Intermodal Terminals
Node-Place Issue and Travelers’ Flow

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Intermodal Terminals
Node-Place Issue and Travelers’ Flow

Gothenburg Central Station Case Study
MASTER’S THESIS IN TRANSPORT SYSTEMS

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Photo: Central station around 1900 -Image Gothenburg City Museum
Photo source: Vårt Göteborg
ABSTRACT:

Intermodal terminals are complex entities; they are nodes in transport networks, and places in the city simultaneously; permanently or temporarily inhabited with compact and varied collection of uses and forms accumulated through time. The purpose of this thesis was to explore the complexities involved in the issue of smooth pedestrian flows within station areas. Gothenburg central station was selected as the empirical case study of this thesis, since it is a station area currently meeting big challenges in terms of smooth pedestrian flows. The thesis was carried out through a literature review for several topics relevant to the complexities of the pedestrian flows at intermodal terminals, such as the node-place dilemma, traveler’s characteristics, flows and the physical layout of stations, and an empirical analysis of the pedestrian flow in the station with specific focus on two bottlenecks within the main building. The empirical analysis was carried out by means of semi-structured interviews with representatives from some of the key institutions involved in the organization of the central station, together with field observations and video filming. The results of the thesis illustrate clearly the need for a more thorough reflection on what main function the railway station should fill today; and understand the node-place dilemma and its consequences for smooth pedestrian flow and accessibility for travelers moving in the station building. More specifically, the thesis recommends several services within the station building to be re-arranged so it guarantees a smoother flow for travelers now and in the future. In addition, it calls for special attention toward elderly and special needs travelers and the importance to address their status in the station within all stakeholders’ development schemes.
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CHAPTER 1: INTRODUCTION

1.1 Background and motivation

Public transport station areas are complex entities; they are nodes in transport networks, and places in the city; permanently or temporarily inhabited with compact and varied collection of uses and forms accumulated through time (Peek et al., 2007). The location complexity has been generated by several reasons; inter alia is the expanded high speed railway system (particularly in Europe and Asia) and light rail systems (especially in North America and Western Europe), which trigger travelers’ shift towards public transport (Peek et al., 2007). Additionally, the integration of land use development and transport at stations under the label of transit oriented development and sustainability, which support the cluster of offices, retails, and housing around stations. Moreover, the move towards greater market oriented transport companies; implies development of commercial activities within the locations (ibid.).

Moreover, Bakerson (2010) agrees with the previously stated reasons and argues that those reasons cause travel tradition and culture around stations to change, a change brought into fruition crowded terminals that serve thousands of travelers on a daily basis with varied interests and needs. These travelers form dynamic, lively, and changeable flows with varied abilities and requirements (Bakerson, 2010). In such an atmosphere, it is crucial to provide smooth trips through the station (Public transport users association et al., 2011) since the conflicting behaviors and demands from the travelers generate congestions and hamper the effectiveness of the station area as a node. Moreover, societies are aging which in turn leads to increase the number of slower and special needs travelers (Karekla et al., 2011); this is why smoother flow will be more critical in the future, a similar view is held by Wennberg et al. (2010); the authors explain that its vital to provide smooth journey for elderly throughout their trips in public transport.

Among the features that create smoother flow for travelers are physical measures; logical station plan and inner arrangements help greatly to make the trip inside the station clearer and easier to navigate (Network Rail, 2011). Moreover, it should be considered that the station as a node-place requires different travelers’ circulation spaces (Fernandez et al., 2010).

This thesis aim to provide a broad understanding of various issues related to station areas complexities; it also aims to produce a broad foundation for continued in-depth studies of the several topics that have been discussed. However, it is not my intention within this thesis to provide a broad overview of urban transport planning performance indicators, nor to pinpoint the performance of places, rather it is a request to dig more deep into both, to draw attention on its complexities, and to increase the readers consciousness about it, hence future decisions could be taken in a more knowledgeable
manner. I also want to illustrate its relevance to people behaviors, flow of pedestrian and congestion locations and ways to tackle them.

Gothenburg central station has been taken as the case study of this thesis, the location is proposed by the Swedish Transport Administration (Trafikverket) as a station area currently meeting big challenges in terms of smooth pedestrian flows. The station today is a crowded convergence node for multi-lines and multi modes of transport; it is also a clear illustration of the conflicting aims of the station as a node and a place simultaneously, along with a diverse ownership differ in future development schemes. Besides, the station is expected to have more travelers in the near future, since several public transport authorities in the region cooperate for the development of the region’s public transport (Göteborg stad et. al, 2008). Accordingly, additional pressure is expected on the current capacity of the station, which triggers the need to explore the traveler’s situation in the station today.

1.2 Aim and research objectives

The general aim of the master thesis is to explore the complexities involved in the issue of smooth pedestrian flows within station areas, considering especially the Swedish aim of a transport system that is accessible for all. Related to this, there is also a more specific aim which is to explore the complexities of smooth pedestrian flow in the central station of Gothenburg city and to provide recommendations of physical measures that will enable smoother walking flows for pedestrians there. This is done through a focused analysis of two bottlenecks in the station.

The thesis has the following more specific research questions:
1 How is the situation in Gothenburg station buildings today in terms of travelers flow?
2 How is the situation in Gothenburg station buildings today for elderly, special needs and in terms of accessibility practices?
3 What are the most problematic issues within the station building, in terms of physical measures, and travelers moving patterns?
4 What are the possible physical measures that will generate smoother flow for travelers within the station buildings?

1.3 Outline of the thesis

The thesis is presented in six different chapters, chapter one presents the background of the study and highlights the motive behind it; it also presents briefly the empirical focus of the thesis and introduces the research aim and objectives.

Chapter two synthesizes the methodology used throughout the thesis; the chapter starts by an overview of the research approach that has been considered, along with a
section describes the qualitative case study research methodology, followed by subsections describe thoroughly the data used to analyze the empirical case; which are the review of existing documentations, collectives interviews, field observations and video filming respectively. Finally, the chapter has a subsection to describe the reliability and validity of the method used.

Chapter three provides an outlook for concepts/issues that have been used through the study, and pinpoints relevant research fields about it. The first section of the chapter defines briefly the station on focus; the second section presents the node-place dilemma of intermodal terminals and synthesizes debates about it. The third section speaks about the travelers’ needs and variations, and draws attention to special needs and elderly users; the section also shed lights over station accessibility and stresses its importance in the design. Finally, the last section defines circulation spaces inside stations and describes preferable layout arrangements of the concourse space; which is one of the circulation spaces inside stations; moreover the section contains a subsection that briefly explains thoughts relevant to pedestrian flow and walking speed.

Chapter four speaks about the empirical case of Gothenburg Station; it firstly presents background discussion about Gothenburg city triggered by its future plans and challenges. The discussion is then taken further to cover the station on focus and draws attention to its crowdedness, along with its complexity as a junction for multi transportation modes, and finally illustrates the fragmented ownership and the conflicting aim of stakeholders in the location, the first section has been expanded further through the second part of the chapter; it presents detailed analysis of the node/place values of the location and describes the shortcomings of circulation arrangements there. It also provides a sneak peak over travelers and flow there. The chapter is closed by presenting two bottlenecks and analysis for the characteristics of travelers’ flow there.

The thesis is finalized by chapter 5, 6 which present a discussion about the findings, Summary and recommendations respectively.
CHAPTER 2: THESIS METHODOLOGY

The research strategy for this master thesis contains several steps. First of all, it contains the review of relevant literature which has provided the foundation for the analysis of the empirical case study. The theory then has been extended further through exploring the case study in focus, through the review of existing documentation, interviews, personal observations, and video filming. The empirical methodological approach is explained further below.

2.1 Qualitative case study research

Case study is a common method that is used to explore a general problematique more in depth (Flyvbjerg, 2006). Yin (1994) defines the case study research method as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used” (Yin, 1994).

There are various types of case studies, such as multiple case studies and single case studies (ibid.). Single case studies can often be used to conduct an explanation, along with exploratory and descriptive purposes, the researcher objective should be to find explanations for a set of events and to indicate how such explanations my apply to other situations (ibid.). Moreover, case studies could be built upon qualitative data and quantitative data, and it can be built upon a mixture of quantitative and qualitative evidence (ibid.). The type of approach to adopt for the case study depends generally on the research questions, if it demands aggregate findings and statistically general patterns, or if it is about analyzing the specific conditions of the subject in focus and makes the analysis more in-depth, which is a key characteristic of qualitative research, that considers, discourse analysis, participant observations, and interviews as key methods (Kvale et. al, 2009).

Yin (1994) also explains further that case studies are a preferred strategy when questions such as “how”, “what” or “why” are being posed, and especially when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real life context.

A case-study is necessary to understand theory if the case is a “rich” and illustrative example of it (Flyvbjerg, 2006). According to Flyvbjerg (2006) context dependent knowledge and experience stand at the center of case study methodology as a research tool and as a teaching and a learning method. Moreover, the author explains further that the case study is valuable for both creating and testing of hypotheses and that it is not limited to these research activities alone (ibid.).
For this study, Gothenburg central station was understood to be an interesting case study, with a potential to illustrate the complexities involved in creating smooth pedestrian flows in an intermodal terminal area. As previously stated in the introduction, the station area currently meets big challenges in terms of smooth pedestrian flows, it acts as a crowded convergence node for multi-lines of transport, and it displays a clear illustration of the conflicting aim of the station as a node and a place simultaneously, along with a diverse ownership differ in future development schemes, which equals a rich example according to Flyvbjerg (2006) definition.

