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URBAN DIVERSITY AND PEDESTRIAN BEHAVIOR - REFINING THE CONCEPT OF LAND-USE MIX FOR WALKABILITY

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Abstract

While land-use mix has continuously been referred to for its importance for walkability, current research demands further investigation to refine the concept and develop the measurement for it so that it may best capture the way it influences walking behavior. This study combines two on-going research projects dealing with issues in urban form, one on urban diversity and the other on walkability, both trying to develop the conceptualization and the measurement of these qualities. Regarding diversity, scales and categorizations as two essential factors for evaluating diversity are examined in this study by the implementation of analysis at various configurational levels and on access to variety. From the research project on walkability, a qualitative observation study was conducted examining the subjective measurement of pedestrian density and its patterns, the route choices made in the walking trips observed while tracking pedestrians, and the different types of walking activities taking place in the study areas. By obtaining hard data on real behaviors of walking in different situations, it provides a detailed description of the walking activities and their patterns in three neighborhoods in Stockholm, Sweden, where the quantitative analysis regarding diversity was also conducted.

Therefore, in this study the multi-level analyses searching for the proper and useful scale for measuring diversity are compared with the descriptive data on walking behavior, in order to test their validity and applicability in walkability research. The results show that areas with higher degree of diversity in the built environment contribute to higher degree of diversity in walking behavior by providing variety in both the composition of pedestrians and the type of walking activities, which may ultimately enhance the walkability of an area. The comparison of the quantitative analysis of the built environment with the description of the walking activities show the potential of the analysis presented in this paper as a tool in measuring factors related to walkability, and the process allows a better understanding of the walkability as a complex subject. Certain parts of the analyses especially show strength in being a more precise measurement and a better representation of the built environment attributes than the ones done in the earlier walkability studies. Although the analyses and discussions presented in this paper yet have limitations in fully exploring the issue of diversity and walkability of the urban form, they provide insight and knowledge for the development of each project.

INTRODUCTION

This study combines two on-going research projects dealing with issues of urban form, one on diversity and the other on walkability, that aim at developing the conceptualization and measurement of these qualities. The study of diversity explores various systems of classifications and the choice of scale in capturing urban diversity. For the study of walkability, while land-use mix is defined as one of the important factors in walkability, current research demands further investigation in refining the concept and developing the measurement in order to better capture the way it influences walking behavior. In this study, the result from the multi level approach in searching for the proper and useful scale for measuring diversity are compared with the data on walking behavior in order to test its validity and applicability in walkability studies. Since both of the projects are in their earlier stage, what is presented in this paper is the brief description of the background, method, and aim of this study and a preliminary testing of simple quantitative analyses of the built environment through the comparison with the qualitative data on walking behavior. The aim is to gain insight on how to further refine the conceptualization and measurement of both the diversity and the walkability of the urban environment. This will be done by examining how the analyses of the built environment done here reflect and explain the walking behavior and what they fail to capture. The study examined three neighborhoods in Stockholm, Sweden.

THE IMPORTANCE OF DIVERSITY FOR WALKABILITY

Studies of walkability that deal with the relation between the built environment and walking behavior have been examining different properties of the physical environment that affect walking activities. The factors that have most consistently been proven to positively influence walking behavior include land-use mix, connectivity, and density. Through the studies on walking from the fields of transportation, urban design and planning, and public health, it has been suggested that neighborhoods with higher residential and employment densities, more connected street patterns, and a variety of destinations show higher rate of walking (Cervero & Kockelman, 1997; Frank & Pivo, 1994; Handy, Boarnet, Ewing, & Killingsworth, 2002; Handy, 2003; Saelens, Sallis, & Frank, 2003). However, current research demands further investigation on how these properties could best be conceptualized and measured for a better understanding of their relationship to walking behavior. With the developments in GIS software and databases that allow advancement in the measurements of the variables on a variety of scales, recent studies are going beyond earlier works (Forsyth, Hearst, Oakes, & Schmitz, 2008), but there still remains a need for a vast amount of additional investigation and knowledge for understanding the relationship between the built environment and walking behavior which is extremely complex.

In order to meet this demand, the conceptualization and measurement of the built environment qualities are crucial, but a better understanding of walking behavior is equally important. Walking behavior is highly complex as it involves different aspects and types of activities. In walkability studies, different aspects of walking are explored since the degree of association with the built environment and physical activity may vary according to the type or the purpose of walking, e.g. utilitarian walking, walking the dog, walking for pleasure, etc. Although simplified and limited both in the categorization and the refinement in dealing with the different aspects of walking activities, existing studies have provided evidence for the usefulness of partitioning walking activities. It has been found that according to the specific purpose of walking, its relation to the physical characteristics of places seems to vary (Forsyth et al., 2008; Lee & Moudon, 2006).

