Analyzing the Impact of the Built Environment on Pedestrian Volumes in Shanghai, China

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Abstract

As the world becomes more and more urban, it is now more than ever critical to consider the ways in which the built environment of a megacity impacts the movement and activities of its residents. This paper provides an analysis on the built environment and its impact on volume of pedestrians. With data collected from eight neighborhoods in Shanghai, walkability scores were produced with the State of Place Index. Findings show that the volume of pedestrians is strongly associated with the components of the built environment, despite the State of Place Index being unable to predict the volume of pedestrians. Conclusions make recommendations based on different findings for the inner city and suburban neighborhoods.

Introduction

With the unprecedented magnitude of growth that has come to characterize modern-day Shanghai, urbanists are taking a distinct interest in how the city is ebbing and flowing, especially with regard to the way people are moving within the built environment (Jiefang, 2017). Mobility within an urban megacity is growing even more necessary as mobility is indisputably tied to larger conversations of sustainability and equity. Previous research on the built environment in Shanghai has primarily taken a health impact focus as air quality is one of China's most popular issues (Alfonzo, 2014). However, characteristics of the built environment and their influence on mobility, and even more specifically walkability, is a research topic that produces results that can be used to make significant improvement to streetscapes with regard to mobility, sustainability, equity, and health. Walkability is about how compatible an area is to pedestrian activities. Studies on the walkability of urban neighborhoods are significant in the fact that they analyze the neighborhood with the perspective of planning for the people, whether they be commuting, engaging in physical activity, or simply going from one place to another for pleasure.

Shanghai hosts a diverse range of neighborhoods and their primary usage that will allow us to construct a study that considers the many characteristics (and relative scale of said characteristics) of a built environment to establish a strong platform to consider walkability against (Xu + Tao, 2017). Thus, our research question asks: Within the built environment of Shanghai, do the characteristics of the streetscape influence the volume of pedestrians?

The purpose of this study is to examine the relationship between the built environment and walkability. This study recognizes the importance of a city maintaining a transportation network that recognizes walking as a legitimate mode of transportation that must be respected and cultivated in city developments as the benefits from such modes of transportation include but are not limited to mental and physical health, communications, local economic, equity, and sustainability, and finally, the impact of the built environment on human activity. Health benefits of walking include reducing the chance of adults developing diabetes by 58%, reducing risks of death from breast and uterine cancer by 19%, and reducing coronary events in women by 35% (New England Journal of Medicine; Harvard University Women's Health Study; Nurse' Health Study). The MA Department of Health found that the state could save upwards of $121 million dollars in heart disease expenditures annually if one in ten adults joined a walking program (Massachusetts Department of Health; 2013).

The promotion of walking can be used to holistically evaluate a city's transportation network. High rates of pedestrians are economically beneficial as they produce more foot traffic for local vendors and stores (Jacobs, 1961). To put it simply, a high rate of pedestrians (in a developed and megacity like Shanghai) is an indicator of a healthy and engaging city. When a built environment is not developed with walkability in mind, pedestrians become endangered.

Literature Review

Impact of the Built Environment on Pedestrians

When considering the built environment of a city, we must look beyond the infrastructure, as the "urban fabric is not limited to the buildings that constitute the physical framework of a city" (Liu, 2014, p. 120). A streetscape is the manifestation of a city's urban fabric into a physical form. In a city built around automobile infrastructure, placemaking with streetscapes can increase walking (Project for Public Spaces, 2016). Conceptually, the built environment is a system of services. In other words, when walking down the Jay Street in Downtown Brooklyn, NY one would expect there to be safe sidewalks, street signs, etc. This is a perceived level of service from the built environment characteristics that contribute to the walking experience, such as, “comfort, convenience, safety, security, and attractiveness” (Khisty, 1994, p. 45).

If the goal is to increase the number of pedestrians on the street, then the city’s need to make the built environment reflect that. For instance, in a case study of Shanghai’s central city, residents listed the following five characteristics as important if not necessary to walking: “having a convenient pedestrian street network, containing mixed-use development along the street, hosting good street landscaping, allowing fewer motor vehicles on the street, and having a clean sidewalk” (Chen, 2017, p. 2295). These characteristics are part of the design of a streetscape. The design of the built environment is one of the most impactful features upon rates of walking (Alfonzo, 2014; Hankey 2012; Forsyth, 2010).

