Influence of railway interiors on dwell time and punctuality

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Why to reduce dwell time?

Trains often run late on main travel days → punctuality

Without changing schedule (same travel time):
shorter dwell time → longer running time → lower velocity → potentials for saving energy
Influence – areas in the vehicle

Entrance

Entrance area – Retention room

seating area – vehicle interiors
Influence – entrance

Gap between platform and first step
Number of steps
Door width
Step ratio

Vehicle based
Influence – entrance

handicaps

age

luggage

passenger based
Influence – entrance

acces height
baby carriages

age/handicaps

Combination
Influence – entrance

number of steps + age

Boarding

Median of the single time [sec]

Children < 10 years  Juveniles/grown ups 10-65 years  Older people >65 years

Age

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Influence/ whole boarding process

Main influence: Luggage

causes troubles:
• when boarding the train
• moving along in the train
  • when storing

⇒ Aftereffect:

Passengers behave the way, to reduce their own problems, but enlarge other passengers‘ or the railway company‘s difficulties!
Actual passenger behaviour

*Passengers want to*

- avoid lifting their luggage!
- have visual contact of their own luggage!

*If it is possible somehow:*

- Luggage is stored on floor level
- Luggage is stored nearby

*Aftereffect:*

- Luggage is stored on/ before seats, in the aisle, etc.
  - Comfort restrictions
  - Lower number of actual available seats
  - Problems when moving along in a train

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Luggage

Average: **1 piece of luggage per passenger**
(0.6 one day trip; 1.2 holiday maker)

- Trolley ~30-60%
- Travel bag ~10-30%
- Rucksack ~20-30%

+ ~40% hand luggage
Vehicle relating potentials of improvement for reducing the stop-over-time

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Entrance area with luggage stores

1st problem: NO VISUAL CONTACT

Ideal boarding time [sec]

Actual boarding time [sec]

Conflict

tailback

Time need without designing influence

Sum of time need of each passenger (only entrance → age, luggage, step, etc.)
Vehicle relating potentials of improvement for reducing the stop-over time

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Ideal boarding time [sec]

Actual boarding time [sec]

- tailback
- Simple entrance area
- technic
- air cond.

Time need without designing influence

- ideal: 45sec
- actual: +65sec
- sum: 110sec
Vehicle relating potentials of improvement for reducing the stop-over-time

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Larger retention room
tailback arises later!

Big entrance area

Actual boarding time [sec]

Ideal boarding time [sec]

sum: 85sec

actual: +40sec

ideal: 45sec

Time need without designing influence
Vehicle relating potentials of improvement for reducing the stop-over-time

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Entrance area of an IC2000

Disadvantage:
- steps – small tailback

Large retention room + split up of passenger flow → More people can board in the same time

Ideal boarding time [sec]

Ideal:
- 45sec

Actual:
- +25sec

Sum:
- 70sec

Time need without designing influence
The passenger flow can split in two directions (+ no steps)

Time need without designing influence

Ideal boarding time [sec]
Seating area - Coach interiors

influences

vehicle based

passenger based

• aisle width
• seat arrangement
• luggage storage
• door location

• agility
• luggage

interaction

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Coach interiors – interactions (examples)

- aisle width too small
  - many difficulties when moving along with luggage

- seat arrangement
  - e.g. row seating
    - no space for luggage (except overhead bin)
    - luggage stored on floor (aisle, etc.)
    - no passing points (2 way traffic)

- luggage storage
  - e.g. too small
    - luggage stored on floor (aisle, etc.)
Coach interiors

Aisle width

general Problems:

own luggage
luggage in the aisle
Oncoming passengers
Coach interiors

Aisle width

~50 cm

~60 cm

~40% \rightarrow 50-60 cm

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Coach interiors
Aisle width

~40% rotate
Coach interiors

Aisle width

aisle width smaller than 60cm

often 50 – 54 cm

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Coach interiors

Aisle width

Many trolley aisles are wider than 50 cm

often 50 – 54 cm
Aisle width - problems

- shorttrip - privat
- one day trip - privat
- journey - privat
- business trip - one day
- business trip - several days
- commuter
- holiday-maker
- main travel day

Aisle width problems

<table>
<thead>
<tr>
<th>Aisle Width</th>
<th>Problems</th>
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<tbody>
<tr>
<td>60 cm</td>
<td>0 %</td>
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<tr>
<td>55 cm</td>
<td>~8 %</td>
</tr>
<tr>
<td>50 cm</td>
<td>20 %</td>
</tr>
<tr>
<td>40 cm</td>
<td>50 %</td>
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Coach interiors

Aisle width

aisle width wider than 60cm

Most trollys are smaller than 60cm
Vehicle relating potentials of improvement for reducing the stop-over-time

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**Personenanzahl**

<table>
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<th></th>
<th>0</th>
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<th>20</th>
<th>30</th>
<th>40</th>
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<td>50.0</td>
<td>100.0</td>
<td>150.0</td>
<td>200.0</td>
<td></td>
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</table>

**Aisle width >60cm**

**Aisle width <60cm**

**Actual boarding time [sec]**

**Number of persons**

- Larger than 60 cm
- Smaller than 60 cm

25%
Coach interiors
Seat arrangements

Row seating
Vis-a-vis seating
Mixed arrangements
Compartments

+ several luggage storage concepts
Coach interiors
Row seating

1st problem: aisle width
Coach interiors
Row seating

2nd problem: only overhead racks
NO SPACE on floor level

needs a LONG TIME!
Storing luggage

- Height of overhead rack
- Width of seats, large diagonal
- Lugage weight
- Large torque, large force!
- Safety risk for sitting passengers
  - Large exertion
  - Safety risks
  $\rightarrow$ negativ sensation

