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Walkability and the complexity of walking behavior

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Abstract:
The issue of pedestrian-friendly urban environments has been of increasing importance lately in urban planning and design. In order to develop a better knowledge about the walkability of the built environment, it is important to understand the complexity behind walking behavior. Since different kinds of walking activities vary in their goal, effort, frequency, duration, etc., they also vary in how strongly and in what aspect they are influenced by the condition of urban form. With an empirical study in three residential areas in Stockholm, Sweden, this study investigated the different types of walking activities in how they interact with the built environment. The results showed that the condition of the built environment related to the density, connectivity, and land-use diversity seems to influence the amount and diversity of walking activities and also affect how the walking activities are conducted. This is related to the degree of the potential urban form has in providing the different qualities that the pedestrians desire from the environment, which is not only related to providing walking destinations and possible routes, but also qualities that enhance the experiential quality of walking. Investigating the different aspects of walking in how they occur and are conducted in the urban environment is important in understanding why and how different conditions of the urban form discourage or encourage walking. This is not only useful in providing insights for more accurate knowledge on walkability, but also assists a better understanding and application of other urban design theories on pedestrian movement as well.

Keywords: *Walkability, pedestrian behavior, pedestrian movement.*

1. Introduction

The planning and design of the walkable environment is receiving more and more attention for its various benefits related to public health, sustainability, economy, or social life. Therefore, there is a growing need for knowledge about the walkability of the built environment. Urban planning, design, and transportation research have examined walking in the urban environment (Frank and Pivo 1994; Handy 1996; Kockelman 1997; Hillier 1996; Gehl 1987), and there is also a growing field often referred to as “walkability” research which is a multidisciplinary form of research initiated from the preventive medicine field with the health beneficial aspect of walking as the most significant motivation (Saelens et al. 2003a; Leslie et al. 2005; Heath et

al. 2006). Walkability studies have provided evidence that individuals' walking behavior is related to the condition of the urban form through statistical analysis between the amount of time spent on walking and the factors of the built environment.

Earlier findings from transportation and urban planning research and the recent walkability studies have defined some major factors in the walkability of urban form, such as density, connectivity, and land use. Existing studies have found positive associations between physical activity and the presence of mixed land uses (Cervero 1996; Moudon et al. 1997; Saelens et al. 2003a), better connectivity (Boarnet and Crane 2001; Crane and Crepeau 1998; Kitamura et al. 1997), and higher density (Cervero 1996; Frank and Pivo 1994; Messenger and Ewing 1996). Studies that have examined neighborhood characteristics related to walking rates indicate that population density is among the most consistent positive correlates of walking trips (Frank and Pivo 1994). Land use mix – especially the close proximity to shopping, work, and other nonresidential land use to housing – appeared related to greater walking rates among residents (Kockelman 1997).

While 'walkability' studies often measure and analyze walking by the amount of time spent on walking by individuals, there are also urban design research dealing with pedestrian movement with an empirical-quantitative approach that often deal primarily with collective patterns of behavior and their relation to the physical environment. Such approaches tend to focus on flows and degrees of presence, numbers of walkers, and how these affect space or place (Stonor et al. 2002; Ewing and Handy 2009). Typically, these approaches are targeted observational studies which often examine the pedestrian flows in given parts of the built environment. Although much has been learned from such studies about the different factors that influence pedestrian behavior especially in terms of where people walk, it also has limitations. For example, it fails to capture the meanings of the rates or flows of pedestrians, since it seldom captures many of the qualitative aspects of these flows. Also, it has little to say about individual routes or lengths of walks and walking routines. Therefore, while providing important knowledge regarding pedestrian flows, there are inherent problems in these methods when it comes to key questions about walkability research, such as distances, recurrences, and routes of walking trips. Although there are indications and preliminary results that show some of these relationships, it is a question that deserves deeper investigation.