The scale of the built environment can also have profound impacts on the experience of pedestrians (Boarnet, 1998; Crane, 2000). With regard to scale, distance to amenities largely influences the amount of pedestrians. Specifically, having a close proximity to a body of water would result in a dramatic increase in the pedestrian traffic (Hankey, 2012).

Historical Trends in Mobility within Urban Shanghai

Beginning in the 1980s, Shanghai experienced spatial re-zoning and housing reforms that helped usher in the massive development years from the 1990’s to now (Zhang, 2012). The rezoning and development projects caused significant changes in the streetscape and the way people move themselves within the urban fabric. Shanghai along with its residents adapt, rather than react. Shanghai’s transport model share holds walking at the highest percentage of 28.9% with cycling coming in close behind at 27.8%, public transportation at 23.2% and motorized vehicles at 20.1% (Zhang, 2014).

The continuous transformations and transitions within the built environment have largely changed people's modes of mobility within the city. The fast-paced changes and rapid urbanism have created citizens to that desire to claim their own space and network in neighborhoods of Shanghai (Schilbach, 2014; Zhang, 2014). For the citizens of Shanghai, mobility is of the utmost importance as "urban planners have moved affordable residential housing systematically out of the city center" (Schilbach, 2014, p. 251). This makes commuting in Shanghai quite the experience with the average commute time for Shanghai is 42 minutes (Zhang, 2014). With the massive expansion of the public transit system to 13 subway lines, intercity buses, and a BRT system, private automobile transportation is usually not that fastest way to get around the city. Instead, Shanghainese residents have embraced the extensive transportation system and usually mix one to three forms of transportation for each commute to fulfill their mobility needs, and always including walking to some degree (Zaki + Sayed, 2016). It is essential to understand the historic and modern options of transportation to comprehend the correlation between the built environment and modern-day pedestrian rates as transportation trends tend to linger even as the dynamic of the city shifts. The streetscape of Shanghai can showcase this as a decipherable urban landscape bustling with people participating in and utilizing different means of commuting around the city.

Methods

Research Design

This survey research design looks for correlations between the built environment and walking. We chose to use quantitative methods to find the correlation because it gives the most objective evidence. By counting pedestrians, we are able to judge neighborhoods' pedestrian usage and volumes. For assessing the built environment, our research design utilizes the Irvine Minnesota Inventory-China (IMI-C).

<u>Location</u>

We collected built environment and pedestrian data at eight sites within Shanghai. Each site was selected from a different neighborhood to provide a variety of built environment characteristics and levels of pedestrians. Each site has four to seven segments (streets) that were observed for IMI-C data collection. Pedestrian counts were collected at three intersections within the site. Below is a map of the eight sites in Shanghai. Refer to Figure 1 for a visual of the neighborhoods.