This issue of partitioning walking activities was one of the main aspects the observation study on walkability presented in this paper tried to explore. This descriptive study investigated the walkability of the built environment and the walking behavior of the pedestrians in the given areas by observing details such as the pedestrian density and its patterns, the route choices made in the walking trips by following pedestrians, and the different purposes or destinations of walking activities taking place in the area. While current research does not yet provide systematical knowledge on how the categorization of walking activities can best be done, in this observation study, the walking trips observed were documented by their specific purposes or destinations, e.g., walking to the public transit, walking to school, walking the dog, walking to the specific kinds of retail, etc.. Being a qualitative study on walking behavior, it is different from the more commonly existing studies on walkability in that it has not yet measured the objective amount or rate of walking done by the residents living in the areas, usually measured by the time spent walking. Instead, at the early stage the project is currently at, by obtaining hard data on real behaviors of walking in different situations, it tries to provide a detailed description of the walking behaviors and their pattern in each area and gain insight on understanding the complexity of walking activities and their relationship to the built environment.

URBAN DIVERSITY AND RELATED ISSUES

The fact that land-use mix is consistently discussed in walkability studies as an influential factor puts forward the importance of a clear definition of what the term indicates. Mixed-use as a concept was presented and widely used by followers of the ideas introduced by Jane Jacobs (1961) in her book 'The Death and Life of Great American cities', and not least in New Urbanism (e.g. Duany, 2000). Jacobs attempted to represent diversity as an essential factor for cities' liveability and attractiveness, and she has listed four main criteria to nurture what in this paper is more specifically referred to as *urban diversity:* density, primary functions, short blocks and old buildings. Yet, there are issues with diversity as a concept and regarding its measurement. First, the definition lack rigor so it is difficult to be clear on what is actually meant with diversity. Second, we lack analytical tools that can measure diversity with high precision which allow us to compare and evaluate different urban areas. Together, this means that arguments for or against concepts like mixed-use are often conducted without proper basis in empirical data. To develop proper measurements of this kind, we need to be precise on, first, what category of urban phenomena we are investigating, and, second, in what scale we measure diversity since cities may be diverse on one scale but prove to be homogeneous on another.

Due to the complexity and the richness of the available data, what is fundamental for any type of analysis of urban space is to develop or choose a satisfying system of classification (Harvey, 1969; Wilson, 2000). The principle behind the choice of classes, the number of classes, as well as their common attributes, will all have decisive effects on the final diversity value. For example, if we measure the diversity of an area regarding the primary functions, divided into the residential and the working population, the result will be very different from its diversity concerning economic sectors, such as office, commercial and industrial uses. Moving further down the hierarchy in measuring the diversity, if we choose, for example, the commercial sector and more specifically retailing which can be divided based on the type of offered goods, such as clothes, shoes and furniture, this will also yield yet a different value. This means that an area can have a high diversity and a low diversity at the same time, depending on which classification is used.

Furthermore, the choice of scale in spatial studies of urban diversity will influence both the observed patterns of diversity and their interpretation. For instance, an area detected as relatively homogeneous on one scale may appear to be rather heterogeneous on another scale, on account of the extent, resolution and level of the investigations, which is also discussed in studies attempting to model diversity (Batty, Besussi, Maat, & Harts, 2003; Smith & Crooks, 2010). Hence, the issue of deciding the proper and useful scale in diversity studies is of fundamental importance. Moreover, for a proper analysis of urban diversity it is necessary to have a multi level approach, covering micro-, meso- and macro-levels in order to get a more comprehensive perspective. This approach provides the possibility to move between the scales and look for interrelations and common patterns.

In addition to other scales, the individuals' perception of the space is of specific interest for both the walkability and urban diversity studies, as well as in other disciplines like human geography - particularly in studies of behavioral geography (Gibson, Ostrom, & Ahn, 1999). Human geographers define the relative concept of space as "a positional quality of the world of material objects or events" (Harvey, 1969) where, 'relative scales' are defined by the objects and processes under study to put the importance on the scale of the relationship between the dimension and the object. On the other hand following the same concepts, 'absolute scales' refer to the scales that exist independent of the objects or processes being studied, such as the scales applied in remote sensing or grid systems (Gibson et al., 1999).