In order to deal with these limitations and develop better knowledge on walkability, it is important to acknowledge and understand the complexity behind walking behavior. Walking behavior will always emerge through interplay between conscious decisions, habits, social and cultural traditions and situations, and the various properties of the built environment. These factors also vary for different walkers or different kinds of walking. For instance, the way in which individuals are affected by and use the built environment may differ according to social factors such as gender, age, and income. Although dividing the individuals according to these standards could support better and more detailed understanding of the relationship between their walking behavior and the built environment, this is more of a challenge for the future, considering the early stage our knowledge is at regarding walkability. While these factors concern the complex classification of individual users or pedestrians, what could be more beneficial and practical at this stage is to consider the classification of walking behavior.
Walking behavior is very complex, as it involves different aspects and types

of activities. Walking can be seen as a physical activity behavior, as a travel behavior, as personal recreation, as a social activity, and so on. The literature from the urban planning and architecture field seldom specifies which aspect of activity or the context of walking it focuses on when discussing walking. Different kinds of walking activities vary in their goal, effort, frequency, duration, etc. Therefore, they also vary in how strongly and in what aspect they are influenced by the condition of urban form and also in the qualities the pedestrian searches for and desires from the built environment. Partitioning walking in investigating their relationship to the built environment may be one of the key issues in dealing with the limitations of the existing studies regarding the difficulty of obtaining reliable and consistent results in statistical analyses (Lee and Moudon 2006; Forsyth et al. 2007; Forsyth et al. 2008). The walkability research has been relatively better at acknowledging and investigating these differences in walking. While simplified and limited both in categorization and refinement, it has provided evidence for the usefulness of subdividing walking activities (e.g. between utilitarian walking trips and walking for leisure). Separating walking types is important because attributes of the built environment influence walking behavior in different ways and to different degrees, since a walker's disposition and attitude vary according to the type of walking. Although it is an important task, there are difficulties in systematically categorizing walking behavior, which also appeared in existing attempts for such categorizations.

This paper reports from an ongoing research project on walkability that investigates the complexity behind the relationship between walking behavior and urban form. One of the main research questions is to explore different walking behaviors regarding their relation to the built environment. Through an empirical study, the difference between walking activities were explored, both in terms of how they differ in their nature, and also in terms of how according to that difference, the way they are influence by and interact with the built environment is different. It was done through detailed observation of walking behaviors combining an anthropological qualitative method. Many studies and theories on walking and the built environment often search for ways to simplify the built environment-walking relationship so that it can be easily measured. This project, however, conversely attempts to subdivide the built environment-walking relationship. Although it may seem to develop in an opposite direction, considering how the current research is pointing to the lack of knowledge about the complexity underlying the built environment-walking relationship and it as a reason for the limitation of existing theories and studies, we may first need a better understanding of the complexity of walkability before we can simplify it. The knowledge that this project tries to produce is not only on whether or not, but more on how and why the built environment influences walking behavior.

2. The empirical study

Three residential areas from Stockholm were selected for the empirical study. Two areas are located in the inner city of Stockholm and one is a suburban neighborhood situated in the southern part of the city (See Figure 1). The two areas in the inner city are situated close to each other in the city center, where one is a traditional urban area and the other is a more recently redeveloped area. The area with the traditional urban blocks will be referred to as the SoFo area. During the 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 area is shown to have a strong connection to the rest of the city in its configuration analysis, which characterizes the area as a part of the inner city of Stockholm, rather than as a localized sub-area (Marcus 2000). The other selected area in the inner city which will be referred to as the South Station area (*Södrastation* in Swedish) in this paper, is a redeveloped area planned in the 1980s, where over 3000 flats were newly built after the renovation of the southern railway station of Stockholm. This area is a highly fragmented area, somewhat segregated from the rest of the island it is located in. This seems to segregate many of its spaces, often directing them towards highly localized usages and characterizing the area as of a rather domestic character (Marcus 2000). Hökarängen, the third area, is a suburban neighborhood planned in the 1940s. In large parts of Hökarängen, the residential buildings mostly have three to four stories, and are positioned being widely spaced with green spaces and yards. While the population numbers are similar in the three selected areas, the population density in Hökarängen is significantly lower than the areas of the inner city.

