Pedestrian flows on railway platforms

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Abstract

Due to the various origins and destinations and a mix of waiting and walking pedestrians, designing of railway platforms can present a challenging task. To determine the demand at different locations on the platform, an adequate estimation of the pedestrian trajectories has to be made. A key factor for this are the assumed walking distances and the chosen origins and destinations. Going by the literature, it is largely unknown how pedestrians choose their destinations on the platform and therefore their paths. One assumption sometimes made is that passengers, especially regular commuters, already walk to the location on the platform at their station of origin where they can minimise the distance to the exit at their destination.

In this work, measurements were made to determine the pedestrian trajectories on two railway stations in Zurich. Both boarding and alighting passengers were observed to determine the walking distance on the platform. Using this method, it was possible to evaluate to what extent passengers try to minimise their walk over the railway platform of the destination. The data also revealed that station layout is an important factor in distances covered on platforms

This paper is based on the project works made by Alexandra Wellig and Marco Binswanger at the IVT during the fall semester 2016.

Keywords

Pedestrians - Railway platform - Pedestrian flow

1. Introduction

Due to the significant improvements in the railway network in the last decades, also the number of passengers increased considerably. This led to the current situation, where certain railway stations are used in the peak hours by more passengers than they were designed for. In few cases, these stations, and especially their platforms might have already reached their capacity limits. Therefore, several extensions of railway platforms are planned.

To design the railway stations to meet the current and future demand, a detailed knowledge about the expected pedestrian flows on the platform is needed. Currently, required basics are still not available in the desired level of detail. Although todays counting devices allow to determine the number of passengers at a cross section (i.e. platform accesses or train doors), data on the movement on the platform is rarely available. Nevertheless, this data is needed to determine the load of specific areas on the platform and thus to determine the required width and dimensions of the platform.

In general, platforms are used for waiting and walking simultaneously. For the design, it is therefore essential to determine the distribution of waiting pedestrians and the trajectories of the walking pedestrian. Using this information and the expected number of pedestrians at the platform, the area showing the highest pedestrian concentration can be determined and used to design the platform.

Aspects of the distribution of waiting pedestrians on railway platforms were already discussed in a previous contribution (Bosina et al., 2015). It was shown using observations that waiting pedestrians prefer to choose locations where they can lean against a wall, obstacle or railing. Other important determinants of the waiting location were the number of passengers on the platform and the time to the next train arrival. In this contribution, the influences on the trajectories of the walking pedestrians will be studies in detail.

2. Influences on pedestrian flows

The most important aspects of pedestrian trajectories on a macro scale are their origin, their destination and their route. A pedestrian flow can then be described as a set of trajectories, which show similar properties in the area considered.

2.1 Origin and Destination

On railway platforms, the origins and destinations are the train doors, the platform accesses and the chosen waiting positions. Arriving passengers leave the train at a car door and walk towards an exit, boarding passengers walk from the entrances either directly towards the train doors, or to a waiting position chosen by the passenger. Situations are also possible, where pedestrians move from one waiting position to another, or change their destination to a train door before reaching their initially planned waiting position. If available service and shopping facilities such as ticket or vending machines can also serve as origins and destinations. On specific railway platforms, also pedestrians crossing the platform from one access point to another are present.

Table 1 possible trips on the platform

Start	Intermediate destination	Destination
Most important:		
Car door		Exit
Entrance	Waiting location	Car door
Entrance		Car door (if train is present)
Other:		
Car door	(waiting location)	Car door (for interchange at same platform)
Entrance		Exit
Entrance	Ticket machine – waiting location	Car door

In Table 1, possible trip sequences are shown. For Swiss railway stations in the peak hour, mostly the first trips are important for the design.

Especially for car doors and platform accesses, usually multiple alternatives exist, which can be used as origin or destination. A pedestrian therefore also must decide, which of them to use. For this choice, several influences are possible (Table 2)

Table 2 Influences on the choice of origin and destination

Important		Less important
Distance	Pedestrian density	Lighting
Distance to final destination	Orientation signs	Platform roofing
Access type (stairs, elevator…)		

The origin at which the platform will be accessed is usually already defined before arrival and is considered to be independent of the platform properties. Although situations are possible, where previous experiences are used to choose an optimal origin and thus path on the platform. On the other hand, the destination, especially for alighting passengers, can influence the origin. It is often assumed that passengers optimise their location within the train to reduce the walking time at the destination. This behaviour would then result in pedestrians choosing their walking destination on the departure station's platform according to their desired destination/platform exit at the arriving station.

The choice of the specific destination can mainly be either based on the length to the destination, hence using the shortest feasible option, or based on the total trip and optimising its length. The first option is often considered for alighting passengers, where it is assumed that they use the next exit and orient themselves from there to their destination. The latter option, as described above, is used for boarding passengers which orient themselves towards their goal at their final destination.

2.2 Walking route

The walking route corresponds to the infrastructure elements that are used to get from the origin to the desired destination. In terms of railway platforms, the route can be described using the opening between obstacles or obstacles and the platform edges, hence the clear openings on the platform.

As a railway platform usually shows a distinctly elongated shape, the routing options are often limited. Most platforms have different kind of obstacles placed in the middle, which divides the platform into two sides. Apart from the microscale, pedestrians therefore usually choose to stay on the side where they left the train or their train is expected to arrive, or to change to the other side of the platform. A common assumption is that pedestrian stay on the side of their train unless the pedestrian density reduces the walking speed too much on this side. Then, more pedestrians will also use the other side. This can occur for example during the boarding and alighting process, when the side of the train is obstructed by waiting passengers and the alighting passengers might chose the other side of the platform as a faster route (Bundesamt für Verkehr BAV, 2011).

Apart from the pedestrian density and the width of bottlenecks, which limit the flow, also other influences on the route choice might be present (Table 3). In general, their influence is considered to be moderate to small.

Table 3 Influences on the walking route choice on railway platforms

Important		Less important
Pedestrian density	Passing trains	Platform roofing
bottleneck width	Orientation signs	Sun exposure
		surface

3. Hypothesis and Method

Based on the common assumptions three hypotheses were formulated concerning the most important aspects of pedestrian trajectories on railway platforms.

