AH2173 PUBLIC TRANSPORT

Final Project

Discussion and investigation of the distribution of platform waiting passengers

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"In case of few entrances to a station, passengers are evenly distributed along the length of the platform when waiting". In this project, based on this empirical investigation, data collection and analysis are conducted to disprove this idea.

Discussion and investigation of the distribution of platform waiting passengers

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1 Introduction

The starting point of the project is the statement "In case of few entrances to a station, passengers are evenly distributed along the length of the platform when waiting". Theoretically, passenger boarding behaviours including waiting location in Metro system partly determines the minimum headways and thereby affecting the efficiency of the entire system operation. In depth, the waiting location choice characteristics during the train arrival are influenced mainly by passengers' vision field at ladder stop as well as the distance between entrance and waiting location. In this project, based on observations of passenger distribution on platform before boarding the trains and examples of Stockholm metro stations with few entrances like one or two, statistical analysis are conducted to explore the outward appearance of passenger distribution along the platform.

2 Methodology

2.1 Previous study

Heinz (2003) points out that passengers spread out evenly which in most cases are not true except the number of passengers on the platform approaches the platform limit all the other distribution tend to converge to the even distribution. Instead, passengers tend to cluster. Theoretically, the four most common distributions that cover most of the cases are said to be the uniform distribution, the bell shaped distribution, the unilateral skewed distribution or the bilateral skewed distribution.

Investigations in Wiggenraad(2001) demonstrate that there is also a clear concentration of passengers waiting around platform entrances. Entrances at the end of the platforms lead to higher concentrations than entrances on the middle of the platform.

In this article Cheng et al. (2009) disclose the fact that the platform passenger distribution has been noted to be very affected by the location of the entrances and people seem to stand close to the entrances.

In Heinz study, passenger distributions are plotted with density (passengers per meter of station) as the y-axis and the station length as the x-axis. The paper also notices that when the train arrives the usual behaviour of door-aimless waiting passengers is to move towards the nearest doors. Therefore, from a calculation aspect, the distribution id divided on the x-axis with door locations and the number of passengers in each section is assumed to move to the closest door. As stated above, in our project, we also notice the significant concentration in front of doors when the train stops at the station and divide the length of platform into door attraction. Instead of assumption risk, the observation time just seizes the moment right after such movement. As a consequence, the distribution plot is primarily the passenger numbers against the door series.

Similarly, Hague HS station surveyed in Wiggenraad's investigation is divided into 40-meter sectors with regard to stair locations. The distribution is displayed with percentage in comparison of boarding percentages and waiting percentages. Such length

division is more or less the same to divide the platform into 24 doors mining. In contrast, the boarding passengers are not taken into account in our project.

The Beijing Subway line 1 example shares the common x-axis carriage level or stop level with our research. Plots are obtained against passenger flow percentage at both AM peak and PM peaks. Normally, waiting passenger we referred to is simply part of passenger flow, distinct from boarding and alighting passengers.

2.2 Assumption

In our study we believed that there are lots of factors influencing the distribution of passengers on the platform such as the physical structure of the station and the information provided in the station.

Above all, we assumed that passengers are more likely to stand close to the entrance of the station. According to our first observations, for convenience, after passengers entering the station they prefer standing or sitting at the closest waiting area to walking far away from the entrance.

What's more, we also believe that familiarity for the location also has impact on the waiting area. For frequent users, say, commuters, they are familiar with the exit location at the destination so they would also like to choose the closest waiting area to the destination exit. For example, though there is only one exit on south of the plat form in Universitet, passengers who want to go to T-centralen for shopping might walk until the far north end because it is closer to the shopping area. As a result, the feature of the exit location and the information provided on the station are also important factors we would like to look into.

According to previous observations, right after the arrival and before train doors open, waiting passengers would gather towards metro train doors. Then, these waiting passengers just stand on the way of alighting passengers after doors are open and consequently reduce the efficiency of boarding and alighting process. Considering this, in our study, waiting passengers are counted at door level at exactly the moment after the arrival and before train doors open.

3 Case Study

3.1 Location choice

Stockholm metro system includes 100 stations, of which most are with one or two entrances at different locations. In this project, as illustrated below, we pick four typical kinds of stations along the red metro line in direction from north to south to collect data, Östermalmstorg with one entrance at south end and one entrance in the middle, Tekniska högskolan with two entrances at both ends, Universitet with one entrance at south end, Zinkensdamn with one entrance in the middle. Besides, Universitet and Tekniska högskolan are transfer stations between red metro line T14 and light rail line L27/L28/L29 while Östermalmstorg and Zinkensdamn are transfer stations between red line T14 and T13.