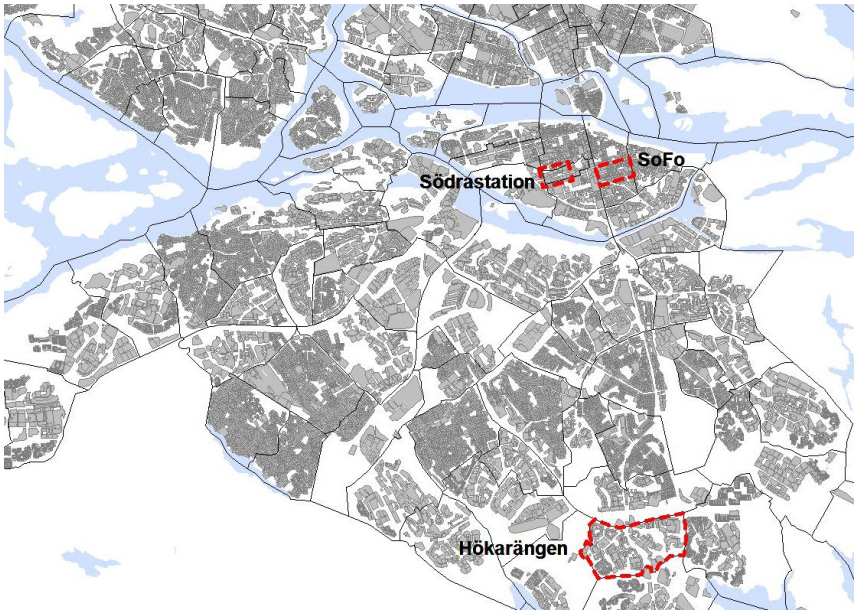

Figure 1. *Map of the three studied neighborhoods in Stockholm.*

As an explorative study, the field study investigated the walkability of the areas by observing pedestrian density of the street segments and its patterns, and more importantly, individual walking trips. By tracking pedestrians on site, the details of the pedestrian's behavior during the walking activity, and the presence of different types of walking activities occuring in the areas were documented. The study aimed at investigating the study areas in how they function as the setting for walking activities by observing who walks where and when, what kind of walking activities occur, what patterns could be found in them over different times and days, what happens during the walking activities, and how the condition of the built environment seems to have influenced them. By obtaining hard data on real behaviors of walking in different situations, it tried to provide a detailed, qualitative description of the walking behaviors and their pattern in each area and to gain insight into the complexity of walking activities and their relationship to the built environment.

The site observation was conducted by the author alone. It included both weekdays and weekends, and covered the hours between 7AM and 8PM. The main part of the field study was the tracking of walking trips on site, which was rather unusual for a study of walkability. Since this project aimed to develop a better understanding of walking behavior, and especially to classify walking

activities, an important part of the field study was in the detailed observation of individual walking trips. In terms of pedestrians' age group/gender and the location of walking trip, the choice of the individual trips to be tracked and observed was made randomly, but with concern for allowing variety. During the entire observation, approximately 2000 walking trips (including partial trips) were tracked and observed in the three areas. The on-site tracking of walking trips recorded not only the data on the origin/destination points and the route taken, but also details of the walking trip being tracked, including specific and detailed route choices at street-level, speed, facial expressions, attitudes, interaction with other pedestrians and activities, etc.

Such details obtained during the tracking allowed assumption and analysis of the purpose of walking and possible reasons for the route choice including the influence of the condition of urban form. The site observation allowed documentation of how, when, where, by whom, and why walking activities are carried out. Such an investigation not only supports better understanding of walking behavior as a whole, but also allows the comparison of different kinds of walking activities. Since current research does not yet provide systematical knowledge about how the categorization of walking activities can best be done, in this observation study, the walking trips observed were first documented with their specific purposes, e.g. walking to the public transit, walking to school, walking the dog, walking to a specific kind of retail outlet, etc. Although a direct inquiry or interview was not conducted, the observation alone often produced rich material for determining or assuming the purpose or type of walking, e.g. through the destination, the time, the attitude and speed, the dog accompanied, the grocery bag being carried, etc. How the walking purposes differed in their route choices according to the purpose of the trip, for example, was one of the important parts of the data from the observation study.

3. Spatial analysis of the areas

The three study areas were selected to compare how walking behavior differs in different contexts in terms of the built environment factors (See Figure 2 for population and density of the areas). While detailed observation of the physical environment was conducted on site as well, spatial analysis through GIS shows the condition of the urban form factors in each area on different scales.

