Walking Behavior and Neighborhood Environment:
A Case Study in Tokyo Metropolitan Area

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Abstract

Walking is an activity that most people engage in and it is the simplest way for majority of people to go about their daily life. Walking behavior is important in both the aspects of personal health and urban mobility. Generally, walking behavior can broadly be categorized into three types: occupational, recreational and utilitarian walking. Among all the three categories, recreational and utilitarian walking are frequently compared with neighborhood environment. The affecting factors of neighborhood environment on these two categories are also different since recreational walking is more impulsive while utilitarian walking is more compulsive.

Walking time is usually used as the value to quantify the degree of walking behavior. In this study, the People Flow Data of Tokyo in 2008 was used for acquiring walking time of residents in Tokyo Metropolitan Area (TMA) and the total number of samples in this dataset reached 576,806. The People Flow Data is a data set processed by Center for Spatial Information Science (CSIS), the University of Tokyo based on the Person Trip Survey Data created by the Ministry of Land, Infrastructure, Transport and Tourism of Japan for monitoring dynamic changes in daily people flow, which provides the individual locations in every minute within 24 hours. A total number of 13 attributes were included in each record for individuals.

In recent years, with the development of GIS (Geographical Information Systems) as well as the growing amount of available spatial data, studies on neighborhood environment with objective data analyzed by GIS software is becoming popular. GIS provides spatial measures of particular environmental attributes in local areas. The

adoption of GIS makes it possible to measure indices of walkability at the local level in cities or regional areas with readily available data for the purposes of evaluating new environmental and policy initiatives to encourage walking.

The purpose of this study is to detect the characteristics of people's walking behavior with the questionnaire-based People Flow Data of Tokyo Metropolitan Area and evaluate the neighborhood environment of these people to find potential relationships between people's walking behavior and the physical attributes of their neighborhood environment.

The spatial patterns of residents' average total walking time (TWT), utilitarian walking time (UWT) and recreational walking time (RWT) were revealed from the People Flow Data. In general, the spatial patterns of these three categories all showed consistency with the urban structure of TMA. Residents living in the 23 special wards of Tokyo as well as the Yokohama city had higher TWT, UWT and RWT. The railway lines showed a potential contribution to the amount of UWT but no contribution to the amount of RWT. People living in rural areas had the lowest walking time regardless of the walking types. This result revealed that people in rural areas of TMA relied much more on vehicles than people in urban and suburban areas of TMA.

When focusing on the effects of personal attributes, men had more walking time than women regardless of the walking purpose. However, the difference didn't have any spatial patterns when allocating the walking time into the map. Age difference was more obvious when separating all the people into groups of adolescence, labor force and retirees. The results showed that labor force had higher UWT and retirees had higher RWT. It was reasonable since labor force spent more time on the way of going to and going back from working places which were included in utilitarian walking while retirees had the most sparing time for their recreational activity which included recreational walking. The difference in occupation could also result in the difference of walking behavior. Similar to the findings from comparing different age groups, white-collar workers and high school students had the highest UWT as they took a lot of utilitarian walking during their way to and back from working places or schools. On the other hand, No-occupation people and housewives had the highest RWT as they had the longest sparing time during weekdays.

The results of evaluating utilitarian and recreational walkability had a consistency with the result of residents' utilitarian walking time and recreational walking time derived from the People Flow Data. This consistency proved that residential density, street connectivity, land use diversity, bus stop density, railway station accessibility are necessary factors for evaluating utilitarian walkability and street connectivity, greenness density, and parks density are necessary for evaluating recreational walkability in TMA.

Besides the findings of the associations, this study also released the maps of eight neighborhood attributes related to walking behavior, utilitarian walkability, recreational walkability, average walking time in TMA. These maps showed the spatial patterns similar to the urban structure. Previous studies mostly concentrated on a micro scale, but the findings here showed a possibility of comparing the neighborhood environment from the perspective of the whole urban structure.

The originalities of this study mainly came from the separation of walking behavior based on the purpose and the method to handle People Flow Data and the neighborhood environment-related data. Considering the big amount of the People Flow Data, the findings in this study could be more trustful. In addition, the widely-separated spatial location of the samples provided the possibility to link the walking and walkability patterns with the urban structure, which was a very rare approach that could not be found in previous studies in this field. The other originality is the buffer analysis based on individuals. Unlike the common approach which evaluates the neighborhood environment first and then assigns the value to the points fallen into each area, this study created a 1 km buffer from individuals' residence and define this buffer as the neighborhood context. With this approach, the scale of each person's neighborhood could be more accurate and it increased the possibility to find trustful relationships between neighborhood environment and walking behavior.

Another point need to be concluded is the comparative study between two different types of walking behavior. Unlike most of the studies in this field, the author employed two sets of criteria for evaluating effects of neighborhood environment on utilitarian walking and recreational walking respectively. When detecting the effect of personal attributes, the analysis was also separated into the two categories of walking. The results in this study proved the value of studying effects of personal attributes as well as neighborhood environments separately based on the type of the walking behavior. This comparative study approach was strongly recommended by the author to be applied into other related studies.

Keywords: Neighborhood Environment; Personal Attributes; Recreational Walking; Tokyo Metropolitan Area; Utilitarian Walking; Walkability.

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List of Abbreviations

BSD	Bus stops density
CSIS	Center for Spatial Information Science
CHS	Community Health Survey
GD	Greenness density
GIS	Geographical Information System
LUD	Land use diversity
NDVI	Normalized Difference Vegetation Index
NEWS	Neighborhood Environment Walkability Survey
PD	Parks Density
PEDS	Pedestrian Environment Data Scan
RD	Residential density
RSA	Railway stations accessibility
RWT	Recreational Walking Time
SC	Street Connectivity
SSA	Sightseeing Spots Accessibility
SPSS	Statistical Package for the Social Sciences
TMA	Tokyo Metropolitan Area
TMG	Tokyo Metropolitan Government
TWT	Total Walking Time
UWT	Utilitarian Walking Time