3.2 Collecting method

With regard to the vehicles, there are both new-type trains with 6 cabins (4 doors each cabin) and old-type trains with 8 cabins (3 doors each cabin) running on red line metro

during the survey time. Regardless of the cabin differences, total number of doors is constant to 24. In reality, waiting passengers at that time has no access to know the type of trains coming and thus waiting passenger amounts in front of each door are totally unpredictable but obey to people's preferences. Here, we assume that the total length of these two trains and the distance between doors are approximately the same. This assures that the type of coming vehicles can be excluded from consideration.

In accordance to train running direction (north to south), the length of the platform can be divided into 24 zones, which is separately represented by a door. For each door, at the moment after train arrival and before door open, the numbers of waiting passengers are counted at door level. Clearly, in this project, the observation timing is closely connected with precision, of much importance. The figures below illustrate the brief structure of each station.

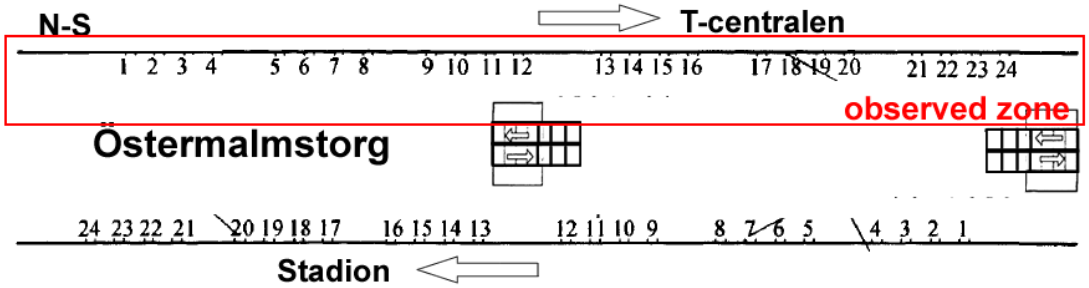

Figure 1 Illustration of Östermalmstorg station

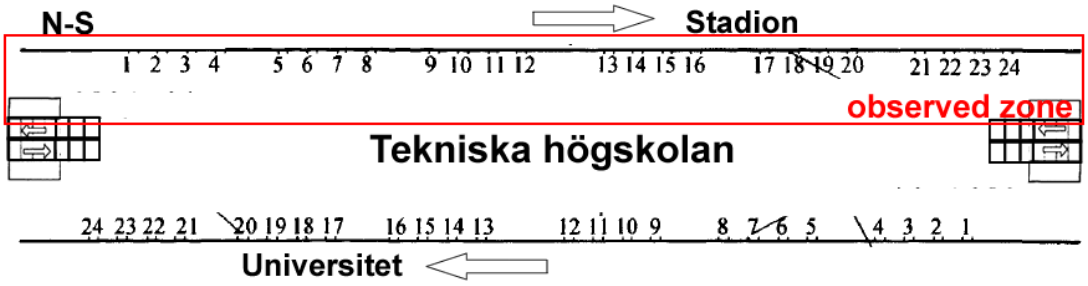

Figure 2 Illustration of Tekniska högskolan station

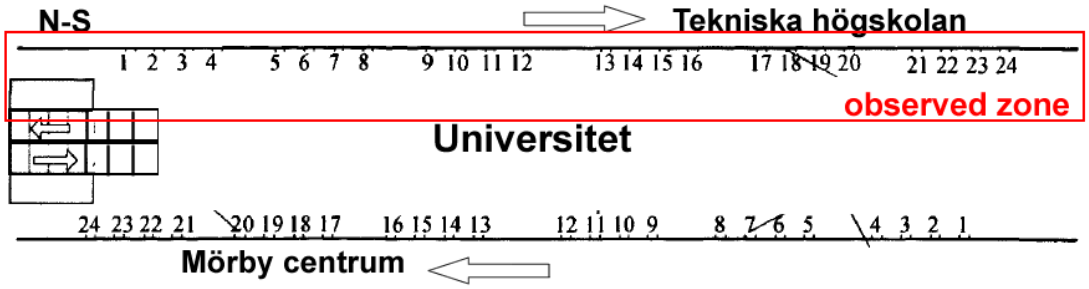

Figure 3 Illustration of Universitet station

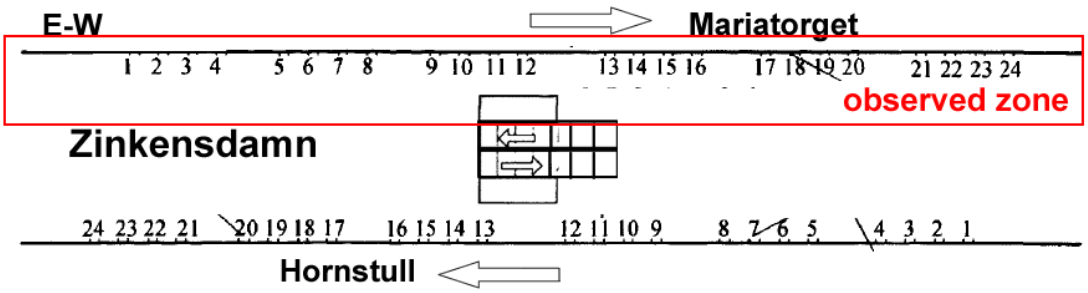

Figure 4 Illustration of Zinkensdamn station

3.3 Date and time

For each station, six sets of passenger numbers are counted separately during 10-12am on April 23rd-25th. The three days chosen are normal working days and the time is after peak hour. In reference to SL timetables, either T14 or T15 line remains same frequency 5 minutes per arrival during the investigation time during 10-12 o'clock. In other words, during the survey time, frequency respectively in station Tekniska högskolan and Universitet is 5 minutes per arrival while in Östermalmstorg and Zinkensdamn is 2-3 minutes per arrival. Here, we assume that all the trains arrive on scheduled time.