For this study, the use of relative scale is used to examine the experienced urban diversity in its influence on walking behavior in different areas, rather than absolute scales. This scale is applied using configurational analyses as developed theoretically and methodologically in space syntax research (Hillier, 1996; Hillier & Hanson, 1984), more particularly using available software tools (depthmap, confeego and place syntax tool[1]). Using the place syntax tool for the analyses enables the investigation of density and diversity of the activities by measuring the accessibility of them within various walking distances. It should be noted here that for this experimental study at its earlier stage, the accessibility is studied as one of the urban criteria that may affect the produced urban diversity. Following the primary aim of the study to explore and understand the essential urban factors critical for urban diversity and walkablility, further investigations will contribute to deeper analyses of the refined four criteria introduced by Jane Jacobs (1961).

The study tests the hypothesis that the level of integration of the areas at various scales may capture the accessible population, in this case including both residents and working population as well as other activities such as leisure, retail, and other services commonly considered as destination points. Such spatial factors as accessibility measured with this method are clearly modified by urban form in how it spatially structures the neighborhoods, and it seems likely that they are critical to the way various areas perform in relation to their surroundings. The density and the diversity among the activities in each area is also evaluated by testing the variety among the accessible activities to address points, rather than the mix of activities and their distribution limited to the studied areas and their boundaries. The classification used for the urban diversity will be according to the branch code of the activities (SNI code)[2], and on the other hand the areas will be evaluated based on their spatial criteria and context, how they perform at the local, district or urban level which will be tested by searching through the retail shops and their level of performance as an indicator of the general diversity. The results from the process of the analytical studies will then be compared with the data on walking behavior in order to test their validity and applicability in walkability studies.

[1] For further description of the Place syntax tool, see (Ståhle, Marcus & Karlström, 2005).

[2] Svensk Näringsgrensindelning: Swedish standard industrial classification

THE EMPIRICAL STUDY

The study here intends to test the application of a multi level analytical investigation on urban diversity in three different neighborhoods by conducting configurational analyses on three levels: global integration (radius 30) showing the location of the areas at the urban level, local integrations (radius 3) representing accessibility on the neighborhood scale as well as the local pedestrian movements scale and radius 6, representing accessibility at the district level covering larger urban extents. The general hypothesis of the investigation is that neighborhoods with a low level of accessibility at the urban and district level will tend to contain mostly activities offering services at local level such as convenience stores, whereas neighborhoods with higher integration at the district level will have more variety, for instance, among retail shops in addition to convenience shopping, and they will begin to offer more of a comparability shopping. Finally, the neighborhoods with high accessibility at the urban and district level will have the highest variety, by adding a new group of activities including more specialized and exclusive shops, restaurants, and fancy food markets to the earlier mentioned activities[3].

THE THREE NEIGHBORHOODS

Two of the three selected areas, SoFo and Södrastation, are located in the inner city of Stockholm, whereas the other, Hökarängen, is situated in the southern part of the city (Figure 1), and all areas have access to the subway system. Hökarängen is a suburban neighborhood planned in the 1940s inspired by neighborhood unit planning with access to a planned neighborhood center where the first pedestrian street in Sweden was designed. Södrastation area is a redeveloped area planned in the 1980s, where over 3000 flats were newly built after the renovation of the South Station of Stockholm (Andersson, 1997). In contrast to the other two areas, SoFo is an area created prior to the 20th century, being a traditional urban area. In recent years, the area has begun to function as a center of creative and innovative fashion and retailing, which offers a wide selection of restaurants, bars, coffee shops, and art galleries. The areas located in the inner city have higher population density comparing to the suburban neighborhood, Hökarängen.

[3] For the discussion particularly about the retail shop, their spatial context and performance see (Sardari sayyar & Marcus, 2011), where the importance of the accessible demand area and other retail activities are tested with similar tools.

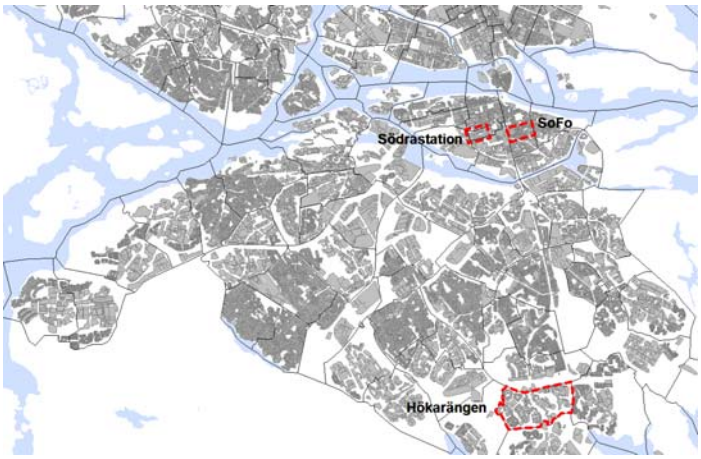

Figure 1: Three neighborhoods in Stockholm: SoFo, Södrastation, Hökarängen

Neighbourhood	Residents	Working population	Total population	Total Population density
SoFo	7540	2650	10190	806
Södrastation	5082	3499	8581	874
Hökarängen	7989	997	8986	150

Table 1: residents, working population, total population and density values (person per hectare) in each neighborhood.