1. *Boarding passengers prefer to stay close to the platform entrance they used.*

2. *Alighting passengers leave the train in the section that enables them to minimise the walking distance to their desired platform exit.*

3. *Alighting passengers change the platform side more often at high pedestrian densities in front of them.*

The first two hypotheses consider the destination of pedestrian trajectories and are somehow contradictory. If the second hypothesis is true, the first can only be true if pedestrians redistribute themselves considerably within the train or they already use the platform entrance at the departure station which will provide the shortest walking distance at the arrival station, which is considered to not be true for most of the passengers. Still, both hypotheses are useful to test, as they reveal different information.

The third hypothesis is based on the most important aspect of the route choice on the platform, the side used. The basic assumption if pedestrians keep their side unless other influences make the other side more appealing will be tested.

To test the hypothesis a case study was performed at two railway stations in Zurich. Using manual pedestrian tracking, the origins and destinations of passengers were recoded. First, the platforms were divided into different sectors, grouping the car doors. For randomly selected pedestrians leaving the arriving trains in each sector, their destination on the platform was recorded. For the boarding passengers, the same procedure was applied, recording pedestrians entering at a determined location and their first permanent waiting position.

Additionally, for the third hypothesis the changing of platform sides was recorded for a subsample of the alighting passengers.

4. Case Study

For the case study two railway stations, Zürich Hardbrücke and Zürich Stadelhofen were selected. For both stations, the platform between the tracks 2 and 3 was selected. Both are stations within the city of Zürich with a high frequency of suburban trains and a high passenger demand. Thus, situations with high pedestrian densities could be observed, which are the most relevant in terms of station design. It also allowed for a time efficient measurement, as the choice of tracking method limits the number of passengers that can be observed per train, as usually only one person can be tracked at a time.

Zürich Hardbrücke is situated between Zürich Hauptbahnhof (Zurich main station) and Zürich Oerlikon. On the two platforms, 28 trains are stopping in the peak hour. Summing over all four tracks, the station is frequented on average by about 22’600 boarding and 24’400 alighting passengers per day (Regierungsrat des Kantons Zürich, 2013). The platform 2/3 (Figure 1) has a length of about 330 m and an average width of about 6.5 m. This station has a special characteristic, as it is situated below a bridge at an intermediate level between the street level on the bridge and the main station entrance below the bridge. In addition, on the western end of the platform, another entrance is leading to a nearby neighbourhood. This leads to the situation that almost every platform access leads to another destination. It is therefore usually not feasible to use a random platform exit and then walk towards the desired goal, but the right exit has to be determined before leaving the platform. Hypothesis 2 can therefore be better observed, as only limited options are available for a specific destination. In total, platform 2/3 has five platform entrances (excluding the escalators, which are only used by a small share of people and therefore are not considered in the study), which at the same time serve as platform exits when alighting from a train.

Figure 1 Zurich Hardbrücke, platform 2/3

Zürich Stadelhofen has a similar position in the urban rail network within the city of Zürich but a completely different station layout. It only hast three tracks and fewer train arrivals, but with 36’900 boarding and 39’200 alighting passengers per day considerably more passengers (Regierungsrat des Kantons Zürich, 2013). One side of the railway station is confined by the stone surface; the other side, where platform 1 is located, is open to the city. From platform 2/3 (Figure 2) most of the accesses lead to an underpass below the station, where most of the destinations can be reached. Only the destinations at the hill can easier be reached using the other platform accesses, leading to an overpass. But as they are considerably less used than the others, these exits are not considered in this study. In total, Zürich Stadelhofen has eight platform accesses, all serving as entrance and exit at the same time.

Figure 2 Zurich Stadelhofen (view from Schanzengasse)

Source: Bosina et al. (2015)

5. Results

5.1 Hypothesis 1

Hypothesis 1 assumes, that boarding passengers tend to wait next to the platform entrances instead of distributing themselves across the platform. This hypothesis was tested by tracking pedestrians from the entrance to their first waiting position. It was assumed, that this position corresponds to the boarding location of the train. Neither passengers boarding a train without waiting, nor passengers moving as groups were recorded.

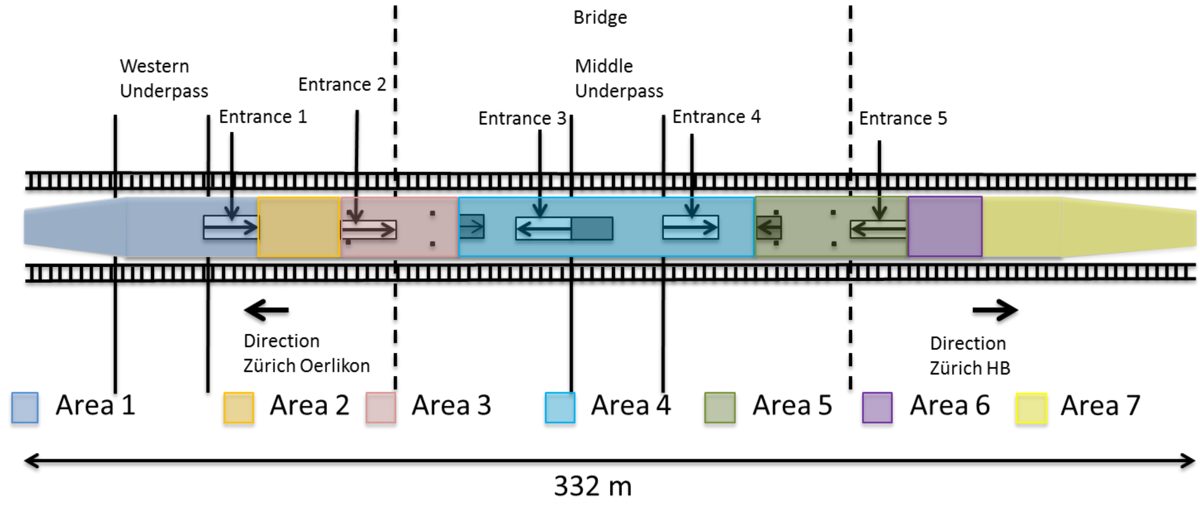
To make sure mainly commuters were observed, who know the station layout and might have already adopted an optimisation strategy concerning their waiting location, the observations were done during peak hours. The measurement were done on Tuesdays and Thursdays in the morning peak between 7 and 9 am and in the evening peak between 5 and 7 pm.