2.2 Data for the case study

2.2.1 Existing documentation

The case study builds on several types of data. One type is the existing documentation about the situation in Gothenburg central station and for the public transport in the city. The study made use of key documents about the public transport within the case study on focus; along with the latest reports about traffic situation there and traveler’s statistics. Information about long-term transport planning and pedestrian situation in the city was also explored. Moreover, maps and one future plan study about the central station of Gothenburg were collected mainly from Jernhusen, a real estate company, which develop and manage the station area. Data were collected by contacting relevant transport authorities through email and telephone, and by exploring their websites.

This phase was then followed by translate most of the collected documents about the case study from Swedish to English language; explore their relevancy to the topic on focus and extract the proper information out of them. Documents were mainly collected from Jernhusen, Vasttrafik, and Trafikverket and they were thirteen in total.

2.2.2 Field observations

Several field trips were conducted in the research to thoroughly explore the location and to understand its complexity, the trips were conducted between April and May, dates and duration of the trips are stated later within the empirical case study of chapter 4. During the field trips I surfed the station buildings and the surrounding areas within random hours during the day, mainly in early morning, afternoon and evening, I aimed to personally explore the complexity of the location after reading the literature and the documents about the empirical case study, I also followed up with travelers’ behavior, the flow and how both are affected by the physical arrangements within different spots in the station. I had a notebook and a personal camera, in order to write down notes and to capture pictures.
2.2.3 INTERVIEWS

Interviews with informants who had important insights about the situation at the Gothenburg central station area were the second method adopted to proceed with the empirical case study. In this study, interviews were carried out in two stages; firstly, to further explore the topic and the challenges the location faces, secondly at a later stage to explore the location on the ground and to define the two most problematic locations. Dates of the interviews are stated later within the empirical case study of chapter 4.

The first phase of interviews aimed to select the most urgent/relevant aspects to focus on in the upcoming, more practically oriented stages of the work, it also included the snowballing method of selecting interviewees, i.e. one interview leads to another. I aimed to interview one person per each of the relevant transport authorities in Gothenburg city; I sent emails in advance to set up appointments, some emails developed further into meetings; I met with staff member from Trafikverket that hold a position of project leader, Market and Planning. I also met with the director of All-access Scandinavia AB; an NGO that works for station accessibility practices. Moreover, I met with the communication director from Färdtjänsten; transportation service for people who find it difficult to travel on their own and with the ordinary public transport. Interviews questions revolved around travelers needs and what group suffers the most when traveling in the central station and about accessibility practices in the central station. Interviews were documented by taking hand notes and sometimes photos, they varied in time between 15 min to 1 hour, and they were semi-structured, which is a description given to interviews when questions are partly prepared in advance, and when the prepared questions are designed to be adequately open that the consequent questions cannot be previously planned (Wengraf, 2001).

The second phase of interviews were conducted at a later stage of the research to explore the location on focus and to narrow it down into two specific spots; I aimed for an interview with all three involved authorities in the station area; Trafikverket, Jernhusen and Västrafik, but it was hard to meet with all the three authorities together, as Västrafik did not respond to my request through the email within the time frame. Yet, I had a productive interview with two representatives from Trafikverket and from Jernhusen, whom their input helped a lot in defining the two bottlenecks. This interview was held as a semi-structured group interview inside the station with thorough discussions and observations for two hours, questions at this phase revolved around the traveler’s practices inside the station and about the crowded spots there, interviews at this stage were also documented by taking hand notes and photos.

2.2.4 VIDEO FILMING

Several video films were used to capture the stream of activities within the two bottlenecks in the location; in order to experience, interpret and explore the location complexity, the idea at the beginning was to extract travelers flow and speed within the bottlenecks in order to carry out quantitative modeling techniques and includes it in the analysis, especially in a later stage for testing the suggested recommendations for
enhancing the situation in the two spots, but the bottlenecks were very complex, both contains varied activities that prevented from capturing the speed of the pedestrian especially with the lack of proper equipment. Thus, it was better approach, in terms of validity to go for a qualitative analysis without the modeling. However, even after dropping the modeling methodology it was necessary for the study to carry out the filming as it wasn’t enough to proceed with in depth analysis of the movement’s patterns and the walking experiences thorough the looser observations; specially the walking breaks due to avoidance maneuvers, and the frequency of the sudden changes of speed. Moreover, travel time was calculated for a few travelers, who have been chosen randomly throughout the hour of filming, to reflect the range of travel time. Eventually, the analysis and the documentation of the video were directed toward an observational approach similar to the one used in the general observational phase.

I did the filming in June 5th and 7th, I took several films during the two days, mainly in early morning from 7:30-8:30, afternoon from 12-1, and later from 4-5, bearing in mind the interviewee’s recommendations, and my own observations within the previous trips, dates and times of the filming are further explained within chapter 4.

2.3 Validity and reliability

Construct validity is a concept defined as forming correct operational methods for the theories being studied (Yin, 1994), it is a criteria used to judge the quality of the case study research within the phase of data collection. Within the research, I adopted one recommended tactic to guarantee construct validity, which is the use of data triangulation, i.e. the use of multiple sources of evidence (ibid.), this tactic is represented by combining the literature review with the interviews, the observations and the video filming within my methodology. This approach is considered as a major strength of case study research since any findings or conclusion is likely to be much more accurate if it is based on several different sources of information (ibid.). Likewise, the concept is represented more specifically through the way I identified the spots/bottlenecks in focus and how I chose the days and time for filming (thoroughly explained in chapter 4).

Additionally, external validity is defined as establishing the domain to which study findings’ can be generalized (ibid.). Although many critics have been discussed on how it is difficult to generalize from one case study to another, yet it is supportable method for the analyst to generalize his findings into theory (ibid.), which is presented in chapter five of this document and considered valid and adequate results for exploring the aim. As for reliability which demonstrates that the operations of a study- such as the data collection procedures can be repeated within the same results (ibid.), it is considered through the clear documentation of the methodology that is used within the research, which makes it credible for future repetition.
CHAPTER 3: LITERATURE REVIEW

Within this chapter a perspective and approach is given for the analysis section, definition of essential concepts is presented, combined with a literature review over relevant research related to the issues in focus of this thesis.

The chapter contains four pieces, firstly a section defines the station in focus, secondly a section called railway stations as places and communication nodes which aims to give a perspective of what is the railway station today, the third section describes the contemporary users of the stations, with extra emphasis on special needs and elderly passengers, the section also shed lights over accessibility issues and its importance inside stations. Finally, a section defines circulation spaces and briefly explains existing recommendations for layout arrangements of the concourse space which is one of the circulation spaces inside stations; the section also contains a subsection that briefly explains thoughts relevant to pedestrian flow and walking speed.

3.1 Intermodal terminals

3.2.1 INTERMODAL TERMINALS DEFINITIONS

Transit stops, stations, and terminals provide particular services for a transit system. These facilities often have mutual features but demonstrate unique qualities (Transport research board; 2003). Among station types and configurations, intermodal terminals are the focus of this thesis. Intermodal terminals are defined as “a variety of stations and terminals that provide key transfers between transit modes. Combinations may include local bus, bus rapid transit, intercity bus, light rail, heavy rail, commuter rail, intercity passenger rail, ferry, or automated guide way transit. Such facilities may have a variety of other services and connections, including parking, drop-off, and ticket vending and information booths and may be integrated with retail shopping, services and entertainment” (Transport research board; 2003).

Additionally, “Railway Station” and “Public Transport Node” are used quite often to refer to the same station configurations and characteristics. For the purposes of this thesis, the above classification has been assumed to be sufficient. However, it should be noted that there is often significant size and facility variation between stations of the same category.

3.2 Railway stations as places and communication nodes

Several writers have described the shift in development of railway stations, and point out the complexity of these places today; Bakerson (2011) primarily describes stations as nodes and places simultaneously, influenced by both, global and local dynamics. Peek et al. (2007) supports this opinion and describe station areas as nodes and places at the same time; nodes of network and places in the city, they articulate that
stations areas are important in transport and non-transport networks, business and consumption. Likewise, Peek et al. (2007) relate to the node place model developed by Bertolini (1999); a model that describes a correlated, double sided relation between the station as a node and as a place (Bertolini 1999, cited in Peek et al. 2007). According to this model, developing transport in a station location will further intensify and diversify activities there. Vice versa, increasing activities cause greater demand for connections and trigger the need of transport there. Consequently, a potential conflict between “place” and “node” features is very possible there (ibid.).

Additionally, Peek et al. (2007) state four different reasons for the current station transformation; firstly, transit oriented development; they express that concerns about sustainability, sprawling, and car-dependent urbanization patterns, all call for shifting towards public transport. They also state the expansion of high speed railway system (particularly in Europe and Asia) and light rail systems (especially in North America and Western Europe), and the dedicated freight interchanges as the second reason, likewise they conclude that promoting cities as places to live, through large-scale urban projects helps offices, retail, leisure and housing to cluster around stations. Fourth and last, the privatization process and the move towards greater market oriented transport companies; they argue that service providers are increasingly looking for rewards for the accessibility they create; which implies development of commercial activities within the station, and redevelopment of land above or around stations (ibid.).

Bakerson (2010) provides a different perspective on the ongoing transformation. He argues that the new situation sometimes left station buildings to fall out of tune; he believes that it causes some of the stations basic functions to miss its importance, yet others to be highlighted, and clarifies that travel tradition and culture have changed; a change brought into fruition new categories of passengers with varied interest and needs, which will be developed more in section 3.2.2 below.