The axial map[4] which was used for the configurational analysis comprises 66000 lines covering Stockholm and some other municipalities in the vicinity. Data used for the accessibility analysis includes census data for all residential and working population from early 2000. Data regarding various activities include all registered economical activities from 2006, sorted according to their branch codes (SNI code). Both data sets have highly detailed resolution on address level, yet at certain steps in the study the data was aggregated in order to compare neighborhoods mainly based on the measured mean values. Figure1 represents total population density values at plot level.

[4] The axial map is merged from several different axial maps made by researchers in the research group Spatial Analysis and Design at the School of Architecture in KTH, and by the consultancy firm Spacescape.

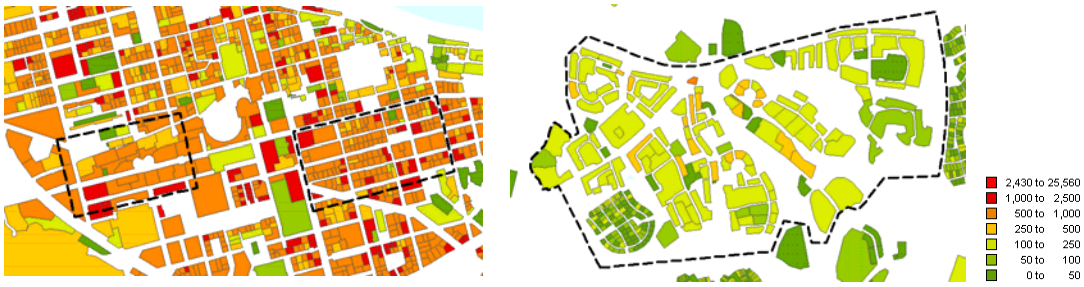

Figure 2: total population density (persons/ha) per plot.

EMPIRICAL RESULTS

Integration analyses at global level (radius 30) and district level (radius 9) show that SoFo and Södrastation are highly integrated with the whole city as a system on an urban scale, as well as highly connected at district level with their surroundings whereas, Hökarängen has the lowest integration at both levels (Figure 3). At local level, comparing first two areas as it is illustrated in Figure4, Södrastation appears to be slightly less integrated than SoFo at some part of the area, while Hökarängen on the other hand has a fragmented structure with few integrated routes (radius 3).

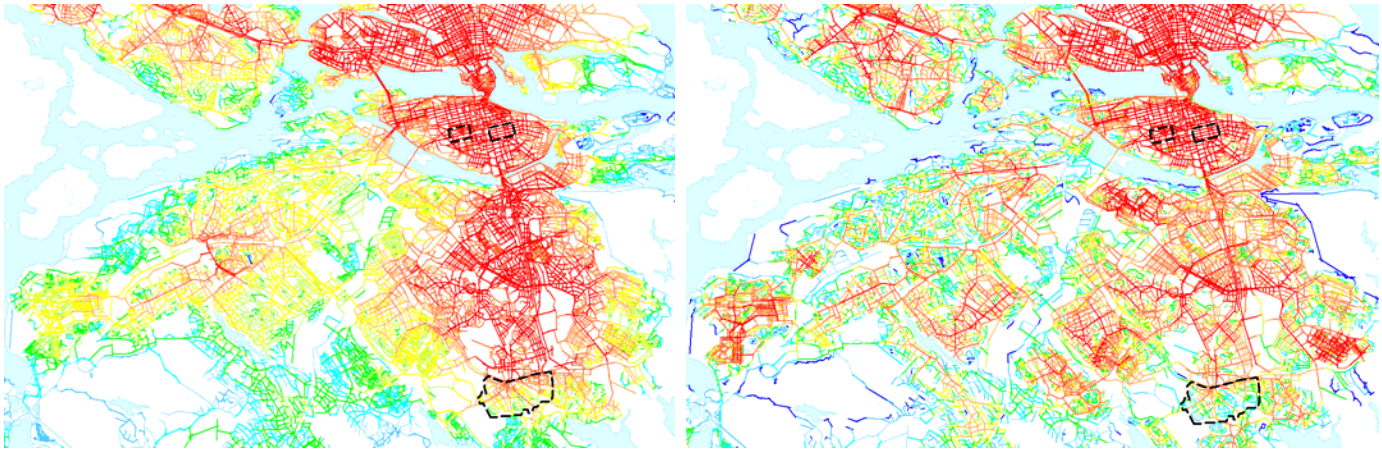

Figure 3: Spatial integration analysis: (left) global level (radius 30), and (right) district level (radius 9)