For the observations, the platforms were divided into seven sections each. The sectors were divided based on platform features for easy recognition, hence their length are not the same, but similar. It was recorded, which entrance was used to enter the platform and in which sector the persons waiting location was situated. Areas close to the entrance currently observed were divided into two to three sub areas.

5.1.1 Zürich Hardbrücke

Platform 2/3 in the Station Zürich Hardbrücke was used for the observations (Figure 3). It was divided into seven areas with a length between 12 and 132 m (see also Table 5). It has to be noted that in the outer areas only long trains in the peak hours are stopping. Entrance 1 connects to the western underpass, Entrance 2 and Entrance 5 to the two sides of the bridge (Hardbrücke) and Entrance 3 and Entrance 4 to the middle underpass.

Figure 3 Layout of observation areas of Hypothesis 1, Zürich Hardbrücke, platform 2/3



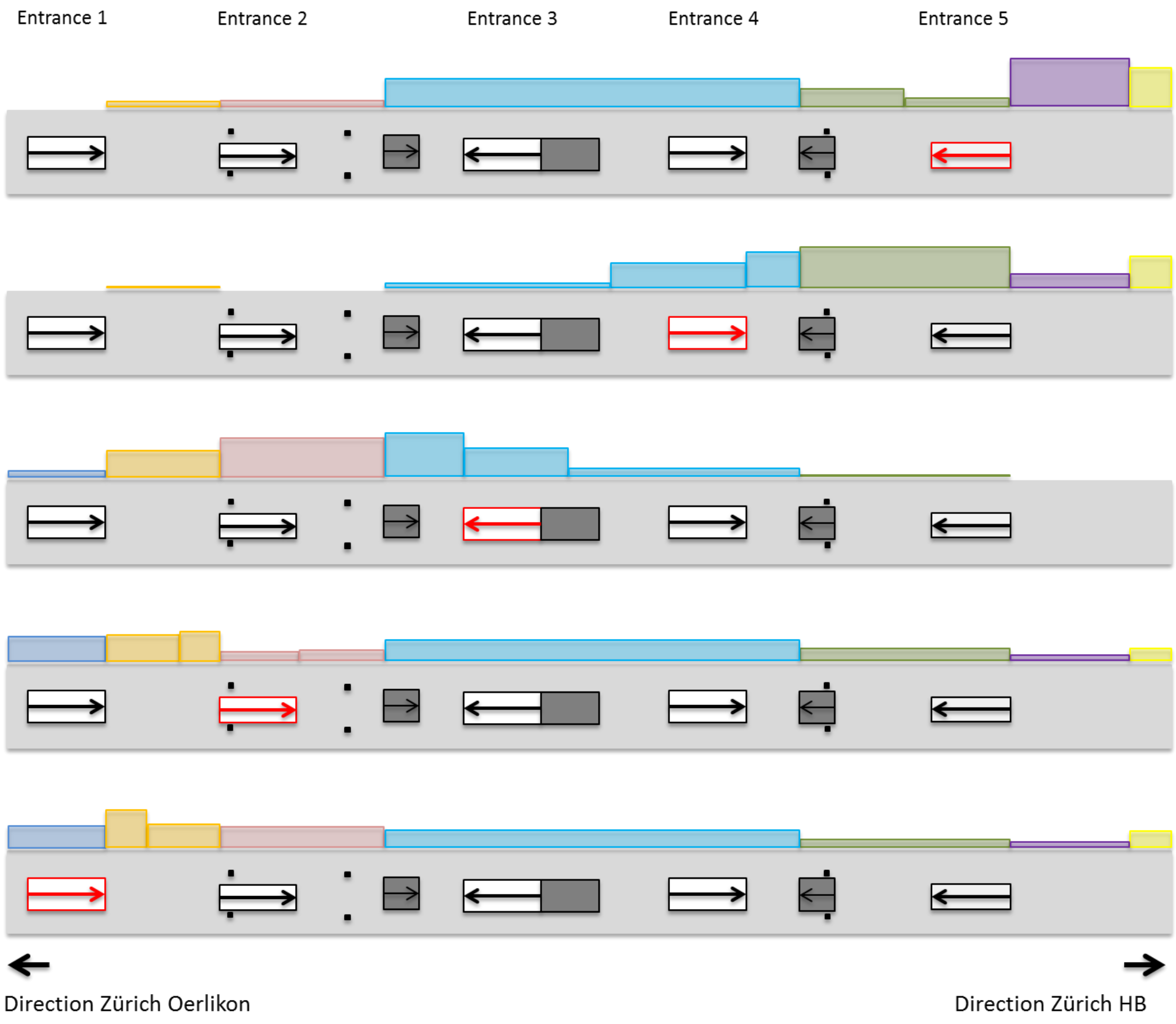
Sources: Binswanger (2016) and Wellig (2016), altered

In Figure 4, the distribution of passengers to the different areas, leaving from the same entrance, are shown. It can be seen that a high amount of pedestrians wait in the vicinity of the platform access used. On the other hand, also a share of pedestrians distributing themselves across the whole platform is visible. The hypothesis that people prefer to stay close to the platform entrance they used can therefore not be verified completely. It seems that a certain amount of pedestrians prefer to wait close to the entrance, but not all.