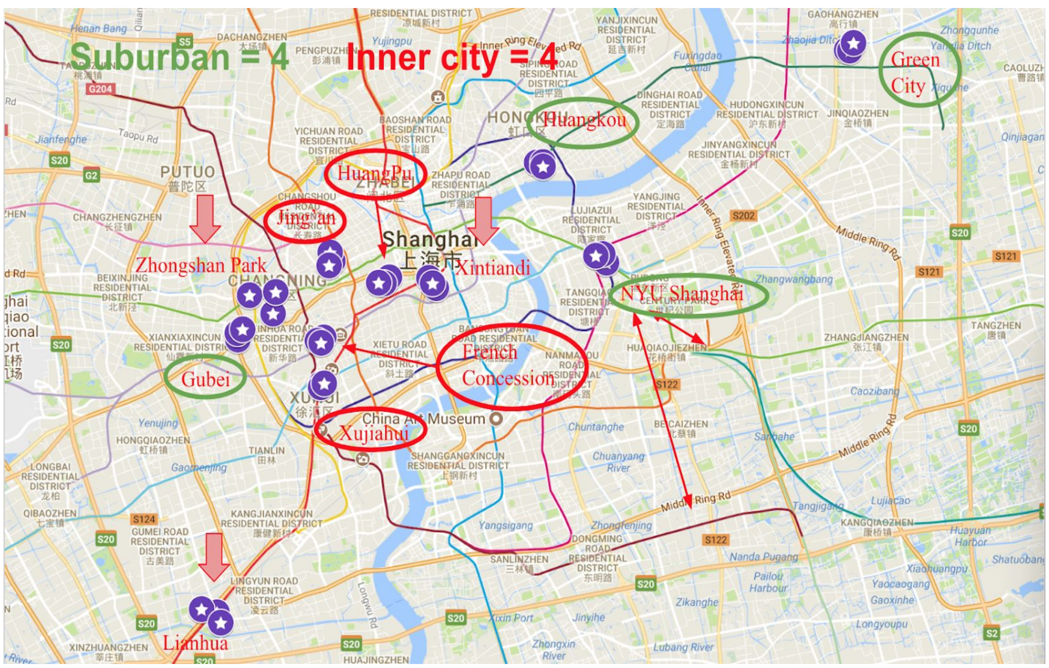

Figure 1

Below is an example of the segments (purple lines) and intersections (purple circle with a white star) that data was collected for each neighborhood. Refer to Figure 2 for a visual reference for the specific neighborhood of NYU Shanghai.

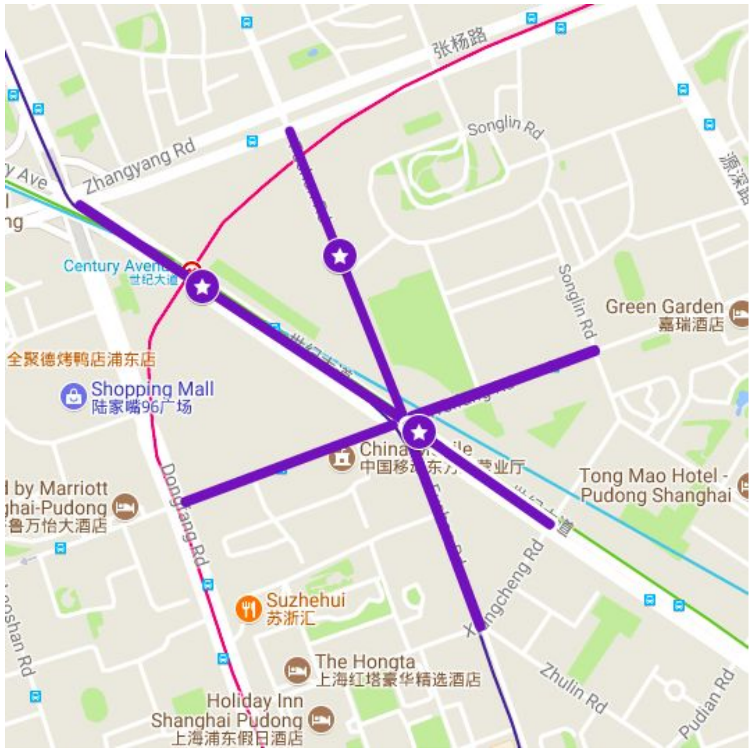

Figure 2

Sampling Procedure

The sample for pedestrians were randomly selected regardless of the gender types or any outward characteristics of pedestrians. A sample of blocks was selected within each chosen neighborhood based on the location. The neighborhoods were Xujiahui, HuangPu, Jing’an, Huangpu, French Concession, NYU Shanghai, Green City, and Gubei. Among those neighborhoods, Xujiahui, HuangPu, Jing’an, French Concession and Hongkou are considered as inner city neighborhoods whereas Gubei, Hongkou, Green City, and NYU Shanghai are considered as suburban neighborhoods. The types of neighborhoods (inner or suburban) were determined by the density of buildings in each neighborhood and will later be used to compare the significance of different built environment components.