Södrastation *SoFo* *Hökarängen*

Figure 4: Local integration analysis (radius 3), the most integrated lines are highlighted

Analysis of the access to popualtion within walking distances, measured by combination of both metric distances and axial steps (Figure 5), illustrates that within short walking distances (500m/3axial lines) SoFo has higher access to both residents (Mean 11885) and total population (Mean 18931) compared to Södrastation (respectively 7621 and 12575 person), whereas within 1500m and 9axial steps both areas have similar degree of access to both groups (on average 60 000 residents, and more than 100 000 persons in total)(Table 2).

	Within 500m and 3axial lines						**Within 1500m and 9axial lines**					
	Residents			**Total Population**			**Residents**			**Total Population**		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
SoFo	8572	14312	**11885**	13748	22549	**18931**	53940	72030	**64418**	86859	122189	**104263**
Södra Station	4137	12405	**7621**	8315	17094	**12575**	54043	68724	**61933**	89870	111438	**101236**
Hökarängen	**28**	2284	**890**	32	2950	**1118**	1720	13975	**8227**	2034	17808	**10024**

Table 2: accessible residential and total population

The empirical results show that although SoFo and Södrastation have similar population densities, the accessible population rate differs at local level, which is the effect of their built environment. It appears that SoFo is highly accessible at both levels by large number of non-residents, while Södrastation is accessible on average by less number of non-residents at local level. Hökarängen is accessed by least numbers at both levels, which is around 10-13% of accessible population in other areas at both levels, containing mainly the residents. The minimum number of residents accessible from the address points in this area (28 persons) at local level displays how empty some parts of the area could be. As it is represented in Figure 5 and 6, Hökarängen as other neighborhoods located in the southern part of Stockholm have access to significantly low number of non-residents at both levels.

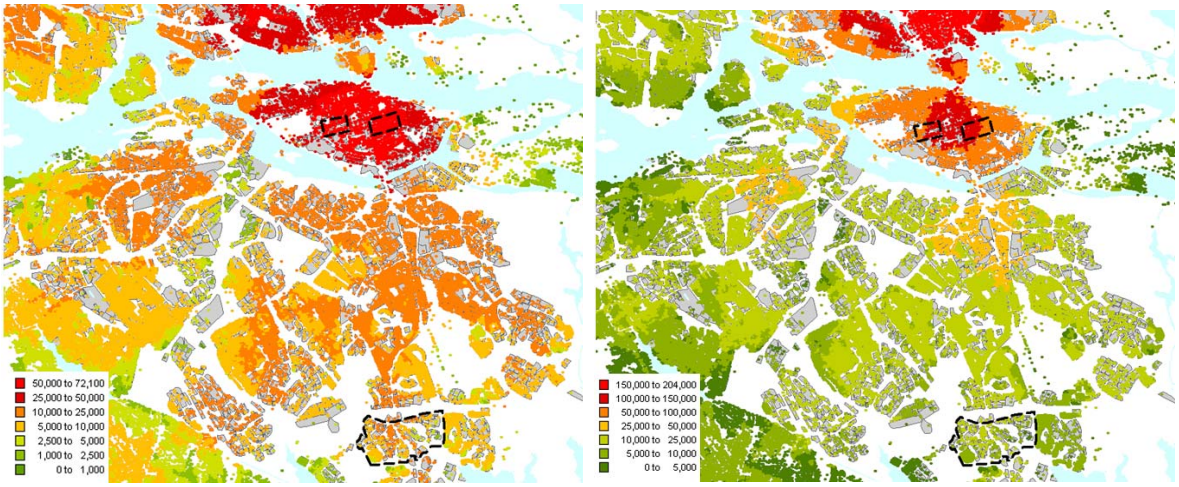

Figure 5: Access to residents (left), and total population (right) on address point level within 1500meters and 3axial lined

Figure 6: Access to residents (left), and total population (right) on address point level, within 500meters and 3axial line

The access to some activities that are recognized as belonging to the most common destinations of the walking trips during the walking behavior observation study, are also tested. The data include various registered activities such as: retail shops (not including vehicle stores), restaurants/bars, leisure and recreational activities (e.g. cinemas, museums, sport facilities), other services (e.g. hairdressing, beauty salons and dry cleaning), in addition to access to services (as day cares, schools) that are represented in Table 3.

