

Influence of passenger behaviour on railway-station infrastructure

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Introduction

In all railway design processes related to passengers, they must be in the focus of all investigations!

The author is focused for more than 16 years on rail passengers by analysing passenger's

- Behavior
- Needs and expectations

..... along the whole mobility chain!

In more the 15 projects the behavior and the needs of passengers during their stay in the rail station have been analysed in many different phases.

This includes the stay in the station as well as all kinds of movements.

Methodology

Over all projects the methodology can be summarized as following:

- Surveys:
 - In total about 5000 passengers were asked about their problems, needs, expectations and behaviour in railway stations
 - In total about 10.000 passengers where asked about their problems, needs and expectations in case of boarding a train.
- Video analyses:
 - About 7000 persons have been filmed in different situations in stations (e.g. on escalators, in lifts, on stairs etc.)
 - About 20.000 passengers have been filmed when boarding or alighting trains and have been analysed
 - About 2.000 passengers have been filmed to analyse their waiting position at the platform
- Automatic passenger counting: Automatic passenger counting of about 4 million boarding situations in Vienna metro system have been analysed.

Passengers in train stations

Passengers stay and move in stations.

Process:

- Entering a station
- Stay in the station
- Move in the station
- Walk to the platform
- Wait on the platform
- Board the train

Needs and behaviour effecting system

- Stay in the station: Passengers want to use the time
- Station operators want to earn money
- Passenger flow shall be quick and without hindrance
- Boarding and alighting shall be as quick as possible

- Passengers are characterized by their:
 - Age & sex
 - Possible handicaps
 - Luggage

Stay at the station

Passengers have to stay more or less long on the station

- Before train departure
- Changing trains, transfer time

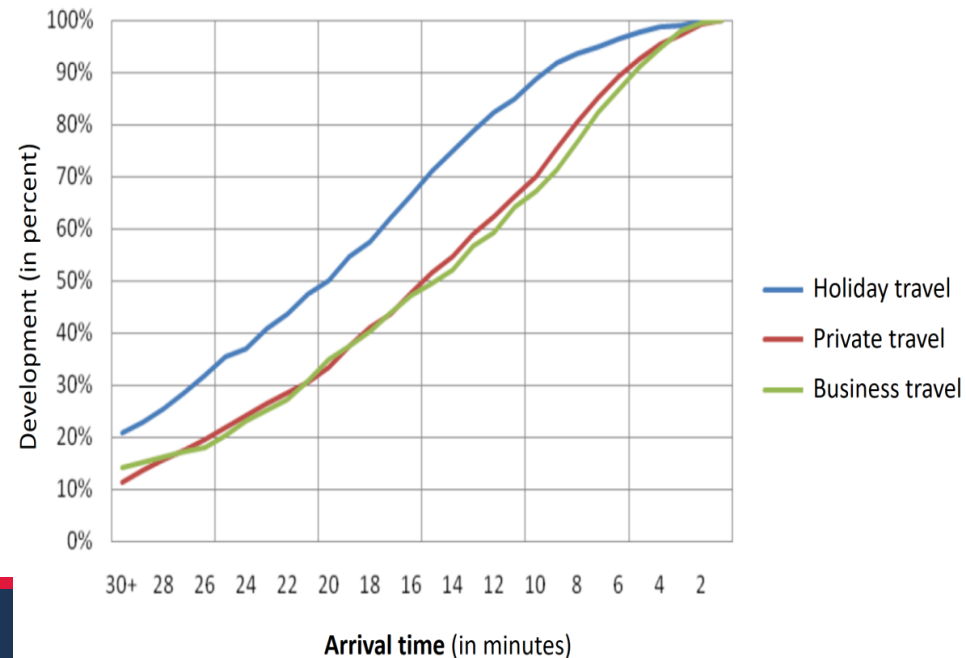
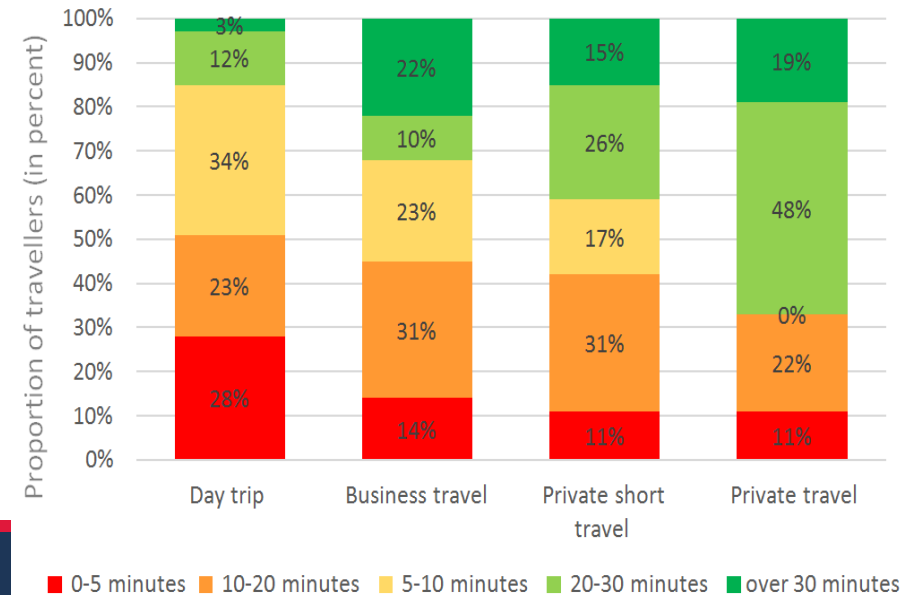
Waiting time ...

- has an influence on comfort → modal split
- is felt subjectively!
- **has to be reduced (subjectively)!**

Stopp over time in the station

Approximately 20% of (long distance travelling) passengers stay more than 30 min. at rail stations (esp. holiday maker)

Stopover time



station

Stations are mutating more and more into **shopping and entertainment centres**

*We do have to care about the **basic needs of passengers***

shopping and entertaining possibilities

⇔ conflict with luggage

⇔ its hardly possible to use attractions

→ easy short term luggage deposing is necessary

Some illustrations



Rail
Newcastle
2017







Waiting passengers – potential shoppers

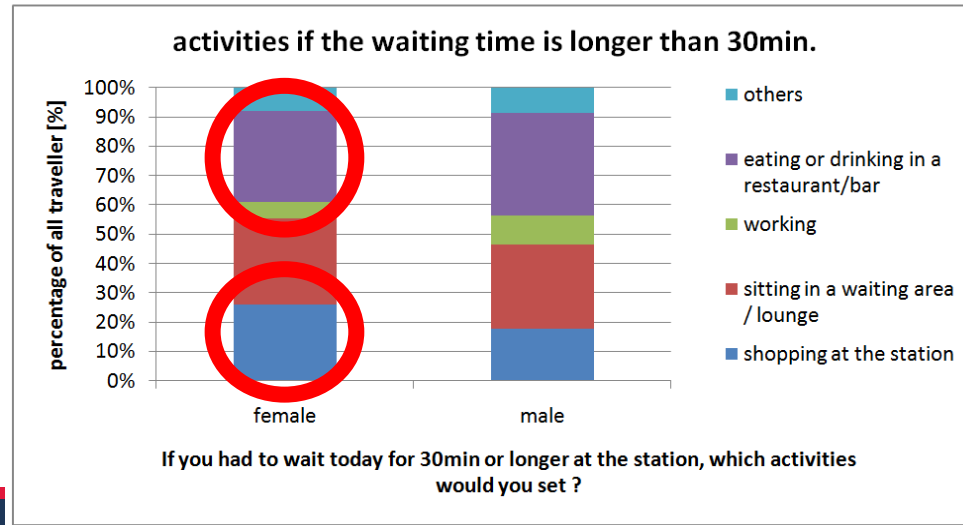


Behaviour, Needs and Expectations

If the waiting time is longer than 30min:

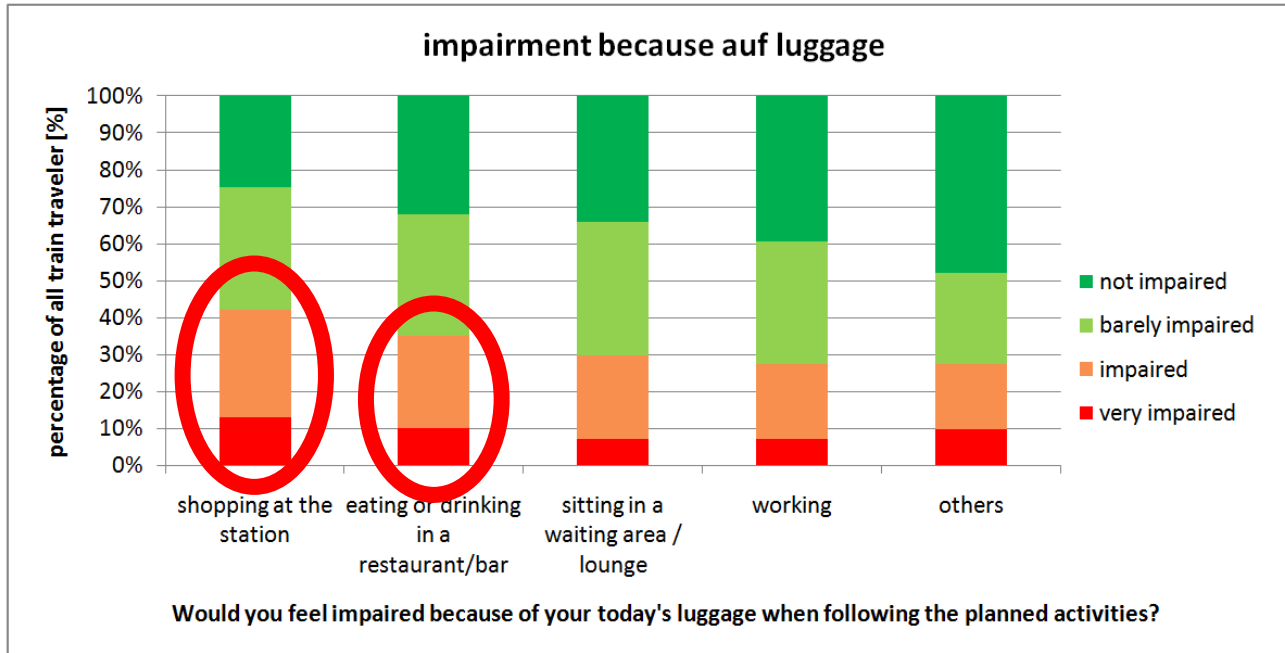
→ ~ **25%** prefer **shopping**

→ ~ **30%** prefer going to a **bar** or **restaurant**



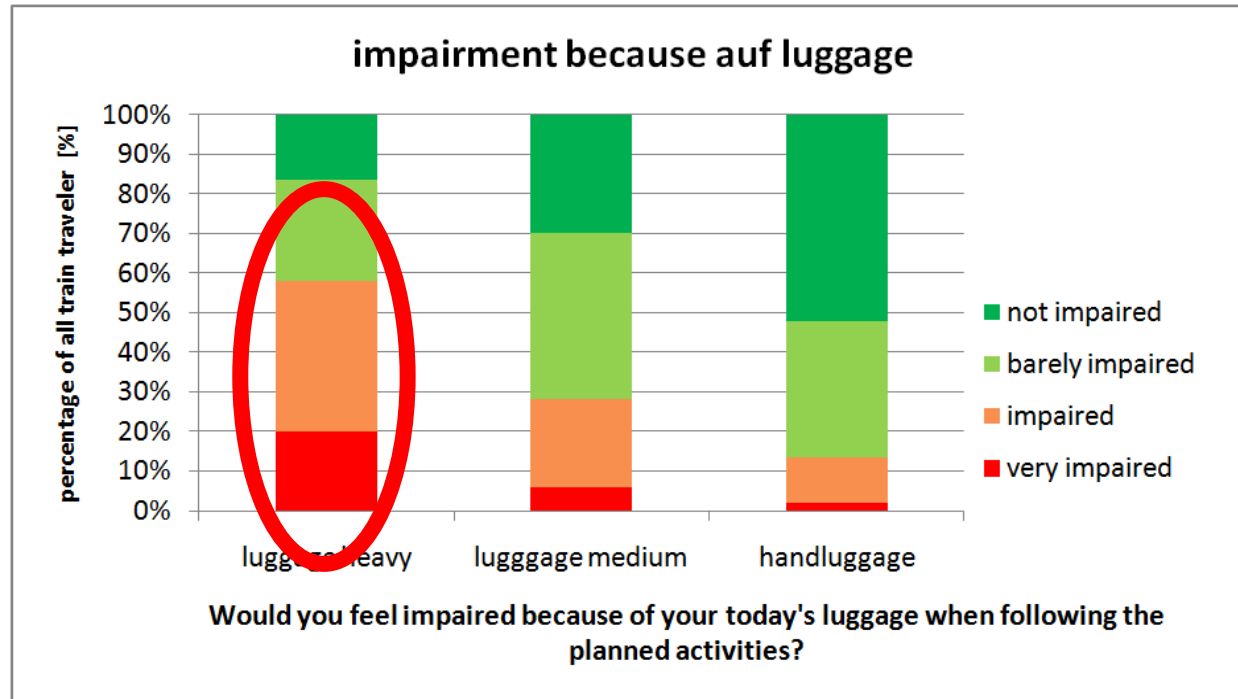
Impairments because of luggage

About **40%** of all passengers who prefer shopping or visiting a bar or restaurant feel **impaired** because of their **luggage**



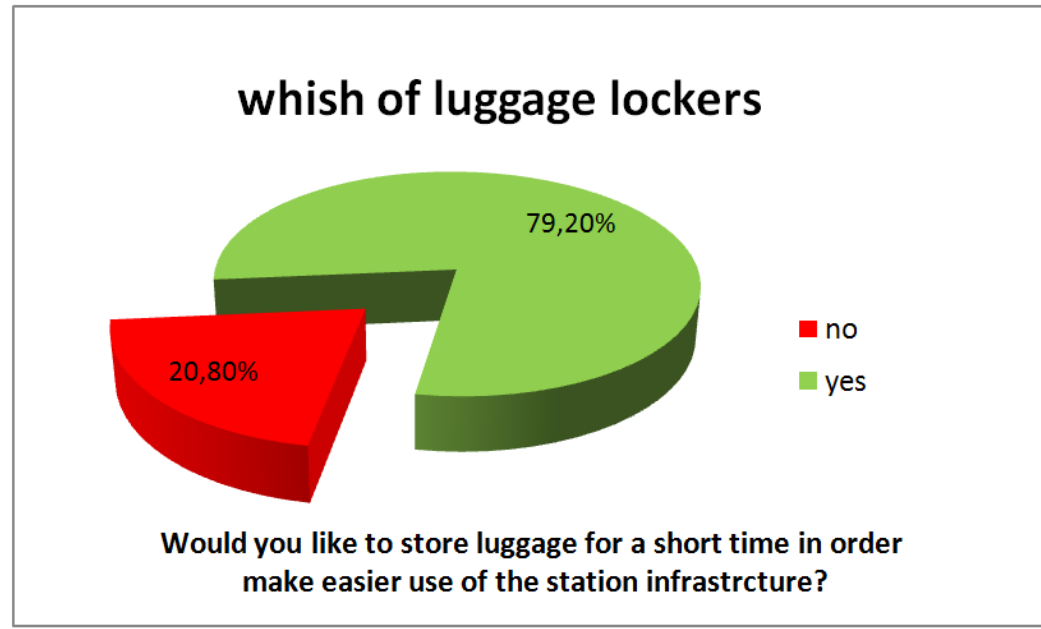
Impairments because of large luggage

60% of passengers with heavy luggage feel impaired while waiting



Whish of luggage lockers

80% wish to have an easy handling luggage storing possibility at the station for shopping etc. without luggage.



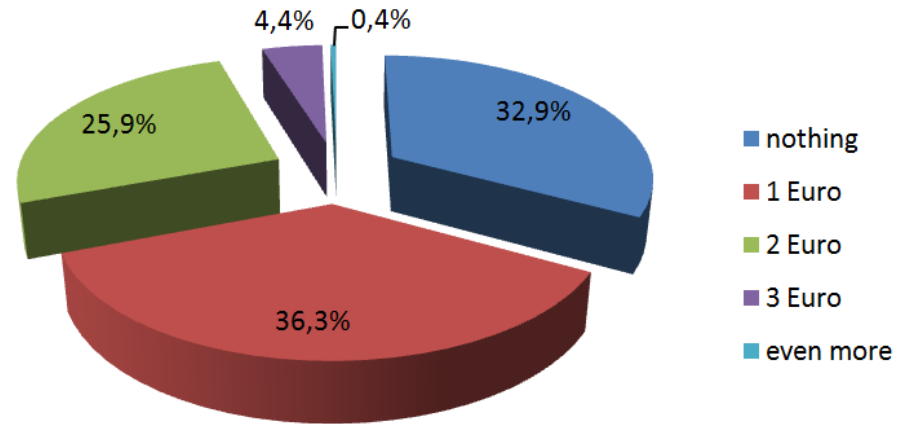
Requirements: costs for short term locking

1/3 is willing to pay 2€ or more

1/3 is willing to pay 1€

1/3 is **not** willing to pay

willingness to pay for luggage storing up to 2 hours



How much are you willing to pay for short term storing (up to two hours) of one big