Data Collection Procedures

The purpose of IMI-C[1] data collection is to evaluate different segments (blocks) by observing the micro-scale characteristics of them such as building facades, building height, number of street trees, condition of the curb cuts, etc. The characteristics were later analyzed by the State of Place Index to develop a walkability score. The team of eight researchers are assigned to complete the basic information of a specific block such as the crossroad name, block number, assessment time and pinpoint the real time location on the map. During the observations, researchers walked on the assigned street and recorded all 286 individual built environment items (Alfonzo, 2014). The assessments were completed with an app called Fulcrum which exported the data in its entirety to Excel for analysis.

For the pedestrian counts, researchers were assigned to specific neighborhoods then each researcher counted the number of pedestrians at three different intersections within the assigned neighborhood. Observed pedestrians were recorded as either passive or active, and if active, whether they were walking on the crosswalk or off the crosswalk. Each intersection was observed for 30 minutes in two minute intervals. Therefore, the pedestrian counts took about one and a half hours for both the morning and afternoon counts. For each intersection, the pedestrian count was done both in the morning and afternoon during two separate full weekdays to keep the pattern random yet cohesive. Standing on the Southwest corner of the intersections, researchers would count the pedestrian flow from East to West.

<u>Analysis</u>

We hypothesize that neighborhoods with high walkability for built environment components will also have high pedestrian volumes. As IMI-C has been recorded by the Fulcrum app, State of Place Index (SOPI) was then used to analyze the IMI-C. SOPI is a score combining

[1] The Irvine Minnesota Inventory China measures a wide range of built environment features that may affect physical activity, especially walking. (Alfonzo, 2014)

eleven sub-scores that measure the urban design features which empirically tie to walking (Alfonzo, 2014). With such a method, the developed score interprets the built environment characteristics with a high score indicating higher walkability and a lower score indicating lower walkability.

This study utilized Excel to organize all of the collected data including the types of neighborhoods, State of Place Index and pedestrian counts. The Excel was then imported to SPSS where the statistical analyses were conducted. The neighborhoods are categorized by locational types which are inner city (n=4) and suburban (n=4) with a total of eight neighborhoods. In the SPSS version 25 program, for each of the eight neighborhoods, three intersections are selected for a total of twelve segments (n=12) corresponding to the pedestrian counts generated at each intersection of the segments. To keep the variables consistent, segments connecting to those intersections are selected to display State of Place Index for further analysis.

We conducted a linear regression test to analyze our research question: Within the built environment of Shanghai, do the characteristics of the streetscape influence the rates of walking? We also use the independent sample t-test to test how the pedestrian volume differs by types of neighborhoods. The State of Place Index and its urban dimension components acted as our independent variable as it represented the characteristics of the built environment whereas the pedestrian counts served as our dependent variable in the association tests. Due to our sample size being so small, we choose a confidence interval of 90%.

Results

The State of Place Indexes which told us about each component of the neighborhood and the neighborhoods overall walkability score. Refer to Figure 3 for a visual of each neighborhood's SOPI.. The components consider in the SOPI include: form, density, proximity, connectivity, parks and public spaces, pedestrian amenities, bikes, personal safety, traffic safety, aesthetics, recreational facilities. The figure indicates that built environment in suburban area is less consistent than inner city built environment.

Refer to Figure 4 for the morning and afternoon total pedestrian (including all active) counts for each neighborhood from all three intersections.