	Retail	Restaurants	Leisure & recreation	Other services	Educational	Total
SoFo	109	67	6	75	36	293
Södra Station	28	21	3	22	26	100
Hökarängen	33	14	19	18	16	100

Table 3: number of registered activities in five studied categories

Comparison between the areas shows that within short walking distances (500/3axial lines), SoFo on average has the highest access to various activities (e.g. retail shops 161 and restaurants 118) followed by Södrastation with access to less than one-third of numbers of activities in SoFo (shops 45 and restaurants 35)(Table 4). Hökarängen has the lowest access to various activities at this level (e.g. on average 5 retail shops and 2 restaurants). However, in Hökarängen area there are 100 activities in total belonging to the chosen categories, on average only14% of them are accessible to the address points at local level. Within longer distances (1500m/9 axial lines) SoFo and Södrastation have access to similar number of activities (Mean: shops 650, restaurants 400), while Hökarängen has the lowest access (both shops and restaurants on average 49 stores) (Table 5), although there are more number of activities accessible at longer distances, the numbers are still significantly less than other areas in Hökarängen.

	Within 500m and 3axial steps														
	Retail			**Restaurants**			**Leisure & recreation**			**Other services**			**Educational**		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
SoFo	108	210	**161**	73	141	**118**	5	13	9	82	134	**113**	44	79	63
Södra Station	20	95	**45**	20	75	**35**	1	5	3	21	69	41	18	64	38
Hökarängen	0	20	**5**	0	8	**2**	0	6	1	0	10	4	0	7	2

Table 4: accessible activities and their numbers on address point level within short walking distances

	Within 1500m and 9axial steps														
	Retail			**Restaurants**			**Leisure & recreation**			**Other services**			**Educational**		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
SoFo	580	884	**689**	364	541	**445**	21	38	29	331	461	401	246	349	289
Södra Station	553	750	**658**	349	477	**409**	24	32	29	336	431	388	260	322	293
Hökarängen	5	140	**49**	4	41	**19**	5	28	13	13	61	34	7	32	18

Table 5: accessible activities and their numbers on address point level within longer distances

In all areas, retail shops comprise the major activities (Figure 7), where in Hökarängen there are too few accessible shops which consist of mostly convenience shops, catering for their local neighborhood (this comparison is according to type of the shops regardless of their offered good). On the other hand, in Södrastation and particularly in SoFo there is access to more shops with larger variety. In these areas, as well as convenience shopping (possible to access at shortest time), there is access to shops offering comparative shopping (possible to compare the quality and price) in addition to number of special facilities and exclusive shops.

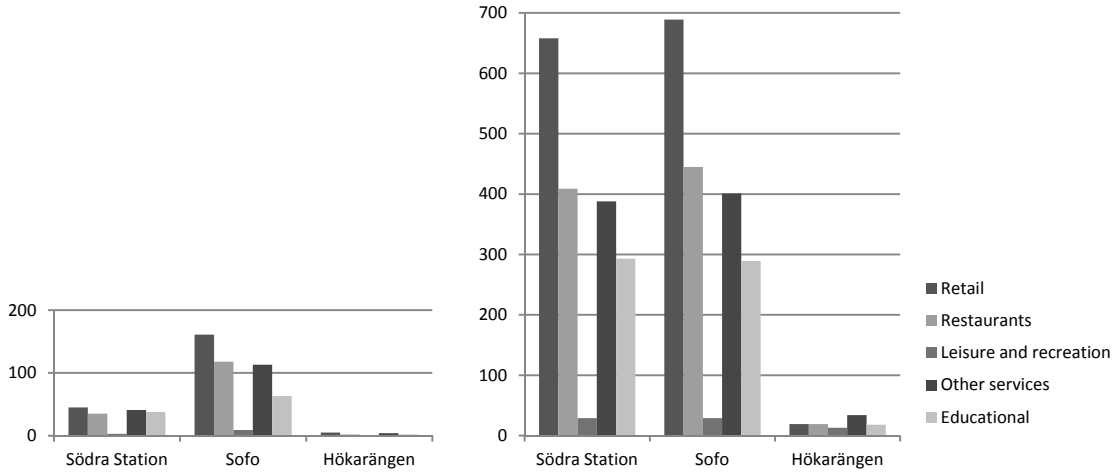

Figure 7: Access to various activities on average at address point level, within 500m/3axial lines (left) and within 1500m/9axial lines (right)