Another indicator that the Hypothesis 1 cannot be confirmed in the case of Zürich Hardbrücke is seen in the passenger distribution from Entrance 3 and Entrance 4 (Figure 4). Those entrances both connect to the middle underpass and passenger walking through the underpass towards the platform 2/3 have the choice which one to take. The distributions of the waiting pedestrians originating from these two entrances are roughly inverted with respect to each other. Pedestrians walking towards direction Zürich Oerlikon mostly stay on this side of the platform and vice versa on the other side. This indicates that boarding passengers already decide in the underpass, which location on the platform they want to reach and then walk there using the shortest path. From the platform entrance, the passengers then walk until their waiting destination is reached.

Considering the data obtained in Zürich Hardbrücke it can be concluded that the desired waiting location, which is assumed to be based on the location of the final trip destination, is highly relevant. There seems to be two strategies present. The first one, as proposed in hypothesis 1, that people stay close to the platform entrance, and the second one, where passengers walks along the platform towards their desired waiting location. An influence on the strategy choice not studied here is the time to departure and the number of pedestrians on the platform, which both increase the usage of strategy one (Bosina et al., 2015).

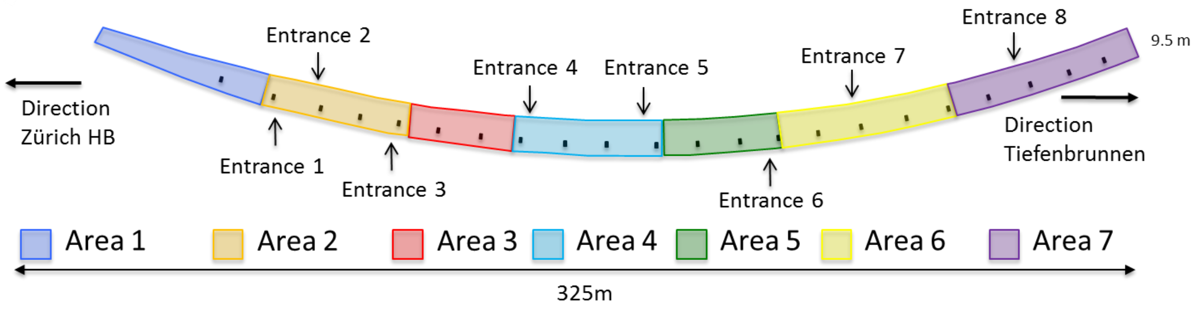
Figure 4 Distribution of pedestrians using the same entrance (marked red), Zürich Hardbrücke. The height of the squares corresponds to the share of pedestrians waiting in this area.



Data source: Wellig (2016)

5.1.2 Zürich Stadelhofen

Figure 5 Layout of observation areas of Hypothesis 1, Zürich Stadelhofen, platform 2/3



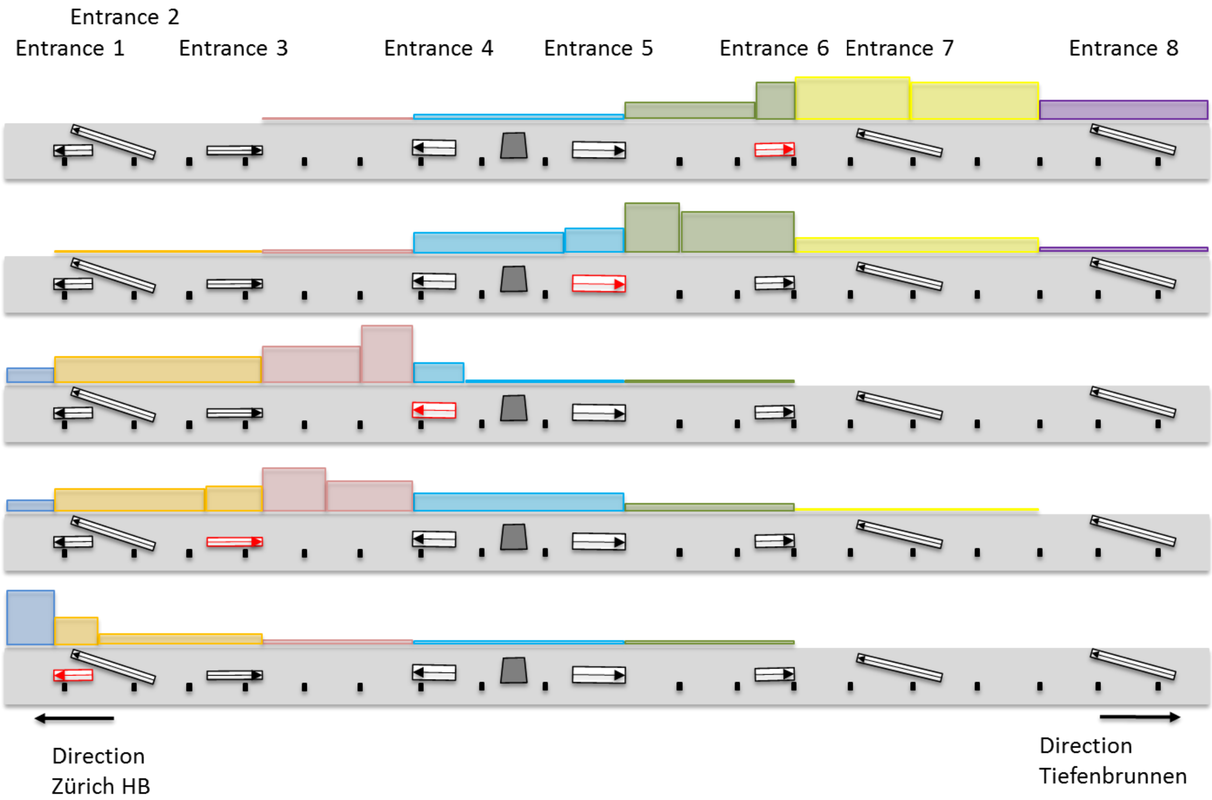
Sources: Binswanger (2016) and Wellig (2016), altered

Similar to Zürich Hardbrücke, the platform 2/3 in Zürich Stadelhofen was divided into seven areas (Figure 5). The areas in Zürich Stadelhofen all have similar lengths, ranging from 31 to 48 m. Entrance 2, Entrance 7 and Entrance 8 lead to the pedestrian overpass, all other entrances connect to the underpass. As the overpass is not used frequently, these entrances were not considered in the observations.