Moreover, Bakerson (2010) questions the reasons that hold back the development of stations in a suitable manner. He frames the reasons in three main problem contexts, firstly, administrative difficulties in running station buildings, Secondly, who encourage travelers’ interests there, and finally, the changes in traveling traditions. However, Bertolini (1998) arrives to the conclusion in a different manner; he states that the redevelopment of railway station areas should take three aspects of planning into account, firstly context variables (institutional arrangements and developments), combined with process variables (actors and organizations), and object variables (the node and place dimensions). He also debates that all three aspects show their relevance at a later stage, i.e. he describes how the variety of outcomes can be explained referring to these variables.
3.3 Travelers in intermodal terminals

The users of intermodal terminals form several groups. Travelers are by far the essential one (Stenlöf, 1996), the rest are formed by those who work inside the terminal; such as tickets’ sellers, information providers, and those who serve in café houses, or keep the zone tidy (ibid.).

Bakerson (2010) classifies travelers into different groups. He describes primarily tourists and business travelers as key groups of travelers, drawing attention to the mutual relation between the city attractions, and the size of this group. In other words, the size of this group is correlated with the number of tourist attractions, the commercial services in the city, and the industrial productions. Likewise, he states that restaurants, hotels, and travel information are vital for this group and highlights the importance of providing them with accommodation close to the station area. Secondly, he identifies work related travelers and refers to them as traditional travelers; he explains that this group usually comes to the town for a few days on a regular basis; they are familiar with the place, and they share the needed services with the first group.

Finally, he describes daily basis travelers or commuters from the metropolitan boundaries and nearby municipalities. Bakerson (2010) explains that this group comes daily to the city to work or study and passes by the terminal. According to him, the majority of the traveler arena today belongs to them. They need the shortest possible route to public transport stops (ibid.).

Classification of travelers could also be built upon other things, for example, travelers’ physical abilities and age. Special needs travelers form different categories themselves, such as; travelers with physical impairment; which might include blindness, deafness, paralysis or heart diseases. Secondly, travelers with mental impairment; which covers a range of deficiencies related to mental functioning, i.e. learning difficulties (Transport Scotland, 2011). As for old travelers, Karekla et al. (2011) explain that the number of this group will increase in many countries the coming decades, a fact that has been taken further by Wennberg et al. (2010), the later also demand governmental actions to ensure this group safe and lifelong mobility. Moreover, there is a strong correlation between elderly and mobility restrictions as the ageing process involves per definition gradually declining functional capacity (Wennberg et al, 2010), and older people often suffer from a group of different functional limitations (Hovbrandt et al., 2007, cited in Wennberg et al., 2010), reductions in vision, hearing, and mobility all together. To conclude, travelers inside the station might have range of difficulties; difficulties in walking, different degrees of loss hearing, and different degrees of seeing, or all together at once.

However, since travelers share different interests and needs and also different capabilities, it is likely that their walking behaviors influence each other’s when they
walk in the station area (Teknomo, 2006). Likewise, a conflict between slower and quicker travelers is very possible. Bakerson (2010) explains that the different classes of travelers create variation in movement patterns and flows, he further describes that travelers need to change their individual speeds, directions and to overtake and to give priority to other travelers in order to tolerate each other. Moreover, he describes how in a very crowded situation travelers experience delay and feel uncomfortable and need to maintain a certain distance toward other travelers and the surroundings to continue their trips.

3.4 Accessibility in intermodal stations

There are several definitions for the accessibility concept. In terms of reaching places; accessibility is defined as “the ease with which activities may be reached from a given location using a particular transportation system”, (Morris et al., 1979). The second type of accessibility is interested in the question if something can be used by someone, and it is defined “as the relationship between the person and the surrounding environment” (Wennberg et al., 2010). The authors argue that it is realized through legislation, directives and guidelines, they also drew attention to its importance within the international community; stating that the European member states have cooperatively adopted the goal for full accessibility in 2010 (ibid.). One current example is held by transport Scotland (2011); it requires all new stations installations, replacements and refurbishments to follow the requirements set out in the national standard.

Within the Swedish experience; accessibility practices are driven by the overall national transport policy functional objective of a transport system that is accessible for all; “The design, function and use of the transport system will contribute to provide everyone with basic accessibility of good quality and functionality and to development capacity throughout the country. The transport system will be gender equal, meeting the transport needs of both women and men equally” (The Swedish Government, 2009), the objective also supports the importance of a transport system that is designed to be accessible for people with disabilities (ibid.).

Additionally, there is a handbook from the former Rail Administration which is now integrated into the Transport Administration that works with the concept “Design for all”, which means that they try to develop solutions that makes it possible for all to move within and use the areas in focus. In other words, it is not about creating special solutions for every special need, but instead solutions that are good and practical for everyone. The document (Banverket, 2005) also provides rules and recommendations for how to shape the area in and around train stations to make them accessible for people with disabilities, It contains recommendations of how to interpret the national general regulations (which are published by Boverket (national board of housing, building and planning), and aims to transfer them into a more practically applicable, hands-on guidance for what to do in practice, in and around stations, to meet these regulations. It also draws attention to the
importance of amending the existing environments in stations; they list several things that help to improve the overall environment, such as; getting rid of thresholds, installing automatic sliding doors instead of heavy manual door openings. It also recommends various kinds of markings (with contrast colors to make it easier for people with vision impairment), adding braille characters on signs, adding handrails at stairs and building access ramps.

Moreover, the link between elderly and special needs that has been explained in the previous section lead to similarities in accessibility regulations for both groups (Wennberg et al., 2010). Whereas, when speaks about elderly, the authors suggest the “usability” concept instead, since it is a subjective concept; it contains in addition to the personal and environmental parts, an activity component, refers to human activities performance in the environment (Wennberg et al., 2010). To conclude, the authors argue that usability is a subjective concept; it displays person’s perception of the surrounding environment, while accessibility is an objective concept, related to societal norms and legislation (ibid.).

However, the above argument about accessibility standards has been challenged by introducing the “Capability Model” (Tyler, 2010). The author adds a third perspective to the discussion, stating that accessibility is between capabilities required by the environment and those brought by the individual. In very simple terms, he explains that if the provided capabilities are greater than the required capabilities, the activity is accessible. He then explains his model further in three different points; firstly, he articulates that single directed approaches to design guidelines are unlikely to provide the best benefits for older and disabled people, since the differences between their needs are far more complex than such simple rules, as a result, there needs are often affected negatively by the attempts to make compromises. Secondly, he highlights the importance of considering the capabilities of the individual in the design, not just the inability of the environment. Thirdly, he stresses the significant opportunities with new technologies, he gives attention to the introduction of intelligent computerized productions, and the fact that personalized designs can be produced as cheaply as the standard prototype. To conclude his work, Taylor (2010) highlights the importance of the individual in accessibility design, as well as, the mutual collaboration between all parties involved, such as; elderly, disabled people, technicians, researchers’ manufactures and politicians in order to make accessibility work.

Regardless the argument on focus, all travelers must be considered in the station environment, in many cases a measure that is necessary condition for one group will prove useful to others (Swedish Transport Agency, 2004).
3.5 Concepts behind circulation spaces and travelers flow

3.5.1 Circulation spaces in intermodal stations:

Within the intermodal station atmosphere, which is described by the existence of heavy and energetic flow of travelers, it is crucial that travelers can move smoothly without developing crowded spots and too much congestion (Transport research board; 2003).

Normally, there are several types of circulation spaces within stations. Fernandez et al. (2010) describes three of them; the train-platform space; where the arrival/departure of trains occur, the platform-stair space which connect the different floors of the station, and the concourse space where stops like tickets machines and desks are located, along with entrance/exist gates, shops, and restaurants. Literature on station design also speaks about bottlenecks, which means reduced capacity (doors or corridors), or an increased demand (Kretz et al., 2006).

Concourse space is described further as the ‘heart’ of the station area, the space that defines the first impression of it (Network Rail, 2011); it is defined as a space within the station away from platforms and travelers circulation routes, where a range of activities take place, such as inquiry desks, timetables and departure boards, along with travelers waiting spaces, retails and shops, platforms and stations access doors (ibid.).

Services within the concourse space warrant careful review (Network Rail, 2011). For example, time table board’s location should guarantee adequate space for travelers to follow up their travel information without hindering the flow of the rest of the travelers; these facilities should be located on station entrances and should have clear space in front of them (ibid.). Moreover, ticket machines and ATM machines should be placed outside traveler’s circulation routes, and should both have a clear queuing distance in front of them (ibid.). Additionally, restaurants and shops should be maximized without hindering essential traveler’s flows, whereas obstructions such as newspapers displays, coffee seats, advertising displays, seating areas should all be situated away from main travelers flow (ibid.).

