reisegepäck im Eisenbahnverkehr, Dissertation at the TU-Wien

Rüger, B.: Grundlagen für eine effiziente Fahrgastraumgestaltung von Reisezugwaggons, ETR 10/2005, Eurailpress

Schöbel, A.; Rüger, B.; Qualitätsmanagement im Personenverkehr am Beispiel der Arlberg-bahn; ETR 11/2005; Eurailpress

Rüger, B.: Optimierungspotentiale in Fernreisezugwaggons, ETR 04/2007, Eurailpres