Requirements: costs for short term locking



Inhibition treshold: between paying anything or paying nothing

- → even 1€ can be to much
- → **short term locking** (up to two hours) must be offered **for free**
- → **benifit** because of **indirect return**

More passengers **without lugage**

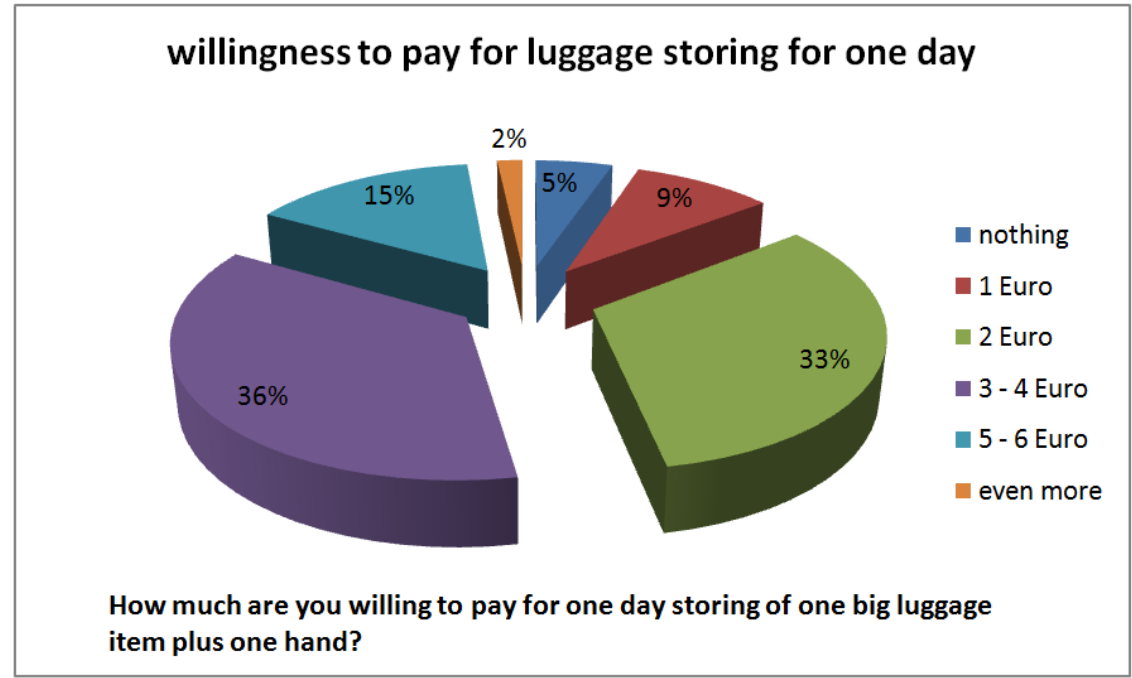
- → more **shopper**
- → more **spent money**
- → more **benefit** for the station operator

Requirements: costs for one day locking

Only **15%** are **not** willing to pay **more** than **1€**

1/3 is willing to pay **2€**

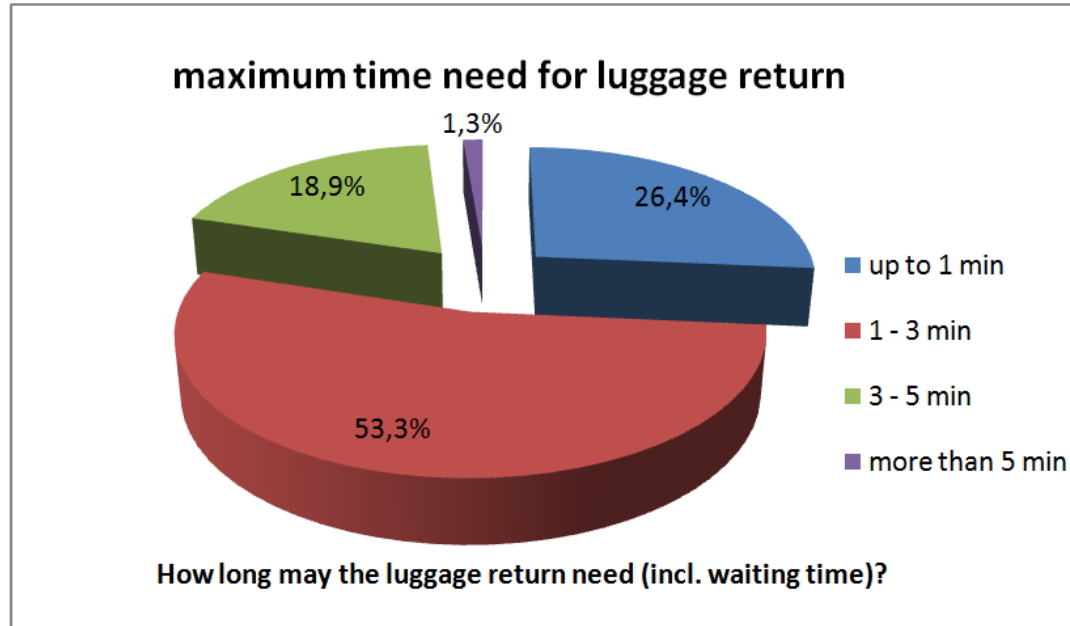
1/3 is willing to pay **2-4€**



Requirements: time need for luggage return

25% are **not** willing to wait longer than 1min

50% are **willing** to wait between **1min** and **3min**



Requirements: time need for luggage return



Problem of **luggage return time** need:

- **Subjectively** felt time
- Passengers in a **hurry**
- Before **train departure**

→ **1min can feel like 5min**

- For technical systems: **Counter** for seconds

Requirements: comfort / lifting of luggage

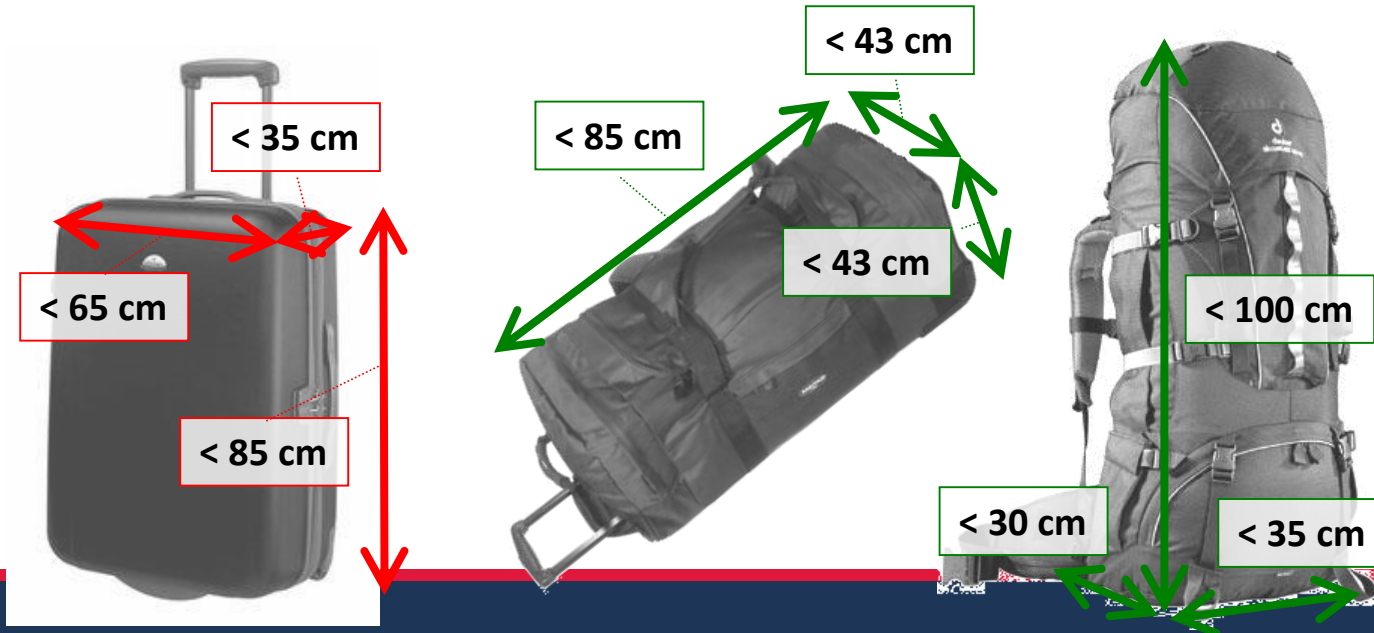


Passengers **do not want** to **lift** their luggage

- **2/3** of female passengers want to store **at floor level**
- **50%** of female passengers **are not able** or **do not want** to lift luggage

→ Storing at **floor level** is a **must!**

basic knowledge about luggage size



Conclusions of luggage storing

Luggage storing in the stations is necessary

- Passengers have the wish of storing luggage, also short term
- Short term locking must be offered **for free** (long term 2 € to 4 €)
- Handling time not longer than **1 min**
- Storing must be as easy as possible
- No lifting of the luggage!
- Size of lockers, extra sized luggage!