15-30kg
185-200cm
185-200cm
Coach interiors
Row seating

Many large items are stored on floor level → ON or BEFORE SEATS / IN THE AISLE

Hindrance in the aisle → Time need

Seats are blocked!
Coach interiors

Row seating

3rd problem: oncoming passengers

No passing room
Coach interiors

Row seating

Luggage in aisle, on seats
Oncoming passengers
Overhed luggage storage

Tailback after view passengers, long time need
Coach interiors
Row seating + luggage rack near entrance
Coach interiors
Row seating + luggage rack near entrance

No visual contact

Tailback after view passengers, long time need

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Coach interiors
Row seating + luggage rack in the middle

better visual contact but long view distance

Long way, many hindrances

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Coach interiors
luggage rack in the quarter point

better visual contact but long view distance

Shorter way, less conflicts
row seating– time need

- Seats standing neatly in a row
- Opposite seats
- Compartment coaches
- Opposite seats in an IC2000

Actual time [sec] vs. Ideal time [sec] graph

- Row seating

- Graph showing different seating arrangements and their corresponding time needs.
Coach interiors
Vis-a-vis seating

Luggage storing between the seats

enough space required
→ Very fast and easy storing
Coach interiors
Vis-a-vis seating

Oncoming passengers

+ Passing points

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Seat arrangements

- Seats standing neatly in a row
- Opposite seats
- Compartment coaches
- Opposite seats in an IC2000

Graph showing:

- Ideal time [sec]
- Actual time [sec]

Row seating

Vis-a-vis seating
Coach interiors
Compartment coach

Longer way $\rightarrow$ larger retention area (until the first compartment)

Luggage storing in the compartment $\rightarrow$ other passenger can go on

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Coach interiors
Compartment coach

Less conflicts with oncoming passengers
Passing points in compartment + wide aisle

aisle width: 70-90cm
Coach interiors
Compartment coach

Less conflicts with luggage in the aisle

aisle width: 70-90cm
Seat arrangements

- Seats standing neatly in a row
- Opposite seats
- Compartment coaches
- Opposite seats in an IC2000

Graph showing actual time vs. ideal time for different seat arrangements.

- Row seating
- Compartment
- Vis-a-vis seating
- Vis-a-vis seating + IC2000-entrance
Seat arrangements - comparison

- Seats standing neatly in a row
- Opposite seats
- Compartment coaches
- Opposite seats in an IC2000

![Graph showing seat arrangements comparison](image-url)

- row seating
- compartments
- Vis-a-vis seating
- Vis-a-vis seating + IC2000-entrance

Actual time [sec] vs. Ideal time [sec]
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time optimised railway interior

conclusion

example for open saloon coach

1) doors at the quarter points

Best: NO steps $\rightarrow$ level free boarding
time optimised railway interior

conclusion

example for open saloon coach

1) doors at the quarter points

If steps required: \textbf{max 2 steps}
time optimised railway interior

conclusion

example for open saloon coach

1) doors at the quarter points
2) Level free boarding, max. 2 steps
time optimised railway interior

conclusion

example for open saloon coach

1) doors at the **quarter points**
2) **Level free boarding**, max. 2 steps
3) Large entrance (tailback) room

aisle width **min 60cm**
time optimised railway interior

conclusion

equation for open saloon coach

1) doors at the *quarter points*
2) Level free boarding, max. 2 steps
3) Large entrance (tailback) room
4) Aisle width min. 60 cm

- Luggage rack
- NOT in the entrance area
- No visual contact, high risk of theft

Optimizing passenger exchange
time optimised railway interior conclusion

example for open saloon coach

1) doors at the quarter points
2) Level free boarding, max. 2 steps
3) Large entrance (tailback) room
4) Aisle width min. 60 cm

Conflicts near the entrance when storing luggage → early tailback

Luggage rack

NOT in the entrance area
time optimised railway interior

conclusion

example for open saloon coach

1) doors at the **quarter points**
2) **Level free boarding**, max. 2 steps
3) **Large entrance** (tailback) room
4) **Aisle** width min. 60 cm

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*Luggage rack*

*NOT near the entrance area*

*No visual contact, high risk of theft*
time optimised railway interior

conclusion

example for open saloon coach

1) doors at the quarter points
2) Level free boarding, max. 2 steps
3) Large entrance (tailback) room
4) Aisle width min. 60 cm

Luggage rack

NOT near the entrance area

Conflicts near the entrance when storing luggage → early tailback
time optimised railway interior

conclusion

example for open saloon coach

1) doors at the quarter points
2) Level free boarding, max. 2 steps
3) Large entrance (tailback) room
4) Aisle width min. 60 cm

Luggage rack

NOT in the middle of the saloon

Long way, conflicts with other passengers
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conclusion

example for open saloon coach

1) doors at the quarter points
2) Level free boarding, max. 2 steps
3) Large entrance (tailback) room
4) Aisle width min. 60 cm
5) Luggage racks in quarter points

Seat arrangement

Not only row seating

Optimizing passenger exchange
time optimised railway interior conclusion

example for open saloon coach

1) doors at the **quarter points**
2) **Level free boarding**, max. 2 steps
3) **Large entrance** (tailback) room
4) **Aisle** width min. 60 cm
5) **Luggage racks** in quarter points

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Seat arrangement

**Better:** more vis-a-vis seats with **enough space between**

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**Space for luggage**

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**Passing points**
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Thank you for your attention

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