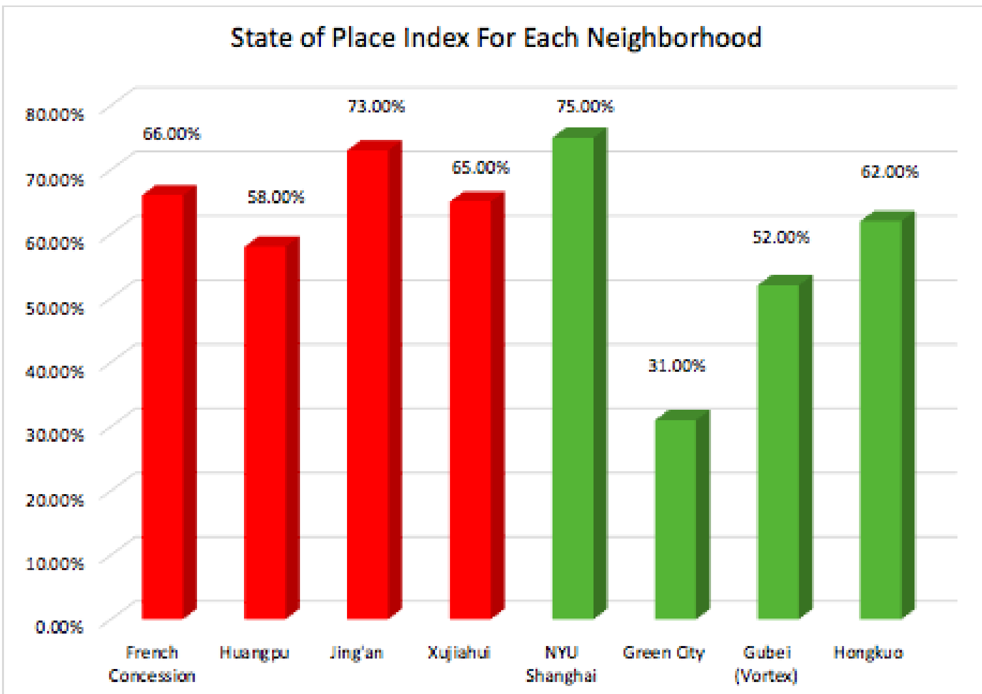

Figure 3.

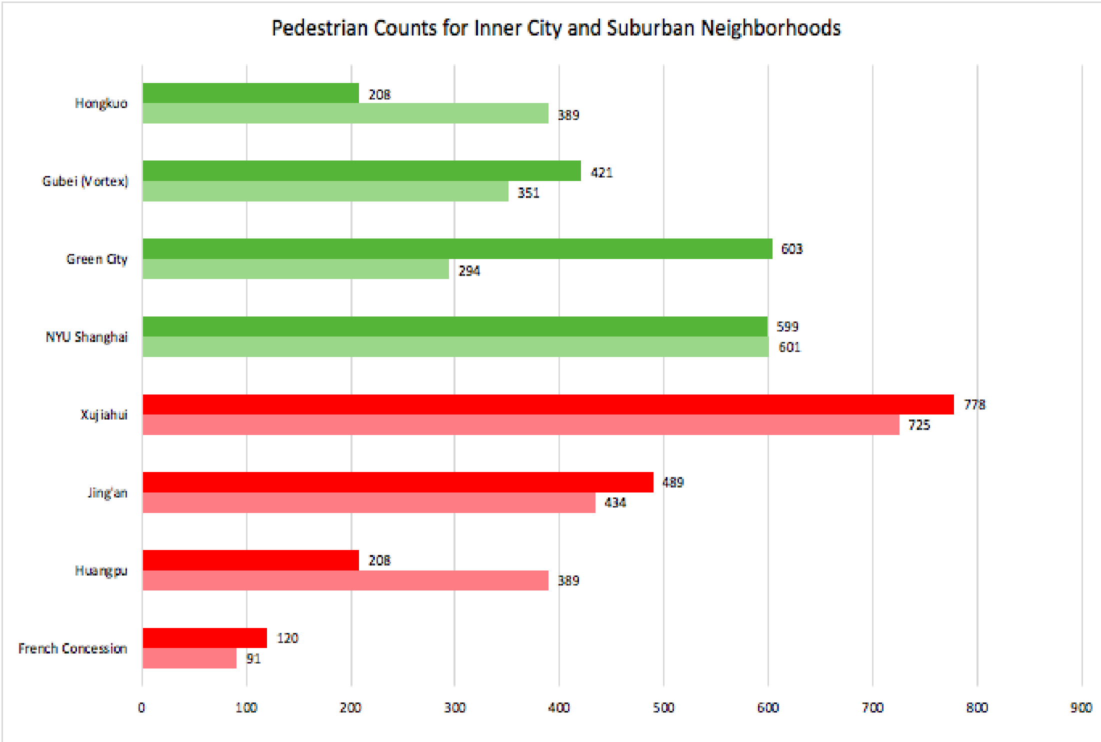

Figure 4.