Benefit for railway and station operators

- more **shopper** → more **benefit** for the station operator
- More satisfied customers

Movement in the station

Choice of opportunities (stairs/escalators/lifts)

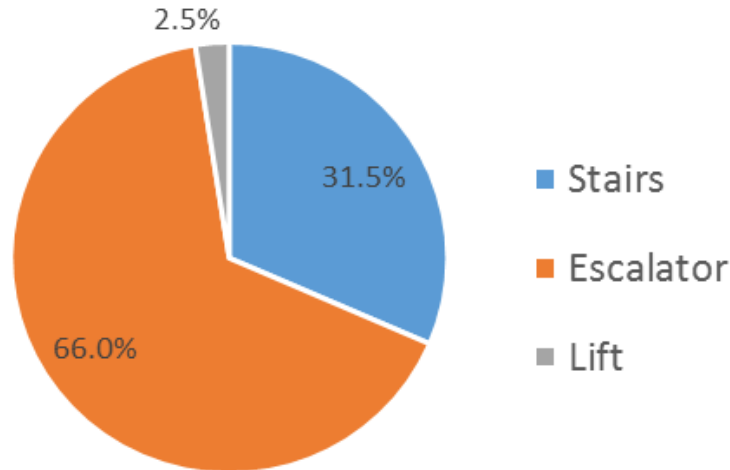
Behaviour

Choice up- and downward

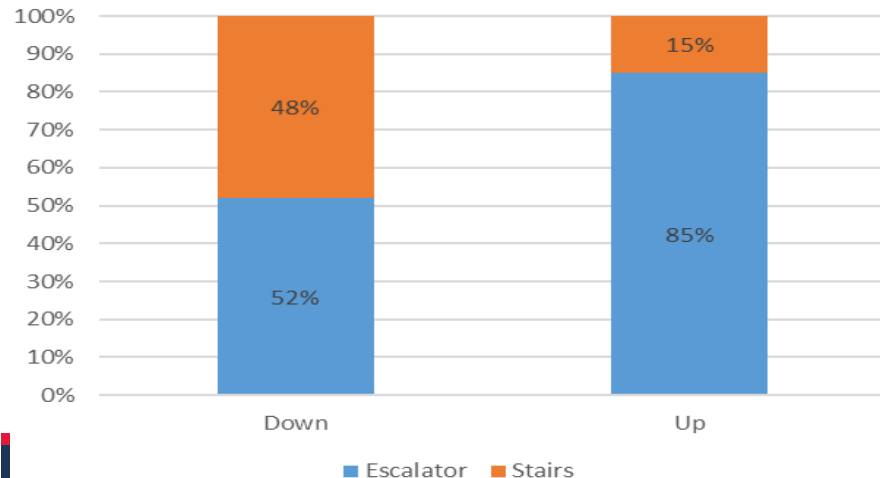
In average (passengers without luggage) 66% choose an escalator and only 2.5% choose lifts!

Downstairs only 52% us an escalator, upstairs 85%!

Distribution of travellers



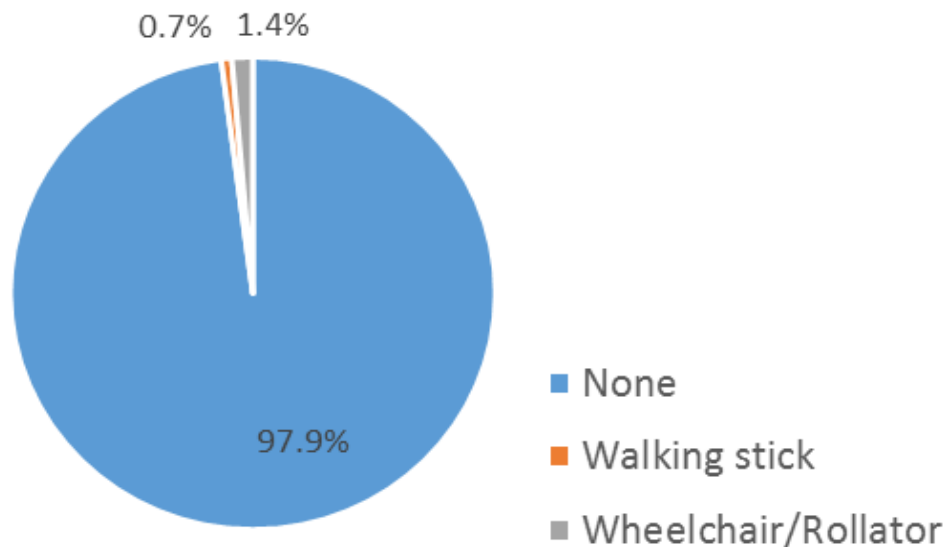
Comparative distribution of passengers with regard to the use of stairs or escalators



Passengers using a lift

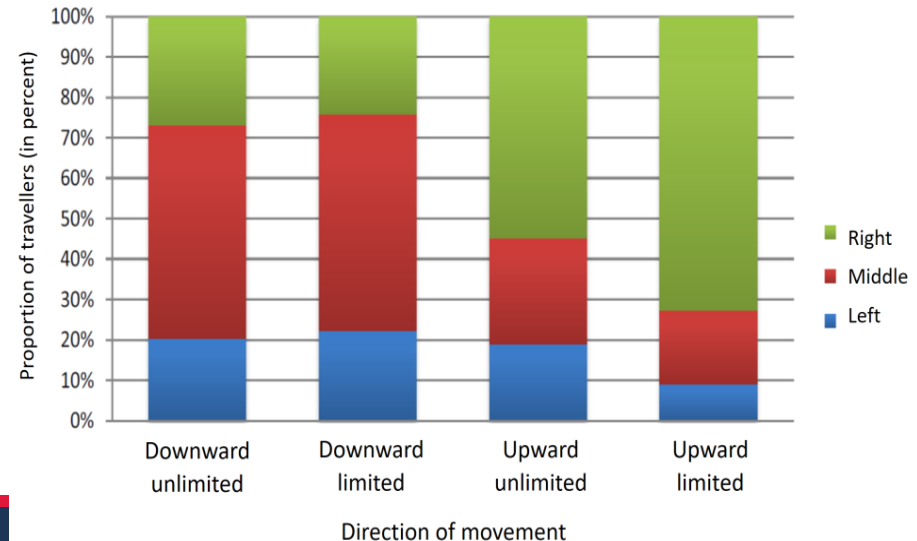
98% of passengers using a lift have no obvious mobility limitations

Obvious mobility limitation of persons using a lift



Behaviour on stairs

- Downstairs about 50% walk in the middle, upstairs between 50% and 70% walk on the right
- Velocity:
 - 1.2m/s (young), 1.1m/s (40-60years), 0.9m/s (elderly)
 - crowding, capacity limit: 0.9 m/s
- Approx. capacity: 1.52 pers./m (stair width)



Escalators – capacity (regulations)

DIN EN 115-1

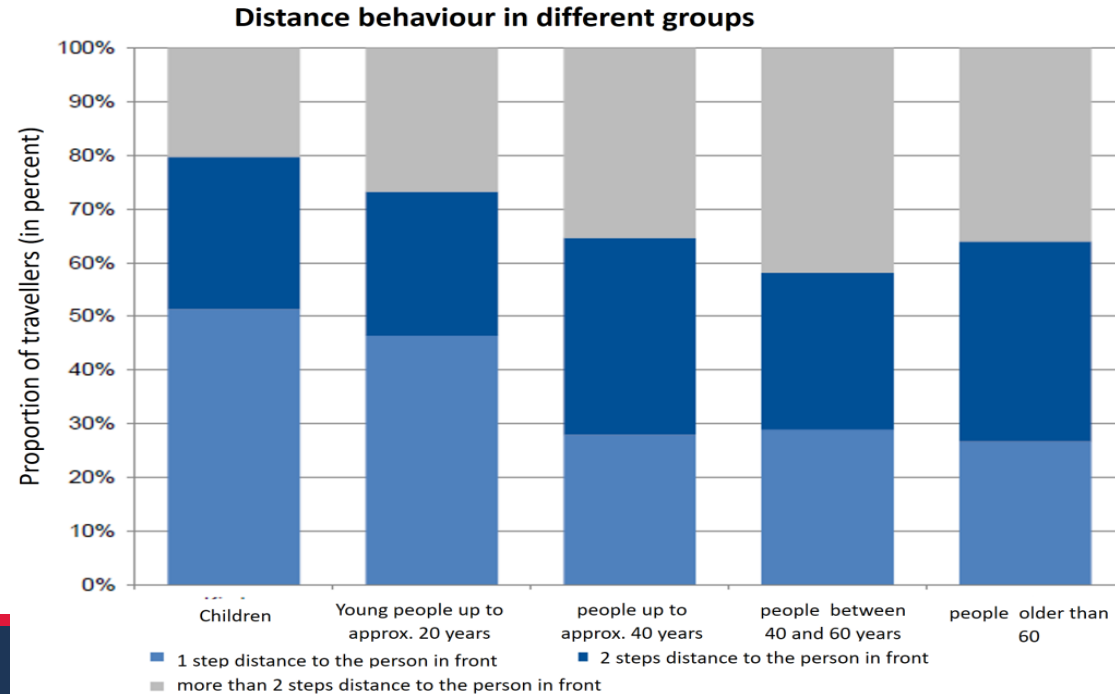
Step-/Surface width [m]	Nominal speed [m/s]		
	0.5	0.65	0.75
0.60	3'600 persons/h	4'400 persons/h	4'900 persons/h
0.80	4'800 persons/h	5'900 persons/h	6'600 persons/h
1.00	6'000 persons/h	7'300 persons/h	8'200 persons/h