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

Figure 2. *Residents, working population, total population and population density values (person per hectare) for each neighborhood (Choi and Sardari Sayyar 2012).*

The GIS analysis presented here is by Sara Sardari Sayyar at the School of Architecture, Royal Institute of Technology in Stockholm, from the co-authored paper, Urban Diversity and Pedestrian Behavior - Refining the concept of land-use mix for walkability, presented at the 8th International Space Syntax Symposium (Choi and Sardari Sayyar 2012). The axial map used for the configuration analysis is comprised of 66,000 lines covering Stockholm and some other municipalities in the vicinity. Data used for the

accessibility analysis includes census data for all of the residential and working population from early 2000. Data regarding various activities includes all registered economical activities from 2006, sorted according to their branch codes (SNI code).

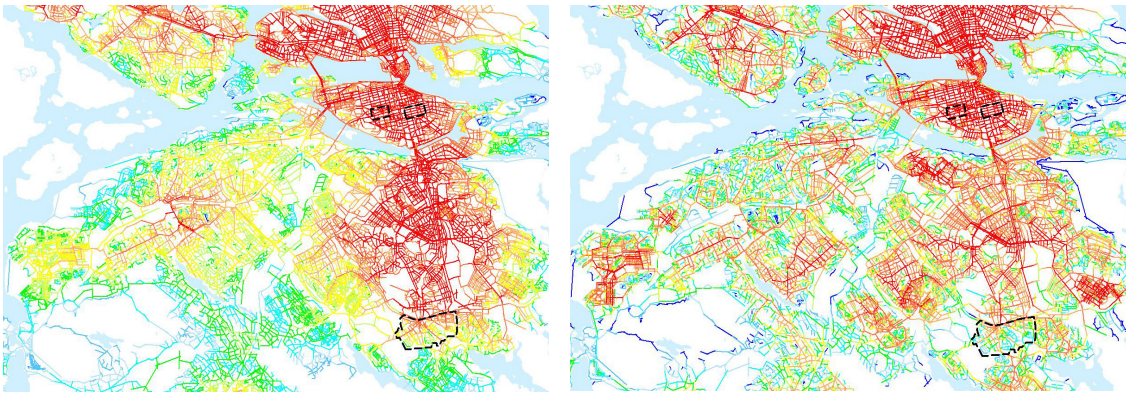

Figure 3. *Spatial integration analysis: global level (radius 30) (left), and district level (radius 9) (right) (Choi and Sardari Sayyar 2012).*

Integration analyses (Hillier 1996) at global level (radius 30) and district level (radius 9) show that SoFo and the South Station area are highly integrated with the whole city on an urban scale, as well as being highly connected at district level with their surroundings, whereas Hökarängen has the lowest integration at both levels (Figure 3). At local level (radius 3), the South Station area appears to be less integrated than SoFo in some parts of the area, while Hökarängen on the other hand has a fragmented structure with few integrated routes (Figure 4).