COMPARISON OF THE ANALYSIS WITH THE DESCRIPTION OF WALKING BEHAVIOR

The analysis of the areas described so far will here be compared with certain parts of the results from the observation study on walkability by discussing some descriptions of the walking behavior in the three neighborhoods in relation to the quantitative analysis of the areas. In this qualitative study on walking behavior, on-site observation was conducted by the author responsible for the project on walkability. The field study was conducted approximately during 30 days in the 3 neighborhoods, covering both the weekdays and weekends and different times of the day between 7 AM and 8 PM. During the observation, details of the walking behavior and their patterns were documented, including relative amount of pedestrians, the patterns in pedestrian movement, and details of the walking trip that has been tracked, which include origins and destinations, route choices, facial expressions, attitudes, and other details. Other than the data on the documentation of the pattern of the pedestrian density and movement, the data from the observation through tracking walking trips include approximately 2000 trips in the 3 areas.

Although the observation study on walking did not measure an objective rate of walking and this study does not aim at proving the correlation between the amount of walking and built environment attributes, when comparing the subjectively documented pedestrian density measured during the observation in the three areas, SoFo has the highest, followed by Södrastation, and Hökarängen has the lowest amount. When comparing the comparatively documented frequency of trips made by the residents of the neighborhood, this order remains the same, with SoFo having highest amount. In these comparisons, what seems to

contribute to the large difference between the pedestrian populated streets of SoFo and the often-empty streets of Hökarängen as well as the walking trips of the residents is the amount of non-resident pedestrians. SoFo, comparing to the other two areas, has a high amount of pedestrians coming from outside of the area, whereas in Hökarängen, there is very low or almost none, and in Södrastation, although higher than Hökarängen, there is still significantly less comparing to SoFo.

The relative amount of walking trips and pedestrian density of the areas could be discussed in relation to the results of the analyses on integration and on access to different population and various activities. Hökarängen is far less integrated at the global and district level, while SoFo and Södrastation are well integrated within the rest of the city. Hökarängen also has the least access to different population and various activities in all levels of the analysis and has few accessible shops which mostly consist of convenience shops. On the other hand, while SoFo and Södrastation are both highly integrated at the global and district level and well integrated with their adjacent areas, the reason that SoFo has by far higher amount of pedestrians from outside of the area than Södrastation may be explained, not only by the difference in the degree of integration, but also perhaps more strongly by the analysis on access to various activities. In the results for within short walking distances, which is regarding the condition within the area itself, SoFo has the highest access (e.g. retail shops within 108-210, and restaurants within 73-141), while Södrastation has access to less than half the amount of SoFo (shops within 20-95 and restaurants within 20-75).

The composition of pedestrians or the rate of pedestrians coming from outside of the area affect not only the overall pedestrian density of the areas, but also the patterns of pedestrian amount in the areas over different times of the day and also over the days of the week. In Hökarängen, with only few pedestrians on most parts of the area during most of the hours, there is only a slight increase in pedestrian density twice a day during commuting hours (each in the morning and in the evening time), consisting mostly of trips going to the public transport (the subway station). In the rest of the hours during the daytime, the streets of the area have very few pedestrians. In Södrastation, the pedestrian density is also the highest during the commuting hours, but the density itself and also the degree of increase during the peak hours comparing to the rest of the hours during the daytime is much higher than in Hökarängen. However, although Södrastation has higher pedestrian density than Hökarängen during most of the hours, when comparing to SoFo, it has lower overall pedestrian density, which is due to a low pedestrian density during the daytime (on the weekdays). While SoFo also shows a concentration of pedestrian movement, especially of the residents, in the commuting hours once each in the morning and the evening with the degree similar to that of Södrastation, the area also has a relatively high amount of pedestrians during the daytime which consists of not only the residents, but to a large degree non-residents who visit the shops, cafes, and restaurants in the area.

The difference in the amount of pedestrians coming from outside of the area affects the pattern of pedestrian density by the day of the week as well, between the weekdays and the weekends. In Hökarängen and Södrastation with lower amount of pedestrians who are non-residents, the over-all pedestrian density decreases in the weekends compared to the weekdays due to the absence of commuting trips that make up the highest percentage of the entire walking trips taking place. However, in SoFo, although the commuting trips of the residents are absent in the weekends, the overall pedestrian density seems to be similar or even higher than during the weekdays, which may be related to the increase in the amount of visitors to the shops, cafes, and restaurants from outside the area, which was especially high during the spring and early summer season with pleasant weather conditions (when most part of this observation study was conducted). The pedestrian density in the areas, especially the distribution and patterns of the amount of pedestrians

over different hours and days are related to the walkability of the area since they are closely linked to the feeling of liveliness or security and may enhance the experiential quality of the walking activities by increasing the chance for (both direct and indirect) interaction with other people and activities during walking.