Distance between steps

In 30% adults stand one step after each other

In 30% one step is free

In 40% at least two steps are free

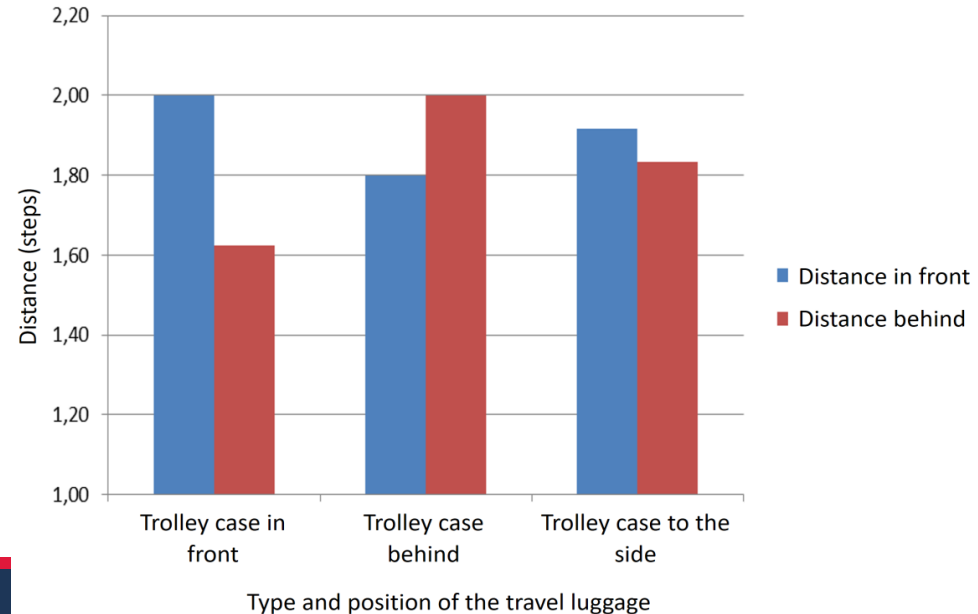
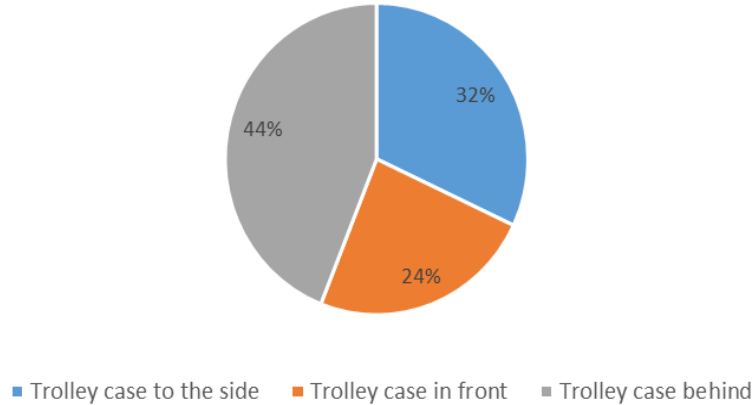


Luggage on escalators

About 1/3 of passengers with luggage put down their items beside of them.

Distance is approx. two steps to the next person.

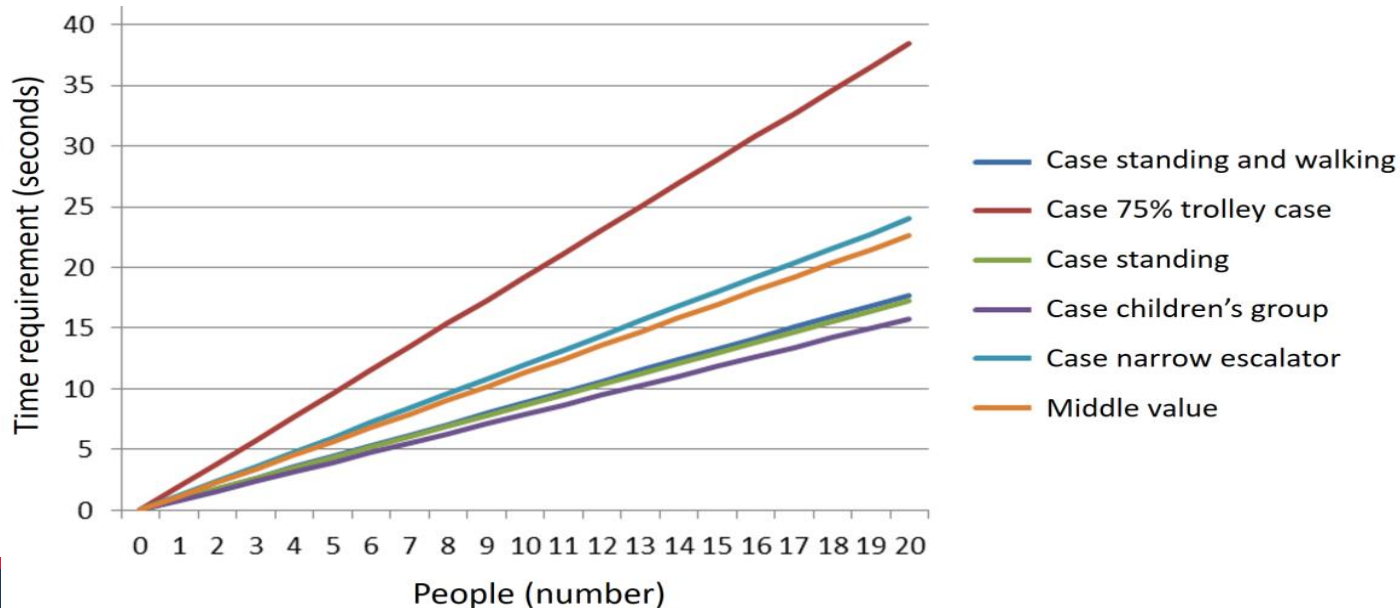
Placement location of trolley cases on escalators



Escalator capacity / time need

The movement of 20 persons need between 15 sec and 40 sec

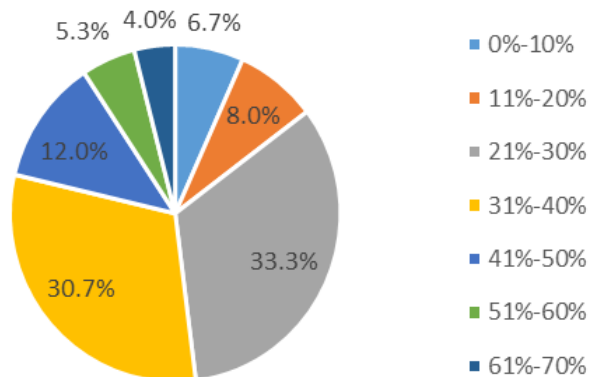
There is no time difference if people are just standing or standing on the right and walking on the left



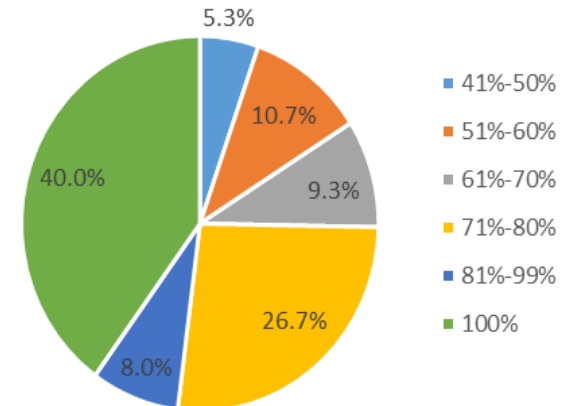
Lift capacity – occupancy rate in lifts

- In 50% of all cases the occupancy rate is just 30% (by people).
- Only in 10% the occupancy rate is higher than 50%, in all cases the maximum is 70%
- In 50% of all cases up to 80% of the area in the lift is occupied.