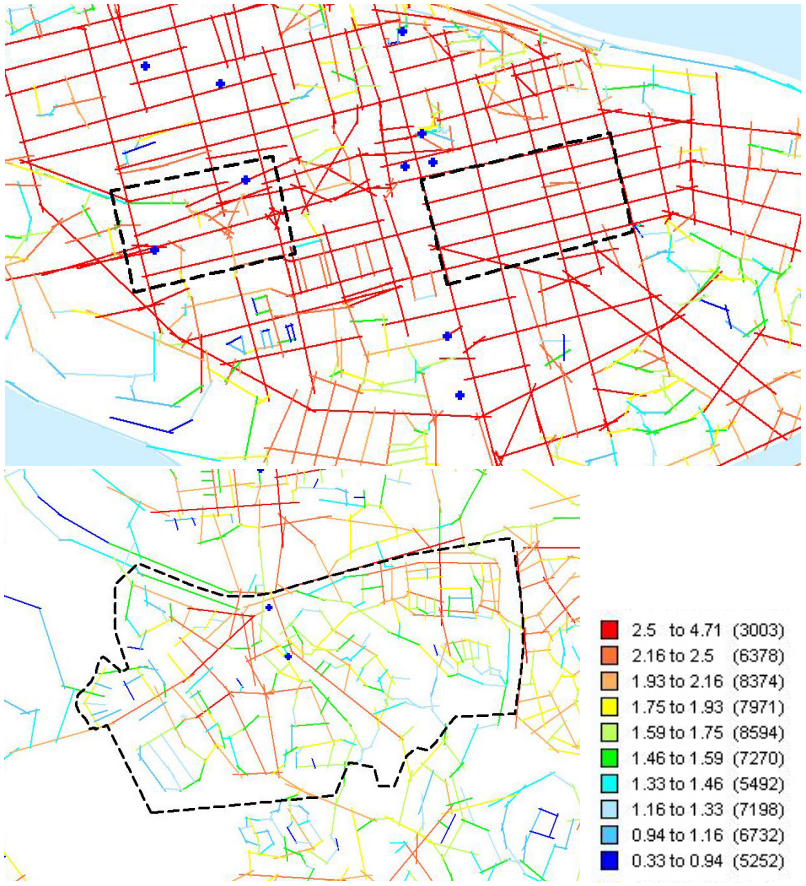

Figure 4. *Local integration analysis (radius 3) with most integrated lines highlighted (Choi and Sardari Sayyar 2012).*

SoFo has the highest access to various activities and population (Ståhle et al. 2005), followed by the South Station area. The suburban area of Hökarängen has significantly lower degree of access to different land use and population compared to the other

two areas. (See Figure 5 and Figure 6). The spatial analysis shows that in terms of connectivity, density, and land-use diversity, the areas have different conditions, both between the areas in the inner city and suburb, and also between the two areas in the inner city.

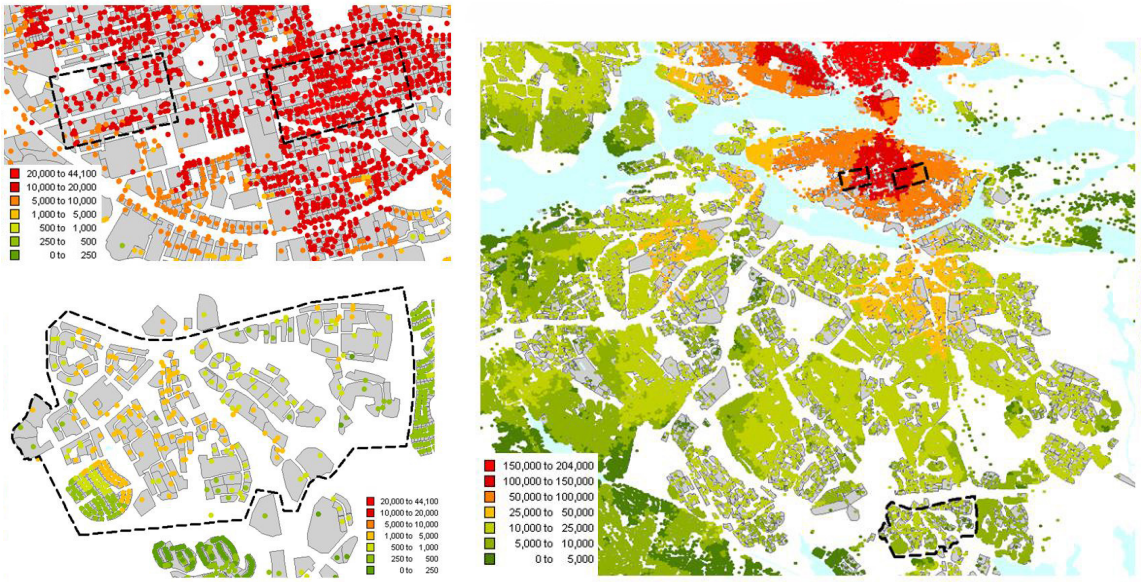

Figure 5. *Access to total population at home address point level, within 500 m and 3 axial lines (shorter walking distance) (left), and within 1500 m and 9 axial lines (longer walking distance) (right) (Choi and Sardari Sayyar 2012).*