The key finding of our independent sample t-test analysis shows that the pedestrian counts differ significantly by neighborhood types with inner city neighborhoods having higher pedestrian counts than suburban neighborhoods. However, the linear regression analysis shows that although with less pedestrian counts, suburban neighborhoods show a higher association of 40% between built environment characteristics and pedestrian volume than inner city neighborhoods with a 30% association.

For the entire sample of neighborhoods, there was an association of .62 between State of Place Index (SOPI) and the volume of pedestrians. The R square value depicts how much the variation of dependent variable (pedestrian counts) can be explained by the independent variable (SOPI). In this case, only 7.5% percent can be explained, which means that if a segment or neighborhood has a high State of Place Index and a high volume of pedestrians, that this is most likely happening by chance.

Discussion

For inner city neighborhoods, the most impactful built environment component is urban density which is defined as the building concentration. The linear regression revealed a positive correlation which indicates that people in the inner city are more likely to walk on streets with high building concentration. However, in suburban neighborhoods, we found personal safety to be the most influential components. Personal safety is interpreted as the amount of graffiti, litter and windows with bars can be perceived on the street. In this specific urban dimension, linear regression depicts a negative correlation between personal safety and pedestrian volume. This means people are more likely to walk on the street with less graffiti, litter and windows with bars.

Our study yielded two points worth further discussion. The first being that a neighborhood with a low State of Place Index will not necessarily have a low pedestrian count, and vice versa. In other words, pedestrian counts cannot be predicted from the neighborhood's State of Place Index. For instance, in Figure 2, Green City has the lowest SOPI however, as seen in Figure 3, Green City maintained one of the highest afternoon pedestrian volumes, only behind NYU Shanghai and Xujiahui. How could this be? Green City scored such a low SOPI because of it being majority residential with little to no pedestrian infrastructure. While the neighborhood may not be compatible for high volumes of pedestrians, it is still necessary for residents to get to and from work which exhibits why there is such a high pedestrian volume during the afternoon. Commuters are some of the most important pedestrians to consider because they will participate in walking despite unsafe conditions.

Another important point yielded in our results is that pedestrians are more impacted by the built environment in the suburban neighborhoods. This can be attributed to the fact that people who live in the inner city are more likely to walk simply out of necessity. This can also be explained by the more prominent lack of pedestrian infrastructure as well as the general inconsistency of the built environment characteristics within suburban neighborhoods. In other words, a cohesively designed built environment is extremely significant in its impact on pedestrians, as a good design fosters *smart* density and personal safety (Forsyth, 2010).

Conclusions and Recommendations

In considering the highest association and the strongest significance, we conclude that cities should intently focus on commuters and their safety through prioritizing pedestrian infrastructure. To more deeply and accurately analyze the impact of the built environment upon volumes of pedestrians, we would recommend increasing the sample size of neighborhoods and doing the pedestrian counts on both weekdays and weekends. We would also recommend that pedestrian counts be taken at mid blocks rather than intersections for more accuracy. There should also be more weight given to the land use of the neighborhood as many segments with a low SOPI and high pedestrian counts can be attributed to people coming home to their residential neighborhood. There is an underlying issue of being able to conclude the significance of the built environment relative to other factors such as self-selection (Forsyth, 2010).

We would also encourage researchers to consider the impact of the new dockless bike share system upon the built environment and pedestrians because they can become littered throughout Shanghai’s streets and pose the same issues that a built environment with bad features would host. Chinese cities, especially cities as fluid as Shanghai, offer great opportunity for urban research and should establish more of a presence as many Chinese cities are looked to by developing countries as the model city (Schellekens, 2013). Walkability within a megacity is a factor of strength, trust, and options. While one may learn a lot about a city through the analysis of walkability, the urban environment can also be used to confront and analyze other urban issues and should not be limited to alternative modes of transportation. The confrontation of these urban issues can lead to urban planning for the people that is inclusive, equitable, and sustainable.

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