The distribution of pedestrians using the same entrance can be seen in Figure 6. In comparison with Zürich Hardbrücke, the results in Zürich Stadelhofen show a lower distribution of pedestrians across the platform. Most pedestrian stay close to the entrance, which confirms the hypothesis 1 for Zürich Stadelhofen. In addition, the share of pedestrians continue walking in the same direction they were entering the platform seems to be considerably higher compared to pedestrian walking in the other direction. When pedestrians turn around and walk in this direction, they mostly stay close to the platform entrance. This indicates that they wait next to the barriers in this locations.

This behaviour indicates that the pedestrians already used the underpass to distribute themselves and to choose a platform entrance close to their preferred waiting location. Therefore, long walking distances on the platform are not necessary any more.

Figure 6 Distribution of pedestrians using the same entrance (marked red), Zürich Stadelhofen. The height of the squares corresponds to the share of pedestrians waiting in this area.



Data source: Wellig (2016)

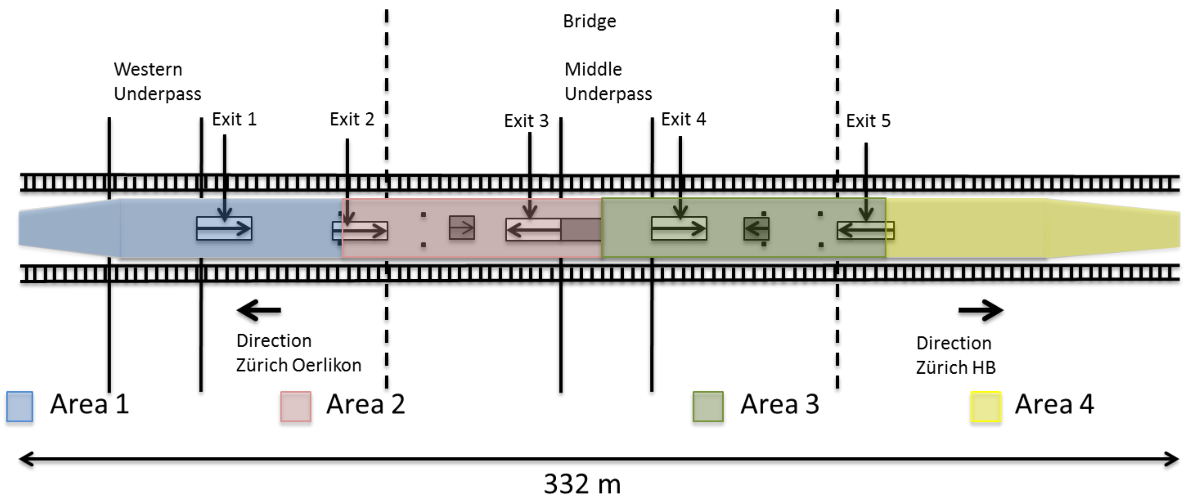
5.2 Hypothesis 2

Hypothesis 2 focuses on alighting passengers and proposes that they are trying to minimise their walking distance by leaving the train in a section close to their desired exit. To test this hypothesis, measurements were done in Zürich Hardbrücke and Zürich Stadelhofen similar to the ones for hypothesis 1.

The platforms were divided into areas. For each area, a random set of pedestrians were tracked and the exit taken recorded. The data obtained can then be used to determine the distribution of passenger from the trains to the exits. The observations were made on working days from 7:00 to 11:00, covering the morning peak hour as well as off-peak times.

5.2.1 Zürich Hardbrücke

Figure 7 Layout of observation areas of Hypothesis 2, Zürich Hardbrücke, platform 2/3



Source: Binswanger (2016), altered

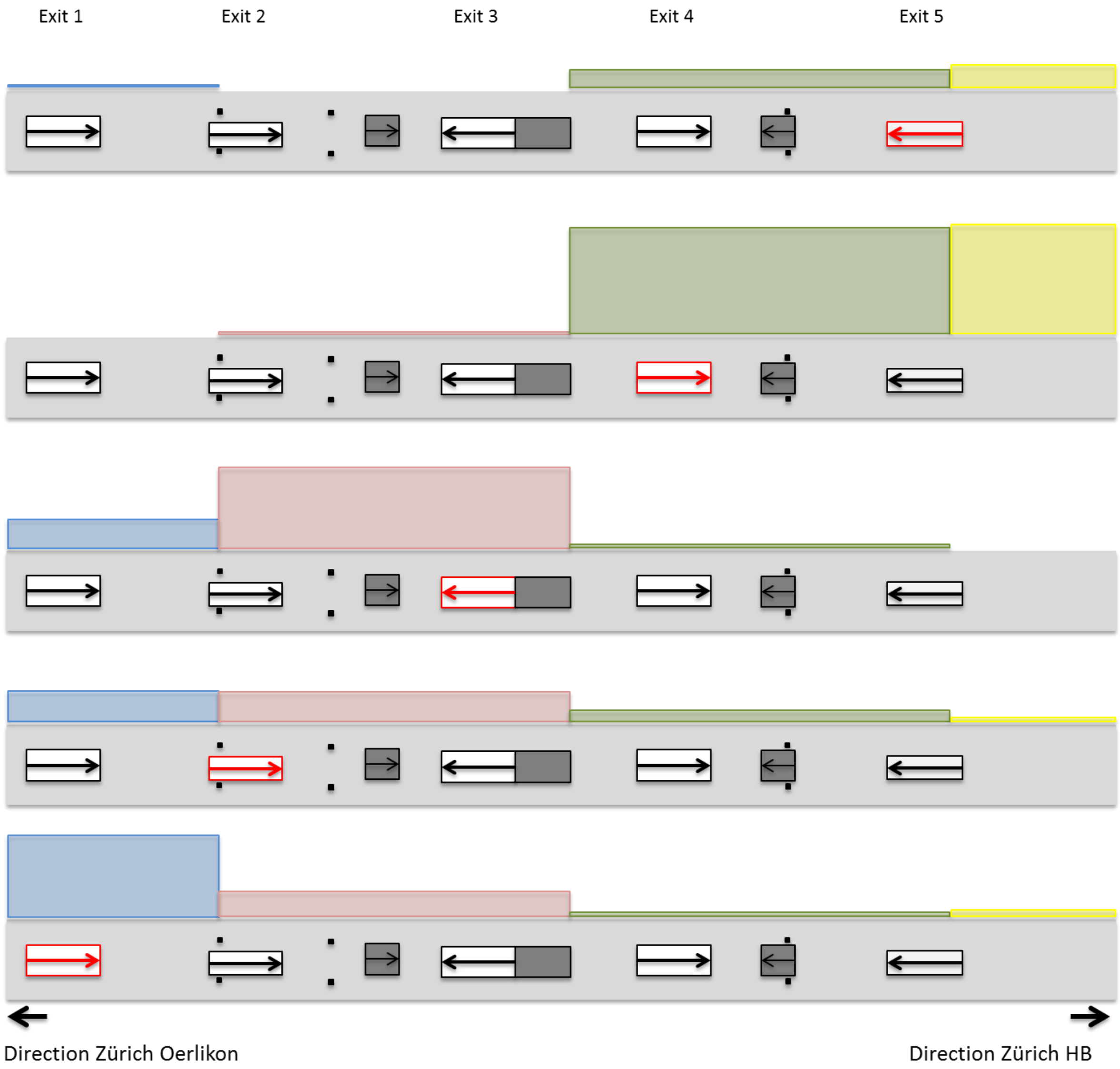
For the observations made to analyse hypothesis 2 at Zürich Hardbrücke, the platform was divided into 4 areas (Figure 7). For each of these areas, the passengers were tracked and the exit taken was recorded.