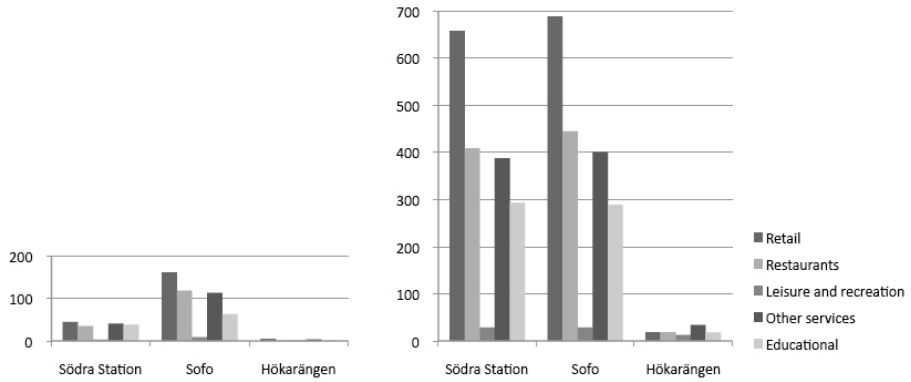

Figure 6. *Access to various activities at address point level on average, within 500 m/3 axial lines (left) and within 1500 m/9 axial lines (right) (Choi and Sardari Sayyar 2012).*

4. Results from the observation study

In terms of pedestrian density, this study confirms existing findings with the result that area with higher density, connectivity and land-use diversity has higher amount of pedestrian density. However, as mentioned earlier, an important issue this empirical study focused on is the investigation of detailed walking behavior profile of the areas. Therefore, this paper will mostly present qualitative analysis of the data which derived from detailed observation of

individual trips *(and the qualitative analysis will be the basis for the statistical analysis to be conducted in the continuing stage of this research project)*. Since the individual walking trips were initially documented with their specific purposes, a description regarding walking purposes in the study areas is discussed. Also, from the qualitative data and analysis, a categorization of different walking behaviors is suggested and described.

4.1 Distribution of walking types in the three areas

The observation showed that the variety and the distribution of walking activities varied among the areas. In Hökarängen, the suburban neighborhood, approximately more than 80% of all the walking trips observed were walking to the public transport (subway station). Other kinds of walking activities with much fewer observations included walking the dog, going to school, going to the convenience store, or walking for exercise or pleasure. In SoFo, area with highest connectivity and diversity, there was far more variety in the purposes of walking activities compared to the other areas. The walking trips there consisted of different activities, such as walking to the public transport, walking to school/day care center, walking to different kinds of shopping (from grocery to specialized retail), walking for pleasure, walking the dog, walking to the park, walking to recreational facilities, walking to the cafés/restaurants, etc. More importantly, the area not only had more variety in walking purposes, but the proportions among the different walking activities were more evenly distributed. The South Station area, both in its variety and distribution of different walking activities, showed a degree of result falling in between the other two areas.

4.2 Different walking activities and their route choices

An important part from the observation data was the different purposes or aspects of walking trips and their patterns. The analysis of the different walking investigated their characteristics such as route choice standards, frequency, location, etc. Such analysis allows discussion on the difference between various purposes of walking in how they interact with the built environment. According to these details, some classification of the walking behavior has been applied in order to show the differences among walking activities.

4.2.1 Utilitarian walking

In this study, walking trips that involve daily activities, such as going to work, school, grocery shopping, and other 'necessary' purposes, including going to the public transit in order to take a trip for these purposes, were grouped as 'utilitarian' walking trips. Although there are many specific purposes within this kind of walking trip, they are discussed together because of the similarity in the behavior, such as the attitude of the pedestrian and the qualities that influences the route choices. The most important factor in the route choice these walking trips have in common is the issue of walking the *shortest distance*. Since the origin and the destination of these utilitarian trips are more often fixed points compared to other types of walking (such as walking for pleasure or walking the dog), in most observed cases they took one of the shortest, or the only shortest route available. "Efficiency in movement" seemed to be the strongest factor or quality sought by the pedestrian for utilitarian walking trips, and it was a common factor for all three areas. However, there were also some other factors involved in how pedestrians interact with the built environment during utilitarian walking trips, where there was a significant difference among the areas.

Contrary to the other areas, in SoFo, pedestrians were usually given alternative route choices due to the grid street network. Therefore, although the route choices of the utilitarian trips were mostly based on selecting the shortest route distance with the least number of turns, there were cases where different routes with similar conditions in this sense were provided. In the tracking of these cases, the results showed that there are streets or sectors that the residents seem to prefer in including in their routes. These were the sectors which had relatively higher number of pedestrians, and which were often the sectors with higher level of non-residential use at ground level. The close observations through tracking suggest that these sectors seem to offer the pedestrian greater opportunities for interaction with other people and the activities inside and outside the buildings, enhancing the experiential quality of the walking activity. Since the other two areas had much lower degree of land-use diversity, similar strong tendency of such behavior was not observed from them.