During the operation of Stockholm metro, short trains are assigned in flat peak time, when there is less demand. At that circumstance the display board on the platform will suggest passengers walking towards the centre of the station, which would influence the distribution of the waiting passengers on the platform. As a result, we tried to avoid this situation during our data collection.

As it is mentioned above, waiting passengers are counted at door level at exactly the moment after the arrival and before train doors open. Thanks to the assistance of several friends, it's available to collect 24 doors data of the same train at the same time.

3.4 Data collection form

According to the method, we applied the form below to collect data. In each station we first look into the physical structure of the platform, then we divided the waiting area according to the respective direction. In our assumption we believed that the distribution is influenced by the exit and the entrance, so in the station description data collectors are required to fill the location of the exit and the related features of the exit. For example the south exit of östermalmstorg is connected to shopping area which might attract more passengers.

The numbers filled in the form are the numbers of waiting passengers counted at door level at exactly the moment after the arrival and before train doors open.

Table 1 Data collection form

Date	23/04/2013		
Time	10:50	3min	11:10
Station	XXX		
	station description		

Direction X-X **Waiting area**	**set 1**	**set 2**	**set 3**	**set 4**	**set 5**	**set 6**

1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
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4 Results

After data collection, bar charts are used to describe the number of passengers on the platform. The graphs below display the collective data of each station. In accordance with the serial number we assigned above in figure 1-4, number 1-24 are used to represent each waiting area. Six sets of data are collected and presented by each waiting area.