Likewise, Boverket: which is the national board of housing, building and planning, have stated that “Fasta och tillfälliga hinder t.ex bänkar, skyltar, stolpar och cykelställ bör placeras i möbleringszoner och vara tydligt markerade visuellt och på ett sådant sätt att de inte hindrar framkomligheten eller utgör risk” (Banverkets, 2005). The statement is a request to place permanent and temporary furniture such as benches, signs, and poles in specific zones for furniture. It also states that these zones should be clearly marked so it do not hinder travelers flow or cause them any risk. Consequently, providing relevant services, fitting them properly are key issue in the design of properly functioning stations, all arrangements together should provide sufficient space to allow smooth flow of travelers through stations (Public transport users association et al., 2011).
3.5.2 **Travelers Flow in Intermodal Stations**

Pedestrian motion has been explored for several years (Helbing et al., 2010). Researchers within this field argue that pedestrian flows seem to follow certain “rules” regardless the chaotic appearance of their behaviors (ibid). It is stated that flows of pedestrian walking in conflicting directions; i.e. bi-directional pedestrian flows have a tendency to separate and to form lines, this phenomena is known as dynamic lane formation (Daamen et. al, 2003). Moreover, as previously mentioned, traveler’s combination within intermodal stations creates variation in movement patterns (Bakerson, 2010); this fact has been taken further by Hongfei et al. (2009) whom on the other hand stress the need for thorough research on the travelers flow characteristics there. Additionally, Lam et al. (2002) describe elements that affect the walking speeds of travelers, such as the personal characteristics; age, gender, size and health, characteristics of the trip, such as walking purpose, route familiarity, luggage and trip length, along with the properties of the infrastructure; type, grade and attractiveness of environment there.

Moreover, recent research emphasizes the importance that planners and engineers should take into account the local travelers flow characteristics when designing facilities (Lam et al., 2002). They support their idea further by highlighting the differences between travelers flow characteristics within Western and Asian cities, for example the flow in Singapore (Asian city) reveals that Asian required less personal space when compared to the western European countries (ibid.). Therefore, Teknomo (2006) states that smoother flows could be guaranteed through less space along with different set of laws to control the situation, one example is when considering two doors with different directions; the author argues that one way door is better than two way doors (ibid.).

Besides the external factors, the walking speed also depends on the crowd. The most frequent reference is Fruin, who in 1970 thoroughly investigated the relationship between walking speed, human “density” and flow (Daamen et. al, 2003). The author also explain that physical disability and luggage reduce walking speed of travelers along with the number of travelers as when the crowd increases it sets down travelers walking speed.

**3.6 Summary**

Through this chapter, I have made a brief overview of some of the most important research fields of relevance for this case study; first of all, the research on intermodal terminals as a transport and a communication node; which illustrates the importance to understand the role of station areas today, and the complexity characterizing these places; especially considering the overall pressure on growing metropolitan areas, and the policies that aim for more people to go by public transport, along with a growth in commercial activities, and the complex institutional conditions. Additionally, the importance to recognize that different groups of travelers have different demands, a vital principle that has been mostly highlighted through the current aging population and the policies stress the consideration of special needs in the design, labeled under accessibility.
regulations and the idea of “design for all”; which calls for solutions that makes it possible for all to move within the areas in focus. However, existing literature on accessibility, elderly and special needs point out several debates; firstly when speaking about elderly the “usability” concept is suggested instead of accessibility which displays person’s perception of the surrounding environment, compared to accessibility as is an objective concept, related to societal norms and legislation. Moreover the “Capability model” introduced by Taylor (2006) argues that single directed approaches to design guidelines are unlikely to provide the best benefits for older and disabled people, since the differences between their needs are far more complex than such simple rules.

Finally, the importance to bring in knowledge about pedestrian flows as it is crucial that travelers can move smoothly within the station without developing crowded spots and too much congestion in the different circulation spaces; especially through the concourse space and its services, as it’s described as the heart of the station. Likewise, the discussion over the elements that affect the walking speed of travelers, such as the personal characteristics, the characteristics of the trips and the properties of the infrastructure, along with the uncomfortability traveler’s face by the frequency of sudden speed changes and by the level of discontinuity of walking due to several avoidance maneuvers.

These various research fields have inspired me during my work within the empirical phase of the research; the synthesized findings within this summery sums up the different topics that I have explored and also clarify the departure points and the building blocks that I have used for the analysis of the case study of Gothenburg central station; which is explained thoroughly in chapter four below.
CHAPTER4: CASE STUDY-GOTHENBURG CENTRAL STATION

4.1 Gothenburg city- a general background

Gothenburg city is Sweden second largest city after Stockholm, it is located within the west coast of the country, and it forms the core of Västra Götaland region, figure (1) below shows the location of Gothenburg city in the western coast of Sweden. The city has a population of 514000 people (Göteborg stad, 2011). Additionally population in Gothenburg “larger” area is 927 000 people (Göteborgsregionens kommunalförbund, 2011).

![Gothenburg city location in the western coast of Sweden](image)

Local public transport in the city includes trams, buses, commuter trains, ferries and Flex lines; on demand services. According to Trafikkontoret, between 2010 and 2011, the city observed a 10% increase in public transport trips (Göteborg stad, 2011), one aspect of the increase is explained by factors such as the demographic changes in the city, and the employment rate growth; between the year 2005-2010 the city population and employment rate has increased by 6%, one more cause for the increase is the expanded range of services for the mentioned transportation modes (ibid.).

Additionally, several public transport authorities in the region cooperate for the development of the region’s public transport (Göteborg stad et al., 2009). They aim to create a strong and a sustainable region, an attractive place to reside, to work and to live in, and inter alia, to have more public transport users, as public transport is stated as a key
issue to achieve the promoted sustainable development (ibid). Moreover, the aim for doubling the Swedish public transport network by a broad constellation of actors from the public transport sector and industry (Swedish public transport association, 2012), and plans for big infrastructure projects in the city, driven by the West-Swedish Agreement, which includes, Västlänken project; a tunnel for through trains in central Gothenburg, and the application of congestion charges policy on designated streets in the city, (Trafikverket, 2012b), all lead to escalate the numbers of the network users.

One of the main transport nodes in Gothenburg is Gothenburg main station; it is formed by three connected buildings; the Central Station, the Central house, and the Nils Ericsson terminal. The station as a whole acts as a convergence node for multi-lines and multi modes of transportation; Passengers come from local buses, long-distance buses, trams, local trains and long-distance trains, taxi and private cars. Figure (2) below displays the station buildings.

![Figure (2) Gothenburg Central Station (Trafikverket-2012)](image)

The station ownership structure is fragmented; the Nils Ericsson terminal is owned and operated by Västrafik, which operates the bus services in the region. The central station and the central house are owned and managed by Jernhusen; a real estate
company in transport business, which on a commercial basis own, develop and manage the station area (Jernhusen, 2012), and the tracks are owned by Trafikverket.

The central station is a clear illustration of the conflicting aim of the station as a node and a place simultaneously. Jernhusen, who owns the station building, has a stated aim to create a meeting point in the station, i.e., increase its place value (Jernhusen, 2012). Within their perspective, the development schemes they apply there, that link travelers’ services with commercial activities, shops and restaurants, creates enjoyable and efficient environment. They argue that creating a station as a destination in itself will contribute to the Swedish aim of doubling the public transport, as even if people don’t want to travel, they still can use the station as a hub and a place to meet (ibid.).

Additionally, the location today is often crowded; its complexity has been debated in the media. In an article published in Gothenburg Posten (GP); Färn et al. (2011) argue that it is often difficult to navigate within the station, especially for buses users. They explain that Västtrafik, the owner of Nils Ericsson terminal, seems dissatisfied with the current situation. Within their perspective, express buses should be located closer to the center of the terminal, and more information should be provided to passengers regarding connections to bus services.

Accordingly, the location complexity has been increased due to several reasons. Such as the diverse ownership within the location, and the obvious tension between the stakeholders’ goals, joint with the future investments in the region that are explained above; such as the Swedish doubling project and the West Swedish Agreement. This situation triggers the need to explore the state of the flow of pedestrians in the station buildings today.

4.2 Crowded and complex buildings

On April 18th, 2012 I had my first trip to Gothenburg; bearing in mind to conduct interviews and field observations in the central station within the following three days. At that time, I had my first interaction with the station. I spent the three following days surfing the station buildings and the surrounding areas within random hours during the day, mostly during early morning, afternoon and evening. Surfing the station buildings gave me a feeling of a chaos. For instance, there are many entrances/exits which creates a complex cross flow of pedestrians. Besides, my feeling was also that the lack of defined walkways and the absence of clear separation in walking directions increased the problematic situation. Additionally, the space layout of the station seemed complex and messy/gave a messy/chaotic impression; the circulation spaces are mixed, restaurants and shops are located everywhere and do not cluster in one precise location, urban furniture; privately owned by restaurants, are placed within the walking corridors, and the lack of a defined meeting point do also creates the complexity and drive people to stop and to have conversations everywhere.
Within the first day, I tried to comprehend thoroughly how the integration of transport modes was supposed to work in the station area, to follow up with my previous reading about it. I walked around and inside the station buildings, and I repeatedly went from one entrance to another. Starting with trams which are quite popular in Gothenburg city; I realized that they were vibrant transport modes in the area with a high frequency and occupancy. People transferred between trams stops in Drottning square; which were crowded most of the time, toward the central station and vice versa continuously. However, a fairly high percentage of the pedestrians who were walking toward the station shifted their way towards a path on the right hand side of the station entrance. They seemed in a hurry, frequently running, and avoiding entering the station building. This path lead to the train tracks immediately. I assumed that most of these pedestrians were probably commuters willing to take the commuter train, and are familiar with the schedule, more or less. Figure (3) maps out the two locations closely and shows the path between both locations.