Occupancy rate by people in the lift when someone remains behind



Area occupancy rate in the lift when someone remains behind



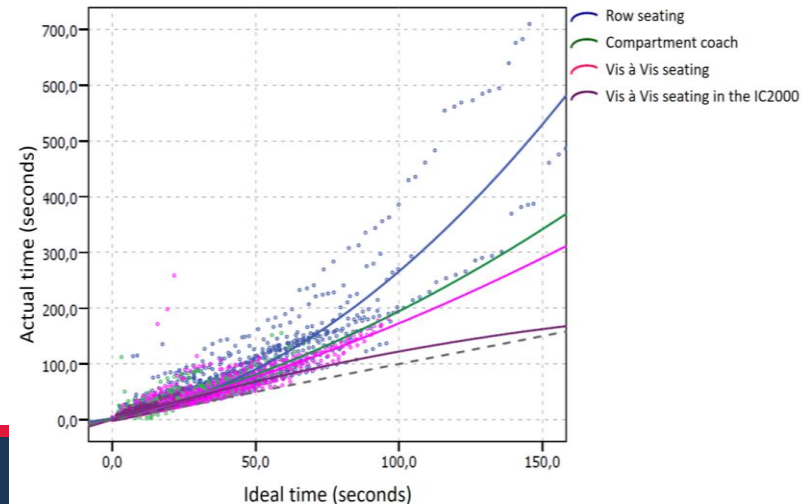
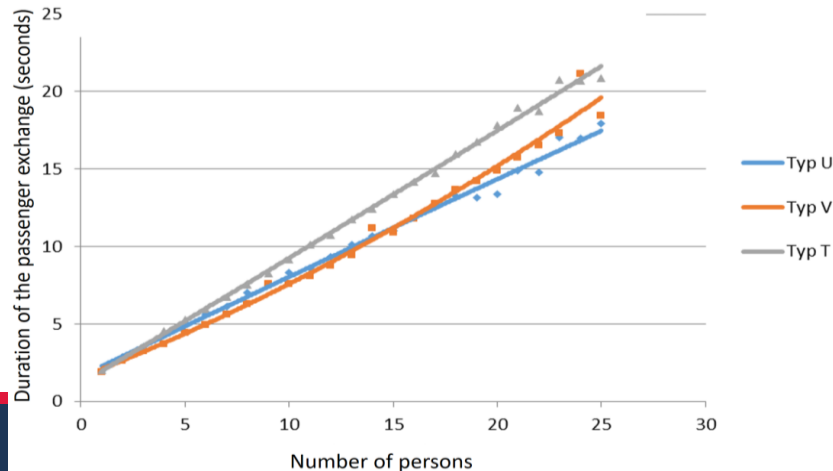
Platform – passenger exchange time

Passenger exchange time has a strong influence on the dwell time.

In long distance travel the boarding time is raising with higher potential, in urban transport it is close (but not exactly) to a linear distribution.

The higher the number of boarding passenger, the longer the dwell time .

Passenger boarding time / metro



Platform – passenger distribution

Usually not all doors are used equally, some doors are strongly over growd.

The over linear time need at over growd doors enlarges the dwell time even more.

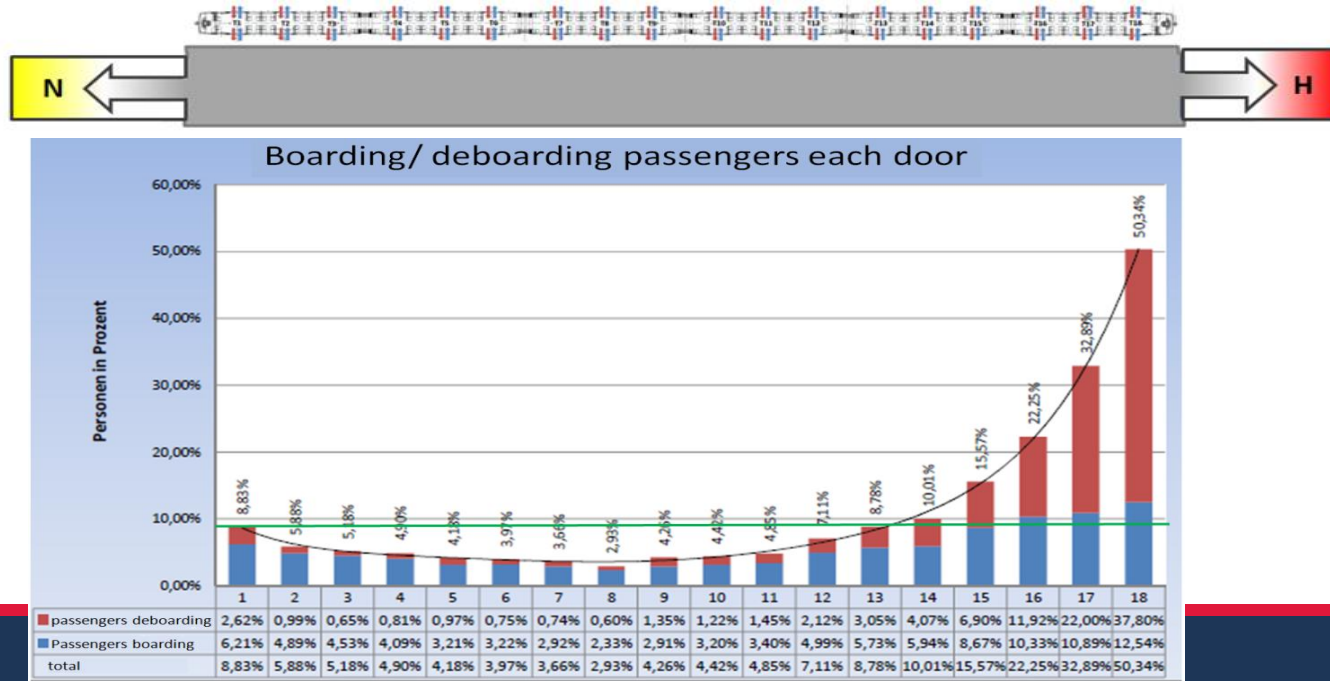
The passenger distribution depends on different behaviour.

Most impact comes from the station design – passengers who are used to the system exactly know where they have to expect the closest exit. Usually the use the door for boarding where they have the shortest way to the next exit at their departure station.

Some examples are following.

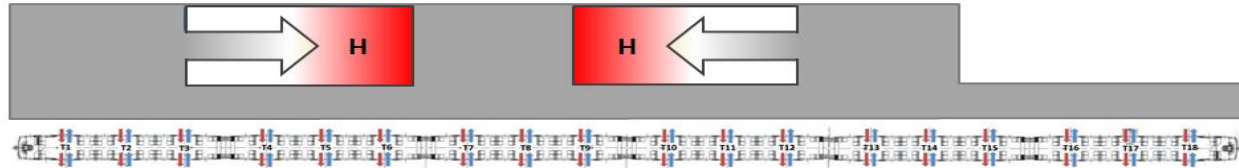
Passenger distribution – example 1

One secondary exit (N); one main exit (H)

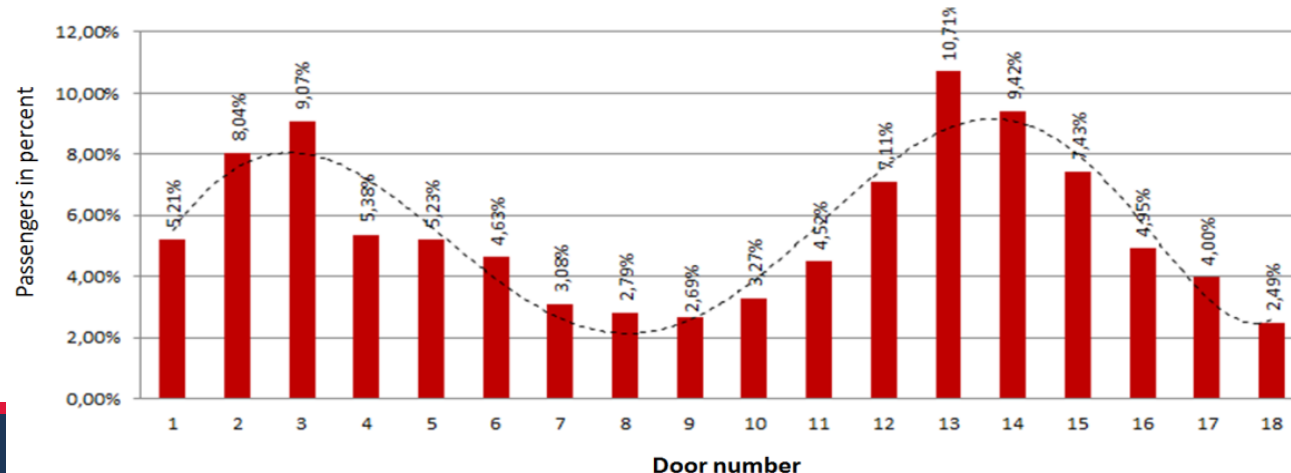


Passenger distribution – example 2

Two main exits (approx. in the quarter points)