The results of the tracking can be seen in Figure 8. For each exit, the percentage of passengers approaching this exit from a specific Area are shown. As all exits except Exit 3 and Exit 4, which both connect to the middle underpass, lead to different areas around the railway station, alighting passengers usually choose the platform exit based on their final destination to avoid long detours.

The data clearly shows a tendency of pedestrians to optimise their walking path at their destination station. For example, the share of pedestrians using Exit 1 is considerably higher in Area 1, which is around this exit. Passengers that know they want to reach the area of the city this exit leads to, appear to already enter the train in the right place so as to minimise the walking distance on the destination platform. This observation can also be made for the other Exits. For Exit 3 and Exit 4, which both lead to the middle underpass, it can also be seen that pedestrians almost exclusively use the next exit, if more options are available.

The observations made at Zürich Hardbrücke thus support the hypothesis that pedestrians try to minimise the walking distance at the destination by deciding where to board the train.

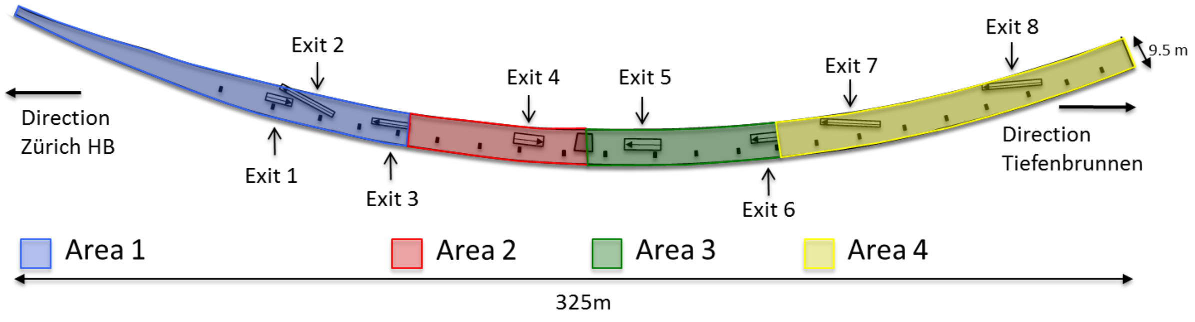
Figure 8 Percentage of pedestrian per area using a defined exit (marked red), Zürich Hardbrücke. The height of the squares corresponds to the share of pedestrians from this area using the marked exit.



Data source: Binswanger (2016)

5.2.2 Zürich Stadelhofen

Figure 9 Layout of observation areas of Hypothesis 2, Zürich Stadelhofen, platform 2/3