![Figure (3) A path on the right hand side of the station entrance connecting Drottningtorget and train tracks immediately](Trafikverket-2012)
As for trains, there are sixteen train tracks, divided between the central station building (from track number 1 until track number 4), and the central house (from track number 5 until track number 16). Trains serve passengers for national destinations there and the last two tracks are dedicated mostly for commuter trains. The platforms and a small square located between the stations building and the platforms were most of the time crowded with pedestrians. I noticed that commuters who arrived from local trains that day were divided almost by half between two groups; one went toward the central house, and another went immediately toward Drottning square. Additionally, there is a taxi-stop parallel to track number one, where a quite small percentage of trains’ passengers shifted immediately to start a new journey.

As for buses, there are 21 bus stops located in The Nils Ericsson terminal. Buses serve local trips, national trips and international trips, mostly to Oslo and to Copenhaagen. Additionally, on the other side of the terminal, there is a parking yard, parallel to the previously mentioned train tracks.

Additionally, during the same day, I met with two representatives from Trafikverket and from Färdtjänsten; transportation service for people who find it difficult to travel on their own and with the ordinary public transport. I met a representative from Färdtjänsten near by the station building, the meeting was quick, and it lasts only for 15 minutes. She presented the work they do with elderly in Färdtjänsten, and she briefly explained that the station building is considered a scary place for old people, and that they usually avoid going there by their own; especially if they are slow or if they have problems in walking or seeing. She also stressed on the high probability for them to fall down there in between the complex crowd. Likewise, I met Trafikverket representative during the lunch break of the same day she explained briefly the challenges they face with travelers flow in the public transport within several places in the city, she emphasizes though the complex flow in the central station area and highlighted the importance of organizing the flow there especially with the planned future projects. She explained briefly about the city future plans for public transport; she noted that there will be many more people to use the public transport, she said” it’s very important now to find out what to do to facilitate the flow. Moreover, when you think about travelers; disabled people together with elderly and children are the weakest groups. When you get older you have problems to travel with public transport, you have problems to understand the complexity of places like Central station with much information and many people who are in a hurry”.

In April 19th, I had my second day of field observations, keeping in mind the place perspective of the central station and the surrounding area. The station is located in an active and a popular square for residents and for travelers to Gothenburg city as well. In Drottning Street, there are two big hotels, the Best Western Hotel Eggers, and Clarion Hotel Post. Additionally, Nordstan shopping mall; one of the biggest malls in the city, faces the western entrance of the central station.
Furthermore, the station buildings from the inside are packed with restaurants, shops and services points. Inside Nils Ericson terminal, you can find varied labels; viz “Bussterninalens skomakeri and nyckeltillverkning” for shoe repairs and for dry-cleaning, next to it stands “NFC fried chicken”, “NILS coffee house”, “La Bella”; a shop for hair cosmetics and perfumes, “Frankfurter and Cabanossy grill”; a restaurant for homemade mash potatoes and sausages, respectively, and finally pressbyran, which is a chain store in Sweden that sells magazines and newspapers, and basic daily use food. Most of these places provide outdoors tables and seats; just in front of its entrances. As for traveler services; places like “Bus for you”; ticket shop, “Europcar”; car rental shop, “Västtrafik”; traveler service point, “Swebus express”; ticket shop, all are located in between the shops, or parallel to them. And in two locations at the beginning and the end of the terminal, stand two automated ticket machines, almost in front of the entrance/exit doors. Figure (4) below shows the very first scene you face when entering the terminal, coming from the central house, with Pressbyran shop signs on the right hand side.
In the central house, the list grows to cover more shops and restaurants, in one side of the main hall stands large “Pressbyrán” once more, combined with “väskaffären”; a shop for expensive leather bags, as well as “Espresso house café”, and “Subway” for fresh sandwiches, all within the same side.

In the opposite side of the central hall stand “Espresso house café” once again, “Blue eat and drink bar”, “Burger king”, “Press stop”; for magazines, “café le croissant and pasta factory”, and “Lindex“ for lingerie and accessories. Additionally, two self-service ticket machines for SJ are located on the sides of the door that lead to the commuter trains platforms. Figure (5) below shows one of the machine location; close to the entry/exit door of the platform. Placing the machine there trigger congestion, especially when people queue to buy tickets simultaneously with running commuters.

Parallel to the main hall, stands another hall less crowded with people, yet full of shops. “Seven-eleven”, and “Apoteket shop”; the pharmacy, likewise “the body shop”; for skin and hair care productions, and “life Hälsobutiken”; for health and beauty products, “Solresor”; a travel agency and “Praline” for chocolate and Cigar. The second
and third floors of the building are full with offices, and “first hotel”; the station hotel, is located in the second floor.

Finally, in the central station building you find the “Pressbyrán” store once more, as well as the “Glitter store” for jewelry and accessories with a big jewelry display stands in front of the main door, “Pocket shop” for English and Swedish Books, “Pullman bar and Kök” restaurant, casino, and sport television, “Café Ritazza”, “takeaway coffee house”, “sun sushi” bar, “CD centralen” for Secondhand CD, and finally “Patey’s blommer”. Some needed services for the station are also located in between the shops, Forex and Exchange for currency exchange and money transfer are among them, SJ travel center and SJ self-services ticket machines are located in the main hall there as well, and two ATM; Automatic cash machines, shown in picture (6) below. The machines are located just next to the main entrance from Drottning street with very small space for queuing in front of them.

Moreover, at 9:30 am, I met the director of All access; an NGO that works for station accessibility practices, we had a walking tour inside and around the station area with thorough discussions about accessibility practices there for about 50 min, he states
that the general atmosphere fits within accessibility standards still many things have to be done, additionally he believes that when looking to the situation perhaps elderly will find it difficult to walk within the station as it’s not easy for them to get around, to read signs, and gets information. He said: “if you are an old person getting inside the station and wants to travel to a certain destination you will find it quite difficult to get to your destination on time, especially when you face a pedestrians running to catch the bus”. He also highlights the importance of having more public places to sit, as more restaurants and cafes are not usually an attractive destination for old people to sit within.

On April 20th, which was the last day of field observations, I went to the site from early morning, and I stayed there the whole day, I moved through the three buildings, following up with travelers as much as possible. Despite the absence of a fixed group of people in the station, the users seemed to fall into patterns, and merge into a culture; the sellers in their shops, the ticket stand operators, teenagers wandering around, morning train commuters, backpackers, slow walking elderly, security staff touring, and the travelers staring at the board of train times, endlessly waiting, and looking forward to pass the waiting time. Some people were running around, perhaps to catch a last minute train or bus departures, some were wandering around slowly, engaged in conversations and scanning restaurants and shops displays. Some were forced to walk slowly because of their inability to do the opposite, all these characters, which their actions were repeated within the previous two days as well and perhaps quite often, form that culture. The station complexity and the presence of energetic, heavy flows of people moving through the space caused the flow of pedestrians to fall out of harmony, and stressed the need to narrow down the locations on focus, and the need to identify congested locations; “bottlenecks” within the station buildings, in order to be able to study the flow characteristics more precisely.

4.3 Two bottlenecks in focus

On May 7th, I went back once more to Gothenburg for two days trip; to carry on with field observations and interviews with stakeholders, I planned for personal interviews from the two involved authorities in the station area; Trafikverket, and Jernhusen. Instead of talking to each party at a time, the interview was held with the two parties together; the quality manager from Jernhusen at Gothenburg Station and a member staff from Trafikverket. The interview was held within the station building and was arranged as a walking tour inside and around the station area, with thorough discussions and observations for two hours. We were discussing the station current situation, their thoughts and ideas about it, the future plans of their companies, and how often they pass through the station. I asked the two interviewees explicitly “Where are the most two congested locations within the station buildings? “ And several other questions revolved around the same matters; the most problematic locations “bottlenecks” in the station, and the reason behind its complexity, problems in the flow, when do they see that, and what are the reasons according to them.
The main hall corridor of the central house were the first to be identified, most of the answers revolved around the difficulty of walking smoothly there; “it is very common to have a swaying movement when you walk here” said the lady from Trafikverket, “However, the back of the central house is empty, if you want to avoid the crowd on a rush hour you can take the back and walk there smoothly”. Interviewee from Jernhusen also shed lights on the same location; “the main hall in the central house is really crowded, people can read information about their trips here, they can sit in both sides, and most station users pass through the same location when they transfer between different connections”. The place they pointed out matched my own observations; as I noticed within my previous trip that the hall was crowded, it contained several attractions for travelers which made it complicated to walk smoothly there.

The connection between the Central station and Drottning street was also highlighted by both interviewees; without indicating clearly one specific location though, answers revolved again around the difficulty of walking smoothly, without being stopped or slowed down by a crossing traveler. To capture the problem, I identified one bottle-neck in the location, the entrance/exist doors that connect the two main hall in the central station building; three doors connects the two halls, two of them are open, while one is closed and could be opened manually in both direction. Figure (7) below display the locations of the bottlenecks inside the station buildings, bottleneck 1 and bottleneck 2, respectively.

![Diagram of station buildings with bottlenecks](image_url)
4.4 Analyzing the bottlenecks

After the interview, I stayed in the station, swapping between the two locations, and scanning them carefully, bearing in mind the question of “what trigger congestion? And what cause the crowd?”, and thinking about the comments I heard from the interviewees in the very same morning. I tried; relating to my previous reading, to pinpoint the reason behind the problematic situation in the flow.