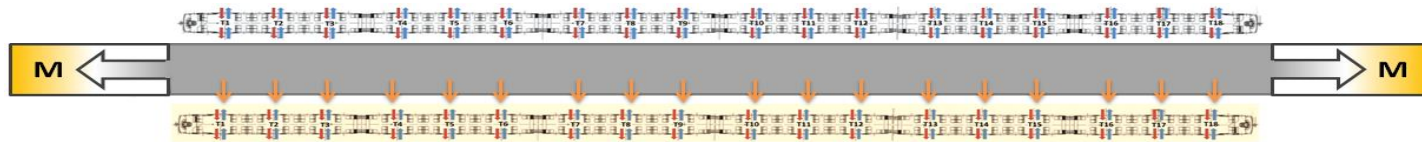


Deboarding passengers

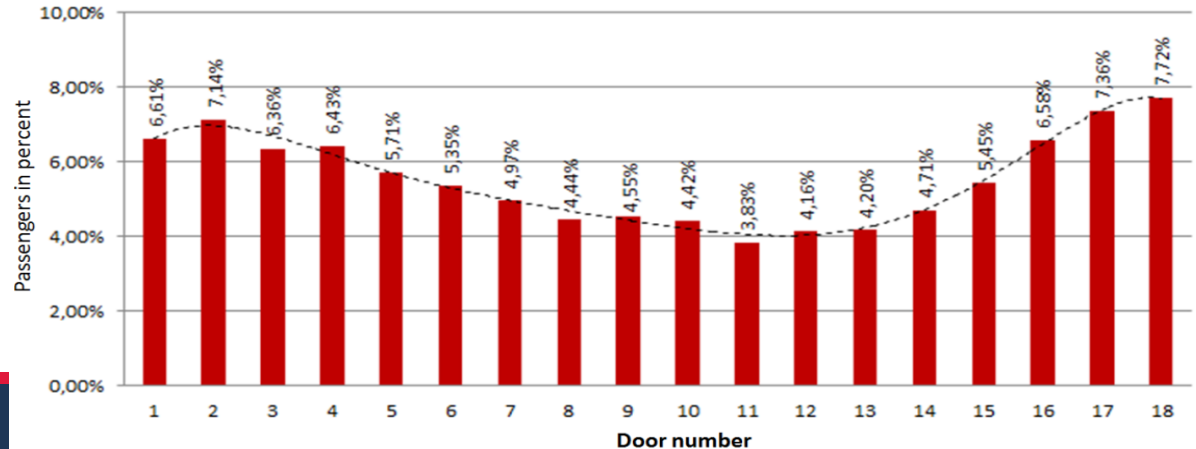


Passenger distribution – example 3

Two medium frequented exits at the and same platform changes

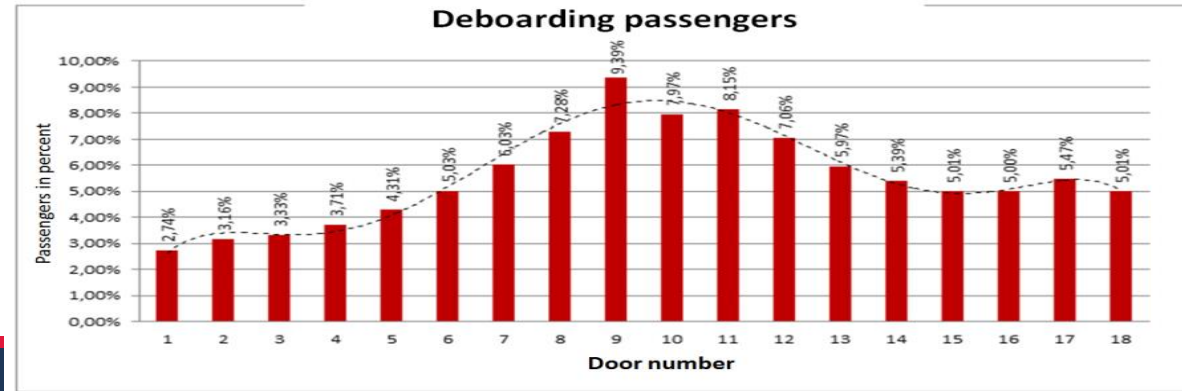
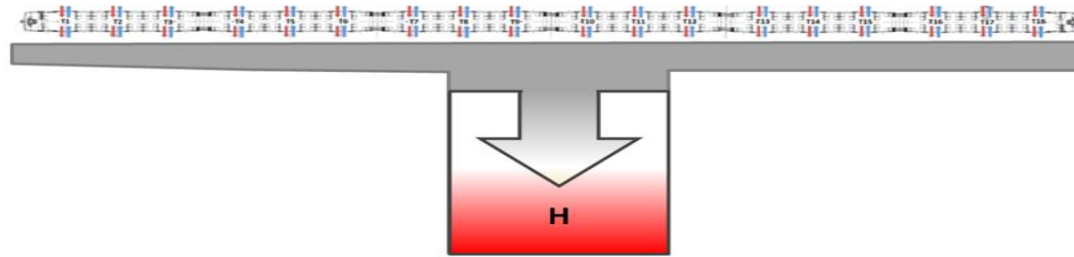