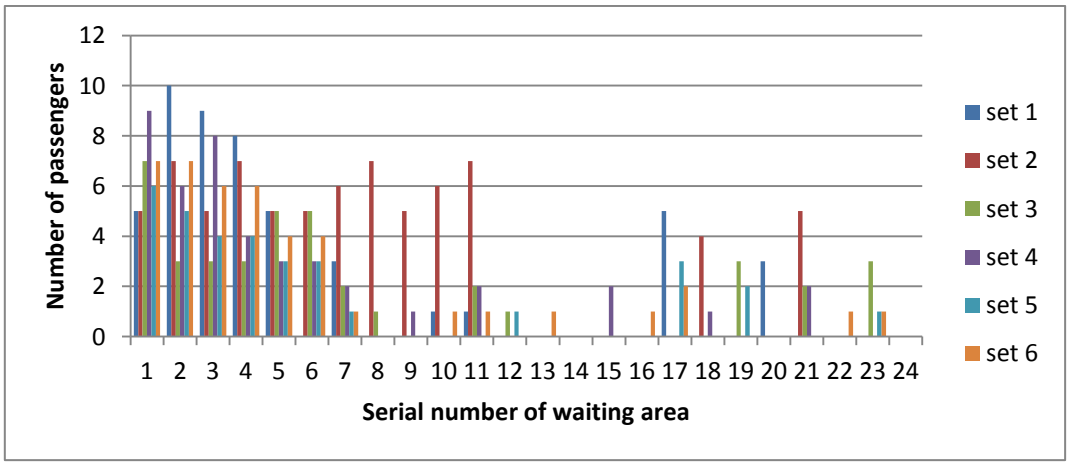

Figure 5 Waiting passengers on the platform Universitet

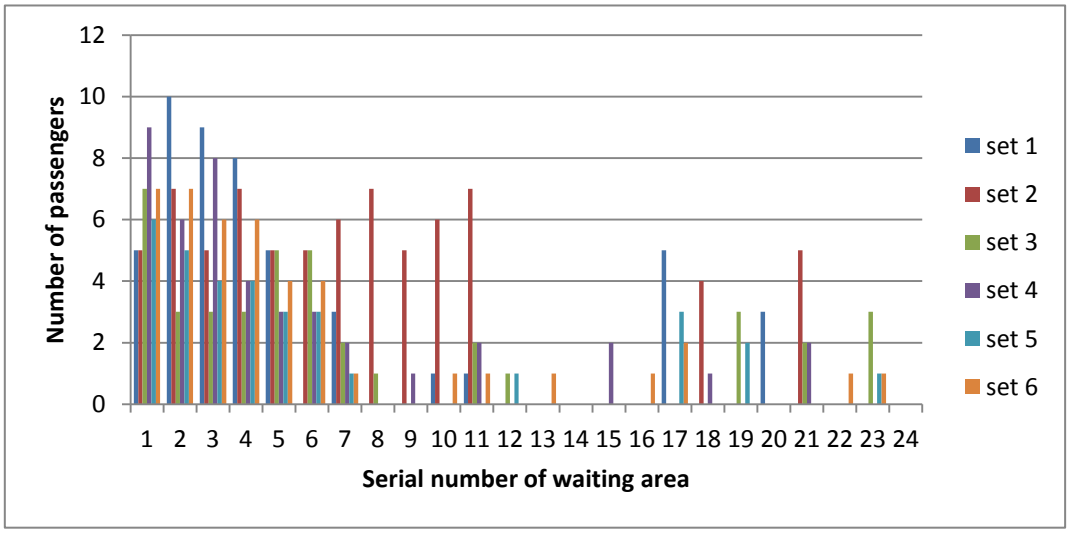

Figure 6 Waiting passengers on the platform Zinkensdamn

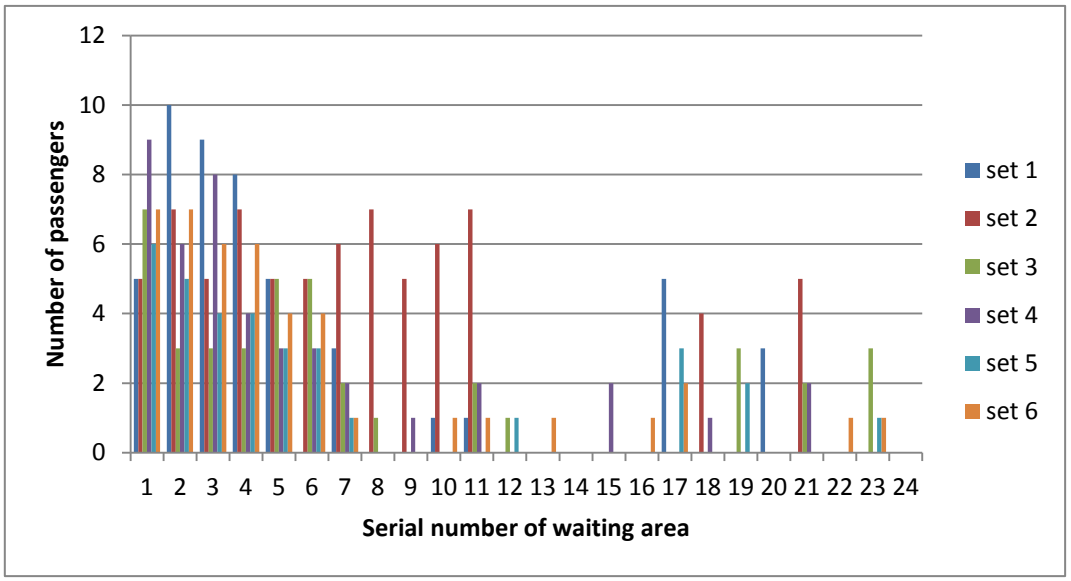

Figure 7 Waiting passengers on the platform Östermalmstorg