4.4.1 The main hall corridor

The first bottleneck, the main hall corridor, is a confusing place. It acts as a narrow walking corridor and as a waiting room simultaneously. Travelers are running in two opposing directions there, and in between the seats, almost clashing at some points. There are various types of furniture; six double sided public seats with a capacity of 6 persons per seat, and seats privately owned by restaurants, are located in the same space. There is also a rubbish can, almost located in the middle of the way. Figure (8) shows the hall complexity; the travelers through zone are surrounded by private restaurants seats and public seats.

![Figure (8) Travelers through zone in the main hall corridor, surrounded by private restaurants seats and public seats photo: author](image)

Additionally, there are restaurant menus and advertising boards standing at the floor. There are also trains arrivals/departures display boards at the walls which command careful review. Both types of boards trigger pedestrians to stop randomly in the middle of the pedestrian through zone, to pick carefully the next meal, or to read their travel arrangements. Those travelers usually hold large bags, and impede the flow of other travelers. Figure (9) and (10) below, show two travelers stop to read the lunch menu in the middle of the walking corridor, and travelers stop to read trains information within the walking corridor, respectively.
Figure (9) Two travelers stop in the middle of the walking corridor, to read the lunch menu of one of the restaurants - photo: author

Figure (10) Travelers stop within the walking corridors in order to read trains information - photo: author
4.4.2 The connection to Drottning street

Picture (11) shows the second bottleneck; the doors between the two main halls in the central station. As previously explained, the bottleneck has three doors, two of them are open, while the third one is closed, yet one can open it manually in both directions. The closed door direct travelers to cluster around the first and the second doors, still few travelers use it, now and then, in order to avoid the crowd. Additionally, trains information boards are located on top of walls parallel to the doors, the location trigger travelers to stop frequently, which hinders the flow for the rest of the travelers, likewise, 4 shops; Upper Crust, Pocket Shop, Glitter and Pressbyrån cluster around the bottleneck, along with one ATM Machine and one currency exchange shop that provides four windows to serve travelers; i.e. one queuing line per each window.
4.5 Analyzing the pedestrian flow within the bottlenecks

In June 4th, I went back to Gothenburg holding my backpack, a two meters long tripod, and a video camera. I planned to film the crowd, in order to capture the travelers flow in the two bottlenecks. I did the filming in June 5th and 7th, I took several films during the two days, mainly in early morning from 7:30-8:30, afternoon from 12-1, and later from 4-5, bearing in mind the interviewee’s recommendations, and my own observations within the previous trips.

I did the filming for several reasons, mainly to extract the local pedestrian flow characteristics, and to analyze the moving pattern in both bottlenecks. The demographic mixture on the videos, younger age group and older, was the first to be realized when I have started to analyze the films; I would put the differences down to the time of the day. Additionally, according to the films it seemed like the walking experience was not always comfortable. Travelers were delayed in many occasions, the frequency and the sudden speed changes were pretty much high, and walking breaks due to avoidance maneuvers was also noticeable. Travelers seemed to move randomly, often changing direction several times within the same walking space, a state trigger pausing, standing aside, and giving priority for running travelers, or walking travelers toward the opposite direction. Travelers also tend to conform, and to follow the actions of each other. Apart from walking directions, physical ability and luggage did constrain the motion, noticeably in the very crowded minutes though.

4.5.1 The main hall corridor

The video films made it possible to explore this bottleneck quite much in detail. The films illustrated the hall as an active spot, traveler’s moved around; they sat and stood up marching the corridors to follow up with train information. People on Public seats tend to keep quiet, they rarely interact with each other’s, they were mainly waiting to get to their connection, whereas the restaurants seats people tend to communicate with each other, initiate a conversation, engage in eye contact, circulate magazines or newspapers, perhaps travelers there have more time to kill, and are looking for things to pass that time.

I started by analyzing the film taken in June 7th, at 7:30 am precisely, the first ten minutes went relatively quiet; not many travelers were around, restaurants and public seats were empty. Neither seniors nor baby strollers appear in the morning video, I would put the reasons down to the time of the day, additionally, at 7:31 a lady appeared -running to her destination, she managed to pass the hall smoothly in 5 sec. Moreover, travel time for walking travelers would range between 10 to 12 seconds. Within the same time period, a lady appeared walking toward her destination just behind another traveler; who seemed to walk slower as he was scanning the hall, the lady started to look irritated and tried eventually to bypass the man, it took her 18 sec to cross the hall. Consequently, this action were repeated several times, many travelers slowed their walking time down when
they crossed the corridor as they tend to scan the hall thoroughly before they cross it, one lady with a bag; dragging it behind her took 25 sec to cross the hall as she was scanning the crowd and the hall in front of her. Travelers started to appear heavily at 7:45 am; most of them were running, perhaps to catch up with a tram or the next bus departure, or they were simply running late to work, old people were still missed during that time. Additionally, a cleaning man tour took place at 8:10 am, he was standing with the cleaning stroller, he stayed there for 1 min and 30 seconds, he stopped for some time on the path dedicated for blind travelers, simultaneously a woman crossing the hall was blocked by the stroller and by the people passing from the other direction, it took her 23 second to finish her journey, as she has to change her direction in order to avoid obstacles. No traveler with obvious special needs appeared in the morning video.

The video film also illustrated clearly how the main hall corridor is an important place for waiting both for individuals and for groups. Groups of four to five young and middle ages’ travelers appear frequently, they were standing mostly with big bags in the middle of the way, engaged in conversations, keeping one eye at the morning coffee and another at the big screen on the side wall, one example is a couple appear at 7:39 am, they stopped in the middle of the walking corridor for about 17 sec for chatting, the girl had a big bag, and she was moving it forward and backward just in front of other travelers. Likewise, a family of five members appeared at 7:51 am stopping next to the public seats, they were waiting, they did not seem to block the way of any traveler immediately, but they narrow down the available space in the walking corridor. Consequently, the morning flow was interrupted, travelers; holding irritated facial expressions, were crossing the space in an oscillation like movement, putting extra effort to pass it, stopped frequently, and perhaps delayed and missed their last minutes connections.

Moreover, while I was taking the film, commuters arrived from the commuter train platforms, frequently enough. Surprisingly, they split into two streams; one went through the assigned walking space directly, and another went through a fairly narrow space; in between the side wall and the public seats, perhaps to avoid the crowd. At 8:30 the hall became more crowded; more travelers were running around, a few old travelers were walking around, and others were standing still, public seats were partly occupied.

Within the second film which was taken during the same day at 12:00 -13:00, the morning actions occurred all over again, however the hall appeared more crowded, and further actions took place, traveler’s combination was quite different; more old travelers crossed the space, kids strollers appeared frequently, and young travelers were actively wondering around. Additionally, restaurants seemed more attractive to travelers; they stopped regularly to read the menus; aiming to sit for lunch, or perhaps to grab a sandwich quickly. The hall seemed as a complex entity, more crowds stopped in the middle, and in both sides of the hall, the flow was interrupted and delayed, traveler’s movements were restricted especially in the main directions, travel time would range
between 13-14 seconds, an old lady appeared in the movie, it took her around 28 second though to cross the hall. One action attracted my attention repeatedly occurred during that hour; individuals approached the rubbish can; the one located in the middle of the hall, and paused there, some to throw the garbage, and others to search for plastic bottles there, although the action seems trivial, yet it adds extra burden to the fragmented walking flow.

Filming at 16:00 pm was the last activity for that day; I did that hour of filming, in order to capture the employee’s departure trips. At that time, the hall was noisy and notably crowded, travelers varied obviously, yet young travelers were the most to be observed, many people were running, and many others were hanging around, all public and private seats were fully occupied, restaurant areas were very active. The through zone was almost blocked; travelers stopped heavily for reading menus and trains’ information display, they looked over both carefully enough; which required them to stand still in the middle of the way for a minimum of 1-3 minutes.

4.4.2 The Connection to Drottning Street

In June 7th, I filmed the second bottleneck, I captured the flow twice; early morning from 7-8, and later from 16-17. The crowd was rather complex, fair in early morning, and jam-packed in late afternoon. Doors serve bi-directional flows; i.e two directional flows of travelers.

The first fifteen minutes between 07.00-07.15 passed on slowly, with minimum activities to capture. However, I recognized that travelers; from both directions, tend to use the intermediate door, whereas avoided using the closed door, and the door that stands to the right. In a while afterward, four travelers; surprisingly enough, stopped just in front of the middle door, one man had a medium bag next to him, and another had two large bags, whereas the rest were backpackers. They completely blocked the entrance. The group was engaged in a long conversation, one of them swapped his head repeatedly between both the information board in front, and his own hand watch, and then they all continued walking toward the entrance. However, the group did not pay attention; to how many travelers had to stop, and how many had to change their directions. Afterward, this action occurred frequently, individuals and groups stopped to follow their train’s departures, in front of the middle door, and in different locations within the hall. The flow was extremely interrupted, several travelers; from both directions, shifted to use the second door, several also had to pause, in order to give priority to panic travelers in a hurry, viz to avoid possible collisions.

The location at 16:00 seemed worse off; it was crowded from the beginning, several travelers stopped to read the detailed information boards, they completely blocked the way, and almost blocked my screen. The location appeared more as a waiting hall than entrance/exist doorways. Some travelers managed to cross the spot in minimum of three seconds while others would spend 8-10 seconds to do so, At 16:20 a woman appeared with a broken leg, she uses one walking sticks to support herself; she had to
change her walking direction twice in order to avoid the crowd, several old travelers appeared in the movie at that time, they were walking slowly hindering the trip of other quick travelers, and annoyed themselves by the travelers that stopped in the middle of the way. Additionally, the closed door was used several times, many travelers, pictured the crowd from a distance, and immediately went through the closed door. At 16:38, the crowd got decreased, likewise did the human blockage, the flow was completely shifted toward the second and the third door.