4.2.2 Walking for pleasure – Social walking

Walking for pleasure was an activity that showed an observably different behavior from the more necessary walking activities. Excluding walking for exercise, these walking trips were generally conducted with much less purposeful attitude and slower speed. These trips are with more flexibility between moving and sojourning. The route choices also showed to be distinctly different from the route choices for utilitarian trips. The destinations of these walks were less fixed and the movement between different locations was also not always directed by the shortest distance route, as in the case of utilitarian trips.

SoFo had the highest amount of pleasure walking observed out of the three areas. It was also the area where the ratio of walking for pleasure to the entire number of walking trips was the highest. The observation of these trips showed that they were mostly directed towards and through the sectors with higher amounts of pedestrians and activities. During the weekdays and the hours with relatively fewer pedestrians in the area, the strolls of the residents were directed more towards specific sectors with retail stores or the public square. In the weekends, with significantly higher pedestrian density, the residents took their strolls in the streets with higher number of other pedestrians. During the walk, the pedestrians often observed other walking pedestrians as well as people sitting or staying in and outside the buildings in stores, cafes, and restaurants. Most of them also looked at the displays of the shops, often stopping from time to time as well. Since there seemed to be a strong preference for these specific sectors during these walking activities, the routes were often circular in shape, or moving back and forth on the same street. South Station area had similar observations where pedestrians on pleasure walking were directed towards the nearby public square with high pedestrian density and filled with non-residential use.

Since these types of walking were strongly attracted to locations with strong presence of other people and activities, they can be referred to as a “social walking” behavior. Compared to more “utilitarian” types of walking, these walking activities are different in the sense that they more naturally involve walking, which means that they can almost only be done by walking and seldom compete with other modes of transport. Also, they often do not involve a fixed destination point, but take place according to the condition of the built environment. The reason for or the desire to generate these walking activities,

and also the factors influencing their route choice seem to include qualities related to liveliness and sociability. This is related to how the built environment effectively provides the pedestrian with other people, objects, and activities to see, hear, and interact with. From the observation study results, walking for "social" pleasure seemed to be the type most sensitively influenced in terms of its quality by the built environment.

4.2.3 Recreational walking

Another type of stroll or pleasure walking that had a significantly different character from the "social walking" also existed. For example, walking the dog, especially when excluding walking "with" a dog for other (utilitarian) purposes, was an activity that also showed a different pattern from other walking activities. These trips involved frequent stopping and staying during the walking activity and was often conducted in a slow speed. In terms of route choices, these walking trips were mostly attracted to the street with more green space. Also in many cases, they seemed to avoid streets with higher pedestrian density, which is an opposite behavior from the social walking behavior.

5. Discussion and conclusion

In most urban planning and design research that examine walking in the urban environment, walking behavior has been dealt as a rather simplified concept, often put under a single label, "walking" or "pedestrian movement". It has been seldom acknowledged that walking activities vary in terms of their effort, goal, efficiency, frequency, continuity, intensity, duration, etc. Some of the recent walkability studies have pointed to the importance of acknowledging these differences in order to obtain more accurate knowledge on how the built environment may encourage walking (Rodriguez et al. 2006; Saelens et al. 2003a; Lee and Moudon 2006). Still, there is not yet any systematic knowledge about how to best categorize walking activities. It seems that partitioning walking trips by the specific purposes could be helpful to some extent in classifying walking based on standards such as goal, frequency, etc. (as was tried in this study as well). However, we should also be aware that although some walking activities might belong to the same category if subdivided by the purpose (e.g. going to the grocery store, walking the dog, etc.), they may significantly differ in the degree of the standards, e.g. effort, intensity. Also, one weakness in such classification is that people often combine different purposes simultaneously.

An important result from this study is on the different characteristics of walking, which is related to how the pedestrian conducts walking, e.g. as reflected in the route choice and attitude during walking. What would determine the nature of a walking activity is not only its purpose or destination, but also the desire of the walker, (which is, again, related to its effort, goal, intensity, etc.). According to this desire, the qualities from the walking environment prioritized by the pedestrians differ, and this would affect which factors most strongly influence the walking activity. It means that a given built environment factor could have a different degree of influence or even a different kind or mechanism of influence according to which walking behavior it is. Although the documentation of the walking trips in this study was by their specific purposes, what the project tried to investigate is this difference on how the various walking activities differently interact with the built environment. The aim is not just a division of walking activities by their type in a simplified categorization, which lacks precision and deeper understanding of the complexity of walking.