Source: Binswanger (2016), altered

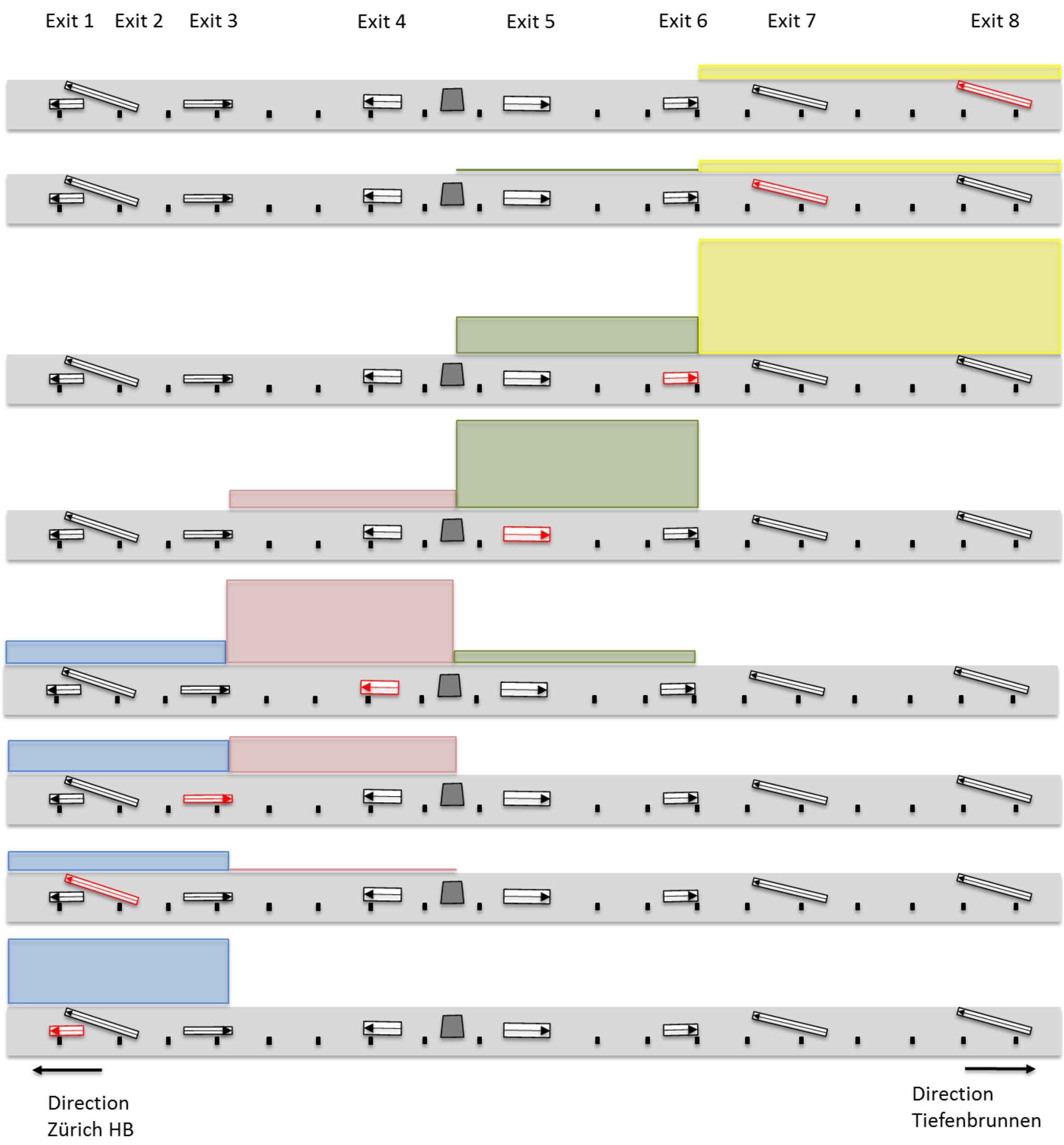
In Zürich Stadelhofen, the same observation procedure was applied. The division of the platform into different areas can be seen in Figure 9.

Figure 10 then shows the percentage of pedestrian in an area using a specified exit. Here it can also be seen that usually the closes exit is used. As all exits except Exit 2, Exit 7 and Exit 8 lead to the same underpass, no conclusion can be drawn if the passengers already adapted their location within the train according to their destination. Still, for the exits leading to the overpass, the numbers indicate that an adaption is present.

Based on the observations made it can be concluded that two strategies are visible. First, pedestrians simply use the closest exit to minimise their distance walked on the platform. Second, pedestrians optimise their route at the destination by choosing a train car close to their desired exit.

In comparison between the results obtained from Zürich Stadelhofen and Zürich Hardbrücke it can be seen, that a connection between different exits within the station is likely to reduce the walking distances on the platforms. If an exit is not connected to the remaining station, alighting pedestrians will be concentrated around this exit, hence reducing the walking distances compared to an even distribution of passengers along the whole platform.

Figure 10 Percentage of pedestrian per area using a defined exit (marked red), Zürich Stadelhofen. The height of the squares corresponds to the share of pedestrians from this area using the marked exit.



Data source: Binswanger (2016)

5.3 Hypothesis 3

For this hypothesis it needs to be tested whether the frequency of platform changes increases at higher pedestrian densities. To be able to do this, it was recorded how often a tracked person changed the platform side. This was done at Zürich Hardbrücke during peak hours (7 – 9 am) as well as off-peak times (9 – 11 am and 2 – 3 pm). For comparison, the side changes were also recorded in Zürich Stadelhofen during peak hours. As pedestrian walking only short distances to their exit usually do not change the platform side, these pedestrians were not considered in the analysis.

In Table 4, the recorded side changes are shown. In comparison, slightly less pedestrians changes the platform side in off-peak times. This indicates that at higher densities, which do occur during peak hours, more pedestrians change the platform side to avoid high densities. This numbers were also supported by qualitative observations during the measurements, which showed that pedestrians changed the platform side to avoid pedestrians, even after some time walking at the same side (Binswanger, 2016). In addition it was observed that side changes occur mostly for longer trips on the platform. Hence the longer the distance walked on the platform, the higher the likelihood of a side change.

Comparing the results from Zürich Hardbrücke to Zürich Stadelhofen shows similar values, with slightly less side changes in Zürich Stadelhofen. A reason for this might be the platform widths, which is about 9.5 m in Zürich Stadelhofen compared to 6.5 m in Zürich Hardbrücke.

Table 4 Platform side changes

		Without side change		With side change	
Zürich Hardbrücke	peak hour	209	71 %	85	29 %
	off-peak	90	76 %	29	24 %
Zürich Stadelhofen	peak hour	149	79 %	31	21 %

Data source: Binswanger (2016)

Although the results indicate an influence of the number of pedestrians on the amount of platform side changes, more data is needed to verify the hypothesis. In addition the geometry of the platform and the walking path lengths are likely to have an influence as well. As the side changing behaviour also influences the local densities in bottlenecks as well as they might result in safety critical situations on the other side of the platform, when a pedestrian walks close to the platform edge while a train is passing, further research is needed to improve the design quality.

6. Conclusion

Although the observations made are limited in terms of number of observations and different stations considered, the results can give first insights on the behaviour of pedestrians on railway platforms.

For the design of railway platforms, the estimation of pedestrian flows is important. Longer walking distances lead to longer length of stay and thus to higher loads on the platforms. The observation that a considerable part of boarding pedestrians stay close to the platform entrance and that alighting pedestrians try to reduce their walking distances on the final station therefore reduces the design load. On the other hand, pedestrians boarding tend to do longer walking trips on the platform to reach the waiting location where their trip at the final destinations are the shortest, which increases the load. Depending on the specific situation, one or the other phenomenon predominates, which impacts the design of the facility.