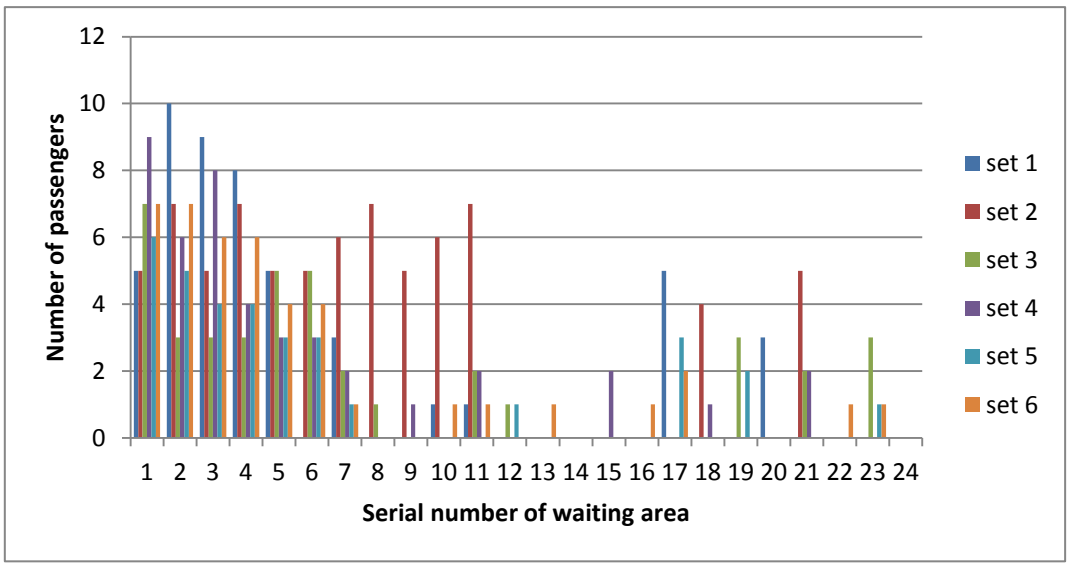

Figure 8 Waiting passengers on the platform Tekniska högskolan

5 Analysis

For each station, we first calculated the average boarding passenger for each waiting area.

First we looked into Zinkensdamn station.