The difference in the nature of walking activities affects how different conditions of the built environment among the areas influence the frequency, diversity and route choices of the walking activities taking place there. The observation study explored how the amount and variety of walking activities are different among studied areas. Higher walkable neighborhood (in terms of density, connectivity, and land-use diversity) not only has higher amount of walking but also more diverse types of walking activities. Another important result is that for the walking activities of the same purpose, there was difference in how they were conducted according to their environmental context. That is, if we consider the experiential quality of the walking activities afforded by the built environment, the actual character of walking seemed to be shaped very differently among the areas although they may be for the same purpose of walking. For example, as illustrated in Figure 7, walking to the grocery store in Hökarängen and walking to the grocery store in SoFo may be significantly different. The difference is in that the latter has more possibilities to have the liveliness and social interaction that people desire for in its route environment, especially for a pleasure walking. It can be described as that the pedestrian in SoFo has more possibility to easily incorporate social walking when conducting a utilitarian walking trip.

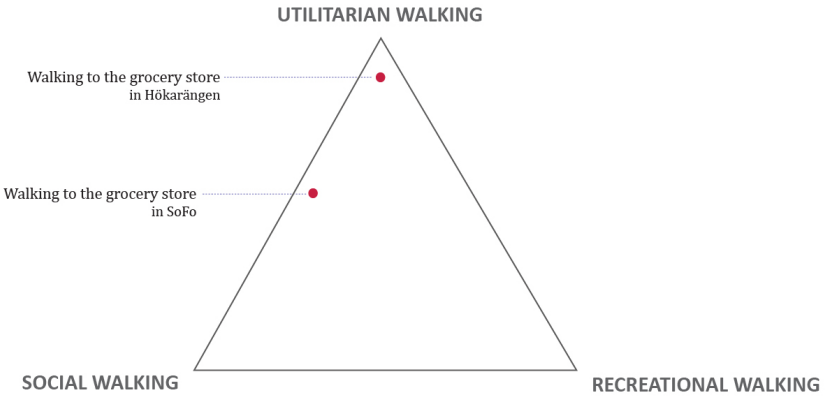

Figure 7. *Different walking behavior.*

What has been discussed so far indicates that urban form influences how much and which kinds of walking may occur in the given environment. It also describes the influence on how the walking activities are conducted which is determined by the potential of providing different qualities that pedestrians desire from the environment during walking. What qualities the pedestrian would prioritize in walking activities is affected initially by the purpose of walking, but it is also determined by the context it takes place in. This means that the condition of urban form regarding what qualities in can provide (and to how much degree), would affect the pedestrian in what kinds of walking they can conduct. Knowing this is important in understanding why different condition of the urban form may discourage or encourage walking. For example, an area with higher connectivity, land-use diversity and density generates higher amount of utilitarian walking by providing more destinations and convenient routes to them. Then, the generation of a considerable amount of walking trips (or pedestrian density and a pattern in them) would function as a generator of walking activity itself. This would be in generating activities of walking for “social” pleasure in particular. Thus, the pattern of pedestrian density would be reinforced. Walking pattern itself becomes a generator of walking.

Investigating the complexity behind walking behavior and its relation to the built environment not only assists developing better knowledge for walkability research, but is also useful in the understanding and application of different theories on walking or pedestrian movement, such as the space syntax research (Hillier 1996). Concepts such as 'to' and 'through' movement (Hillier et al. 1993; Peponis et al. 1997; Penn et al. 1998) capture some very important characteristics of how pedestrian movement occurs. Yet, they may be limited in fully describing how walking in the urban environment are conducted, and would not be capable of providing enough explanation in answering certain types of questions regarding walkability. By understanding the mechanism behind different walking behavior (especially in their relation to urban form), we can more effectively understand how and why the principle such as 'natural movement theory' may more strongly or less evidently explain a given urban environment. It would also better suggest how these ideas may be applied in the design of urban form for better walkability.

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