4.4 What hinders the flow in the bottlenecks?

The findings from the bottlenecks analysis illustrate the situation in Gothenburg central station area; the two bottlenecks reflect two congested locations within the station buildings, yet several others problematic locations do also appear all around the area. The reasons behind the bottlenecks complexity varied between weak layout arrangements, the cluster of attractions all in the same spot, along with several transport connections, which all together trigger the diversity of traveler’s characteristics and needs, and hence cause problems in the flow.

The main hall corridor is a complex waiting area and a walking corridor, likewise the entrance/exists doors that connect the Central station and Drottning Street, as it also highlight travelers complex situation in the station. Within the first spot, problems cluster around the diversity of restaurants, consequently placing its furniture/attractions within the available space of walking, alongside with traveler’s services such as train information boards that are placed to the side of the same crowded spot. As for the second bottleneck, providing two opened doors for travelers and closing one triggers crowd to cluster around the first and the second doors. Moreover, the problem clearly appears there through placing train information boards next to the doors. The situation within the bottleneck mimics several other locations in the station that has weak layout arrangements; such as the locations of (ATM) machines, currency exchange services, and other traveler’s services.

Additionally speaking, the diverse connections between transportation modes among other things help to generate the diversity of traveler’s characteristics and needs; travelers varied between young travelers, kids in strollers, and slow walking elderly travelers that appear mostly in the afternoon and afterward. Likewise, some travelers were running to their connections, some were walking slowly, and some were scanning restaurants, train information boards and shops displays, all these characters were displayed through the presence of energetic, heavy flows of travelers.

Within the bottlenecks, travelers were stopping randomly in the middle of the pedestrian through zone to keep up with several attractions in both locations, those travelers usually hold large bags, and impede the flow of other travelers. Additionally, filming the bottlenecks highlight that the walking experience was not always
comfortable, it shows that travelers were delayed in many occasions due to pausing; changing their speed suddenly and due to the avoidance maneuvers they have to conduct for travelers standing in the middle of the way, running travelers, and walking travelers randomly or toward the opposite direction. Moreover, it also shows that the problem with the flow gets more problematic later during the day when compared to early morning flows, as the bottlenecks get more crowded, travelers’ combination varied more, and more travelers stop in the pedestrian through zone to follow up with station attractions.
CHAPTER 5: DISCUSSION: PEDESTRIAN FLOWS & THE NODE-PLACE DILEMMA

This thesis has shown that the flow within Gothenburg station buildings today is chaotic; travelers there go through several complex crossing locations. Moreover, from the observations presented in chapter 4 it is clear that travelers loose time and are hindered in their movements through the station, which in turn causes more crowds and accessibility problems. The reasons behind the chaotic impression varied between the availability of several entrances/exits, the lack of defined walkways, mixing circulation spaces. Likewise, the flow complexity increases due to travelers various needs and capabilities. All these issues are discussed further later within this chapter. Moreover, the situation there mimics the description of the intermodal station atmosphere which is described by the existence of heavy and energetic flow of travelers (Transport research board; 2003), and characterized by the presence of slower and quicker travelers all at the same space (Teknomo, 2006).

This chapter presents a synthesized discussion over the findings of Gothenburg case study in relation to the research overview that has been presented within chapter three; it presents a discussion over the previously stated research questions, as it explicitly discusses the state of flow of travelers in the station area, along with traveler’s characteristics there. It also explores the state of elderly, special needs and accessibility practices within the station buildings today. Additionally, the discussion has been taken further to cover the bottlenecks; its physical measures, the flow and the moving pattern of travelers there and the relevant measures that would generate smoother trips for them. The chapter is closed by a discussion over the question of what is the railway station today through discussing the node-place dilemma, and the shift in development of railway stations.

5.1 Travelers and accessibility

The literature review in chapter 2 explored the multitude of users of railway stations; tourists and business travelers, work related travelers and others. Although it was difficult to differentiate these groups within the case study through loose observations and video filming, still it was noticeable that the station building provides them with the key activities such as; restaurants, hotels, and travel information, along with the accommodation within the station area. Bakersson (2010) also describes a third group of commuters or daily basis travelers, this group was the easiest to be recognized among others, as it was possible to track their routes between the commuter trains and tram/bus connections, however although the literature highlighted that the majority of the traveler arena today belongs to them (ibid), they were not completely provided with their need for shortest possible route between connections.
Furthermore, several researchers speak about elderly and special needs travelers within station atmosphere, a discussion that is most of the time developed further to cover debates about accessibility and its standards. These groups appear within the case study through the phase of loose observations, but did not appear that much within filming the bottlenecks. However, both groups form key categories within the station atmosphere, and the problems identified in terms of hinders for smooth pedestrian flows probably affects these groups even more than others. Researchers demand governmental actions to ensure their safe mobility (Wennberg et al., 2010), and their status within the station atmosphere has its importance within the international community and specifically through a national Swedish aim of a transport system that is accessible for all. In relation to this, one may note that the bottlenecks in particular and the station area environment in general are rather developed according to the basic standards of accessibility design guidelines documented within the handbook from the former Rail Administration; such as the availability of automatic sliding doors, and braille characters on signs, and marking.

However, as Wennberg et al. (2010) perceive accessibility as the relationship between the person and the environment, and following to their suggestion of the “usability” concept when speaks about elderly; as a concept displays person’s perception of the surrounding environment (ibid.), the overall atmosphere within the station, reflected by the crowd, the chaotic situation, mixing the circulation spaces, the random locations of shops and restaurants may decrease the efficiency of applying accessibility standards. This argument has been taken further by the description of the station building as scary place for old people by the interviewee from Färdtjänsten, and by their explanation that those group usually avoid going there by their own; especially if they are slow or if they have problems in walking or seeing, along with their fear of falling down there in between the complex crowd.

5.2 Bottlenecks and circulation spaces

As for the bottlenecks, analyzing the situation there highlights the importance that travelers could move smoothly without developing crowded spots and too much congestion. Literature on station design describes bottlenecks as reduced capacity (doors or corridors), or an increased demand (Kretz et al., 2006). Likewise, it defines the station concourse space; “a space within the station away from platforms and travelers circulation routes, where a range of activities take place, such as inquiry desks, timetables and departure boards, along with travelers waiting spaces, retails and shops, platforms and stations access doors “(Network Rail, 2011), it also highlights the importance that station have simple, obvious, and comfortable circulation patterns. This literature is of key relevance for the further development of Gothenburg Station.
Thus, along with the theory of the circulation spaces one can note that the main hall corridor presents the concourse space of the central station mixed with one major walking corridor that connects key transport modes. Besides mixing circulation spaces, and since fitting services properly is key issue to allow smooth flow of travelers through stations (Public transport users association et al., 2011) several services within the hall could be re-arranged so it guarantees a smoother flow for travelers. For example, the space in front of the time table board should be adequate and defined for travelers to follow up their travel arrangements without hindering the flow in the walking corridor. This could be done by placing a barrier dividing the two spaces. Additionally, restaurants and shops obstructions especially menus and advertisements within the walking corridor should all be relocated away from the walking corridor. On the other hand, since a fairly high group of commuters who arrived from the commuter train platforms went through the narrow space in between the side wall and the public seats causing crowded spots and chaos, the entrance connecting the commuter train platforms with the hall should be closed, or a wider space should be provided to assign that space as a path for commuters.

As for the second bottleneck, providing two opened doors for travelers and closing one triggers crowd to cluster around the first and the second doors. Moreover, the problem clearly appears there through placing trains information boards next to the doors, and by allowing two ways flows per each door, Teknomo (2006) states that smoother flows could be guaranteed through less space along with different set of laws to control the situation, he also draw one example when considering two doors with different directions; the author argues that one way door is better than two way doors (ibid.). The situation within the bottlenecks reflects several other locations in the station that has weak layout arrangements; such as the locations of ATM machines, currency exchange services, and more mixing of circulation spaces.

5.3 Travelers flow within the bottlenecks

The case study has generated several illustrations of travelers being delayed due to bad pedestrian flow. The examples reflects clearly Lam et al. (2002) description of the elements that affect the walking speeds of travelers, such as the personal characteristics; age, gender, size and health. In this case, travelers varied between young travelers and slow walking elderly travelers that appear mostly in the afternoon and afterward. Similarly, Lam et al. (2002) stresses on the characteristics of the trip, such as walking purpose, route familiarity, luggage and trip length, along with the properties of the infrastructure; type, grade and attractiveness of environment there which were all reflected through travelers running to their connections and by others walking slowly, and some others scanning restaurants, train information boards and shops displays, and eventually by travelers stopping randomly in the middle of the pedestrian through zone to keep up with several attractions in both locations.

The analysis of the films of the pedestrian flow in the bottlenecks also highlight that the walking experience also depend on the crowd. Daamen et. al, (2003) explain that
physical disability and luggage reduce walking speed of travelers along with the number travelers when the crowd increases which explains why the flow gets more problematic later during the day when compared to early morning flows, as the bottlenecks get more crowded, and travelers’ combination varied more. Moreover, the films also display Bakerson’s (2010) description of the walking experience as being not comfortable, it shows that travelers were delayed in many occasions due to pausing; changing their speed suddenly and due to the avoidance maneuvers they have to conduct for travelers standing in the middle of the way, running travelers, and walking travelers randomly or toward the opposite direction.