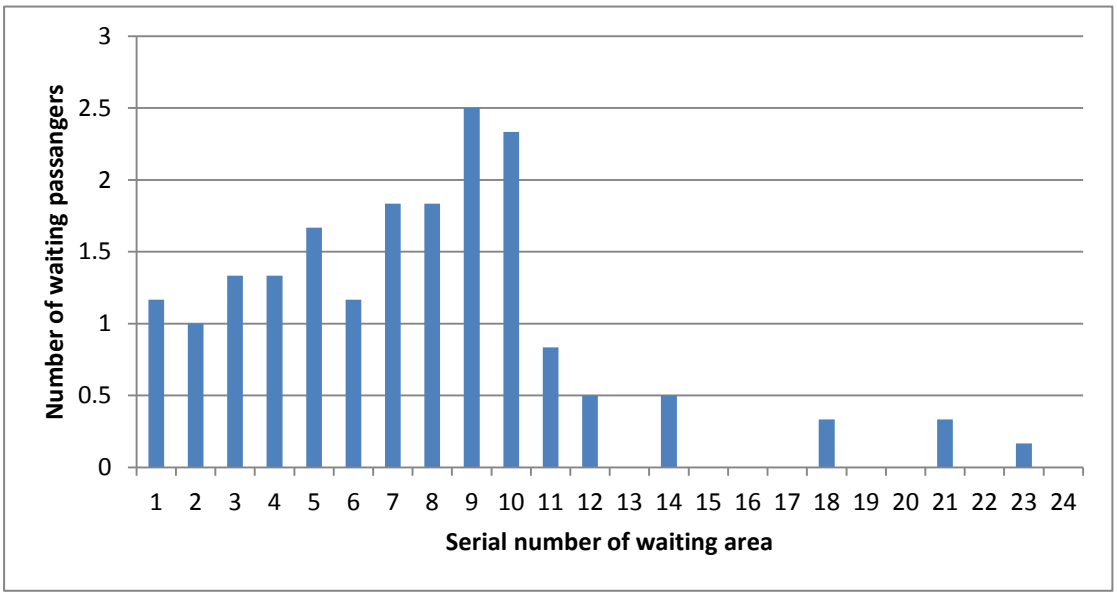

Figure 9 Average of waiting passangers on the platform(Zinkensdamn)

Apparently, from figure 9 we can see that waiting passengers are not evenly distributed along the platform during such flat hours rather than concentrated in the same direction as the entrance to the surveyed platform. Specifically, the entrance to Zinkensdamn locates in the middle of platform and the stairs are face to the same direction of the observed trains. Normally, according to our observation, when passengers go down stairs, usual way is to go directly along platform to the front part instead of turn back to end of trains. In addition, there are few passengers waiting at train ends who trailing back with acknowledgement of the destination exits.

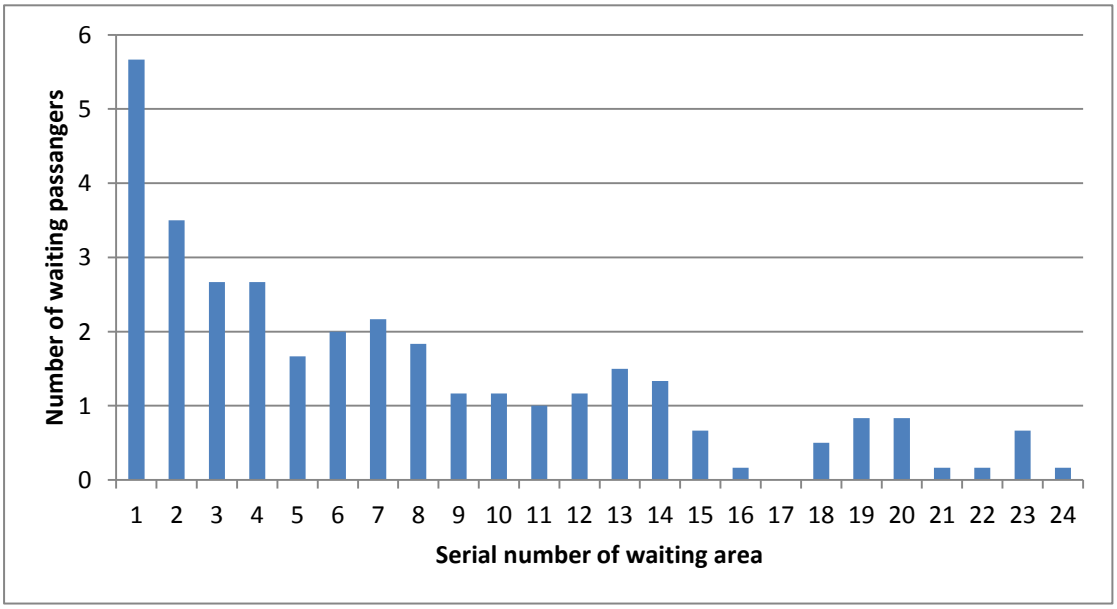

Figure 10 Average of waiting passangers on the platform(Östermalmstorg)

From visual sight, waiting passengers at Östermalmstorg station are not evenly distributed either. Most passengers choose to wait between the south entrance and the middle entrance. According to the location setting of the station, the south exit is close to main commercial area where people choose to go shopping. So the south entrance attracts more passengers.