It was also shown that the pedestrian flows on the railway platform depend on the station layout and its surroundings. If the station connects all platform accesses and station exits well, it is assumed that the pedestrian flows on the platforms are reduced. A proper design of the platform therefore also has to consider the complete station layout.

The study indicates, that hypothesis 1 (boarding passengers stay close to the entrance) has to be rejected, whereas the other two hypothesis can be supported based on the results. Nevertheless, certain limitations apply to these conclusions. As the number of stations and passengers observed are rather small, more measurements are needed to consider also other layouts and times, where a different pedestrian behaviour might occur. Especially the time to departure is another aspect which will likely influence the results, especially for waiting pedestrians. In addition, further studies should also try to quantify the number of pedestrians on the platform and the total number of boarding and alighting pedestrians, which can provide more insights into the pedestrian’s behaviour. An extension of the observation area to the whole station will also provide valuable information.

Furthermore, using more advanced technologies that have become available commercially in the last years, like tracking with stereo cameras, significantly more data can be collected with relatively little effort. Such data could be used to provide a much more solid basis on which to test the proposed hypotheses.

In conclusion, it was able to provide useful data about pedestrian flows on railway platforms. Using them it was possible to show that pedestrians indeed minimise their walking trips and commuters orient themselves towards the exits at the final station already at the boarding station.

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8. Appendix

8.1 Hypothesis 1, Zürich Hardbrücke

Table 5 Distribution of boarding passengers on the railway platform, Zürich Hardbrücke

	Area 1		Area 2		Area 3			Area 4		Area 5	Area 6	Area 7	N
L [m]	71		32		20			41		22	12	132	
Exit 1	14%	25%	15%		14%			12%		5%	4%	11%	111
Exit 2	16%	17%	20%	6%	7%			14%		8%	3%	8%	86
Exit 3	4%		17%		26%	29%	18%	5%		1%	0%	0%	121
Exit 4	0%		1%		0%	3%	16%	23%		27%	9%	21%	129
Exit 5	0%		3%		4%			18%	12%	5%	32%	26%	130

Data source: Wellig (2016)

8.2 Hypothesis 1, Zürich Stadelhofen

Table 6 Distribution of boarding passengers on the railway platform, Zürich Stadelhofen

		Area 1		Area 2		Area 3		Area 4		Area 5		Area 6	Area 7	N
L [m]		46		45		31		44		34		46	48	
Exit 1	37%	33%	17%	6%		3%		2%		2%		0%	0%	110
Exit 2		7%	14%	16%	28%	19%		11%		4%		1%	0%	144
Exit 3		9%		16%	23%	37%	13%	1%		1%		0%	0%	117
Exit 4		0%		1%		2%	13%	15%	32%	26%		9%	2%	142
Exit 5		0%		0%		1%		3%	10%	24%	27%	24%	12%	136

Data source: Wellig (2016)

8.3 Hypothesis 2, Zürich Hardbrücke

Table 7 Distribution of alighting passengers to the platform exits, Zürich Hardbrücke

		Exit 1	Exit 2	Exit 3	Exit 4	Exit 5	N
7 - 9 am	Area 1	49.2%	25.4%	23.8%	0.0%	1.6%	63
	Area 2	12.5%	25.0%	62.5%	0.0%	0.0%	72
	Area 3	4.2%	8.3%	0.0%	77.1%	10.4%	48
	Area 4	4.8%	0.0%	0.0%	77.8%	17.5%	63
9 - 11 am	Area 1	66.1%	17.9%	16.1%	0.0%	0.0%	56
	Area 2	24.6%	15.8%	56.1%	3.5%	0.0%	57
	Area 3	1.9%	7.7%	3.8%	73.1%	13.5%	52
	Area 4	4.2%	8.3%	0.0%	75.0%	12.5%	24
total	Area 1	57.1%	21.8%	20.2%	0.0%	0.8%	119
	Area 2	17.8%	20.9%	59.7%	1.6%	0.0%	129
	Area 3	3.0%	8.0%	2.0%	75.0%	12.0%	100
	Area 4	4.6%	2.3%	0.0%	77.0%	16.1%	87

Data source: Binswanger (2016)

8.4 Hypothesis 2, Zürich Stadelhofen

Table 8 Distribution of alighting passengers to the platform exits, Zürich Stadelhofen

		Exit 1	Exit 2	Exit 3	Exit 4	Exit 5	Exit 6	Exit 7	Exit 8	N
7 - 9 am	Area 1	45.5%	18.2%	18.2%	16.4%	1.8%	0.0%	0.0%	0.0%	55
	Area 2	0.0%	1.9%	22.2%	61.1%	14.8%	0.0%	0.0%	0.0%	54
	Area 3	0.0%	0.0%	0.0%	6.8%	55.9%	35.6%	1.7%	0.0%	59
	Area 4	0.0%	0.0%	0.0%	0.0%	0.0%	83.9%	7.1%	8.9%	56
9 - 11 am	Area 1	48.0%	8.0%	28.0%	16.0%	0.0%	0.0%	0.0%	0.0%	50
	Area 2	0.0%	0.0%	29.5%	60.7%	9.8%	0.0%	0.0%	0.0%	61
	Area 3	0.0%	0.0%	0.0%	0.0%	75.0%	14.6%	0.0%	0.0%	48
	Area 4	-	-	-	-	-	-	-	-	-
total	Area 1	47.1%	13.5%	23.1%	16.3%	0.0%	0.0%	0.0%	0.0%	104
	Area 2	0.0%	0.9%	26.1%	60.9%	12.2%	0.0%	0.0%	0.0%	115
	Area 3	0.0%	0.0%	0.0%	8.4%	64.5%	26.2%	0.9%	0.0%	107
	Area 4	0.0%	0.0%	0.0%	0.0%	0.0%	83.9%	7.1%	8.9%	56

Data source: Binswanger (2016)