Another result on the description of the walking behaviors in the areas, which may be explained by the quantitative analysis is regarding the difference in a pattern of walking activities between SoFo and Södrastation. In the analysis on access to various activities and their average numbers in each area, there is a difference between SoFo and Södrastation if one compares the results each for within 500m/3axial lines and within 1500m/9axial lines. While the two areas have similar values in the results in the analysis for longer walking distances (1500m/9axial lines), in the analysis for short walking distances (500m/3axial lines), there is a large difference in the result, with Södrastation having access to less than half the amount of SoFo (See Figure 5). This may be related to how the walking trips of the residents in Södrastation were directed to and from outside the neighborhood, in other words, the set boundary of the area, more often than in SoFo. This could also partly explain the lower pedestrian density within the area in Södrastation compared to SoFo.

An important description of the walking behavior in the studied areas that also seems relevant here is the on the distribution of different purposes or types of walking activities. Examining the trips made by the residents of the areas, the variety and the distribution of different walking activities varied among the areas. In Hökarängen, at least 4 out of 5 walking trips of the residents were going to the public transport. Other kinds of walking activities with very low frequency included walking the dog, going to school, and going to the convenience store. In SoFo, which showed the highest degree in the results from the different analysis for diversity, there was far more variety in the purposes of walking activities comparing to Hökarängen. The walking trips here consisted of different activities such as going to the public transport, going to school/day care center, going to different kinds of shopping (from grocery to specialized retail), walking for pleasure, walking the dog, going to the park, going to recreational facilities, going to the cafes/restaurants, etc. The area not only had more variety of activities, but the amount of the different walking activities in making up the total walking trips were more evenly distributed. Finally, Södrastation, both in its variety and distribution of different walking activities showed a degree that lies between that of the other two areas. This discussion on the variety in the purposes of the walking activities in relation to the analysis of the urban form may suggest that the diversity in the built environment may contribute to the diversity in the walking activities as well. As described so far, areas with higher degree of diversity in the built environment - although the analyses done here were only a preliminary, simple beginning step in measuring urban diversity - shows higher degree of diversity in walking behavior through variety in both the composition of pedestrians and the kind of walking activities, which may ultimately contribute to a better walkability of an area.

DISCUSSION AND CONCLUSION

The comparison between the qualitative and the quantitative studies presented in this paper showed how the methods support each other, and the process enabled a better understanding of the walkability as a complex subject. One aspect of this is in understanding how different factors function in close relation to each other in affecting the walkability of an area. Here, it showed how land-use mix as a factor affects walking behavior in close relationship with the co-existing condition of other factors such as density and connectivity. Also, for the studies of the urban form, regarding both the urban diversity and walkability, the investigation of the configuration levels and the related analysis suggested the possibility to study the

individuals' perception of the areas and their access to various activities, since the method helped to explore the studied areas as it is lived and not as it is represented in the maps by distribution and density of the activities. As stated earlier, the aim of this study is not in testing an attribute of the built environment in its validity or influential power as a factor for increasing the amount of walking, but in investigating different ways of quantitatively measuring and analyzing the attributes of the built environment that existing research defines as major factors in walkability by examining their strength and weakness through the comparison with descriptive data on walking behavior.

This comparison of the quantitative analysis of the built environment with the description of the walking activities and their patterns in the study areas showed the potential of the analysis presented in this paper as a tool in measuring factors related to walkability. Some of the analyses especially showed strength in being a more precise measurement and better representation than the ones done in the earlier studies on walkability. For instance, the analyses within various walking distances at cognitive level seems more appropriate than metric distances for studying the proximity of the attraction or destination points. Moreover, analysis regarding the accessible population, which measures the amount of accessible people within walking distances, rather than other conventional density measurements such as population per geographical unit restricted to the studied area, appears to give more insight to the subject by better capturing how population density may influence walking activities. For example, the fact that SoFo and Södrastation have similar population density but different degree of access to total population illustrated the importance of the experienced density in the urban context. Furthermore, the analyses of the integration and accessibility facilitated the investigation of the areas in relation to their surroundings and not limited to their set boundaries.

Although the analyses and discussions presented in this paper have limitations in fully exploring the diversity and the walkability of the urban form, the preliminary testing done here provides insights and important knowledge for the development of each project, as well as addressing the necessity and usefulness of the cooperation between different projects of various methods and perspectives in obtaining a broader perspective on the subjects.

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