5.4 What is the railway station today?

Finally, the case study of the station area also highlights the more general question of what is the railway station today. It provides a clear illustration of the node-place dilemma and the reasons behind stations transformation that has been debated by several writers. Intermodal stations are of key importance in transport as they serve the complex transportation network of the multi-lines and multi modes of transportation, and they also have a high position within business and consumption, reflected by the intensive and diverse attractions of restaurants, shops and services points inside the station. In this case, it is even further emphasized with the location of the station within the active Drottning square with a cluster of offices, retails and several big hotels and Nordstan shopping mall. The situation there triggers a reflection to Bertolini’s description of the correlated, double sided relation between developing transport in a station location and increasing the activities there (Peek et al., 2007).

The results of this analysis overall mirrors Bakerson’s (2012) thoughts about the ongoing transformation of stations today. The findings altogether reflects his argument that the new situation sometimes leaves station buildings to fall out of tune, causing some basic functions to lose its importance and others to be highlighted. This was illustrated by the chaotic impression inside the station, through mixing circulation spaces, the random locations of shops and restaurants, and placing urban furniture; privately owned by restaurants, within the walking corridors.

Moreover, there are also reasons to relate back to Bakerson’s (2010) questioning of the reasons that hold back the development of stations in a suitable manner. He frames the reasons in three main problem contexts, firstly, administrative difficulties in running station buildings, which is visualized through the fragmented structure of station ownership, and the involvement of more than one party to run the buildings; Västrafik, which own and operate the Nils Ericsson terminal, Jernhusen which owns and manage the central station and the central house, and finally Trafikverket who owns tracks there.

The result of this study thus gives even further reasons to reflect upon what initiatives and what actors that encourage passengers’ interests in the area. In this case,
Jernhusen has an overall aim to develop the station area as a meeting point, which is interpreted in terms of linking travelers’ services with commercial activities, shops and restaurants. This should however be done in accordance with the role of Trafikverket in developing accessibility in the station area and the overall aim of doubling the public transport, and with the Swedish national transport policy goal to develop a transport system that is accessible for all.

Finally, Bakerson (2010) describes the changes in traveling traditions; he argues that this change has developed new categories of travelers with varied interest and needs. Picture (10) below display an image for the central station and Drottning square in 1900, the picture was published in November 22, 2001 in vårt Göteborg. The picture reflects the simplicity the station surroundings had at that time. It also shows that horses and carriage were used for transportation. Whereas, the station surroundings today express a complex urban area, several large scale projects, high speed trains and several commercial activities.

![Figure (12) Central station around 1900 -Image Gothenburg City Museum - Vårt Göteborg](image)

Gösta Öborn states a description underneath the picture, he says that the picture shows the Queen’s Gate, which is now named as Queen Square, along with horses and carriage that used to be the main transport mode, all before the Industrial era which brought rail travel crowds, and the rapidly growing cities, he also states that at that time people could not think in their wildest imagination how the situation around the station would look like today, 100 years later.
CHAPTER 6: SUMMARY AND RECOMMENDATION

The aim of this thesis has been to explore the complexities involved in the issue of smooth pedestrian flows within station areas, considering especially the Swedish aim of a transport system that is accessible for all; it also aims to produce a broad foundation for continued in-depth studies of the several topics that have been discussed, such as the node-place dilemma of intermodal terminals, traveler’s characteristics, flows and the physical layout of stations. Gothenburg central station was selected as the case study of this thesis, since it is a station area currently meeting big challenges in terms of smooth pedestrian flows. The station today is a crowded convergence node for multi-lines and multi modes of transport. Accordingly, additional pressure is expected on the current capacity of the station, which triggers the need to explore the traveler’s situation in the station today.

This study was based upon existing literature illustrating the complexities of intermodal station areas today. This literature highlights the question of what is the railway station today, and provides a clear illustration of its importance in transport along with its high position within business and consumption, reflected by the intensive and diverse attractions of restaurants, and shops inside stations. Besides, it draws attention to the typical situation with a heavy and energetic flow of travelers inside the terminal buildings. It also classifies the contemporary complex groups of travelers, with tourists and business travelers, work related travelers and commuters. Besides, it presents the key needs per each group. Furthermore, several research speak about elderly and special needs travelers; as both groups form key categories within station atmosphere, and hold a vital national and international status. Additionally, researchers synthesize these groups with accessibility practices, which varied between standard designs ‘guidelines and a mutual relationship with the surrounding environment.

The literature on station design suggests that a functional station requires different circulation spaces for travelers (Fernandez et al., 2010). Additionally, it states that stations should have simple, obvious, and comfortable circulation patterns, since a logical station plan and inner arrangements help greatly to make the trip inside the station clearer and easier to navigate.

Besides, travelers have different behaviors and speed inside station, several elements affect their walking speed there, such as the personal characteristics; age, gender, size and health, the characteristics of the trip, such as walking purpose, route familiarity, luggage and trip length, along with the properties of the infrastructure; type, grade and attractiveness of environment there (Lam et al. 2002). In addition, travelers walking experience inside station are described of being not comfortable (Bakerson, 2010). The author states that they get delayed due to pausing, changing their speed suddenly and due to several avoidance maneuvers.
Examining Gothenburg central station helped to explore the previously stated complexities on the ground. The overall atmosphere within the station displays the crowd in a chaotic situation, it also shows how mixing the circulation spaces, and placing shops and restaurants in random places affect travelers there. As for travelers, commuters were the easiest to be recognized among other group of travelers, compared to tourists and business travelers, and work related travelers. The station building provides the latest two groups with restaurants, hotels, and travel information, along with the accommodation within the station area but it did not provide commuters efficiently enough with their need for shortest possible route between connections. Furthermore, elderly and special needs travelers form key categories within the station atmosphere. The station area environment in general is rather developed according to the basic standards of accessibility design guidelines documented within the handbook from the former Rail Administration. For instance, there are automatic sliding doors, and braille characters on signs, and marking. Still however, the overall atmosphere within the station decrease the efficiency of applying these standards, the station building today is considered as a scary place for old travelers, according to a key informant they avoid usually going there by their own; especially if they are slow or if they have problems in walking or seeing, along with their fear of falling down there in between the complex crowd. The empirical analysis conducted in this thesis confirms the problematic situation. According to the analysis of two bottlenecks within the station, walking within the station is fairly not comfortable; travelers were delayed in many occasions due to pausing; changing their speed suddenly and due to the avoidance maneuvers they have to conduct in several occasions. The study also identifies a range of key measures that would easily make the situation better. For instance, traveler’s services such as time table boards, ATM machines, currency exchange services, and others should be placed away from the main walking corridors and station entrances. Moreover, restaurants and shops obstructions especially menus and advertisements should all be relocated away from the walking corridor. Additionally, the station circulation pattern could be organized through several measures, such as regulating stations entrances/exists, defining walkways, separating circulation and waiting spaces.

As stated in the introduction to the thesis, Gothenburg station is expected to have more travelers in the near future due to several factors; one factor is the demographic changes in the city, another is plans to expand the range of services for public transport there (Göteborg stad, 2011). Another key factor is the national Swedish aim of doubling the public transport (Swedish public transport association et al., 2012), and promoting public transport as crucial issue to achieve sustainable development by different stakeholders (Göteborg stad et al., 2008). Likewise, through a plan for big infrastructure project in the city “Västlänken project”; a tunnel for through trains in central Gothenburg that will take Gothenburg central as one of its terminals (Trafikverket, 2012a). For this reason, the issue of smooth pedestrian flow should be a key issue to work with for the public institutions, not the least from the perspective of the national policy aim to provide
a transport system that is accessible for all. This thesis illustrates the issue of smooth pedestrian flows as a key aspect of accessibility.

To conclude, the thesis recommends experts and policy makers, who are involved in the further development of station buildings, to dig more deep into the subject of intermodal terminals and to draw attention on its complexities, and to increase their awareness about it; hence future decisions could be taken in a more experienced manner. As for the practical case study, it highlights various important issues for the location, in terms of accessibility and if there is a will to prioritize smooth pedestrian flow, the thesis recommends that several services within the station building to be re-arranged so it guarantees a smoother flow for travelers now and in the future. In addition, the situation there calls for special attention toward elderly and special needs travelers, and the importance to address their status in the station within all stakeholders’ development schemes. Likewise, it request stakeholders to pause upon the question of what is the railway station today; and to understand the obvious conflict between the “place”-logic and the “node”-logic, and to recognize the conflict consequences.
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INTERVIEWEES:

- Interview with /project leader, market and planning/ at Trafikverket Göteborg, Date [first interview: April 18th, 2012, second interview: May 7th, 2012].
- Interview with /communication director/ at Färdtjansten Göteborg, Date [April 18th, 2012]
- Interview with/director/ at All access Scandinavia AB, Date: [April 19th, 2012]
- Interview with/ Station quality manager/ at Jernhusen, Date: [May 7th, 2012]
APPENDIX 1

INTERVIEW GUIDE FOR THE INTERVIEWS

• Presentation (aim of the study, background to the research)

• Your background and professional role

• Your perspective on the situation at Göteborg Central station
  o How would you describe the situation in terms of pedestrian flow in general?
  o How would you describe the situation for elderly, and people with special needs

• For All access: your view on accessibility design in the station building

• For second stage of interviews: The most crowded locations in the station

• Any other thoughts/comments of relevance to the pedestrian flow and accessibility?