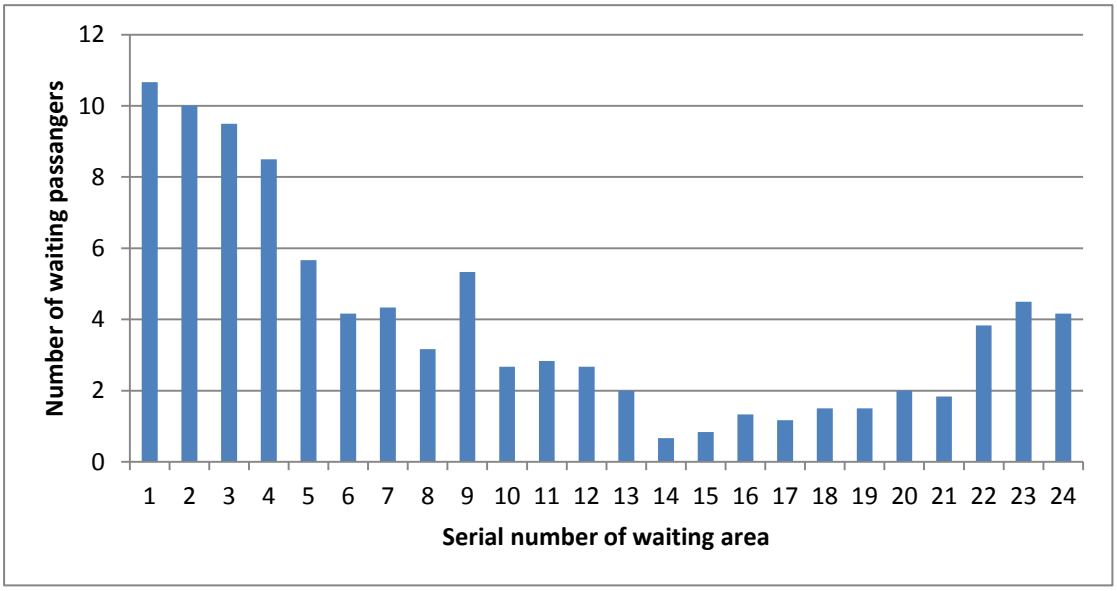

Figure 11 Average of waiting passangers on the platform(Tekniska högskolan)

In accordance with the entrance locations, waiting passengers are not evenly located, with a distribution that more close to entrance choices at ends and less further to entrance choices in the middle. Besides, at the train heading direction, the entrance is connected with the light rail station and thus results in more concentrated near the entrance zones.

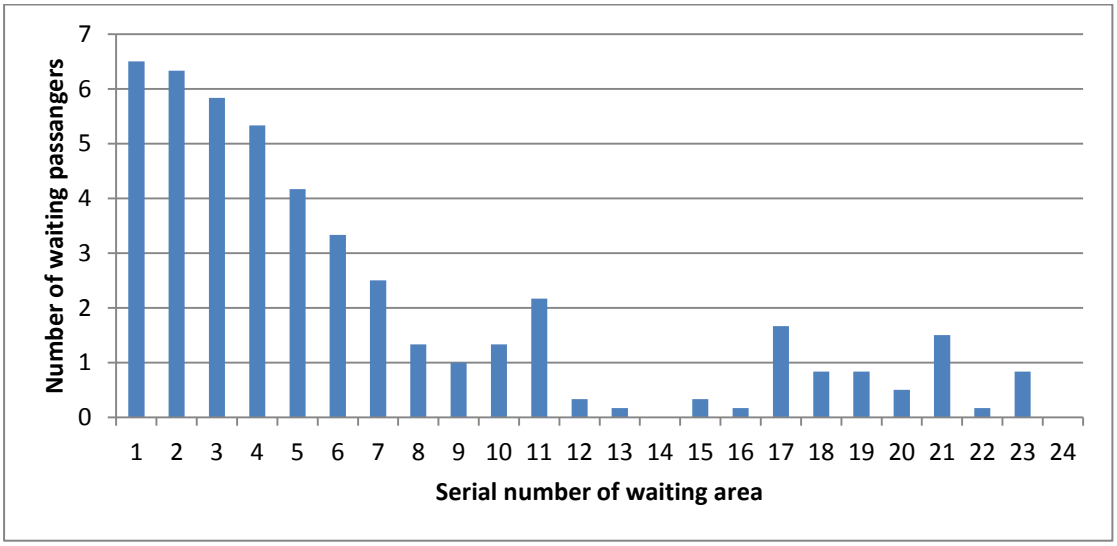

Figure 12 Average of waiting passengers on the platform (Universitet)

As well, Universitet station indicates similar trends, waiting passenger location choices mainly arrange closer to the entrance instead of even distribution. Similar to Zinkensdamn station case, the passenger concentration at the further end from only entrance are due primarily to the previous aim to alighting at destination.