Deboarding passengers



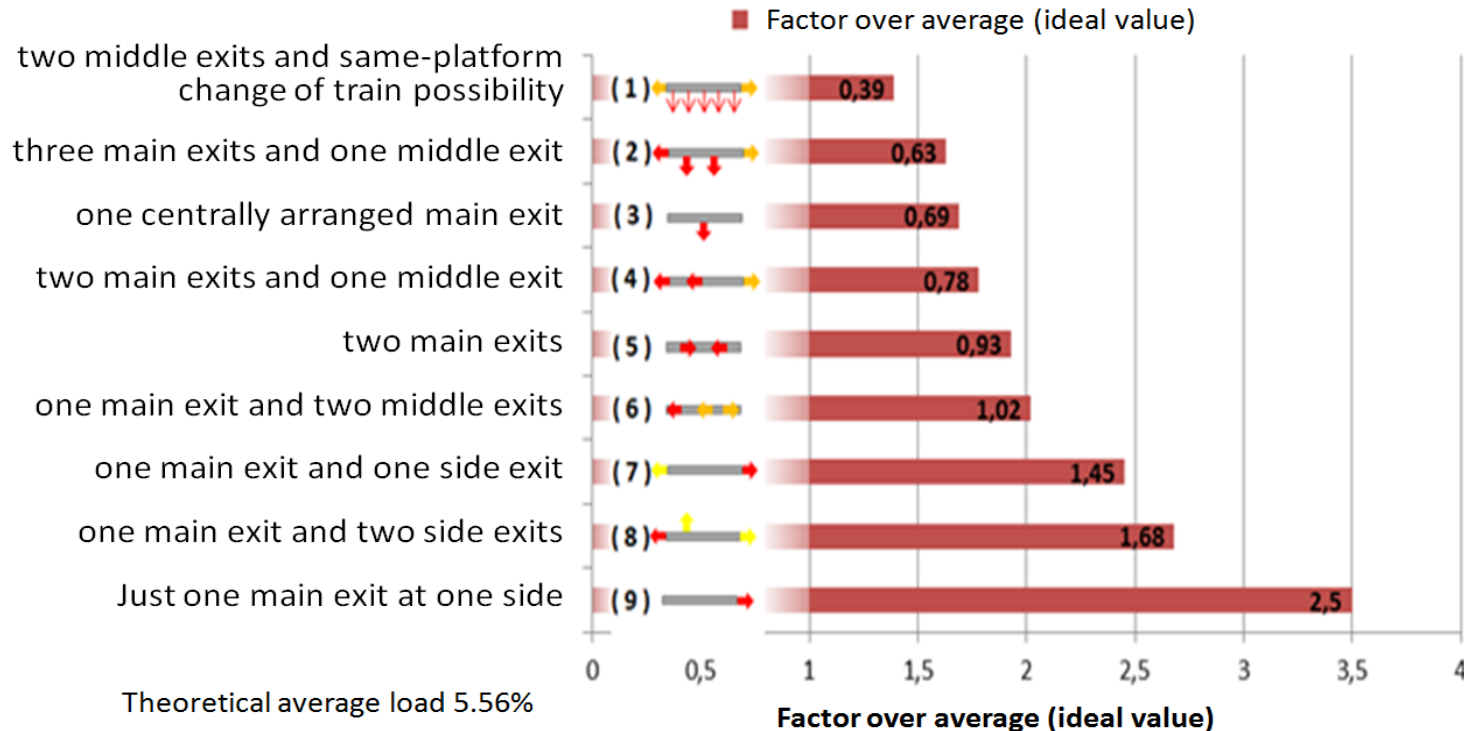
Passenger distribution – example 4

One wider main exit in the middle of the platform



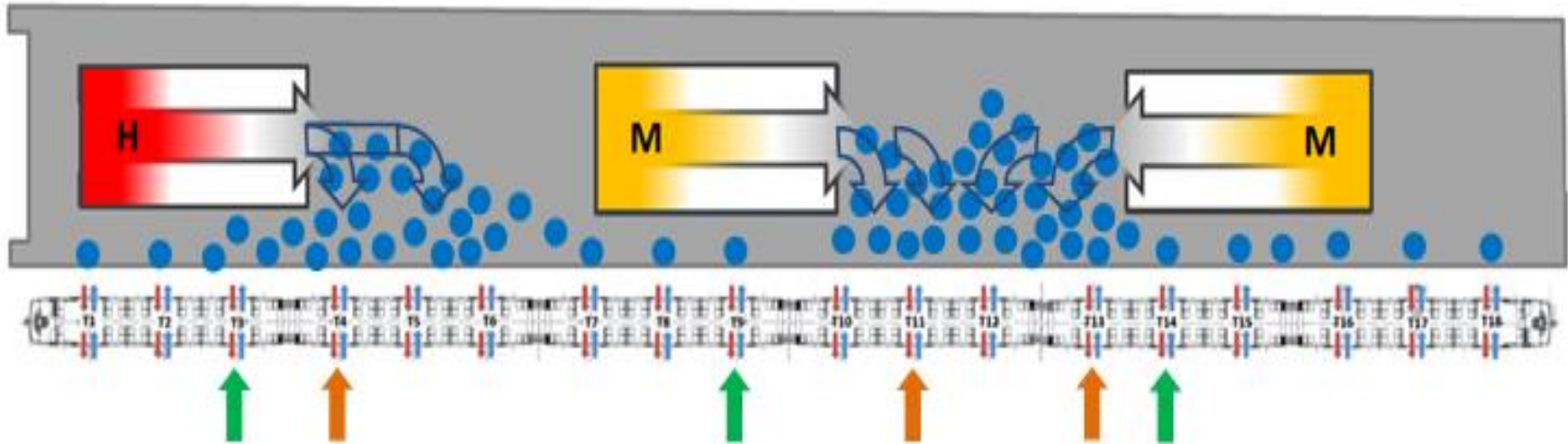
Comparison of different platform types

Deboarding passengers in percent for the most frequented door for each platform type



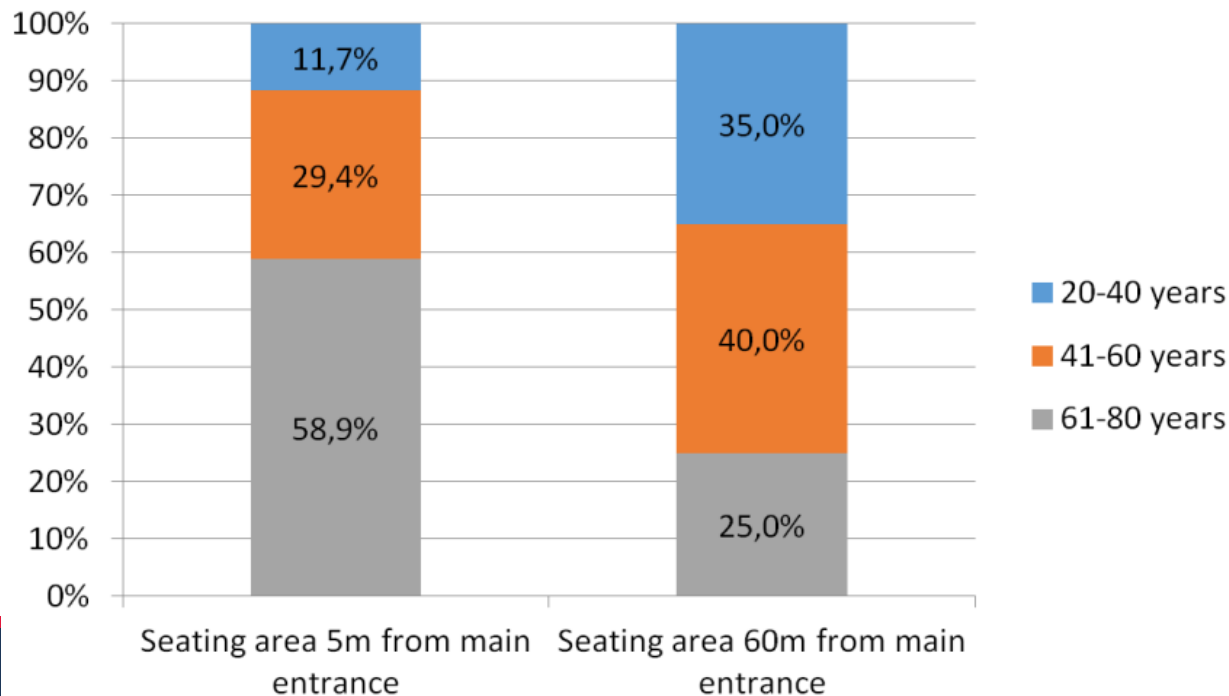
Passenger flow depending on access

H=main access, M=medium frequented access



Waiting areas - seats

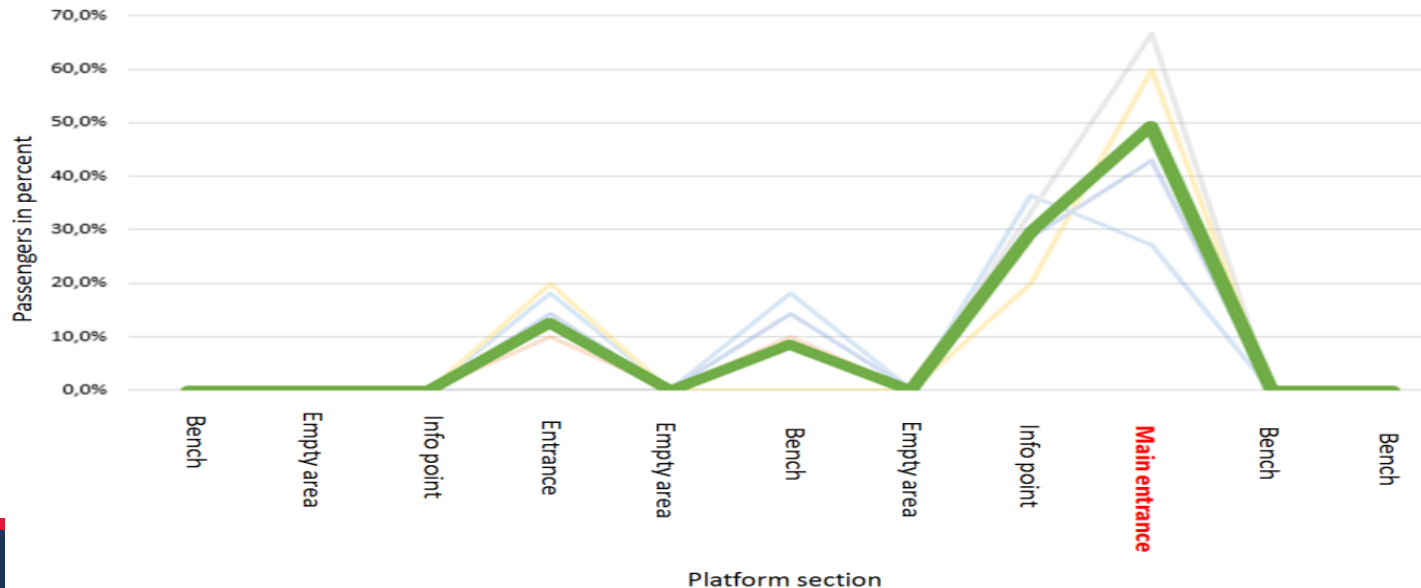
Older people stay closer to the platform access, younger people also use benches away.



Passengers with heavy luggage

Passengers with heavy luggage avoid walking on the platform. Some of them are also tourists which do not exactly know the system – that's why they are waiting close to the access.

Passengers with heavy luggage – distribution along the platform



Conclusion

Stay in the station: Passenger want to make use of facilities – easy handling short term baggage storage is required – also benefit for station operator → more passengers will spent more money

Dimensioning of lifts, escalators and stairs: Actual behaviour must be the basis for designing

- **Lifts:** Maximum achievable occupancy rate is 50%
- **Escalators:** Example 80cm wide steps: max. 4500 to 5000 persons per hour
- **Stair:** Maximum achievable capacity is 1.5 Persons per meter stair width
- **Platform access:**
 - more than one access is meaningful
 - Not only at the end of the platform, better additionally in the quarter or third points
 - Along the line not exactly always at the same places

Thank you for your attention!

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