In order to see the variation of the data sets, coefficients of variation were calculated. Regardless of the waiting areas which have mean value of 0, the coefficients are displayed below.

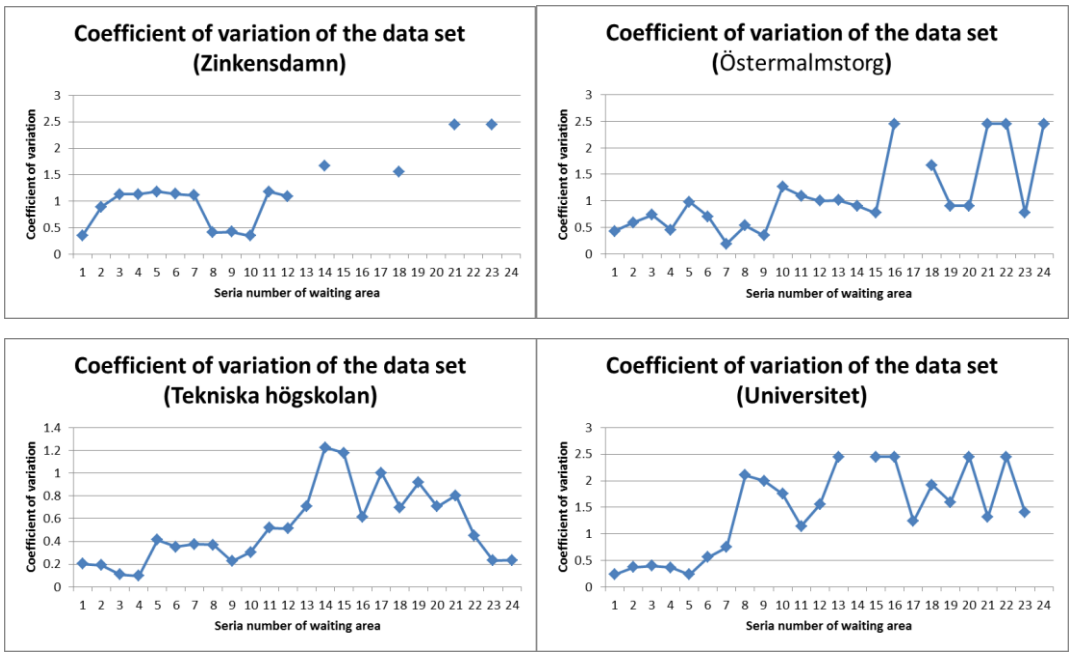

Figure 13 Coefficient of variation of the data set

According to the figures above, in accordance with the average number of passengers, the part that with more passengers the variation value is low, which means the number of passengers is with low variation, in other words, the parts are likely to have certain number of waiting passengers compared to other parts of the platform. For instance, Östermalmstorg has more passengers at the south part of the platform, we can see that the front part of waiting areas have lower variation than the other parts. On the contrary, the high coefficient of variation indicates the wider fluctuation. It can explain the situation that some passengers choose unfrequented areas to avoid the crowdedness or they have special needs.

6 Conclusions

All in all, opposite to even distribution, most waiting passengers are tend to distributed close to entrances and few make locational choice according to acknowledgement of destination exit information in case of few entrances to a station in flat hours.

Besides, for peak hour distribution, we notice that such close to entrance trend in flat hours may change. Due to data collection limitations, we were not able to verify this in the project even helps. However, at station Tekniska högskolan, during the morning peak between 7:30-9:00, the platform is kind of crowed with people. Distribution for waiting passengers seems to be the same everywhere evenly. In this way, the distribution develops in a way like, in the very beginning after one train passed by, passengers start to accumulate as in flat hour's patterns; later when zones become to visually crowed,

passengers choose to move towards middle part, quite reasonable, people have the instinctive to avoid crowdedness and thus move towards the middle part of the platform; As a consequence, waiting passengers seem to evenly distributed along the platform.

Due to limitations referred, if possible, further study can be conducted to explore the distribution along the platform during peak hours.

References

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CHEN Feng, WU Qibing, ZHANG Huihui, LI Sanbing, ZHAO Liang. Relationship Analysis on Station capacity and Passenger Flow: A case of Beijing Subway line 1. Journal of Transportation Systems Engineering and Information Technology, 2009, Vol.9(2), pp.93-98